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Czech Academy of Sciences, Institute of Archaeology, Brno

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Content

Chapter 1

Introduction

'History is not the past, it is the present.
We carry our history with us. We are our history.'
James Baldwin

Change over time is an inherent feature of all entities, both past and present, including our understanding and knowledge of those past realities, particularly in archaeology. Knowledge in this field has evolved significantly, allowing us to deepen our insights into the past. The sheer volume of archaeological data available today, amassed by generations of professional archaeologists and engaged members of the public, is vast. This immense scale presents new challenges, particularly in terms of how to preserve the data and, more importantly, how to fully harness its potential (cf. Kuna et al. 2015; Richards et al. 2021). When combined, these sources of information on past societies offer a robust foundation for quantitative analysis using computational techniques, providing fresh perspectives on the development of the Germanic populations in the 'Marcomannic' settlement zone west of the Lesser Carpathians during the first four centuries AD (the Roman Period; Fig. 1.1).[1] In this context, a research project funded by the Czech Science Foundation (see Acknowledgements below) has been undertaken to explore new ways of exploiting archaeological data. The aim is to develop a series of general or specific proxies that could potentially reflect various developmental trajectories within the studied anthropogenic context and employ various computational techniques to explore and analyse available data and address the developments in demographic, economic, societal, and political domains.

The study region can be understood as a borderland defined by the boundaries of the Roman Empire. Within this liminal landscape, numerous interactions occurred between the Romans and the populations beyond the Middle Danube. It has become a particular scene of multifaceted Roman-Germanic interactions, most of the time peaceful ones. Although the conflict periods covered a considerably lesser proportion, some had far-reaching implications for the overall relations and geopolitical situation. In this regard, the turbulent epoch of the so-called Marcomannic Wars (e.g. Erdrich et al. 2020) has impacted significantly both the 'barbarian' and Roman environments of the Middle Danube region. The method and applied approaches in this book aim to broaden the current research agenda towards further understanding Germanic societies of interest and provide another perspective on their development through innovative methods and differentiating a relatively homogenous picture of the settlement structure and its development in the study region during the Roman Period.

Archaeological data are distinctively incomplete and inevitably biased, limiting available interpretation possibilities significantly in many aspects (e.g. Neustupný 2009). Nevertheless, they represent an exclusive source of information for most past human societies, whereas available narrative sources are burdened through other distortions (e.g. Todd 2005). As a science, archaeology can only develop further by exploiting and utilising all the available knowledge base and methodological tools to explore further the theoretical research avenues. By doing so, the aim is to develop a comprehensive framework that allows to enhance the potential of archaeological data to be explored from quantitative perspective.

1 If there is not stated otherwise, the author of all the figures is the author.

Fig. 1.1. *'Germania Magna'*. Reconstructed distribution of the main socio-political 'tribal' entities based on ancient narrative sources during the Early Roman Period.

There have been various initiatives integrating big-data approaches in archaeology. One of the early and relatively broadly conceived approaches based on the Iron Age archaeological data was conducted by L. Hedeager (1992), where the information from the burial context and other representative datasets were utilised through the temporal distributions of documented quantities in archaeologica record on various segments of archaeological data. Presently, the research activities, oriented to the exploitation of large quantities of radiocarbon data, generate substantiated proxies regarding demographic variables and other adjoined societal properties (e.g. Bird et al. 2020; Freeman et al. 2018). However, such datasets are not yet available in the amounts required for the Middle Danube Roman Period. Therefore, archaeological data and information are the only means for the establishment of broadly conceived proxies at present.

The main purpose of this research could be best described as a shift from singularities (individual artefacts) to more generalising structures. Despite obscuring some particular and specific aspects and properties, one of the aims lies in quantitatively oriented perspective. The research builds more broadly on big-data approaches, where quantitatively significant segments of data (e.g. habitation units, widespread everyday-use artefacts) are employed. The main focus lies in identifying the features and structures of development tendencies in available archaeological data and potentially shedding additional perspectives on the causes and character of the structural changes in various dimensions of the societal fabric, foremost demographic, economic, political and social. The project activities involved making a framework that allows for comprehensive collecting and structuring of either width (i.e. evidenced types of areas of past activities) and depth (justifiably formalising the typo-chronological determination elaborated through the more or less thorough antiquarian analysis and evaluation in the past) of the input archaeological information.

These represent indispensable sources of information, once correctly identified, described and published, but in quantitatively excessive conditions, some of their properties comply with the 'big data' approach. Therefore, within this scope, there is not much significance in paying attention to detailed aspects at the level of individual finds. This was neither an ambition of the research project nor would significantly exceed its time constraints to tackle these issues through proper antiquarian analysis and critical examination and evaluation of archaeological material. It is, therefore, imperative for this novel approach to abstain from the detailed features and properties of the input data, such as arguments regarding chrono-typological aspects of individual finds. For the same reasons, in the respective chapters regarding the exploration of interpretation potential in main areas of activities (residential and funerary components), context (pit houses or graves), or individual find categories (e.g. brooches, coins), a brief outline of research history has not been conducted (i.e. chronological aggregation and development of archaeological knowledge, theory and interpretation schemes). However, in some cases it was decided to include this information. This was only done when such information was relevant to the understanding of the larger scope (e.g. the theoretical background on the meaning and use of the Roman coinage in the Germanic context).

This study makes use of a so-far unprecedented amount of input data, which was gathered during the research project within the framework of the MARCOMANNIA dataset (see Chapter 4). This also poses new challenges in adequately coping with the featured sources of information – foremost, the heterogeneous variety of published archaeological and other related field activities and their outcomes, as well as the large amount of the finds originating from the metal detecting activities outside the profession archaeological environment (i.e. the hobby metal detecting, e.g. Komoróczy 2022; Pajdla et al. 2023b), which are substantially changing viewpoints in archaeology. Yet, it is inevitable that such a large approach conducted within the time constraints of the project solution is burdened by a certain degree of mistakes and omissions.

The information basis of the MARCOMANNIA dataset consists predominantly of published sources, regardless of the level or quality of an information source (from short reports to monographs). The number of references almost reaches one thousand (959 records). Therefore, it would be impractical to provide their list as primary sources in the book's printed part. Instead, this information will be made available in a digital form in the supplementary information environment, which is another part of this research project output. Additionally, as a part of the project, a comprehensive web map application can also be found there. It is named MARCOMAP (WebMap Application MARCOMAP), and it represents the complementary attribute and spatial information from the MARCOMANNIA dataset on the project-based collected information basis, which contains either spatial and attribute data components. It is intended to provide a novel too that is freely available for the scientific and general public to explore data and perform various queries on various aspects of archaeological data. Through this, the aim is also to incite feedback from both the scientific and general public regarding the precision and completeness of the data. The long-term objective of the Research Centre for Protohistoric Archaeology is, therefore, to enhance and improve the quality of the MARCOMANNIA dataset with time and to provide a solid basis for additional and advanced research activities in the future.

The presented research results are principally intended for the scientific community of the respective region of study. Still, it is also aimed at non-professional readership interested in the quantitatively oriented understanding of the Roman Period Germanic societies. It is conceived as a reference output of one of the long-term scientific activities performed within the Research Centre for Protohistoric Archaeology[2]. This research project has facilitated the emergence of digital archaeological and other information sources on the Germanic populations of the Middle Danube region, further enhancing their potential through data accumulation. This book may also serve as a reference for comparable datasets from other chronological segments of the Protohistory (La Tène Period, Migration Period, and possibly also the Early Middle Ages), as these societies exhibit fundamentally comparable features and structural aspects of their societal organisation, subsistence basis, technological capabilities and demographic conditions. However, the approach could be, in general, aspects applicable to others who are more temporally distant past societies of Prehistory. Therefore, future datasets would enable addressing a whole new series of substantiated and diachronically oriented research questions.

2 Formerly known the Research Centre for the Roman Period and Migration Period.

The book's structure is conceived to provide a synoptic outline of the principal research endeavours oriented to a comprehensive analysis of the quantitatively representative archaeological information on the Germanic populations of the 'Marcomannic' settlement zone of the Middle Danube region. The general introduction (Chapter 1) is followed by a principal outline of the research questions and means for their answering (Chapter 2). The methodological, underlying theoretical aspects and the basis of the input information are dealt with through the initial part of the book (Chapter 3, 4). The following Chapter 5 is dedicated to the series of main derivates of the primary input data - the structured proxies and trajectories of development based on quantitatively representative segments of the data on the level of archaeological components (areas of activities), context and individual material categories and finds. Chapter 6 deals with the spatial aspects of the selected subsets of data from the MARCOMANNIA dataset, and the following Chapter 7 aims to tackle some of the questions from the field of archaeological demography. Chapter 8 provides an outline of quantitative and qualitative aspects of the funerary context and its interpretation potential towards the Germanic social structure. The contextualisation of the social anthropological perspective on the Germanic society is the subject of Chapter 9.

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Chapter 2

Outline of research questions, objectives and study context

The Marcomannic settlement zone of the Middle Danube region underwent substantial transformations during the Roman Period. Archaeological evidence and other relevant sources point to a dynamic trajectory in settlement patterns, reflecting shifts in population size and structure, as well as external drivers of anthropogenic (migrations) and environmental nature (e.g. quality of the local subsistence sources, climate change). The general development tendencies are expected to be traced and quantified by exploring the available data aggregated within the MARCOMANNIA dataset. Applying various computational techniques, including tools for data collection and formalisation (database systems), as well as more advanced tools and methods of generally 'static' (GIS) and 'dynamic' (system modelling and simulation) orientation towards the time dimension, enhanced with the data presently at hand, opens new opportunities for understanding the development of the Marcomannic settlement zone. It is also an intention to address these issues through the available methodological tools and means of socio-cultural anthropology (e.g. Steuer 1982; 2006; Earle 1987; 1997; Härke 1990; 2000; Roymans 1990; Carneiro 1991; Hedeager 1992; Beliaev, Bondarenko, Korotayev 2001; Carneiro, Grinin, Korotayev eds. 2017) in the context of properties connected to the chiefdom-type of the societal organisation to enrich the theoretical constructs of the archaeological research of the Middle Danube Germanic societies. These spatio-temporal patterns result from internal factors, mainly demographic and economic development, as well as external influences, particularly Roman economic, political and military activities.

The political organisation of the Germanic society was also a significant factor that affected Roman-Germanic relations. The rise of influential tribal leaders, or 'tribal' confederacies (e.g. Gibson 2017), generally influenced the frequency and intensity of confrontations with Rome (depending on the overall rate of violence and coercive aspects of interactions). In turn, Roman policies, such as diplomacy, military intervention, or economic sanctions, would have shaped the internal dynamics of Germanic societies. These models can provide insights into processes not immediately visible in the archaeological record, such as long-term demographic trends or the effects of social and political networks. For example, power structures are rarely visible in the archaeological record, with a few notable exceptions which allow for the association of wealth and power (e.g. the princely tomb of Mušov). However, the theoretical framework connected with the critical elements of the chiefdom societal organisation and chiefly power strategies could be drawn through the properties of the *prima facie* prestigious goods – Roman 'imports' (e.g. Eggers 1951; 1955; Tejral 1967; 1970a; Kunow 1983; Lund Hansen 1987; Erdrich 2001). Their spatiotemporal patterns, based on quantitatively representative subsets of archaeological data, are expected to provide further insights into horizontal structuring in space and temporal dynamics reflecting changes in economic, political and cultural preferences, processes and systemic responses.

Furthermore, the aggregated archaeological data used in this study will enable the investigation of potential structures in the funerary record regarding various aspects of the stratified Germanic chiefdom society. Despite a series of theoretical (actual representation of the social roles and status in funerary archaeological data) and methodological (low survival rate of contexts) pitfalls, the aim is to identify potential structuring entities through statistical methods and tools. However, the regional study perspective has the potential to move beyond traditional approaches to differentiating and defining grave goods and other characteristics, as seen in earlier works (e.g. Saxe 1970; Binford 1971; Brown 1971). This approach can better establish the features of societal structure among the Germanic populations in the Middle Danube region. The theoretical research on social and political organisation has been anchored in a cultural-historical paradigm for the more significant part of its development. The formal statistical analysis (descriptive and multidimensional statistics) aims to address the respective areas of the statistically representative structures (i.e. quantitatively and qualitatively substantiated trends or development features in available archaeological data) in a subset of the presently available archaeological data from burial contexts. Nonetheless, with regard to the theoretical and methodological concepts and framework long before (but many of them are still debated) within the social anthropological research on the chiefdom societies (cf. Carneiro, Grinin, Korotayev eds. 2017).

nced chiefdom organisation systems (i.e. complex chiefdoms or their analogues; e.g. Gavrilets, Anderson, Turchin 2010; Grinin, Korotayev 2017; Smith 2021) on its various vertical levels, represented by numbers of differentiated chiefly entities. In order to grasp and evaluate the temporal dynamics and variability, apart from the 'static' type of the analysis of attribute and spatial property through traditional analytical tools, there have also been accented methods and techniques. The application of probabilistic approaches plays a vital part in the evaluation and analysis of the individual established proxies of the development trajectories of the Middle Danube Germanic societies. What is more, they have been employed in the pursuit of the quantitatively conceived explicit modelling of the chiefly organisation structure and testing various properties, thresholds or internal developmental dependencies that could bring further insights into the understanding of the potential drivers of some societal and geopolitical changes (e.g. underlying triggers of the extensive conflict of the Marcomannic Wars).

Broadly defined, the research objectives of this book lie in the comprehensive study of the Germanic societies of the so-called 'Marcomannic' settlement zone (Moravia, Lower Austria and Slovakian Záhorie; for further details, see Chapter 2.1) during the Roman Period. This is accomplished by leveraging all available archaeological and related data that have the potential to reveal broad patterns underlying social, economic, and political changes, as well as the development of settlement structures, subsistence strategies, climate susceptibility/resilience, and Roman-Germanic interactions. The resulting explanatory framework, through the above-mentioned areas of the research focus, may shed new light on the evolution of the Marcomannic settlement zone and provide additional perspective to some of the existing theoretical models within the Roman Period archaeology, such as various significant events, such as causes and consequences of the Marcomannic Wars (cf. Friesinger, Tejral, Stuppner Hrsg. 1994; Erdrich et al. 2020), the presence of the Roman-origin artefacts within the Germanic context (e.g. Tejral 1967; 1970a), or other development aspects within the study region (e.g. Tejral 1998; 2017).

From the above broadly formulated areas of interest, approaches and objectives, the following research questions could be drawn:

- Exploration of the causal connections in the archaeological data on Germanic demographic, economic and political development and structural changes based on a derived series of development proxies.
- Complexity and scale of the societal structure and stratification through the evaluation of the funerary record archaeological data.
- Conceptualisation of the Germanic society within the theoretical framework and models of social anthropology based on archaeological data, narrative sources and relevant parallels.
- The evaluation of Roman-Germanic interactions, confrontations, temporal development, and spatiotemporal structures in Roman production ('imports') distribution within the Germanic context.

These broadly conceived questions will be addressed through the following tools and methods of applied computational means for archaeological data collection, processing and analysis (see Chapter 3):

- The large-scale data collection and formalisation of the relevant and available (foremost published sources) archaeological data into the resulting MARCOMANNIA dataset.

- Derivation of the temporal probabilistic proxies (aoristic weights and sums) to draw general development probability distributions and trajectories on various segments of archaeological data within the Marcomannic settlement zone.

- Application of standard geostatistical tools to provide a framework for spatial and formal data interoperability and analysis performance (GIS) and formal descriptive and multidimensional statistical analysis (Cluster or Factor analysis) to identify structures in data.

- Incorporation of tools for analysing and evaluating the 'dynamic' aspects of the studied systems through modelling and simulation (foremost, the concept probabilistic modelling). These approaches also integrate, on various scales, the principles of system evaluation through the network science and its metrics.

2.1 Study region and temporal scope

The initial stage of any investigation must include a precise definition of the area under consideration. This definition should take into account not only the physical characteristics of the landscape but also the archaeological and historical sources of information available for the area in question, as well as their spatial distribution. In this case, the general spatial outline is set to a part of the Middle Danube region, which is consensually labelled as the 'Marcomannic' settlement zone (Komoróczy et al. 2020, 176; Rajtár 2014, 111). The most obvious delineation is on the southern border, where the border with the Roman Empire – comprising the provinces of Pannonia and Raetia – was established along the Danube River at the turn of the era change. The delimitation of the remainder of the zone is based on geomorphology and archaeological sources. The backbones of the region consist of the main rivers (Morava, Thaya, Jihlava and Svratka) and the adjoined ravines, which provide the dominant environment in the occurrence of the archaeological evidence (Fig. 2.1). The region displays a relatively high

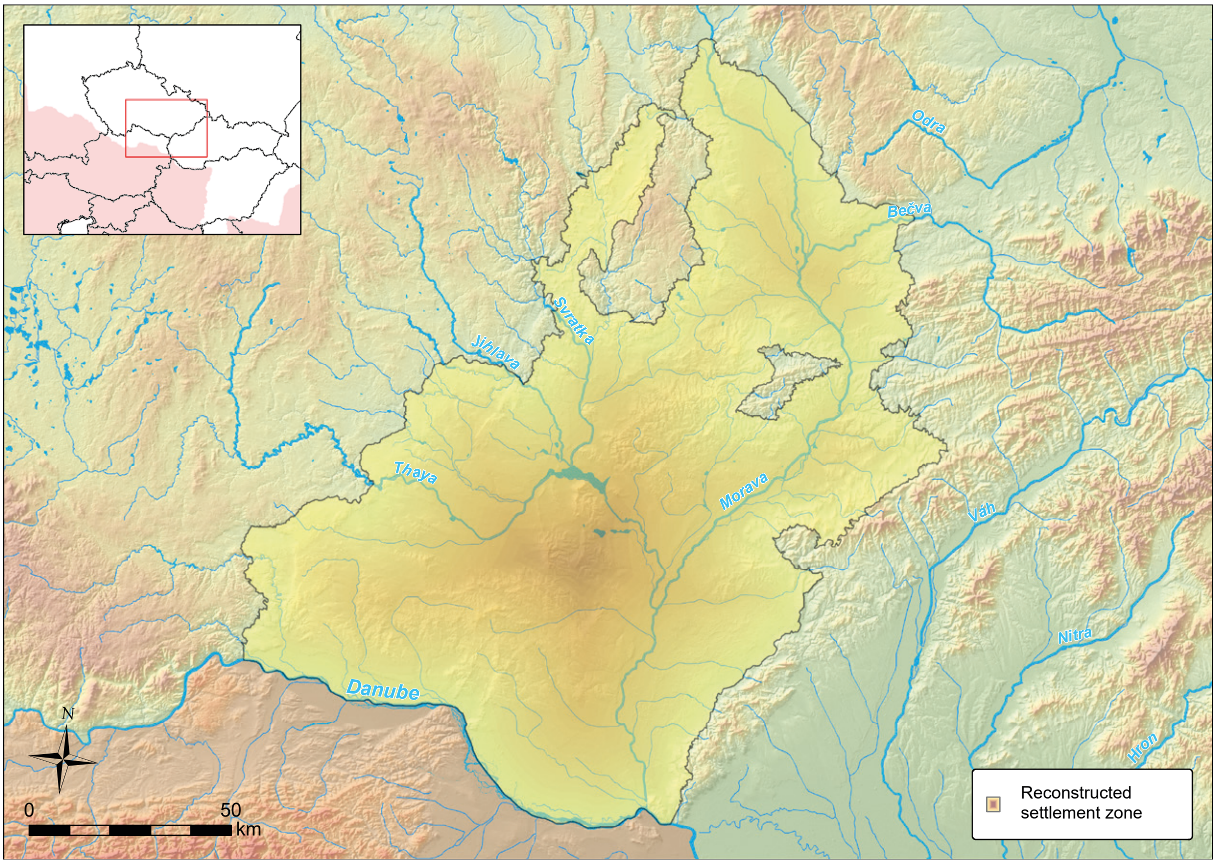


Fig. 2.1. Middle Danube region. The outline of the analytically reconstructed extent of the 'Marcomannic' settlement zone used in this study (see Chapter 6.1).

degree of variability in geomorphological characteristics. However, its outer borders can be delineated with reasonable precision through the identification of significant geomorphological units, which include the Lesser and White Carpathians, the Bohemia-Moravian Uplands, and the Jeseníky Mountains.

In addition to the aforementioned spatially oriented modelling, an attempt has been made within the research agenda of this book to generate the borders of the settlement zone based on the geomorphological properties of the landscape (elevation) and archaeological data (dated residential areas) through least-cost path modelling (see Chapter 6.1). This constitutes the general margins of the studied region. The resulting envelope is a crucial element for further analyses, such as demographic estimates and complex system modelling, including a model of the vertical and horizontal structuring of power organisation and distribution.

The temporal framework is primarily set to cover the overall occurrence of the archaeologically documented traces of the material culture associated with the Germanic societies (generally Suebian, but most frequently identified with the ethnic designation of 'Marcomanni'). This will be within the spatial context outlined above. Generally, this covers the first four centuries AD, called the Roman Period, but it also encompasses minor temporal overlaps before and after these centuries. The earliest chronological stage (period A) belongs to the end of the 1st century BC), while the latest ('terminal') period (C3/D1) extends until the start of the 5th century AD (see Chapter 3.3). Accordingly, this publication's chronological scope of interest formally encompasses 460 years. However, the marginal periods (approximately the initial and terminal 30 years) of the development are significantly underrepresented, particularly for the initial phase.

Chapter 3

Methodology and applied analytical tools and computational techniques

As stated within the established research questions section (see Chapter 2), the methodological framework in this book is conceived to address the broader aspects of the development within the 'Marcomannic' settlement zone through the formalisation and analysis of a large part (available or published) relevant information into data, providing the grounds for ascertaining additional knowledge for interpretation of various aspects of the Germanic populations. Inevitably, these sources, consisting of archaeological data, are profoundly heterogeneous, and each has its value of interpretation potential. While archaeological data provide seemingly continuous records (i.e. residential or funerary areas have been confirmed for the entire study period), narrative sources reflect unique perspectives in varied temporal frequencies. Yet, they embody dynamics, which the archaeological data lacks.

To address the outlined research question, several well-established tools have been applied from the area of computational methods in archaeological research, such as the standard tools (database systems, GIS) and techniques (e.g. spatial analyses, statistical analyses, agent-based modelling and simulation, network science, probabilistic simulations) for the creation, editing, maintenance, evaluation and analysis of the digital data. As most of them are well-known and well-established in archaeological research, there will only be a limited outline focusing only on the specific aspects of their use and implementation within the methodological framework of this book.

3.1 Input data

The backbone of the data used in this book consists of archaeological data that is both mobile and immobile. However, other relevant data from the humanities fields (history, social anthropology, archaeological demography, etc.) and natural sciences (physical anthropology, paleoclimatology, geography, etc.) were included for the comprehensive approach of this book. The delineation of the general issue and the framework of the resolved hypotheses are based equally on the formal and spatial aspects of the artefacts and the existing typo-chronological systems. In the process of creating models of various structural problems, it is also necessary to include the data as well as many results and findings from natural science disciplines (e.g. paleoclimatology and other disciplines (archaeological demography, social anthropology, etc.).

3.1.1 Archaeological data

The relevant sources of information naturally include archaeological data, gathered on a long-term basis and available through various means, which constitute the mainstay of the input data collected within the project's framework. The essential property of any information is representativeness, which is significantly burdened by a series of biases (cf. Neustupný 2007, 46–72). A large variety of transformation processes during the past changed and distorted various properties and aspects of archaeological information. Foremost, the representation of different categories of material culture is variably conditioned by a series of factors and aspects, such as the durability of the material, the ways and frequency of use, deposition conditions and postdeposition processes. Subsequently, these transformations include the effects connected with the ways and conditions of discovery, recovery, documentation, and publication of archaeological contexts and finds (Neustupný 2007, 60–61). Therefore, despite the methodological approach of this book, based on compiling a representative amount of archaeological information conceived to compensate for some of the quantitative deficiencies, a variety of biases persists and are imprinted in the MARCOMANNIA dataset. The gaps in the archaeological record and the find assemblages, either caused by the 'detectability' of some areas of activities (e.g. various off-site activities connected with subsistence procurement), are the primary result of the pre- and post-deposition processes and adjoined archaeological transformations.

Apart from that, the spatial distribution of available archaeological information is also conditioned and biased by present and past land use (i.e. destructive processes of agricultural activities, accessibility for field prospections, etc.), past constructions and land-changing activities. The regionally differentiated activity pattern also depends on the frequency and quality of either professional archaeological (rescue and systematic excavations, field prospections and other surveys) or other activities (e.g. engaged amateur surveyors before metal-detecting, e.g. Kolbinger 2013, hobby metal detecting).

The essential prerequisite for the outlined research objectives and approaches is deriving a set of quantitatively representative indicators of the development of Germanic society, which is the collection of relevant information. Due to the estimated volume of published sources of different natures (the availability and quality of information oscillate between a brief short report of an informative type (e.g. *Přehled výzkumů* in the Czech Republic or *Fundberichte aus* Österreich in Austria and many others) to complex monographic outputs oriented to the publication of individual areas of activities (e.g. Zeman 1961; Droberjar 1997; Elschek 2017).

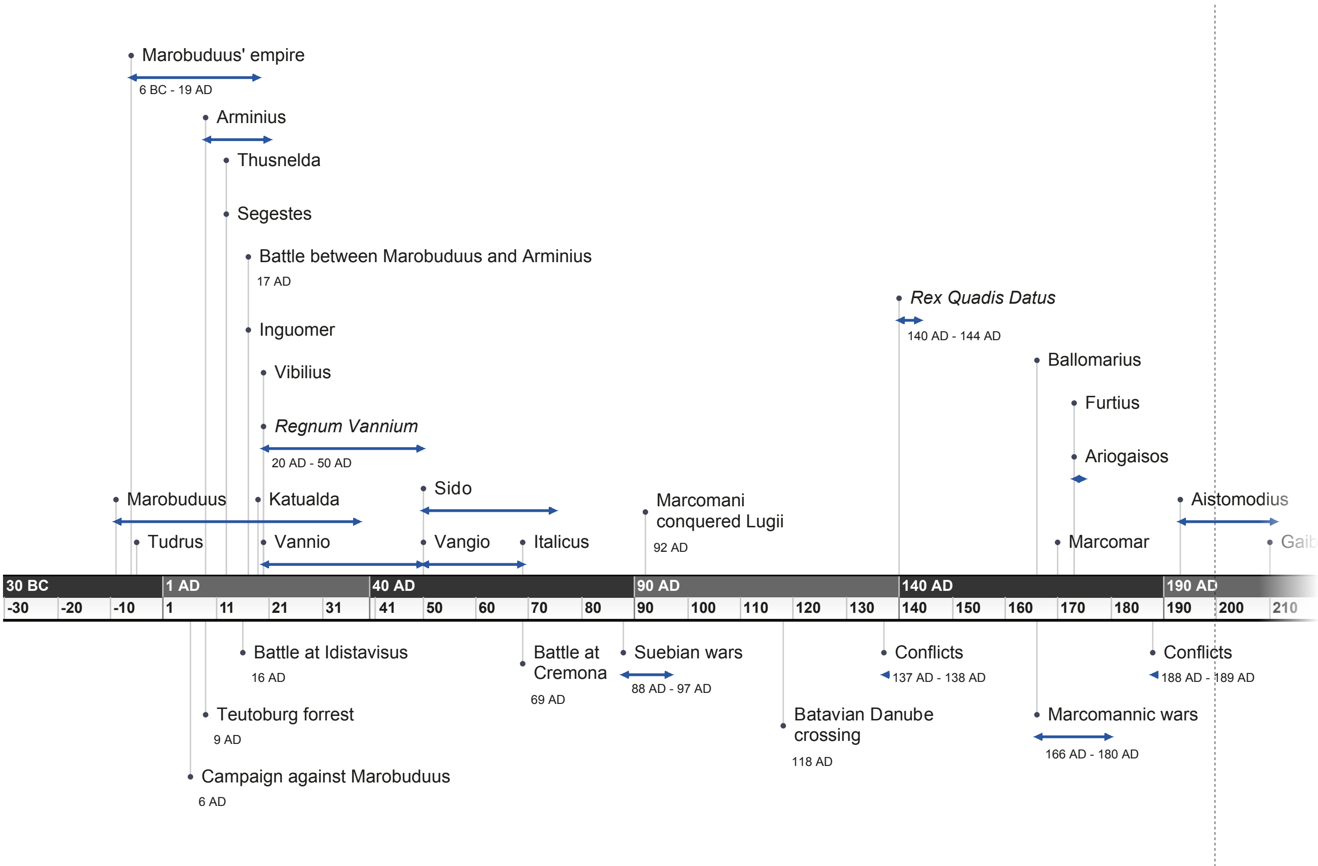


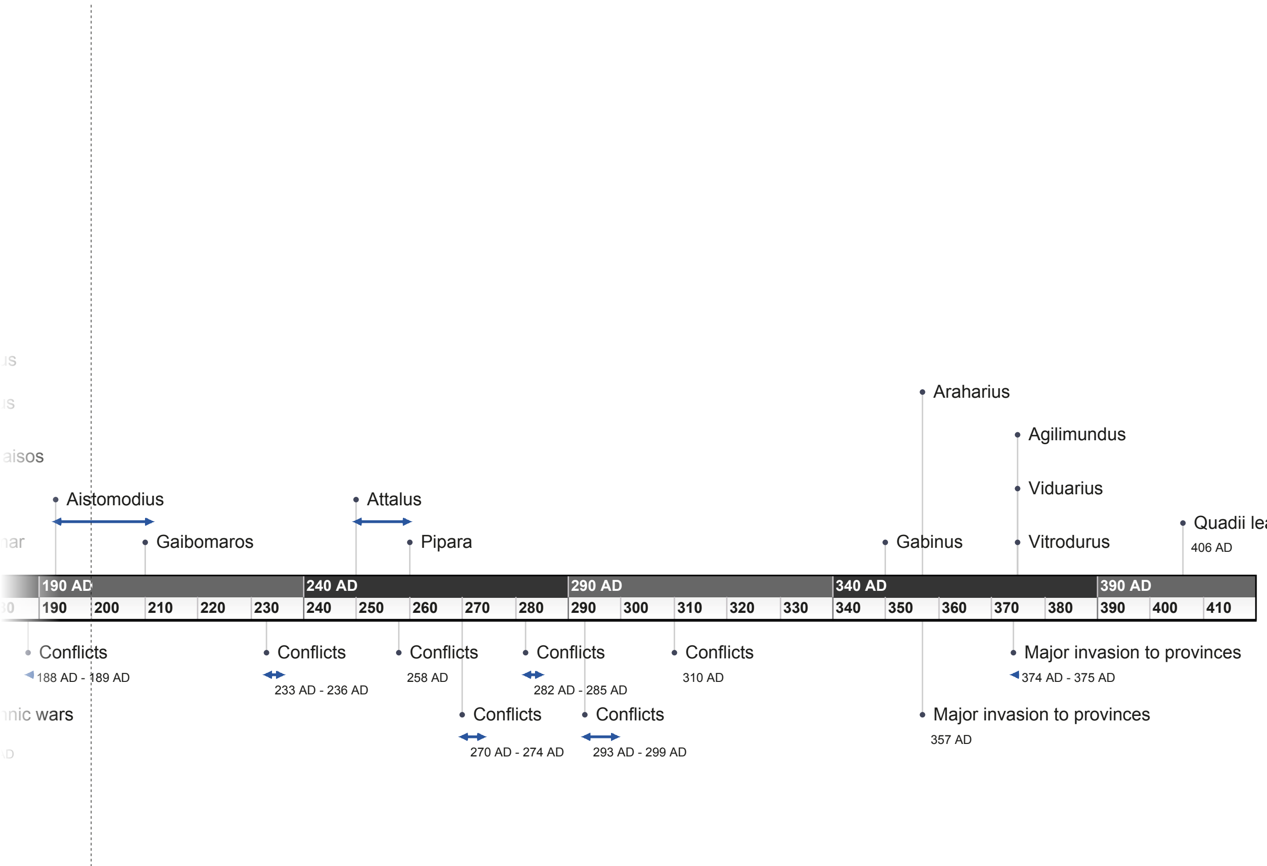
Fig. 3.1. Outline of the featuring and prominent Roman-barbarian (foremost Germanic) conflicts and interactions (below the timeline) and recorded individuals from the surviving narratives regarding the Roman Period Middle Danube region (above the timeline).

3.1.2 Narrative, historical, and epigraphic sources

The surviving narratives represent a unique category of information sources on the Germanic societies of the Roman Period, providing the dynamics, perspectives, and time resolution. However, their embedded specific properties imply the necessity of a critical consideration of narrative validity and representativeness. Although they tend to cover the studied temporal extent inconsistently and are burdened by a variety of biases (e.g. political agenda of narrative, focus to readership, contemporary or later distortion of figures, tendential exaggeration or underrating of particular aspects, events, or individuals), they amongst others provide indispensable insights into multiple aspects of Germanic societies (Fig. 3.1). Traditionally, *Germania,* by P. C. Tacitus, holds a prominent place in Roman historiography on Germanic populations. Despite a series of biasing factors, such as the use of traditional *topoi*, a comparative dualism stressing the moral aspects of the Roman and 'barbarian' worlds), it is considered to provide indispensable insight into multiple aspects of Germanic societies in general (e.g. Beare 1964; Bazelmans 1999; Pagán 2012). Moreover, parts of surviving narratives by Cassius Dio provide essential inputs foremost concerning the extensive conflict of the Marcomannic wars (e.g. Kehne 2016). The Later Roman Period is occasionally represented at the Ammianus Marcellinus. Significantly less coherent and circumstantial sources represent individual passages and remarks, in general, on the topic in other authors, e.g. C. I. Caesar (*De Bello Gallico*) and Pliny the Elder (*Res Naturalis Historiae*).

3.1.3 Environmental and natural-scientific data

Additionally, an array of environmental data was employed to address the research questions for analytical purposes or visualisation. Primarily, they consist of the *Digital Elevation Model* (DEM) and secondary layers derived (various properties of the physical landscape through spatial analysis), pedology or paleoclimatology, processed within the



established GIS environment. Yet, the size of the study area and the fact that it stretches over three states poses a challenge to the availability of spatial data of comparable quality and rather general type of digital representations of the various physical phenomena of the natural environment (i.e. elevation, soil quality, land-use, etc.). The primary DEM (using both ASTER GDEM v2 with 30 × 30 m DEM and SRTM4 90 × 90[3] m DEM) provided the base for a large part of the analyses, and the standard-used secondary layers from the physical geography (e.g. slope gradient, slope aspect, least-cost path analysis, etc.) have been derived from the primary elevation data.

Several analyses have used the spatial distribution of the various types of present land use, available on the EU scale, as freely available results of the EU Copernicus project on land use (Urban Atlas Land Cover / Land Use 2012).[4] Therefore, the available resolution of the raster layer is 100 × 100 m, which is sufficient for the purposes of these analyses. It was foremost indispensable in assessing the potential and limits of archaeological knowledge throughout the studied region.

A significant input to the scientific research on the climatic dependency – susceptibility and resilience of the Germanic societies of the Middle Danube region – is a unique, robust proxy on the development of the conditions and potential for successful performance of productive agricultural activities (foremost plant growing), developed within the Global Change Research Centre of the Czech Academy of Sciences and Mendel University (e.g. Büntgen et al. 2021), based on robust tree-ring isotopic analysis for the past two millennia and the resulting agroclimatic reconstructions (cf. Torbenson et al. 2024). The results of the joint research activities will be published in near future.

3.2 Tools and techniques employed for data collection, processing, analysis, and computational modelling

The solution of the highlighted research questions and defined objectives is methodologically rooted and possible only through the usage, amongst others, of the computational techniques already well established in archaeological science for a long time in various segments of heuristics, data management, and research (field research and data collection) and their analytical possibilities. One of the primary tools to formalise and analyse data procedures and analysis within the presented work is the application of spatial statistics tools commonly implemented in software tools such as GIS (geographical information systems). To explore the dynamics and temporal probabilistic aspects, a method from the category of applied computer simulations – agent-based modelling – allows studying complex phenomena on the temporal scale (compared to GIS primary design) of the dynamics of modelled systems (problems).

3.2.1 Collection and formalisation of attribute data

The critical initial point of the outlined approach (see Chapter 2) represents the conceptualisation and formalisation of the primary data collection. Its outcome also provides a general framework, basis, and margins for the research question, which might be reasonably addressed. For the outlined analytical purposes to address these questions and research objectives, the resulting data structure must include all the vital information and characters to be able to answer them. Given the possibilities (foremost the workforce and time requirement for the data collection), the aim was to gather and formalise data to the maximum efficiency. Records are created so that volumes of data do not arise, for which it can be assumed already at the stage of building the data structure that they will have limited use for analytical purposes. The most representative example of this approach can be found in the case of the table designated for the pottery. Individual records for fragments or individuals are created in case of available information on diagnostic elements (ceramic shape, decoration). Conversely, in the case of large amounts of indifferent (undecorated) fragments, only one record containing the relevant quantitative information will be created. At the same time, a whole range of typological systems for the different find categories often means that one artefact can be classified even in several generally accepted typological systems (e.g. brooches).

The entire data structure within the research project contains 52,100 attribute records. There are 2,200 identified archaeological components (i.e. areas of activity), 3,200 archaeological 'actions' (cf. Chapter 4.1), 5,300 archaeological contexts/

3 The data originate of from multiple missions of the NASA Shuttle Radar Topographic Mission, and the 4th presently available version was used.

4 Urban Atlas Land Cover/Land Use 2012.

objects, 17,700 non-pottery and 13,200 pottery artefacts. A long-term goal is the further development of the infrastructure and gradually filling in the archaeological information from unpublished sources, above all, the field excavation reports, which contain a significant amount of relevant data. In terms of the amount of data, the concept of the described data structure can be categorised as 'big data' (Cooper, Green 2015; Gattiglia 2015; McCoy 2017).

3.2.1.1 Database model and hierarchical structure

The structure of the relational database of all collected archaeological data was designed so that, based on an appropriate degree of data formalisation, it would enable the analysis of data in terms of spatiotemporal structures on a global scale (e.g. demography, spatial aspects of settlement strategies, distribution networks, social stratification properties) and the search and filtering of data when working with analogies. The main goal is to formalise data from published sources for all types of archaeological components (identified areas of activities) evidenced within the 'Marcomannic' settlement zone of the Middle Danube region. For some categories of data, it was crucial to maintain a limited and structured amount of possible recorded qualities or entities (e.g. determining the find category of objects) to avoid inconsistency.

The model of the relation is based on the five primary hierarchical interconnected levels (tables), which enable the principal structuring of the dominant part of archaeological information. The topmost (1st) level represents the archaeological sites broadly, particularly concerning their spatial representation associated with the point layer in the spatial data segment. It contains the standard location information (i.e. location, cadastre, district, region). The subsequent 2nd level holds information on the registered and identified areas of activities (e.g. residential or funerary areas; see Chapter 5.2), including the dating and precision of the localisation. The 3rd level records the ways through which the archaeological information and under which circumstances they have originated – the so-called 'archaeological actions' (see Chapter 4.1). The records include information on the type of 'actions', institutions/persons involved in the process, year/s of conduct, deposition and bibliography references. Within the 4th level is the formalised information on the contexts, verified in particular archaeological actions (e.g. plough soil in metal detecting or visual artefact surveys, archaeological objects in rescue or systematic field research, etc.). Apart from basic spatial properties (metrics or orientation), information is being collected on typology, dating, and interpretation. Level 5 contains attribute data on the mobile archaeological data – the individual artefacts/finds, where the standard set of substantial information on the material, state of preservation, find category, elementary identification, detailed typology, dating (chronological margins within two or one temporal identification – stage/phase/subphase) and physical properties (dimensions and weight), including references.[5] The particular information in the 5th level is provided foremost for a non-pottery material base, and due to the specific set of characteristics and descriptors of this, by far, the largest domain of material culture in general, the respective information is structured and stored within the subsequent 6th level. It covers the local Germanic and Roman production and allows for the formalisation of the input archaeological information, including technology, typology (for Germanic pottery, the system from Droberjar 1997), dating, etc. Additionally, the immobile find table (level 4) is connected to the tables containing ecofactual data (archaeozoological, archaeobotanical, physical anthropological).

The database runs on the institutional IT infrastructure using MS SQL Server Express (managed through the MS SQL Server Management Studio 14), interconnected with the MARCOMAP web application (see Chapter 3.2.4). The MS Access 2017 software is used as the data management and input interface, allowing multiple users to access the data simultaneously at various authorisation stages.

3.2.2 Formal statistics of attribute data

Apart from a standard set of descriptive statistics (Drennan 2009; Baxter 2010), multivariate analyses were used to investigate various structures in the input data. Clustering analysis was used to explore internal relationships and patterns in archaeological data. Furthermore, *Principal component analysis* and *factor analysis* were applied, foremost, to analyse the data in the funerary context. Statistica 12 software by StatSoft was used for the study.

5 On this level, additional fields must also be included, for example, the general identification of brooches (bent, knee, crossbow, etc.) or coinage information (denomination, ruler, dating, etc.).

3.2.3 Spatial data and geostatistics

An inalienable property of archaeological data is its spatial dimension, and within the arsenal of archaeological methodology, there is a large variety of GIS tools and solutions in various segments, from archaeological field methods to comprehensive geostatistics (Connolly, Lake 2006). The ascertained abundant archaeological information gathered and formalised within the MARCOMANNIA dataset provides significant opportunities through their spatial dimension. Therefore, a substantial proportion of the analysis within this book deals with the spatial dimension of the relevant and input data. The input archaeological data are spatially represented foremost through the point layer of the sites (primary level of the formal database structure), through which the respective spatial analyses, amongst others, the density calculations (*kernel density*, etc.). The vector features represent primarily the point distribution of the sites, through which most of the quantitative outlines have been made, as well as various density calculations. To complement these, a series of the significantly explored, examined, and published areas of activities of either funerary (e.g. Kostelec na Hané 'Prostřední pololány', Šitbořice 'Padělky od Moutnic', Mikulov 'Rybníky'), or residential (Křepice 'Záhumenice', Mušov 'Na Pískách', Vlčnov – Dolní Němčí 'Dřínky') sites have been digitalised and referenced. Apart from the vector-type spatial data, a significant portion of the used spatial data is represented by continuous data of raster layers. A substantial deviation from them are the agroclimatic reconstructions conducted on the large-scale isotopic analysis of dendrological records (Büntgen et al. 2021; Torbenson et al. 2024).

The spatial database (vector features) contains 35,400 records, of which 2,000 represent archaeological location/site points, 5,100 records of various excavated component features, 12,500 aerial prospection features for the distinctive archaeological sites of the Roman Period, etc. The ArcGIS Desktop 18.2 and ArcGIS Pro 3.2 by ESRI software were utilised for spatial data creation, editing, management, analysis, and visualisation.

3.2.4 Web-map application

The archaeological data from the MARCOMANNIA dataset used as inputs in various analyses in this book significantly exceed the volume compatible with the printed form. Therefore, the complementary web-map application, MARCOMAP, has been developed as a multipurpose platform for viewing and querying the respective archaeological data from the MARCOMANNIA dataset. It serves both as a reference for the data used in the book and is intended as an example of the open-science principle's embracement and provides the scientific researcher in archaeology and related fields as well as engaged and informed general public with a comprehensive source of information of the archaeological sources for the 'Marcomannic' settlement zone during the Roman Period. The application is deployed on the infrastructure (ArcGIS Enterprise 10.6 by ESRI; i.e. the main components ArcGIS Server and ArcGIS Portal) of the Institute of Archaeology of the Czech Academy of Science, Brno. Therefore, the complete control of the content and maintenance rests on the author's institutional capabilities[6] and could be adjusted and expanded accordingly to the further plans of its spatial (primarily Bohemia and SW Slovakia to the east of the Lesser Carpathians) and temporal extensions (La Téne Period, Migration Period).

3.2.5 Computational modelling and complex systems

A model is a universal representation of the present or past realities, representing an inevitable means to its conceptualisation and understanding. The main features of each model are the reduction of complexity and the abstraction of the modelled reality to observe and describe mutual internal connections (Gilbert, Trotzsch 2009, 2). In archaeology, as well as in other scientific fields, the hypotheses and theoretical models on the subject of the research could not be tested and experimented on directly for many reasons. For example, they are too far in space (e.g. astronomy) or time (e.g. paleontology, archaeology), and they must rely on other options. The advances in computation application have enabled the humanities to generate digital frameworks to investigate past societies further and investigate underlying causal mechanisms that determined their developments and transformations (Romanowska, Wren, Crabtree 2021, 4). The archaeological material, as a result of a variety of archaeological transformations, lacks explicit information on its purpose, as well as its position in time and space, and they could be restored through archaeological methods (Neustupný 2007, 47–72). However, the simulation

6 MARCOMAP Webmap application.

approaches enable the formalisation and conceptualisation of theoretical models and hypotheses into computational frameworks, as well as their testing and validation. The underlying principles build on the system theory (cf. Boulding 1956) and complexity theory (Manson 2001) and the assumption that the system as a whole cannot be understood based on a study of individual interconnected components ('subsystems'). A complex system is capable of non-linear behaviour that can produce emergent structures (changes in systemic properties), which the system did not contain in the initial phase. A specific type of computational simulation is the so-called agent-based modelling, which enables the investigation of complex phenomena from the 'bottom-up' perspective (Romanowska, Wren, Crabtree 2021, 5–6). That means the resulting emergent structures could explain conditions of change in systemic properties, where individual actors (agents) change in their mutual interactions and with their environment.

For various computational models in this book, the software (toolkit) NetLogo by U. Wilensky (2011), including some of its extensions, has been used. Amongst other capabilities in agent-based modelling, the 'network' extension also enables the exploration of the phenomena studied through the methods and tools of network science. The software was used for both geographically explicit and implicit contexts. It was conceived as a framework for the derivation of some of the secondary proxies (e.g. Chapter 5.3.2.4, 5.3.6.2).

3.2.6 Network modelling

One of the efficient methods of model conceptualisation and its analysis is based on network science. Its principles are long-standing and present in social sciences before the introduction of computation capacities and capabilities, as 'connecting dots' provide one of the straightforward ways to describe and understand mutual relations (e.g. similarity, hierarchy, or physical connections – roads). The respective set of tools allows us to test hypotheses towards the network model and describe various aspects of individual interconnected entities as well as the network as a whole. Both spatial and formal relations between multiple entities (e.g. archaeological finds, lineages, individuals, settlements) could be developed into a network model (cf. Barabási, Réka 2014) and analysed concerning a large variety of statistical measures and metrics (e.g. betweenness centrality, degree distribution, eigenvector centrality). These methods have also been applied to innovative research on various aspects of the past populations during the last two decades (cf. Brughmans, Peeples 2017; 2023; Brughmans et al. 2023). The network analysis within this book has been conducted using the NetLogo (Wilensky 2011) extension, which provides capabilities for the computation of main network metrics.

3.3 Absolute and relative chronologies and temporal resolution of archaeological data

Long-term archaeological research into the Roman Period within the broader Middle European *Barbaricum* has gradually produced various chronological systems (for general information and outline, see, e.g. Droberjar 2002, 101–103; Tab. 3.1). These systems oftentimes reflect many different aspects, such as the (usually country-specific) scientific research tradition, environmental (regional) specifics, or presumable ethnic associations (Vandals, Goths, Suebii, etc.). These are predominantly relative chronological systems since the absolute chronological scale is more subject to change due to the methodological constraints of archaeological data. As a result, their mutual synchronisation is a subject of ongoing debate.

In this study, the generally accepted and adapted relative chronological system for the Middle Danube region was decided to be used, which was developed foremost by J. Tejral and others (Tejral 1977; 1998; 2008; 2011; 2015; Droberjar 1997, 134–148; 1999; summarised in Zeman 2017a, 12) and others (Kolník 1971; Varsik 2009, 235, Abb. 16:1) refined and revised this chronology. The developed stages and phases have been primarily based on the material basis of the funerary context and their representatives within each of them (e.g. Tejral 1970b; 1970c; 1971). This relative chronology serves as a basis for the data classification and allows for an absolute chronological approximation (Tab. 3.1). Its general applicability and acceptance throughout the study region of the 'Marcomannic' settlement zone the West of the Lesser Carpathians make it a convenient means for standardised chronological evaluation of the registered types of formalised entities within the MARCOMANNIA dataset – archaeological components, objects/features, and the individual movable finds.

The three 'levels of detail' system also enables to consider various precisions in temporal differentiation (Tab. 3.2) and identification of various phenomena from the whole 'stages' (A, B, and C),

		Study region		Bohemia		Slovakia	Poland	
Interval	**Eggers 1955**	**Tejral 1975; 1968**	**Time blocks**	**Droberjar 1999**		**Kolník 1964; 1971**	**Godlowski 1994**	**Wielowiejski 1970**
-30 – -20	A	A (LtD2b)	-30 – 0	A	-35/25 – 10/5	A	A	
-20 – -10								
-10 – 0		B1a		B1a	-10/5 – 20/30	B1a		
0 – 10	B1		0 – 50					
10 – 20								B1a
20 – 30				B1b	20/30 – 50/70			
30 – 40		B1b				B1b		
40 – 50								B1b
50 – 60	B2	B1c	50 – 100			B1c		
60 – 70				B2a	50/70 – 100/120			
70 – 80								B2a
80 – 90						B2a	B2a	
90 – 100								
100 – 110		B2a	100 – 150					
110 – 120				B2b	100/120 – 150/160		B2b	
120 – 130						B2b		B2b
130 – 140								
140 – 150							C1a (B2/C1)	
150 – 160	C1	B2b	150 – 200	B2/C1	150/160 – 180/200			
160 – 170		B2/C1				B2/C1		
170 – 180								
180 – 190						C1		C1
190 – 200		C1a		C1	180/200 – 250/260		C1b	
200 – 210	C2		200 – 250					
210 – 220								
220 – 230								
230 – 240		C1b				C2		C2
240 – 250								
250 – 260			250 – 300	C2	250/260 – 300/320		C2	
260 – 270		C2						
270 – 280								
280 – 290								
290 – 300								
300 – 310	C3		300 – 350			C3	C3	
310 – 320				C3	300/320 – 380/400			C3
320 – 330		C3						
330 – 340								
340 – 350								
350 – 360			350 – 400					
360 – 370							D	
370 – 380								
380 – 390		C3/D1						
390 – 400				D1	380/400 – 410/420			
400 – 410			400 – 430					
410 – 420								
420 – 430								

Tab. 3.1. Outline and synchronisation of the most commonly used relative chronological systems regarding the study region and its neighbouring regions, complemented by an absolute chronological scale. The relative chronology in light green is currently the most relevant for the study region (summarised in Zeman 2017a, 12), and gradient colours (brown and blue) mark the preset time blocks.

'phases' (B1, B2, C1, C2, and C3), and 'subphases' (B1a, B1b, etc.). In addition, the transitional phases, such as B2/C1 (mainly conceived to refer to the historical period of the Marcomannic Wars; e.g. Tejral 1983; Freising, Tejral, Stuppner Hrsg. 1994; Erdrich et al. 2020) or C3/D1, reflecting the transition to the Migration Period; e.g. Tejral 1975; 1982), reflect the specific nature of the historical processes and event, as well as distinctive structures in material culture occurrence and co-occurrences. In the MARCOMANNIA dataset, individual entities contain this information either through a particular relative chronology denomination or as their interval defining the inception and end. For the purposes of this book, we will stick to the general chronological sequence used for the *Barbaricum*, which is conceived as the Initial (phase A), the Early (phases B1 and B2/C1), the Late (phases C1 and C2), and the Terminal (phases C3 and C3/D1; *sensu* Tejral 1975; 1989) Roman Period.

Interval	General	Year span	AC	1st level	Year span	AC	2nd level	Year span	AC	3rd level	Year span	AC
-30 – -20	Roman Period	460	1	'Initial'	20	0.04	A	20	0.04	A	20	0.04
-20 – -10												
-10 – 0				Early	200	0.43	B1	110	0.24	B1a	40	0.09
0 – 10												
10 – 20												
20 – 30												
30 – 40										B1b	20	0.04
40 – 50												
50 – 60										B1c	50	0.11
60 – 70												
70 – 80												
80 – 90												
90 – 100												
100 – 110							B2	60	0.13	B2a	50	0.11
110 – 120												
120 – 130												
130 – 140												
140 – 150												
150 – 160										B2b	10	0.02
160 – 170							B2/C1	30	0.07	B2/C1	30	0.07
170 – 180												
180 – 190												
190 – 200				Late	130	0.28	C1	70	0.15	C1a	40	0.09
200 – 210												
210 – 220												
220 – 230												
230 – 240										C1b	30	0.07
240 – 250												
250 – 260												
260 – 270							C2	60	0.13	C2	60	0.13
270 – 280												
280 – 290												
290 – 300												
300 – 310												
310 – 320												
320 – 330				'Terminal'	110	0.24	C3	60	0.13	C3	60	0.13
330 – 340												
340 – 350												
350 – 360												
360 – 370												
370 – 380												
380 – 390							C3/D1	50	0.11	C3/D1	50	0.11
390 – 400												
400 – 410												
410 – 420												
420 – 430												

Tab. 3.2. Representation of the relative chronological system entities and their correspondence to a probabilistic distribution through aoristic calculation.

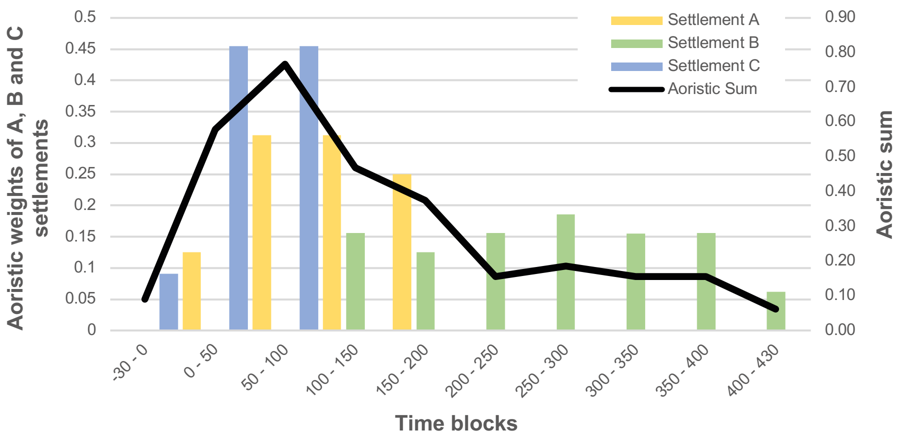
3.3.1 Aoristic calculation and probabilistic modelling

Aoristic calculation and probabilistic modelling originate in criminology, with the aim of analysing and identifying events of high temporal uncertainty (Ratcliffe 2000). In practice, this boils down to obtaining a more precise time determination of a specific type of event (e.g. the temporal probability of the occurrence of a burglary during the night) when only a time interval of varying width is available. In structuring contexts (mainly the same *modus operandi*, or the time when a given event repeatedly occurred in a similar time), the sum of the probability coefficient within the assigned time units can be used to define more or less reasonable periods when the event took place (e.g. Ratcliffe, McCullagh 1998).

These principles can also be applied to problems of absolute and relative chronology within archaeological data. Based on established dating

	A	B1a	B1b	B1c	B2a	B2b	B2/C1	C1a	C1b	C2	C3	C3/D1
Settlement A	0	0	1	1	1	1	1	0	0	0	0	0
Settlement B	0	0	0	0	1	1	1	1	1	1	1	1
Settlement C	0	1	1	1	0	0	0	0	0	0	0	0

	-30 – 0	0 – 50	50 – 100	100 – 150	150 – 200	200 – 250	250 – 300	300 – 350	350 – 400	400 – 430
Settlement A	0	0.13	0.31	0.31	0.25	0	0	0	0	0
Settlement B	0	0	0	0.16	0.13	0.16	0.19	0.16	0.16	0.06
Settlement C	0.09	0.45	0.45	0	0	0	0	0	0	0
Aoristic Sum	**0.09**	**0.58**	**0.77**	**0.47**	**0.38**	**0.16**	**0.19**	**0.16**	**0.16**	**0.06**



Graph 3.1. Example of computational principles through the aoristic calculation of multiple objects. Recalculated probability indexes from the relative chronological stages are transformed into uniform time block probability distributions.

schemes for mobile archaeological finds, there is usually a certain chronological interval, which is generally defined using relatively chronological stages, phases, etc. In these cases, there is typically a specific form of synchronisation between the relative and absolute chronological systems, or at the very least, a framework for determining the duration of the phases at the beginning and end. The possible occurrence of the event in question is also taken into account. This is typically the production of the artefact (see Johnson 2004; Crema, Bevan, Lake 2010; Crema 2012; Verhagen et al. 2016).

As outlined in the previous chapter, the relative chronological system divides the entire duration of the Roman Period into segments, i.e. stages, phases, and subphases (cf. Tab. 3.2). At the 1st level of detail of temporal resolution (i.e. the Early or Late Roman Period), the average duration of a temporal segment is 115 years with a standard deviation of 74.2 years. In the subsequent level (stages A, B1, B2/C1, etc.), this value is 57.5 years with a standard deviation of 27.1 years. At the 3rd level, with the finest detail of temporal resolution, it is 38.3 years (standard deviation 16.4 years). As a result, these figures also provide a hint into the general possibilities of precision of archaeological contexts and material chronological determination in the sense of the average temporal resolution. The average span of the temporal segments of all three levels combined is 57.5 years (standard deviation 42.9 years), which enabled setting the 'baseline' value of the duration of the uniform temporal segment – time blocks – to 50 years (see Tab. 3.2). Moreover, the equalised temporal classification is consistent with the frequently used, generally applied dating of the half-century. This standardisation is essential for any representative data outline and provides an indispensable methodological tool for quantitatively evaluating various component, contextual or artefactual (material) categories of archaeological data. Only two deviations within the time block framework represent the shorter time blocks at the beginning (-30–0 BC/AD) and the end (400–430 AD) of the scope temporal extent (Tab. 3.1 and 3.2). This methodological approach makes it possible to overcome compatibility and standardisation problems in the temporal representation of the calculated probability of the occurrence of certain past phenomena in the archaeological record.

In the case of phenomena with an expected duration over more than one time block, such as the residential and funerary areas or pit houses, an additional differentiation was made with regard to the probable identification of the start or end of the activity (cf. Verhagen et al. 2016). Therefore, three categories – *foundation*, *continuity* and *abandonment* – a simple dichotomic (0/1) differentiation was calculated for the respective archaeological components and objects to identify the transitional dynamics (*foundation* and *abandonment*) or their duration (*continuity*).

The applicability of the outlined temporal statistical approach undoubtedly contains a certain proportion of the biases and problems. In the case of this study, the normalised type of aoristic weight has been calculated based on the relative chronological identification of each input entity, dividing the interval 0–1 by the respective time slots (Graph 3.1). Therefore, the contribution to the mutual evaluation and comparison is even weighted. However, these data could be transformed to reflect the qualitative potential of the particular type of archaeological action through which the information was acquired (for the qualitative evaluation of archaeological data, see Chapter 4.5).

In this respect, the concept of the aoristic weights and sums also allows the application of the probabilistic simulation methods to archaeological data (Crema 2011; 2012; Verhagen et al. 2016). There is a particularly significant advantage in the application in the case of the sub-datasets, where the expectation of the occurrence in time is anticipated for narrower temporal margins, specifically with the minimal baseline resolution of the 50-year time blocks (e.g. artefacts in general, brooches, metal vessels, Samian ware). Using the probabilistic simulation, their calculated aoristic weight could be employed for their potential occurrence in only one time block. This probabilistic method even has the potential to shift the development of the baseline aoristic-based temporal distributions significantly. It works especially well in the case of the more pronounced differences in dating possibilities within a find category, such as brooches (see Chapter 5.3.1). On the contrary, on the other part of the spectrum stand the components, which expectedly lasted for a lengthier period of time.

Chapter 4

MARCOMANNIA dataset – an outline of the archaeological knowledge

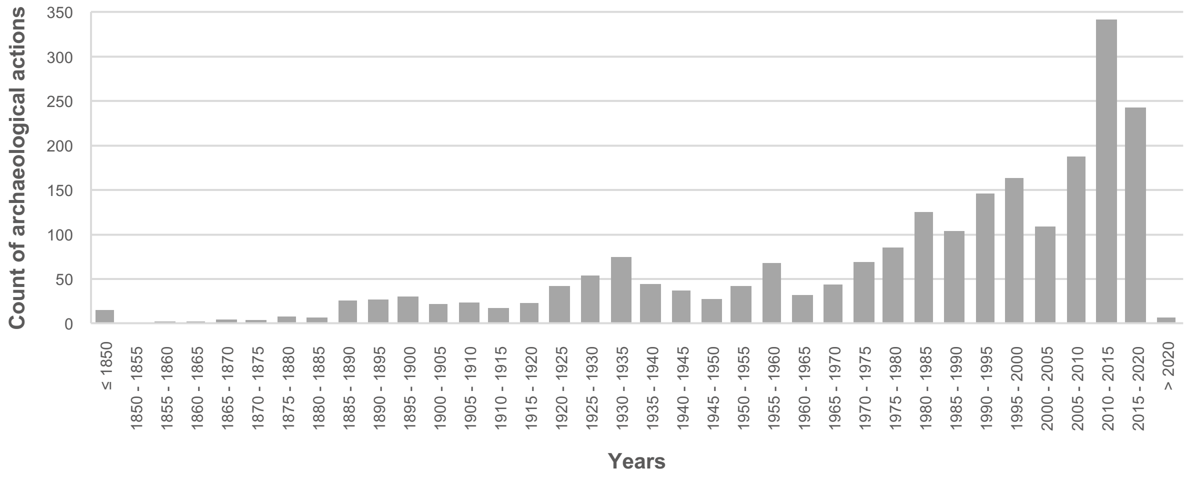
Besides the primary project-driven purposes of the large-scale collection and the formalisation of available archaeological information, this dataset also offers the unique opportunity to outline and quantify the scale and structure of archaeological knowledge available to us within the given spatio-temporal extent. Apart from the immense gaps in this knowledge stemming from the very transformation processes (cf. Neustupný 2009) connected with the 'archaeologisation' of the past material and immaterial culture, deficiencies also come from the ways of acquiring, recording and providing such information. The increased time lap from its acquisition usually conditions the quality of such information. Information can be biased in various ways (e.g. mixing archaeological material from different contexts) and its subsequent transformation into data and knowledge acquisition proportionately. In addition, a number of extensively researched and crucial archaeological sites are still awaiting publishing (e.g. Vyškov 'Žleby'). In contrast, in the last decades, archaeological information has been complemented by the phenomenon of metal detecting, which considerably enriched our understanding of quantitative perspectives in metallic material categories, as well as the adverse effects and opportunities connected to it (cf. Komoróczy 2022). Many of these processes shape the available archaeological knowledge.

4.1 Archaeological action

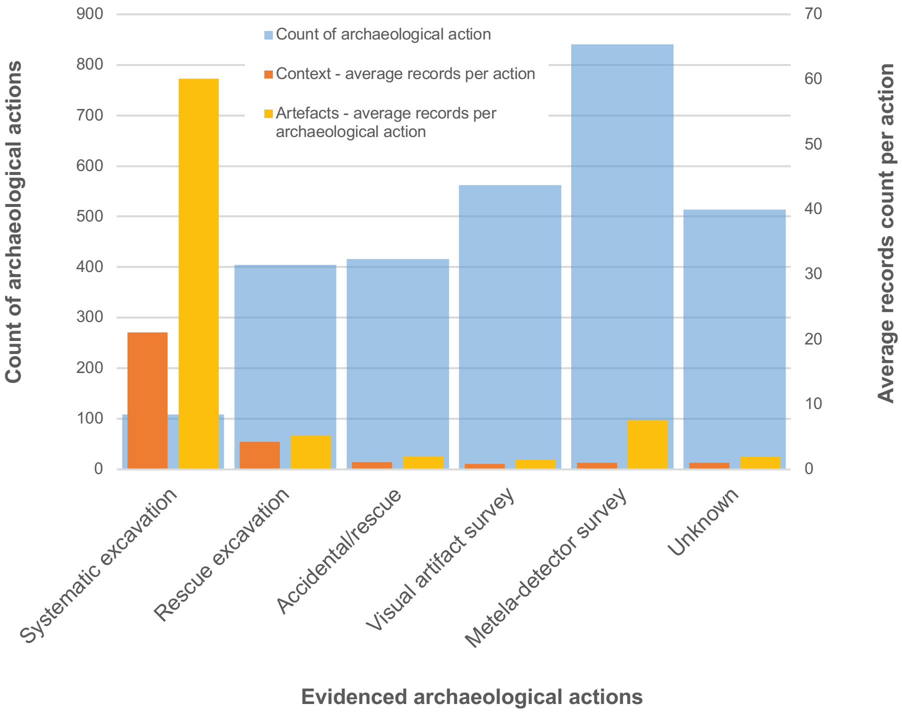
Within the MARCOMANNIA database, the hierarchical entity below the component level represents the *archaeological actions* or, more generally, the means and various ways through which the archaeological data and/or artefacts have been acquired and became available to archaeologists (cf. Demján, Dreslerová 2016).[7] This categorisation covers a wide array of destructive (forms of field excavations) and non-destructive (surface or remote sensing prospections) field methods of archaeological research. It also includes information acquired through non-professional channels (e.g. metal-detecting outside the professional archaeology, which results have been mediated to archaeologists; see Komoróczy 2022), including unintentional or more or less *accidental* (not to be mistaken with the professional archaeological rescue excavations) conditions. The latter concerns usually a non-intentional disruption of archaeological contexts, from which a selective collection of archaeological material was obtained (Graph 4.1).

Currently, the largest group of archaeological actions are from metal-detector surveys (841 records). Although the average number of portable finds per action is relatively low, the high number of *archaeological actions* makes it the most yielding source of archaeological information in general (8 records per action). The artefact survey is the second most represented category of archaeological actions (562 records). It usually includes a large quantity of clay-based artefacts (e.g. pottery, spindle whorls, daub, etc.), which are generally less diagnostically

7 For clarity this information entity will be referred as an *archaeological action*.



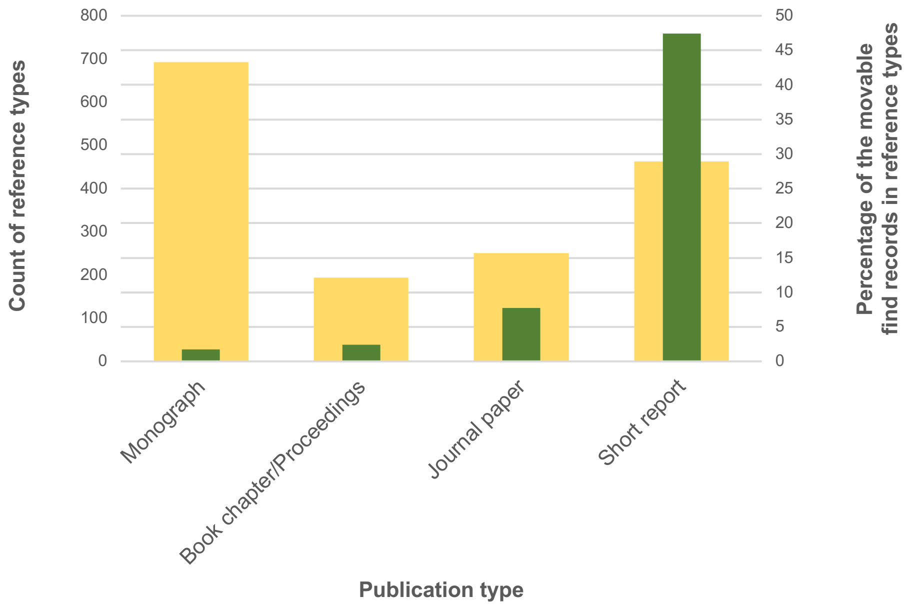
Graph 4.1. Temporal outline of the *archaeological actions* (5-year aggregation).



Graph 4.2. The outline of the quantitative representation of evidenced types of *archaeological actions*.

sensitive (large proportions of undecorated coarse ware) and give a lower average of the records per action.[8] The lowest level of information quality and representativeness regarding the ways of procurement of archaeological information contains the category *unknown* (514 records). It mainly involves discoveries made in the (distant) past and usually includes stray finds or collections with biased contextual details, e.g. grave goods assemblages procured during past industrial activities aimed at the extraction of soils. However, a significant proportion of archaeological actions falls in this category with constrained interpretation possibilities (see Graph 4.2). Unsurprisingly, the most significant proportion of information on the archaeological context and portable finds (21 and 60 records per action, respectively) comes from systematic excavations, the least represented type of archaeological action (108 records).

8 The average of one context per site in this type of 'archaeological action' represents a topsoil from which the portable finds were obtained.



Graph 4.3. Quantitative representation of the types of input published sources (green) and the portable find records based on them (yellow).

4.2 Data inputs and sources of information

As pointed out above, the heterogeneity of published archaeological information used as an input for the MARCOMANNIA dataset also dictates the width and depth of their yield and quality (cf. Graph 4.3). For the general outline, the published sources have been divided into four categories: *monographs*, *book chapters/proceedings*, *journal papers*, and published *short reports*. Unsurprisingly, the overwhelming majority (759 records) falls within the general category of the 'short reports' (e.g. *Fundberichte aus Österreich* for Austria or *Přehled výzkumů* for Moravia and Czech Silesia), whereas the other categories are represented significantly less. The smallest category is 'monographs' (28 records; e.g. Beninger, Freising 1933; Zeman 1961; 2017; Pollak 1980; Droberjar 1997; Peška, Tejral 2002; Kolbinger 2013; Elschek 2017). Expectedly, they have a differentiated impact on the dataset level of the number of portable finds, as demonstrated by the fact that a considerable proportion of these records (43%) come from the least represented publication type, i.e. the monographs. In contrast, the large quantity of 759 short reports yielded only 29% of the portable finds.

In addition to 'standard' published sources of relevant archaeological information, there is a non-negligible amount of finds originating from metal-detecting outside professional archaeology was also included (cf. Komoróczy 2022). To maintain consistency of the use of referenceable archaeological information, the MARCOMANNIA dataset contains only the finds openly available through the Archaeological Information System of the Czech Republic, which also includes a *Portal of amateur collaborators and a repository of individual finds*[9] (cf. Pajdla et al. 2021; 2023a). However, due to the methodological aspects of these finds, only those with a convincing spatiotemporal context were included in the dataset.[10]

4.3 Identification and differentiation of activity areas

The overall interpretation and differentiation of the particular past activities based on the archaeological record of the Middle Danube Roman Period are limited by the available sources of information within archaeological knowledge. Traditionally, the vast majority of spatially identified archaeological components were differentiated into 'settlements' and 'burial grounds'. In reality, this must have been much more varied, as the various forms of human activities must have been much more varied and complex in the past (cf. Neustupný 1998; 2003; 2009; Kuna 1991). Moreover, it must have been interconnected through a heterogeneous network of

9 This is a result of a joint effort of the Institute of Archaeology of the Czech Academy of Sciences, Prague, and the Institute of Archaeology of the Czech Academy of Sciences, Brno, to proactively tackle one of the significant topic of the contemporaneous archaeology in the Czech Republic. Amongst its objectives is the leading initiative in archaeological monument protection for salvation of countless metallic artefacts, which eventually also significantly enriches the archaeological research.

10 Within the webmap application MARCOMAP, the finds from this sources are complemented with ID from the Portal.

economic, social, political and other links. Unfortunately, many leave no traces in the archaeological record, while others are insignificant or hard to interpret, such as production activities, social interaction, etc. However, a traditional and general preconception perceives an aggregation of archaeological material, mainly consisting of the pottery sherds and other adjoined find and material categories (e.g. daub, animal bones, etc.), as sufficient and justifiable for the identification of human habitation (i.e. residential function) area, hence as a 'settlement'.

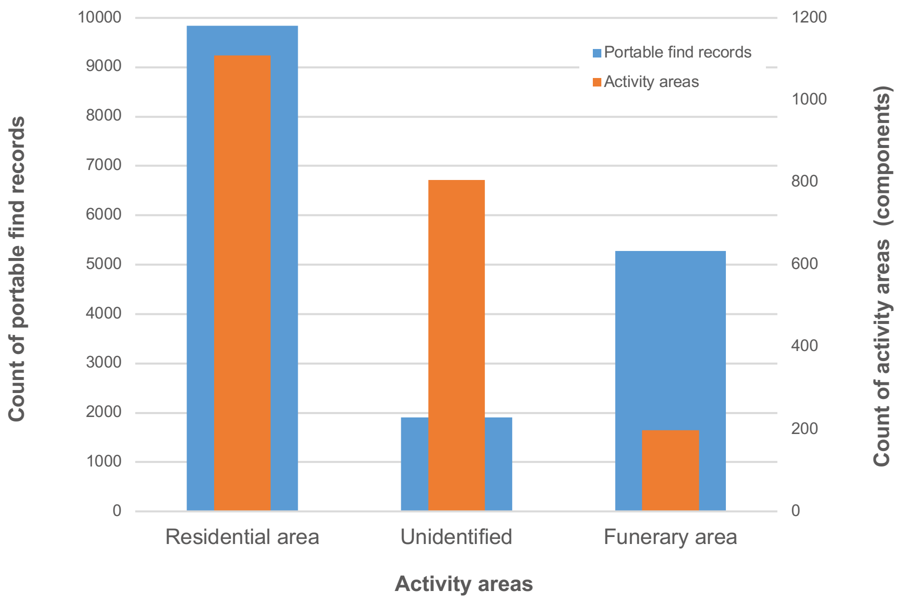
Nevertheless, as a result of the mentioned methodological deficiencies and generalisation in activity area identification, over 95%[11] of all records on the database hierarchical level of identified areas of activities (archaeological components) are split unevenly among the general categories: residential areas (i.e. settlements), funerary areas and unidentified (Graph 4.4). The three-category structure is obviously dominated by the residential areas (1,109 records), where the most significant proportion of evidenced contexts and movable finds are also found (9,841 records). Inverse disproportionality could be observed in the remaining categories, whereas the nature of the *funerary areas*, which are generally not abundant in the region, predominantly due to the taphonomical characteristics (cf. Vachůtová, Vlach 2011), as well as the structure and composition of predominant cremation burials, they provide a significant amount of movable find records (5,281). On the other hand, *unidentified* areas of activities (806 records) provide only two records on average per area and primarily represent incidental and solitary finds, which could hardly give the grounds for activity area identification. This perspective underlines the uncertainty distribution within the information basis of the MARCOMANNIA dataset. Therefore, in the case of activity areas exceeding the number of five records of the movable finds associated with the residential function (e.g. pottery, daub, etc.), they have been conventionally designated as residential areas.

4.4 Archaeological site-based data distribution

Another perspective could provide an additional perspective and outline of data distribution based on the top level of the dataset structure – the sites.[12] In this approach, each spatial point entity is represented by the sum of all the sublevel records with even weights regardless of the hierarchy. Therefore, the most abundant level representing portable finds is the most influential in evaluation. Through

11 The rest consists of the sites reflecting the Roman military presence (foremost the Roman temporary camps; cf. Komoróczy et al. 2020) or raw material extraction sites (e.g. iron ore exploitation near Sudice).

12 In the MARCOMANNIA dataset, the level is conceived foremost as an entity of spatial identification through two-dimensional formalisation (point), under which are adjoined individual discerned and identified areas of activities. Presently, there is a total of 2,072 record of this category.



Graph 4.4. The outline of the quantitative representation of the most represented areas of activities and the proportion of movable finds distributed through them.

five exponentially conceived threshold values (15, 30, 60, 120) reflecting the total record count per one site (Graph 4.5), it is evident that only a marginal fraction of the sites (5%) that contain more than 120 records per site include as much as a little over 50% of all the records (archaeological components, actions, immobile and portable finds). These sites usually have been extensively examined on a long-term basis and intensively researched (through various compositions and frequency of archaeological

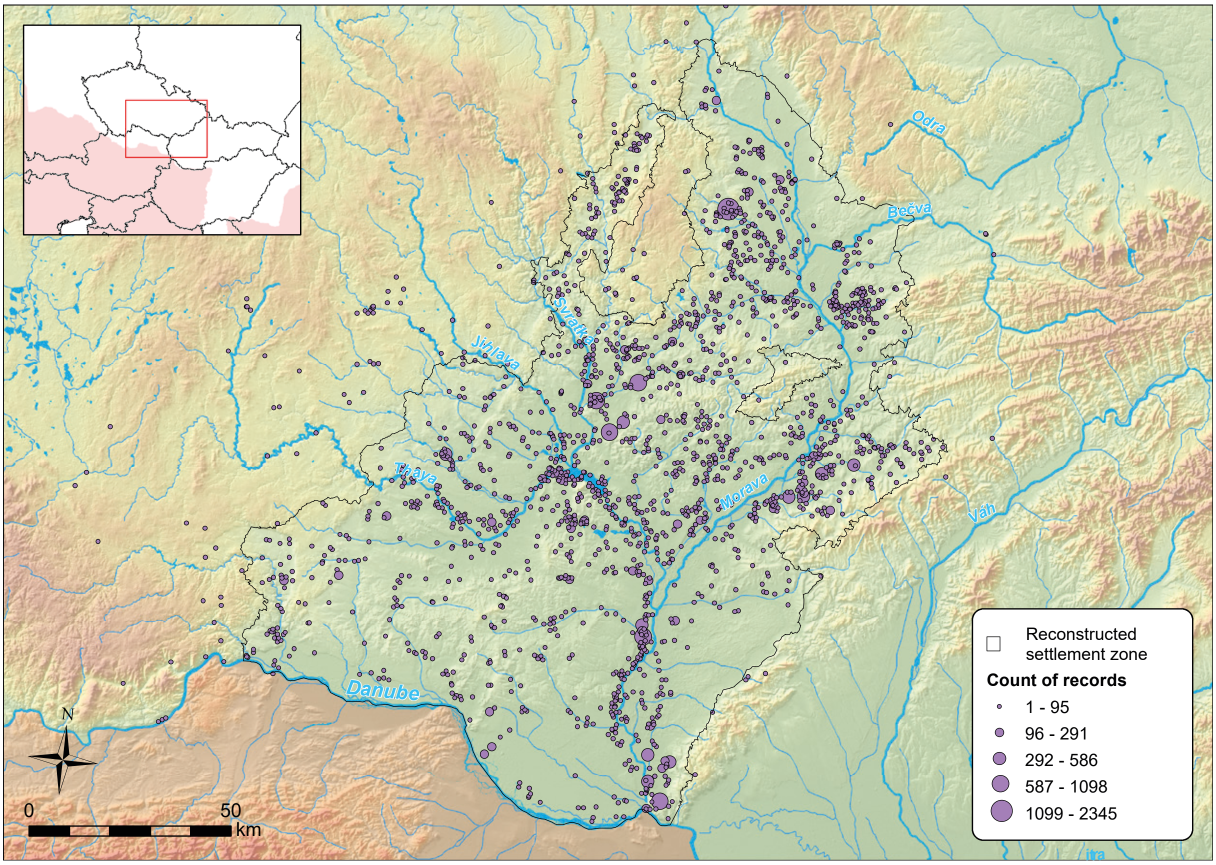
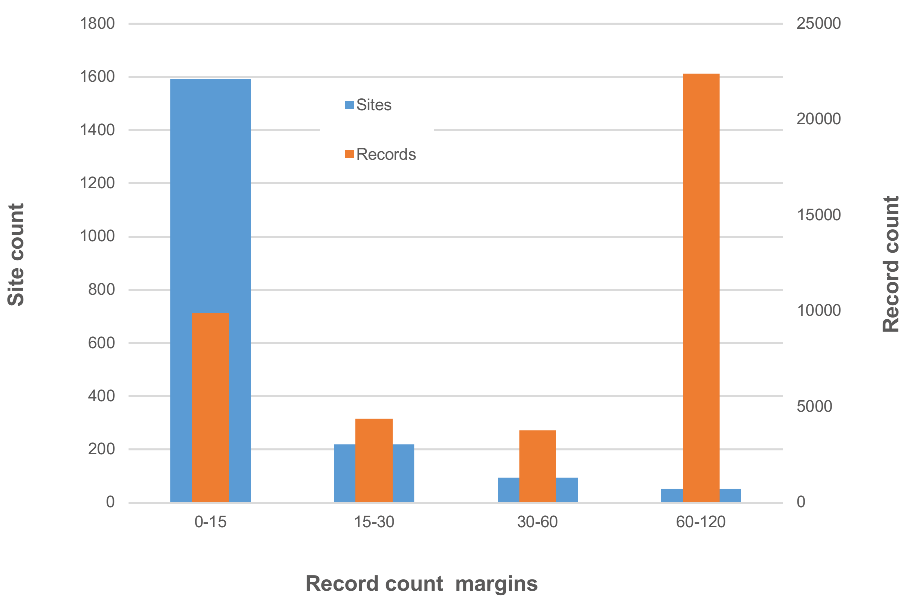


Fig. 4.1. Dataset representativeness. Quantitative outline of all evidenced records in individual locations.



Graph 4.5. Representation of the records within the evidenced sites in general.

actions) and published archaeological sites or regions (e.g. exceptional sites from various viewpoints, such as Kostelec na Hané 'Prostřední pololány', Křepice 'Záhumenice', Blučina 'Spodní Kolberky', Bratislava 'Dúbravka', or the cadastres of Zohor, Drösing, Ringelsdorf and many others). Nevertheless, with the threshold of only 15 records per site, only 35% of the sites and 84% of all the records are represented. Therefore, two-thirds of the sites contain less than the minor threshold record count mentioned above.

Conversely, despite the relative abundance (2,072 records) and spatial coverage of the sites (Fig. 4.1) throughout the study region, disproportionality, heterogeneity, and unevenness in archaeological data could be seen in most central or 'core' regions. These regions also have the highest densities of the Germanic population and contribute the most significant part of the archaeological evidence. Therefore, the asymmetricity in data representation propagates clearly through the spatial distribution.

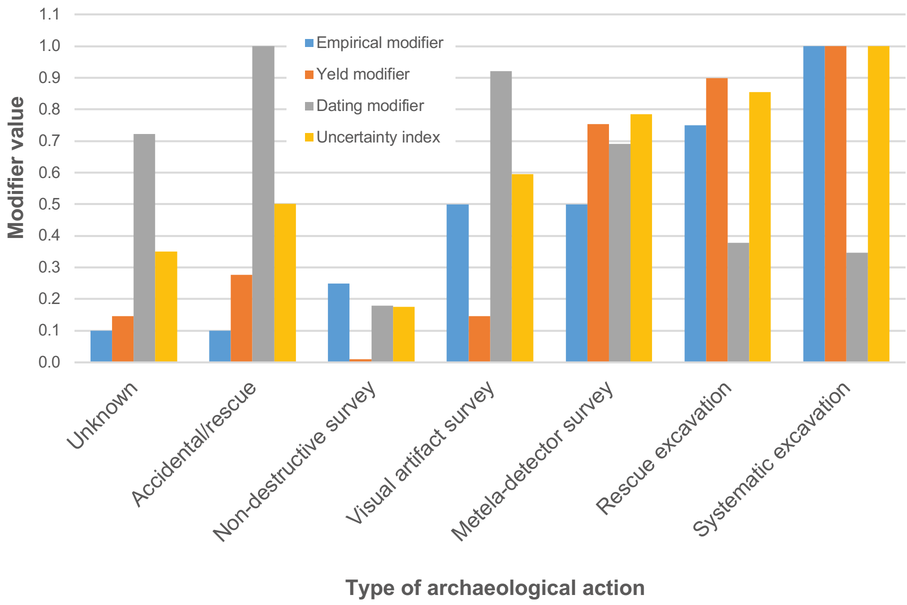
4.5 Uncertainty index

To address the quality of the input information and the types of procurement of archaeological information (archaeological action, e.g. Demján, Dreslerová 2016), there has been an intention to establish an evaluation principle at the level of individual discerned archaeological components. This would help to rectify some of the biases that have arisen in this area of archaeological transformations (e.g. Neustupný 2007, 46–72). It is inevitable that any such classification will be viewed from a number of different perspectives. The overall quality of the input information ultimately depends on the intensity, frequency and diversity of the archaeological actions conducted. It stands to reason that the most relevant and accurate information will be obtained from a systematic excavation or a similar 'rescue operation' when conducted thoroughly. It is possible to evaluate the potential quality of information yielded by different archaeological actions from three perspectives: *empirical*, *yield*, and *dating*. This is illustrated in Table 4.1 and Graph 4.6. Each factor has been assigned a value between 0 and 1, ensuring an even weighting across the model. The resulting uncertainty index (calculated as the average of the modifiers) has also been normalised to the stated value range.

The *empirical modifier* has been established on the fundamental presupposition that the resulting representativeness of obtained archaeological data and information generally can be scaled from the 'low-quality' types (*Unknown*, *Accidental/rescue*) to comprehensive field research (either *Rescue* or *Systematic*). The *yield* and *dating modifiers* were calculated using empirical archaeological data from the MARCOAMNIA dataset. The *yield modifier* was introduced to reflect the relationship between the averaged sums of the identified and verified immobile and portable archaeological finds resulting from individual *archaeological actions*. While there are quantitative biases in archaeological data, the *yield modifier* provides an objective assessment of the information available, offering a less substantial basis for interpreting functional or temporal differentiation (relative chronological identification of activity) in activity areas (archaeological components). The third modifier, which is based on the proportionality of dated portable or immobile archaeological finds in individual archaeological actions, is the (*dating*) *modifier*. The value distribution is in relative contradiction with the previous two modifiers but allows for capturing a crucial aspect connected with the *yield modifier* and proportionality of datable archaeological material procured through different ways and means. It is evident that large-scale terrain research activities yield a considerable number of well-datable archaeological finds. However, a notable proportion of these lack a more detailed temporal determination beyond the 'Roman Period', largely due to the vast quantity of non-diagnostic pottery fragments. Conversely, in the distant past (i.e. 18th or 19th centuries AD), the various 'accidental' forms of archaeological actions often resulted in the survival of only prominent and, therefore, more diagnostically representative finds.

Acquisition type	Empirical modifier	Yeld modifier	Dating modifier	Uncertainty index
Unknown	0.10	0.15	0.72	0.35
Accidental/rescue	0.10	0.28	1.00	0.50
Non-destructive survey	0.25	0.01	0.18	0.18
Visual artefact survey	0.50	0.15	0.92	0.60
Metal-detector survey	0.50	0.75	0.69	0.79
Rescue excavation	0.75	0.90	0.38	0.86
Systematic excavation	1.00	1.00	0.35	1.00

Tab. 4.1. The input modifiers and resulting *uncertainty index* on individual evidenced types of archaeological actions based on evaluating information potential of the archaeological data.



Graph 4.6. *Uncertainty index*. Individual modifiers differentiated through archaeological actions and the resulting uncertainty index.

The resulting *uncertainty index* was subsequently implemented to evaluate individual archaeological components (areas of activity)[13] within the MARCOMANNIA dataset. Subsequently, for each item mentioned above, an uncertainty index was calculated for all evidenced archaeological actions. Their summarisation resulted in an uncertainty score, highlighting the potential for information and representativeness of all the archaeological components. Therefore, as with Principal component analysis, the resulting score is not limited to the interval 0–1. The value of the repeatedly and extensively researched, surveyed, and excavated archaeological components could be relatively high. The evaluation process has impacted both the spatial and formal aspects of the input archaeological information and the analysis results.

13 They can be found in the chapters on respective baseline proxies of the residential and funerary areas.

Chapter 5

Proxies on the development trajectories of the Middle Danube Germanic society

One of the research project's key objectives is to derive and establish a series of representative indicators for various aspects of the Germanic society of the Middle Danube region, which we will refer to as *baseline proxies*. In general, these have been based primarily on the quantitative and qualitative representative segments of the data compiled within MARCOMANNIA. This allows us to obtain substantiated correlations between development trajectories in demographic, economic, societal and political aspects of the studied spatial context of the Marcomannic settlement zone. The baseline proxies are based on both identified and differentiated archaeological components (i.e. 'settlements' and 'burial grounds'), representative archaeological context or features (in particular pit houses, i.e. residential units) and selected find categories (Roman coins, brooches, metal vessels, *militaria*, tools, *terra sigillata*). The resulting proxies vary in quantitative representation, as well as in the methodological aspects involved, such as formal and functional interpretation schemes and the identification of temporal margins within various stages of their presence in 'living culture' through the appropriate relative chronological systems. Despite the significant quantitative representation of the Roman-origin pottery production apart from Samian ware (i.e. foremost orange or grey fine ware) would constitute grounds for its inclusion into the proxies, the relatively low chronological sensitivity, with predominant applicable dating to the 2nd and the 3rd centuries AD (e.g. Pernička 1963; Krekovič 1976; 1987; Droberjar 1989), prevented its further exploration in this book.

Evidently, the development trajectories are also embedded in the less quantitatively represented subsets (i.e. foremost material categories with higher typological variability and chronological sensitivity) of the MARCOMANNIA dataset (e.g. bone-antler combs). As the available archaeological information grew, it became possible to exploit further their information potential in this regard. Additionally, a number of baseline proxies were derived from the technological aspects of the societies under study based on the temporal distribution of the evidenced materials and variability in the material basis.

The resulting temporal probability distribution presumably reflects the number of domains and aspects of the Germanic intrinsic conditions and development (demography, economy, etc.) as well as the almost omnipresent materiality of the Roman-Germanic interactions of various natures – the items of Roman origin. Naturally, in most cases, the proxies reflect these aspects in varying proportions, which were also subject to change over time (e.g. Roman-Germanic interactions and the resulting influx of imported goods into the Germanic context). Despite the advantage of quantitative representativeness, the archaeological record contains considerably transformed traces of past realities (e.g. Neustupný 2009), which inevitably limits the interpretation possibilities. The number of such inherent uncertainties and biases may limit their potential for explaining some processes within the scoped spatio-temporal context. However, the methodological approach based on quantitatively representative input information is used to compensate for some of these shortcomings.

The temporal structuring of all the proxies by predefined time blocks is based on the aoristic evaluation principle and the resulting probability distributions (see Chapter 3.3.1). This standardisation of temporal probabilities allows for their synchronisation and mutual evaluation of the development tendencies. However, this approach inevitably raises a number of related issues in the context of the study and the structure and quality of the available data. Firstly, all input entities (records of areas of activity, contexts/features or individual artefacts) are given the same weight. *Prima facie*, there is no formal differentiation of the potential importance, significance, complexity, cost of the analysed component, context and artefact. The relevant information is often missing for such an assessment. This evaluation, scaling, and categorisation at various levels are then carried out based on multiple aspects (e.g. the type of 'archaeological action' and its information quality potential) and characteristics (quantities of the find categories, etc.). Inevitably, the MARCOMANNIA dataset-based *baseline* and *secondary proxies* are biased by this phenomenon. Still, from a positivist and substantivist perspective, they provide consistent and internally coherent subsets concerning the selected entities of interest.

Although the period of interest witnessed many developmental changes in various aspects (e.g. structure and composition of the cemeteries, appearance of the 'Jiříkovice-type' fine grey ware of local in the Late Roman Period, e.g. Pernička 1970; Tejral 1985), in short, the characteristic and structuring elements did not change (e.g. forms of habitation, form of burial rite). In terms of the 'visibility' of the archaeological components (mainly residential and funerary) in the archaeological record, they don't change structurally over time. Despite the varying intensity of their occurrence, they are also present throughout the whole temporal extent of the Roman Period in the studied region.

5.1 Residential areas (settlements) and pit houses

For most periods of the human past, archaeological data connected with spatially contextualised settlement and occupation represent the most important source of information. The continuous human presence inevitably aggregates a wide variety of archaeological artefacts and ecofactual material (cf. Neustupný 2007, 24–32). Nevertheless, the nature of the respective depositional and post-depositional processes within these archaeological components resulted in a complex mixture of archaeological material originating from the entire stretch of existence of a settlement site, ending eventually with the backfills, which ultimately poses the challenge of establishing a credible chronological position and differentiating the internal temporal development phases of individual settlement features (cf. Kuna, Němcová et al. 2012). From a methodological perspective, they represent a complex aggregation of various areas of activity, in which the most central role is played by the residential activity and the large variety of other activities, such as production (adjoined crop cultivation and animal husbandry, iron smelting, metal forging, processing of bone and antler etc.), economic activities (trade and barter), many of which hardly discernible through the information based on standard archaeological field methods (cf. Neustupný 2007).

With regard to the overall spatial and quantitative representation, the 'settlements' (Fig. 5.1) probably contain the most relevant information about the spatio-temporal development of the Germanic settlement structure within the 'Marcomannic' settlement zone (for the archaeological perspective of

Fig. 5.1. Residential areas. Visualisation of the possible appearance of a Germanic settlement (Archive of the Institute of Archaeology, Czech Academy of Sciences, Brno).

the component characteristic, see Chapter 4.3). Despite the inevitably differentiated past developments within individual regions of the settlement zone (cf. Chapter 4), they provide substantial indirect information about this region's economic, political and military capabilities of 'Marcomannic' society. *Prima facie*, they are one of the most consistent and representative correlates of the fundamental basic demographic characteristics – population size.[14] Only their spatial distribution could suggest the actual extent of the settlement zone. It also reflects the current state of archaeological knowledge and its limitations (under- and over-representation in different regions). The resulting trajectory, based on the sum of the calculated aoristic probabilities, reflects, to some extent, the actual population size, and the dimensionless variable contains information about the magnitude of the change, showing several distinct development structures. A cornerstone role of the Germanic habitation of a temporary or long-term nature is also underlined by the distribution of data in the MARCOMANNIA dataset, where they represent the most significant part of the data origin.

The archaeological data on Germanic settlement during the Roman Period in Europe show a relatively heterogeneous picture (e.g. Leube Hrsg. 1998; Todd 2004, 62–75). Despite this heterogeneity, this picture is even more complex as several phenomena obscure its observance. This consists foremost of the state of archaeological research and the available data. Within the debate on structural types of settlement of the Germanic societies along the Danube, residential socio-economic units are usually differentiated into standard low-lying 'settlements' and hamlets/farmsteads (e.g. Droberjar 1997; Tejral 1998; Kolník 1998). Unfortunately, their distinction is often not straightforward, and in some cases, it appears that a hamlet represents a unit from which the 'settlements' consist of and generally outline kind of a fundamental building block (cf. Mikkelsen 2000). In some cases, a hamlet seems to be established in isolation, but this is often caused by the limited archaeological investigation (e.g. Vlčnov – Dolní Němčí 'Dřínky').[15] However, it is not the intention to go into detail on this issue. The 'Marcomannic' settlement zone also generally lacks evidence of the fortified and elevated sites, except for minor occurrences from the final phase of the Late Roman Period (e.g. Mohelno 'Skřipina'; Droberjar 2002, 185).[16]

At present, there is little evidence for more complex vertical differentiation in settlement hierarchy (in contrast to the funerary record) that would provide substantiated clues towards the societal stratification entities (elites) throughout more complex agglomerations or places of a convincingly central character (cf. Droberjar 1997; Tejral 1998). According to some opinions (Neustupný 2010, 150–151), such a situation indicates a presumably lower density of social relations of these populations or a lower level of structuring of social organisation (Earle 1987). However, the possibility of such differentiation in South Moravian and other Germanic settlement regions seems to be apparent through the long-term non-destructive (e.g. aerial or geophysical prospection) or low-intrusion methods (metal detecting), as it is evident from the aggregations of archaeological contexts and finds, such as the Mikulov-Mušlov settlement complex (Komoróczy et al. 2021) or Drnholec 'Holenická pole' (Komoróczy et al. 2019a).

The reflection of social stratification in the settlement environment is sometimes seen in the presence of 'higher' forms of Germanic architecture with a lower frequency of occurrence, i.e. in particular all large above-ground 'hall-like' buildings, which have already been recorded in several residential areas of the Middle Danube *Barbaricum* (e.g. Vyškov 'Žleby', Šedo 1991; Slatinice 'Trávníky', Kašpárek 2008; Pasohlávky 'U vodárny', Komoróczy, Vlach 2010). These unique building complexes, usually with a central position within the residential area, differ mainly in size and internal structure (post-hole arrangement). Their interpretation varies usually between economic and residential functions (cf. Donat 2002; Droberjar 1997, 36–37). These limitations are due to a number of factors, most notably the state of knowledge of the individual sites and components. Very few have been fully or even partially excavated, processed, and published (cf. Droberjar 1997). The potential of

14 This would also apply to the absolute or relative size of the settlement structure (absolute number of residential areas), regardless of the actual size of the population distributed among them.

15 There is also a valid assumption that the archaeological manifestation of a 'hamlet/farmstead' represent a settlement unit that has not yet, or for unknown reasons has failed to, to develop into a 'settlement' (Mikkelsen 2000). The aggregation of these units would be logically expectable principle on several grounds, foremost security (number of community members available for effective protection), economy (relations in production activities and consumption), or social (e.g. reciprocity).

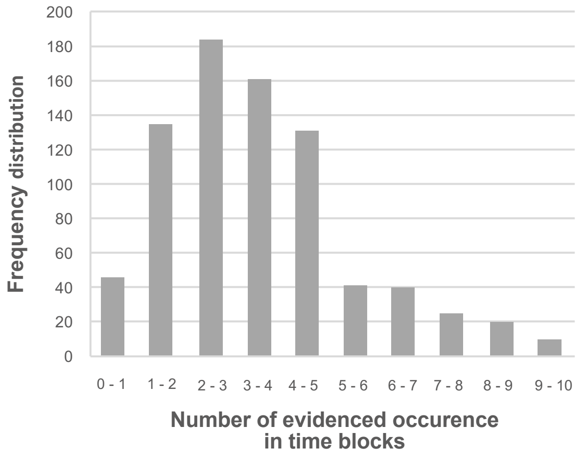
16 This contrasts, for example, with the Alemannic settlement zone between the upper Rhine and the Danube in the former Roman province, where a number of conspicuously rich and centrally located hilltop sites are known (e.g. Brather 2005).

their substantiated reflections in the archaeological record is also limited by the very nature of construction, in which archaeological remains – post-hole structures – may not always survive or be discerned through field methods.

5.1.1 Input data

Within the MARCOMANNIA dataset, 1,109 components are identified as traces of past residential activity from the Roman Period throughout the 'Marcomannic' settlement zone. From this amount, 789 'settlements' (hereafter referred to as *residential areas*) have information on the chronological position and are spatially identifiable (Fig. 5.2), at least at the cadastral unit level. Therefore, this subset provided the basis for establishing the residential area baseline proxy.

Additional information on the structure of the probabilistic temporal data also gives insights into the frequency of residential areas throughout the different periods of activity (Graph 5.1). Moreover, the weight point of this variable is between two and five time blocks (i.e. duration between 100 and 250 years, or less in the case of the time blocks that are cut off at the end of our predetermined date range), representing 77% of all input entities. The mean value, as well as the median, is four blocks, or rather 200 years of existence. A longer duration of residential areas has only been observed in ten cases



Graph 5.1. Residential areas. Histogram of quantitative distribution per activity period.

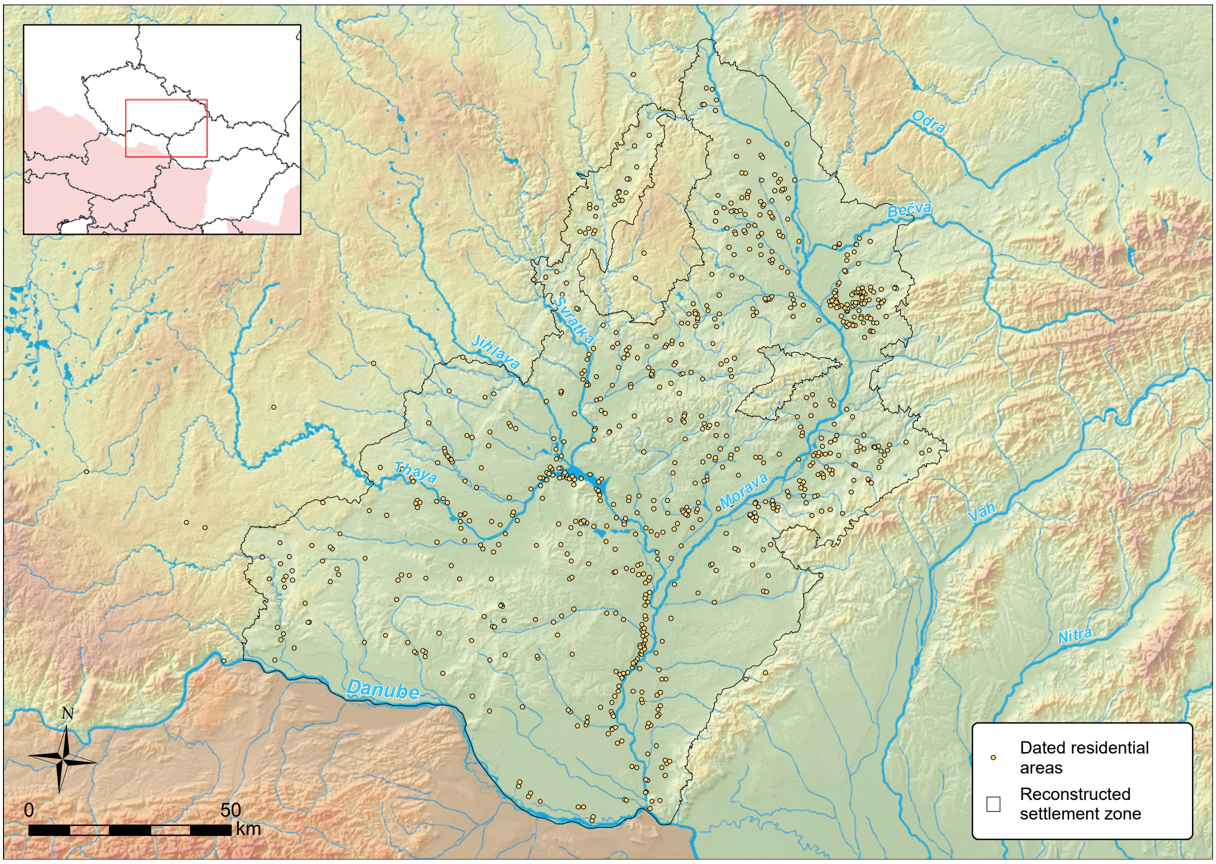
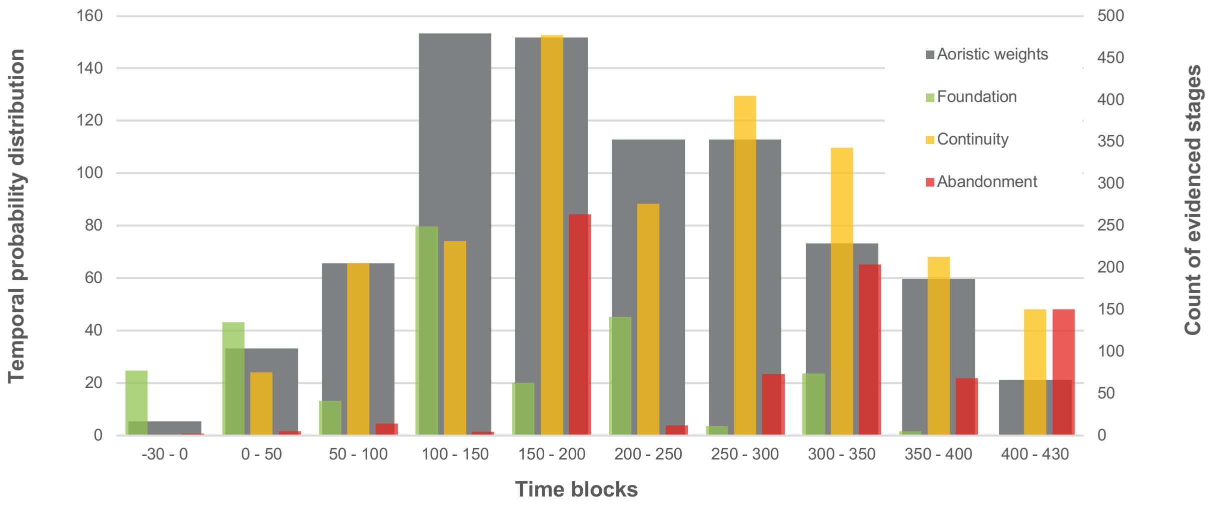


Fig. 5.2. Residential areas. Spatial distribution of all sites identified residential areas.



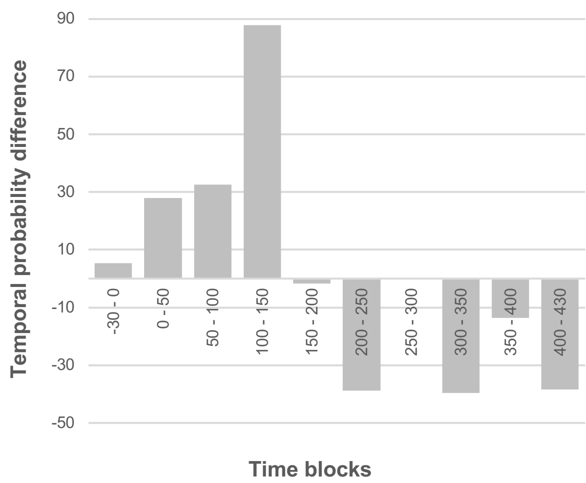
Graph 5.2. Residential areas. Temporal probability distribution (grey) complemented by the counts of the evidenced *foundation* (green), *continuity* (orange), and *abandonment* (red).

throughout the entire Roman Period. This short exercise makes clear that the quality and detail of the sub-dataset are limited. In most cases, no gap or *hiatus* in settlement activity could be discerned despite being expected. However, most of the available archaeological material and its dating possibilities don't allow the identification of the presumed breaks and gaps. Such phenomena are generally only visible in thoroughly examined residential areas (e.g. Vlčnov – Dolní Němčí 'Dřínky'; Droberjar 1997, 153–154, 176, Abb. 67). To address these issues, the probabilistic simulation of the empirical data was used to provide additional information on development trajectory (see Chapter 5.1.4).

5.1.2 Baseline proxy of the settlement structure

The aoristic probabilistic evaluation results in the shape of the baseline development trajectory (Graph 5.2). This baseline corresponds with the current theoretical archaeological model regarding the emergence, growth and demise of the Germanic societies of the Middle Danube region during the first four centuries AD. In addition to this distribution outline, the derived difference rates between the time blocks (Graph 5.3, Tab. 5.1) also allow the identification of periods with structural changes in Germanic settlement structure. Their magnitude was evaluated by their percentage representation, and as significant ones, and transitions exceeding 10% in the positive or negative could be identified as significant. Therefore, three distinct transitional of *foundation* (0–50, 50–100 and 100–150 AD) or *abandonment* (200–250, 300–350 and 400–430 AD) could be observed from the temporally distributed aoristic weights.

The earliest stage of the investigated period, the -30–0 BC/AD time block, reflects only limited settlement activity through the aoristic probability distribution, as the relative chronological phase A is only marginally represented throughout the region. The observed foundations in this time block are mostly from the relative chronological stage B1, which starts to overlap partially with the first non-standard time block (see Chapter 3.4). In contrast, the areas to the south (the lower course of the River Morava) are significantly richer in archaeological finds from



Graph 5.3. Residential areas. Difference in temporal probability distribution.

	-30 – 0	0 – 50	50 – 100	100 – 150	150 – 200	200 – 250	250 – 300	300 – 350	350 – 400	400 – 430
Aoristic weight	5.3	33.2	65.7	153.4	151.7	112.9	112.9	73.2	59.6	21.2
Foundation (count)	77	135	41	249	63	141	11	74	5	0
Continuity (count)	0	75	205	232	477	276	405	343	213	150
Abandonment (count)	2	5	14	4	264	12	73	204	68	150
Difference (%)	1.9	9.8	11.4	30.7	-0.6	-13.6	0	-13.9	-4.7	-13.4

Tab. 5.1. Residential areas. The outline of the data and baseline proxy.

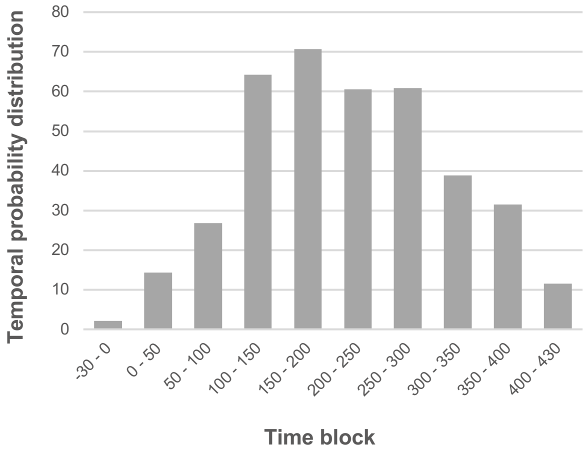
this period than Moravia (Tejral 1970b; 1977; 1993, 426–429; 2009). The results show a relatively stable increase of about 10% during the 1st century AD. The increase could not be explained by intrinsic growth alone, as the Germanic population appears to have been relatively small and thus limited in its reproductive potential. The cause could, therefore, lie elsewhere, particularly in the development of the settlement structure in Bohemia. A pronounced decrease in settlement activity has been recorded between the A and B1a periods (Salač 2009, 124, 125, Abb. 8) due to a significant shrinkage of the settlement zone by 25% (Vlach 2018b, 47).[17] Some of these populations probably moved to the Middle Danube region, where the increase in settlement activity is recorded.

The magnitude of subsequent change during the Early Roman Period (3rd and 4th time blocks, i.e. the period from 50 to 150 AD) clearly shows exponential growth, followed by the most significant positive transition of the scoped temporal extent between the time blocks 50–100 and 100–150 AD at the magnitude of 30% (Graph 5.2, Tab. 5.1). Similar insights come from the results of previous modelling of the Germanic demographic development (Vlach 2018b), as well as the general assumptions of archaeological models (cf. Tejral 1993). In this case, as well, the magnitude of the increase could not be based solely on the intrinsic growth of the Germanic population of the 'Marcomannic' settlement zone. A certain proportion of immigration from the northern and north-western Germanic settlement areas (especially the Wielbark and Przeworsk cultures) has already been argued based on archaeological material analysis, but mainly within the funerary context of the second half of the 2nd century AD (Tejral 1970b; 1971). However, due to the logic of the time lag between the 'living' context and its subsequent propagation within the funerary record, it would potentially suggest an earlier onset of these migrations from the northern environment, which are sometimes associated with the somewhat obscure socio-political entity of *Narsiti* (e.g. Dobiáš 1958; Zlatuška 1960). Nevertheless, the population input, to a varying degree, could have originated from other neighbouring regions to the west (Bohemia, Upper Austria) and east (Slovakia). Their similarities in material culture, however, limit the possibility of verifying this through archaeological data.

For the 2nd century AD, in general, the probabilistic distribution indicates that the settlement structure, and implicitly also the Germanic population size, reached its peak in the period under consideration. Despite high numbers in observed *continuity*, its 2nd half is marked by a significant increase in observed *abandonments* of residential areas. However, the change within the development of the 2nd century AD already suggests a relative stagnation. Nevertheless, this and other proxies, whether based on components (funerary areas; Chapter 5.2.), contexts (pit houses; Chapter 5.1.3.) or finds (e.g. brooches, metal vessels), show peaks, which, together with the spatial distribution of the settlement structure suggest that certain limits of various kinds have been reached. These are discussed in detail in Chapter 7 about demography.

In contrast, the further development of the second half of the studied period (i.e. from 200 to 430 AD) exhibits significantly different dynamics and characteristics after the first considerable decrease at the turn of the 2nd and the 3rd centuries AD. This resulted in the first significant reduction of 14% in residential areas (Tab. 5.1). It would be tempting to be able to ascribe at least part of the substantial increase in residential area abandonment to the atrocities of the large-scale conflict of the Marcomannic Wars. However, much of this peak is caused by the significant shift in relative chronological systems, which are generally sufficiently distinct.

17 Approximately from 16,000 km^2 in period A to 13,000 km^2 in period B1.



Graph 5.4. Residential areas. Temporal distribution based on *uncertainty score* reclassification of input data.

5.1.3 Data quality and uncertainty evaluation

The aoristic-based development trajectory (i.e. baseline proxy) reflects the overall distribution of temporal uncertainty in estimating the actual chronological position of the residential components. However, each calculation input/object of analysis (residential area) provides a different quality of information. Therefore, by means of the derived *uncertainty index* and *uncertainty score* (see Chapter 4.5), reflecting their informational potential and value, a recalculated temporal distribution has been established, which could partially correct the present biases and additionally provide the temporal probability distribution of the occurrence of residential areas (Graph 5.4). It is noteworthy that the overall development pattern remains largely the same, although some weight points shift slightly. The limited changes can be observed in the dynamics during the 2nd and the 3rd centuries, which tend to show a marginal increase instead of a decrease. Likewise, the decrease between the 150–200 and 200–250 AD time blocks is less significant than in the original baseline proxy. However, given the methodological limitations, such differences are negligible. Nevertheless, the results of this procedure confirm the validity of the baseline proxy and the potential for use in further analysis.

The significant impact of the evaluation of the information potential of the residential areas through the *uncertainty index* and the score based on the archaeological actions can be observed in the spatial patterns (Fig. 5.3, 5.4). There is an obvious shift in weight points in several regions. First and foremost, there is a notable downscaling of the Přerov District, where a large amount of evidence comes almost exclusively from the visual artefact surveys (Kolbinger 2013), meaning there is less information (of good quality) in this region. The shift from the uncertainty calculation generally favoured the region at the confluence of the Rivers Thaya, Jihlava and Svratka. This was due to the fact that a significant number of important rescue excavation activities were done prior to the building of the Nové Mlýny water reservoirs (cf. Stuchlík ed. 2002),[18] as well as other types of archaeological actions in the region. Nevertheless, this outcome offers a crucial correction and has been integrated into the spatially based analysis of the residential areas (e.g. regionality, see Chapter 6.2).

5.1.4 Probabilistic modelling of the temporal distribution of the residential areas

In addition, a probabilistic simulation (cf. Crema 2012, 450–451, Fig. 6) was used, where the primary input consisted of the dichotomously expressed evidenced *foundation* and *abandonment* (graph 5.2). This approach allows to compensate for two significant uncertainties in the archaeological record of residential areas: the question of the precision of archaeological dating and the possibility of an unobserved hiatus in habitation. The archaeological dating uncertainty was formalised as a more widely distributed probability of identification of their transitional events with a bilateral overlap of 25 years (half of a time block and the 'standard' pre-modern average life expectancy; cf. Knapp 1998) outside the particular time block, with an arbitrary 33% probability of hiatus occurrence providing an additional variability in the simulation process. In contrast to the time block framework, this results in a more continuous temporal probabilistic distribution of the residential area development (graph 5.5), which allows for the capture of trends that are not observable in the aoristic sum representation of the residential areas. Therefore, the resulting simulated development trajectory doesn't just represent averaged values or the self-serving mimic of the respective baseline proxy but provides an additional layer of information for further understanding and analysis of the 'Marcomannic' settlement zone populations.

18 Nevertheless, the relativity of the computational approach is demonstrated by the high densities, despite the fact that large parts of the archaeological actions associated with the construction of the reservoir have not been fully processed and are yet not available.

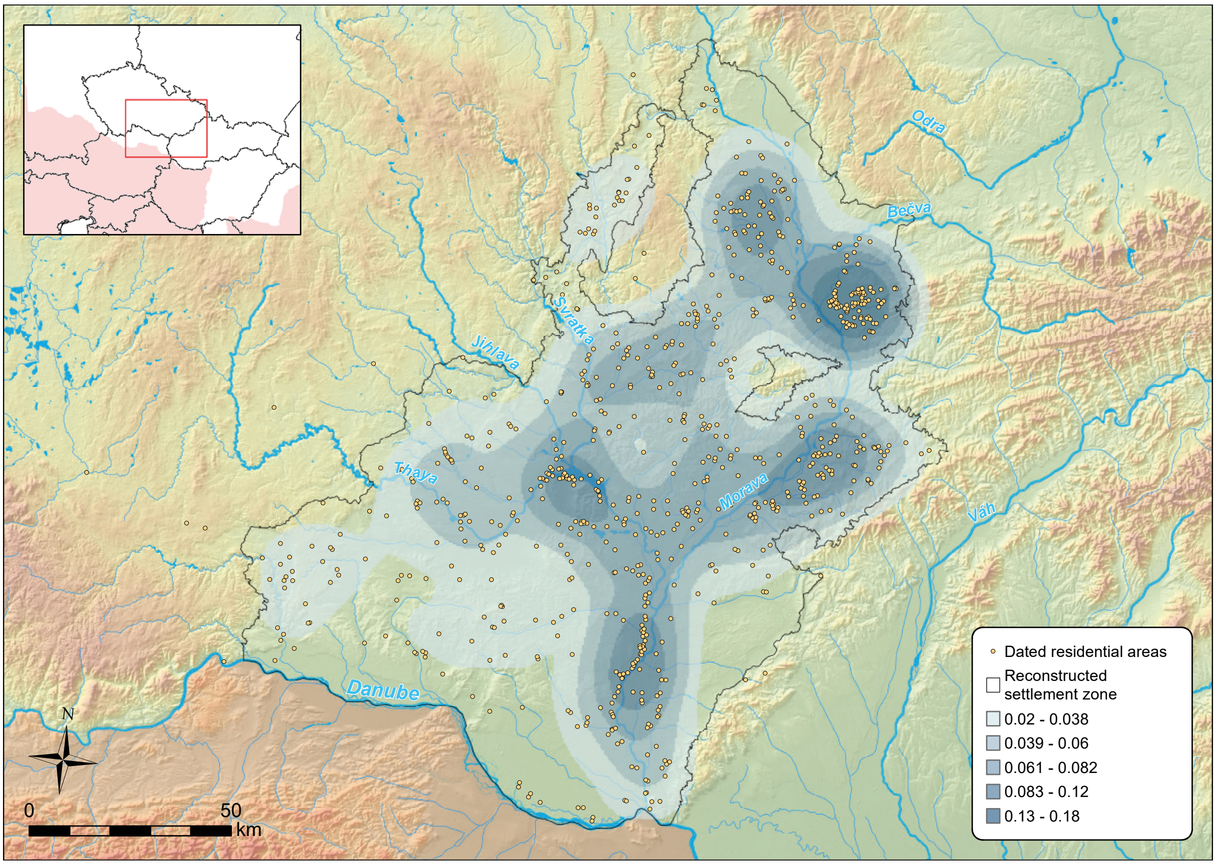


Fig. 5.3. Residential areas. Density distribution based on evenly weighted input data.

The resulting probability map (graph 5.5, 5.6) is based on a thousand simulation runs and shows, particularly for the 2nd and the 3rd centuries AD, somewhat wider vertical margins reflecting the degree of uncertainty in the estimates for these periods. Conversely, the initial and final segments of the temporal extent suggest a higher degree of certainty, as the number of simulated units (residential areas) is lower and either starts or ends at the consensus value of 0, defining the *ante* and *post quem* methodological margins of the simulation framework. Compared with the baseline proxy (Graph 5.2), the simulation results allow some short-term structures to be distinguished. In particular, the simulated development of the settlement structure shows a partial recovery after the first marked decline during the second half of the 2nd century AD, which is not visible in the baseline proxy. Therefore, following the previous observations in the archaeological data, the increase in the population is probably due to the external influx from other regions of the Elbian cultural environment, which also led to the emergence of the newly established extensive funerary areas, such as Kostelec na Hané 'Prostřední pololány' and others (e.g. Zeman 1961). This phenomenon is also well attested by the baseline proxy of the observed burials (Chapter 5.2.3). The vertical margins of uncertainty also suggest that the population size could have reached the numbers of the mid-2nd century AD, just before the Marcomannic Wars.

5.1.5 Pit houses

The archaeologically explored and excavated residential areas (e.g. Vlčnov – Dolní Němčí 'Dřínky', Křepice 'Záhumenice', Blučina 'Spodní Kolberky', Vyškov 'Žleby', Mušov 'Na Pískách', Zlechov 'Padělky', and many others), including archaeological features (above ground structures, kilns and ovens, storage pits, wells, etc.) and artefacts, usually provide traces of standardised manifestations of the settlement features, which in the Central European *Barbaricum* are traditionally associated primarily with dwelling or housing function (Fig. 5.5), formally representing a basic economic and social

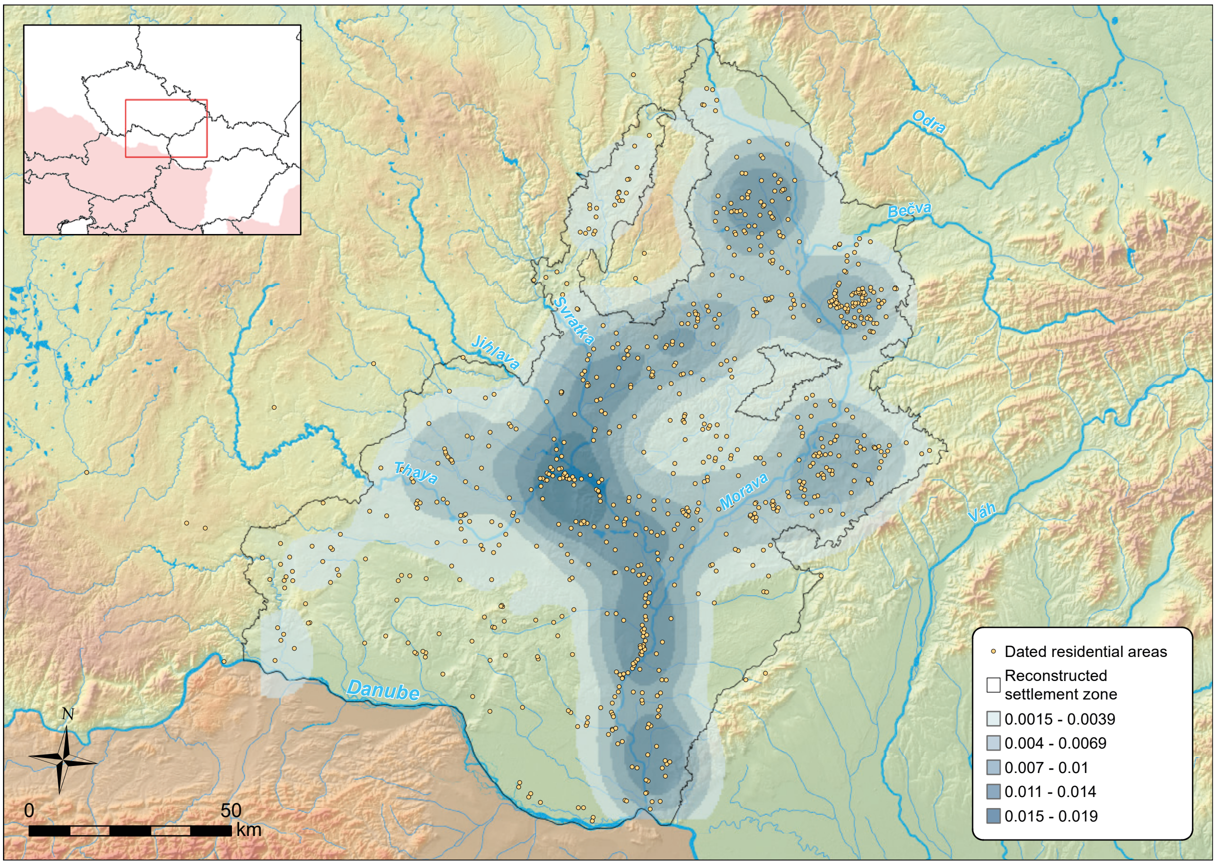
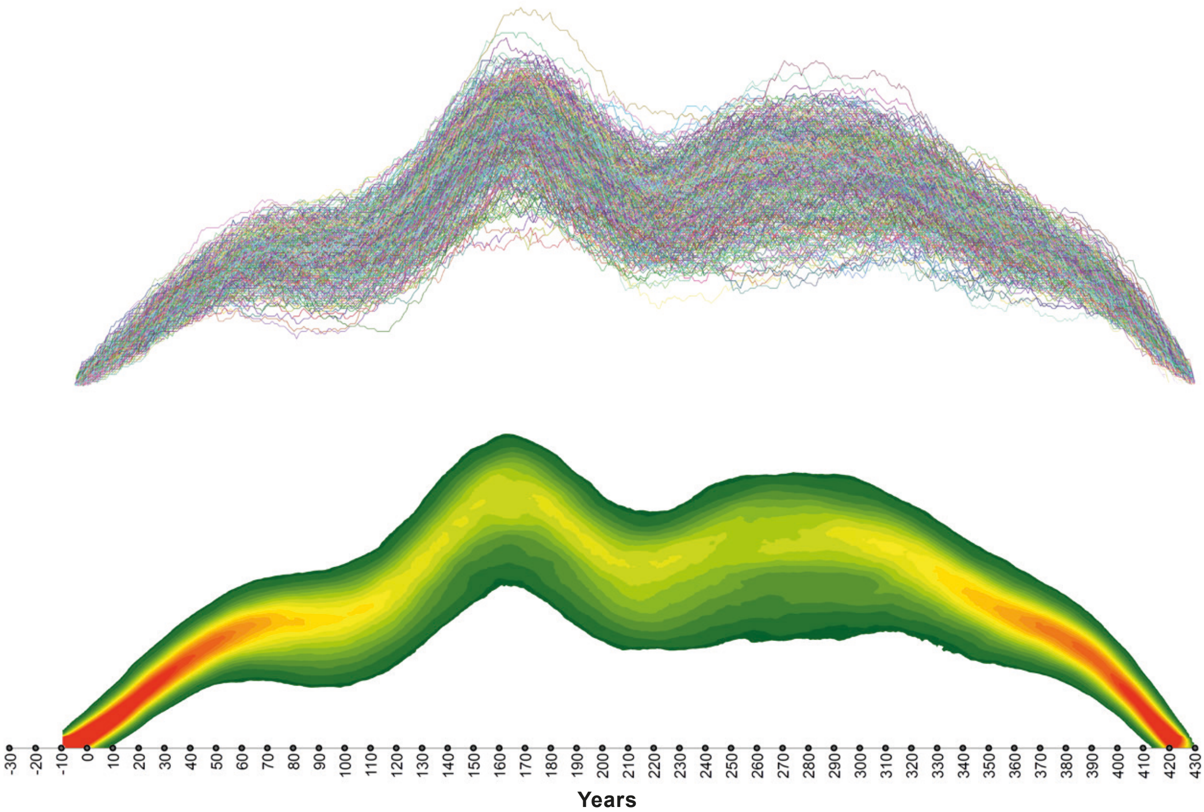
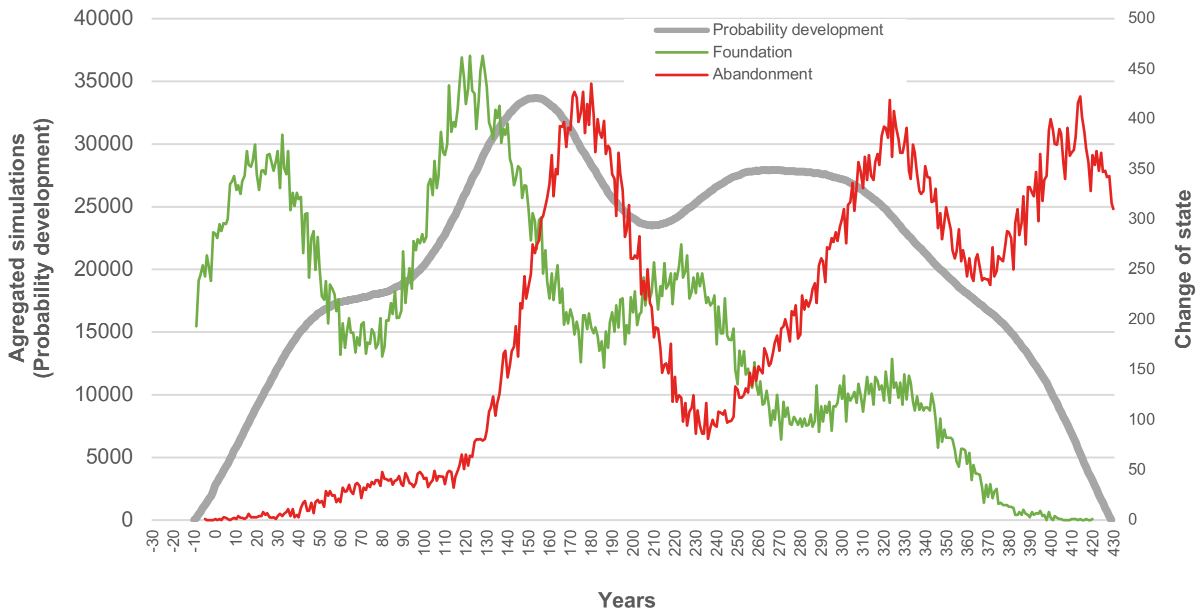


Fig. 5.4. Residential areas. Density distribution based on uncertainty score.



Graph 5.5. Residential areas. A – Outline of all the simulation runs; B – density mapping of the simulation runs for assessment of probability margins of the quantitative parameters.



Graph 5.6. Residential areas. Simulated temporal distribution and probable rates of *foundations* and *abandonments.*

unit – a household (e.g. Kolník 1964; Leube Hrsg. 1998; Droberjar 1997).[19]

The interpretation of the primary function of pit houses within the Germanic communities has been the subject of lengthy research and extensive debate, primarily through the differentiated representation in individual parts of the immense territorial extent of European Germanic civilisation in the Roman Period (e.g. Leube Hrsg. 1998; Todd 2004, 69–70). They usually provide varying amounts of mainly pottery (cf. Droberjar 1997), as well as scarce evidence for other material categories, and generally provide only a limited amount of metal finds (e.g. Komoróczy, Vlach, Kmošková 2024), as probably all valuables were collected upon abandonment of the site or scavenged later.

Fig. 5.5. Pit houses. Visualisation of the potential appearance of a Germanic pit house of the Roman Period (Archive of the Institute of Archaeology, Czech Academy of Scieneces, Brno).

Several aspects weaken the interpretative and analytical power of this proxy. Most importantly, they are known only from a limited number of the available residential areas (122 in total[20]) with a differentiated quantitative and qualitative representation. As can be seen in Figure 5.6, although they are relatively well represented in the study area as a whole, their representation varies considerably from site to site, with the majority (84 residential areas) providing evidence for one or two pit houses. However, several sites contain the majority of the available records, but with varying degrees of information availability (e.g. Vyškov 'Žleby', Zlechov 'Padělky', Bratislava-Dúbravka 'Veľká lúka', or Křepice 'Záhumenice', Theiß 'Gewerbegebiet').

19 The excavated objects with the same features and parameters sometimes provide non-eligible archaeological evidence of various production activities (e.g. metalworking in Pasohlávky 'U vodárny', Tejral 2006; bone-antler combs in Zlechov 'Padělky', Zeman 2006; 2010), which rules out a primarily dwelling function of these objects. However, the production activities were the primary function of such objects in the northern Germanic milieu (e.g. Todd 2004, 66–75).

20 Regardless of the available information on them (dating, layout, typological identification or dimensions). However, it is only from the 71 sites that the record of pit houses with archaeological dating originate.

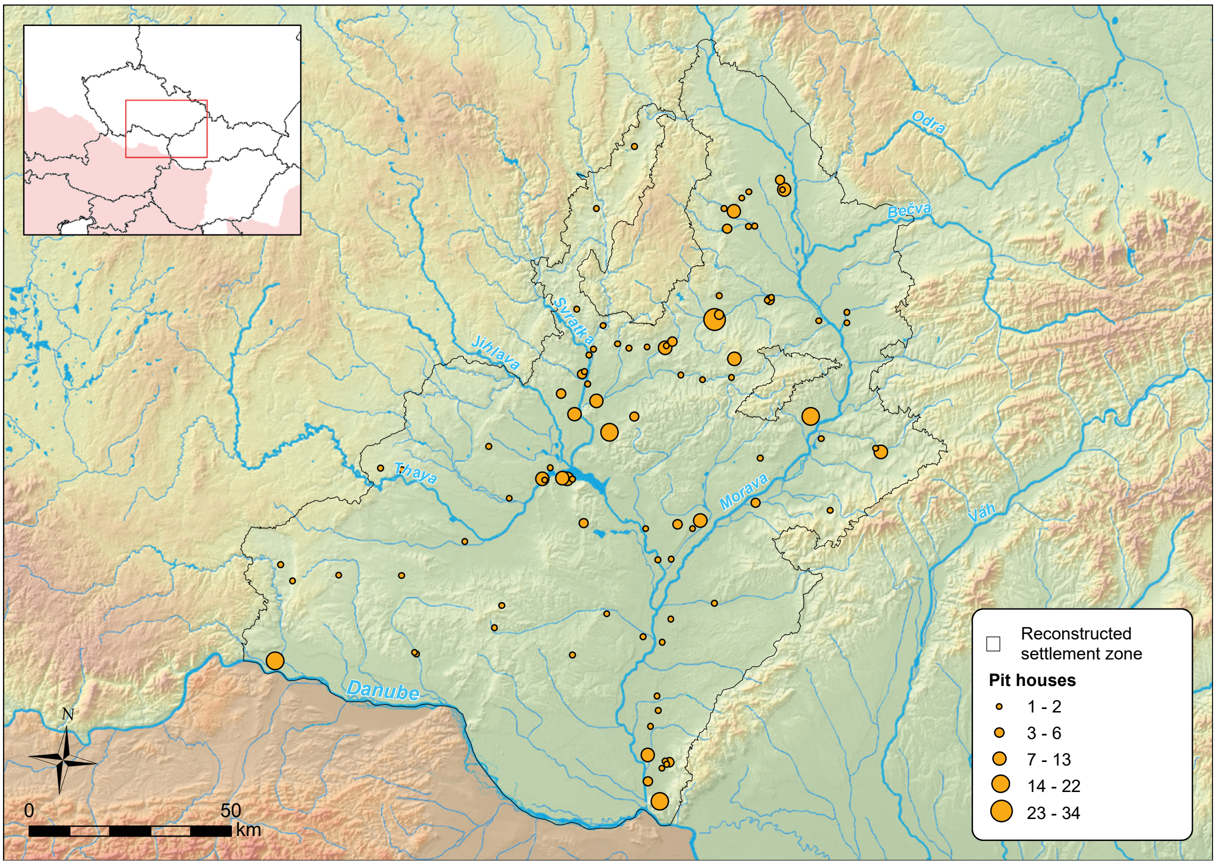
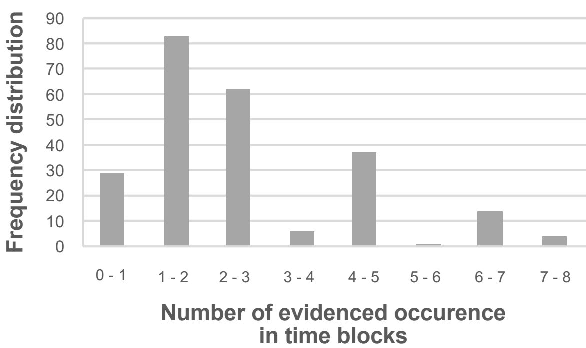


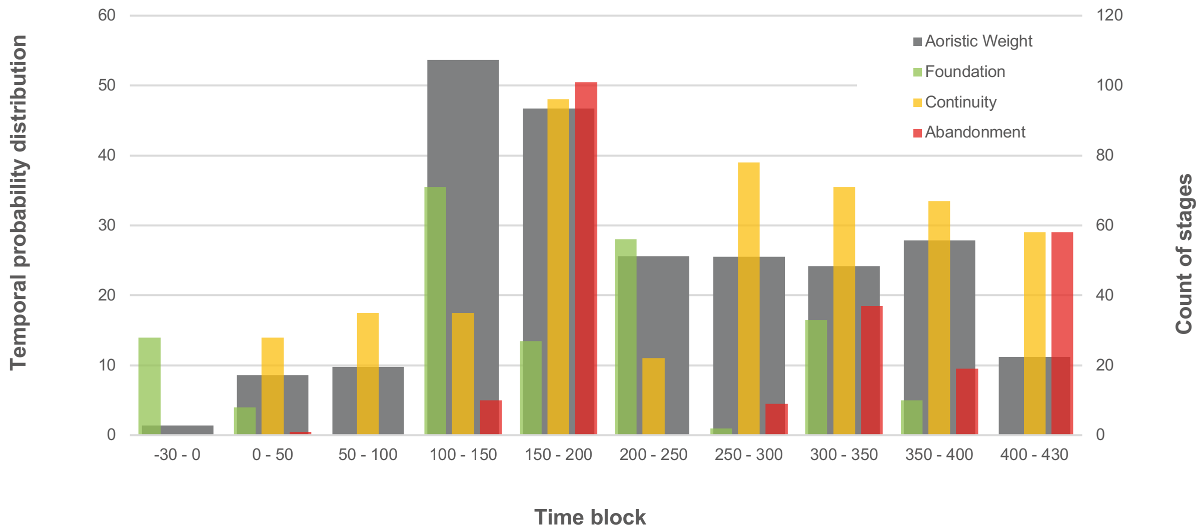
Fig. 5.6. Pit houses. Spatial distribution of the quantitative representation of the evidenced pit houses.

5.1.5.1 Input data

During the data collection, 424 records of pit houses were formalised into the MARCOMANNIA dataset structure. From this subset, 257 has some information on the chronological position, which could be used to derive the baseline proxy. In 165 cases, the dimensions and typological identification are also known (after Droberjar 1997, Abb. 11). Although the resulting baseline proxy is based on a relatively limited number of records, the importance of these entities in the 'living' context justifies their use. From the point of view of their duration, the most significant part falls within the margins between one and three time blocks (Graph 5.7), i.e. their formal duration is between 50 and 150 years. The higher representation is also observable in the recorded duration of the five time blocks. However, it is generally assumed that the average period of use of each type of building is about 20 years (Neustupný 1986, 227). Nevertheless, there is evidence for lengthier periods of use, as attested by the presence of repairs of the supportive structural features of a building, the posts, which are manifested in the archaeological record as double post-holes. Other structural elements of buildings (i.e. daub-made walls, thatched roof covering) could also be easily repaired, including the impregnation of the wooden construction posts, which, coupled with the estimates from other well-examined Germanic settlements (Vlach 2018b, 54–55), could potentially prolong the period of use.



Graph 5.7. Pit houses. Histogram of evidenced number of time blocks of recorded activity.



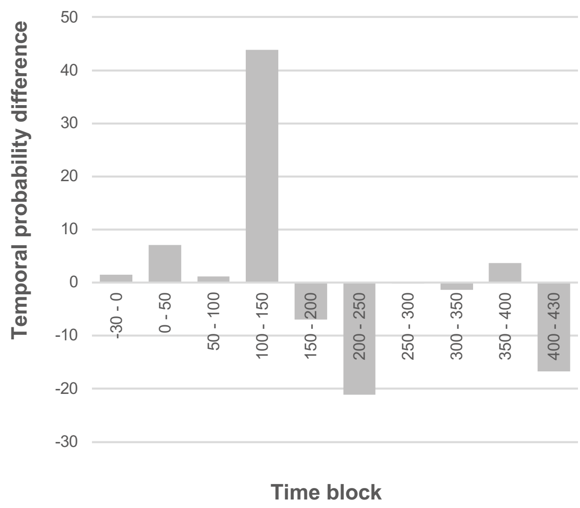
Graph 5.8. Pit houses. Probability distribution of the occurrence based on aoristic sums (grey), complemented with the sum of evidenced foundation (green), continuity (orange) and abandonment (red).

Nevertheless, it is evident that the wider temporal margins, resulting in considerable durations, stem from the possibilities of dating the available material culture, which is severely constrained by the formation processes of archaeological contexts. Yet, the vast majority of the pit houses are consistent with the general assumptions. Therefore, this apparent inconsistency between empirical data and theoretical models has been reflected in the probabilistic simulation in Chapter 5.3.3.

5.1.5.2 Baseline proxy of the pit houses

Unsurprisingly, the derived baseline proxy (Graph 5.8, 5.9, Tab. 5.2) generally show similar trends to the residential area baseline proxy (Graph 5.5), to which they are closely linked. Only a limited amount of evidence from the 1st century AD is represented in the MARCOMANNIA dataset (e.g. Zohor 'Piesky' or Vrchoslavice 'Panský lán'). This contrasts with the development trends in the residential areas, which is mainly due to the state of archaeological knowledge and the availability and quality of archaeological dating.[21] The most significant increase (by 42%), the peak of the aoristic probability distribution, together with a peak of recorded *foundations*, could be observed during the first half of the 2nd century AD. In general, however, it is in line with the trend of development in both the residential and funerary areas (see Chapter 5.2). The similarities can also be observed during the second half of this century, with the peak of recorded *abandonment* of pit houses or their continuity from the previous time block 100–150 AD.

The development at the end of the Early Roman Period resulted in a significant decrease of their modelled occurrence (by 20%) at the beginning of the Late Roman Period (time block 200–250 AD) but with the second highest number of observed foundations within the emerging layer of 'settlements'



Graph 5.9. Pit houses. Change in consecutive time blocks based on the aoristic probability distribution.

21 In some cases, the lack of available information for temporal differentiation has led to a simplified method of dating that overlaps with the chronological margins of the respective residential area.

	-30 – 0	0 – 50	50 – 100	100 – 150	150 – 200	200 – 250	250 – 300	300 – 350	350 – 400	400 – 430
Aoristic weight	1.5	8.6	9.8	53.6	46.7	25.6	25.5	24.1	27.9	11.2
Foundation (count)	28	8	0	71	27	56	2	33	10	0
Continuity (count)	0	28	35	35	96	22	78	71	67	58
Abandonment (count)	0	1	0	10	101	0	9	37	19	58
Difference (%)	1.4	6.9	1.1	42.4	-6.7	-20.4	-0.1	-1.4	3.6	-16.1

Tab. 5.2. Pit houses. The outline of the data and baseline proxy.

of this period, mainly connected with the substantial changes within the Germanic milieu at the aftermath of the Marcomannic Wars (e.g. Tejral 2008; Komoróczy, Vlach, Kmošková 2024). The development of the Late Roman Period until the turn of the turn of the 4th and the 5th centuries AD is characterised by relative stability in probabilistic distributions. However, the second-highest decrease in the probability distribution (16%) is finally recorded for the terminal time block 400–430 AD. It represents the final disappearance of the Germanic (Suebian) population from the archaeological record of the Middle Danube region.

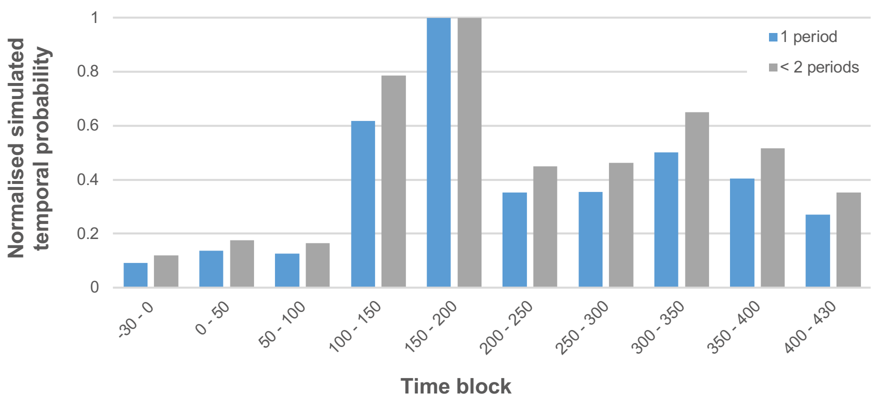
5.1.5.3 Probabilistic simulation of the pit houses

As mentioned above, it is necessary to address the discrepancies between the empirical data (observed durations in time block resolution) data and archaeological theoretical models regarding the duration of use of pit houses and its impact on the baseline probabilistic temporal distribution – baseline proxy. Therefore, the simulation framework was set up, where the underlying methodological principle is based on the expectation that these dwelling structures could have existed for one (up to 50 years) or, at most, two (up to 100 years) time blocks. During the simulation process, in the case of a duration of more than one time block, either one or two time blocks of activity are randomly selected for the simulation iteration, depending on the preset threshold value, i.e. a scenario setting (Graph 5.10). In the 'minimal' version, only one time block is selected from the empirical data temporal distribution, and in the 'maximal' version, two are selected for those exceeding two-time block durations. The results of both probabilistic simulations have been normalised (range 0–1) for better comparison.

The simulation results, therefore, correct the empirical data. There is an apparent shift in the original baseline proxy-based peak of the probability distribution from the first half of the 2nd century AD to its second half, which is more consistent with the residential area baseline proxy. What is more, the partial increase during the Late Roman Period (time block 300–350 AD) is also apparent but simultaneously not observable in the original baseline proxy. In addition, this approximation provides supportive evidence for the viability of the residential area baseline proxy.

5.2 Funerary areas / burial grounds

The Germanic Roman Period burial grounds represent a vital source of archaeological information and a keystone for its understanding. The burials traditionally hold exceptional importance and relevance to understanding material culture and its chronological, technological, and material aspects, along with the impact and significance for



Graph 5.10. Pit houses. The results of the probabilistic modelling through the imposed limits on the duration (scenarios): 1 – Only one period (blue); 2 – up to two periods (grey).

developing and refining individual relative chronological stages and phases and their absolute chronological connotations (see Chapter 3.3). Nonetheless, they provide an indispensable testimony to the characteristics of the Germanic religious domain and supernatural beliefs imprinted into the funerary rites and reflected through the transformed realities of the respective archaeological contexts. Throughout the Germanic world of the Roman Period, relative variability in mortuary practices could be observed.[22] However, within the Middle Danube region, the homogeneity of the manifestation of final transitional rites can be observed in the archaeological record, dominated by cremation practice, resulting in most cases in urn-type burials (see Chapter 3.2.3, 8.1.).

Compared with the residential areas (see Chapter 5.1), it is quantitatively significantly less represented. However, this component-level deficiency is counterweighted through the representation on the contextual level, through the burials/graves. The burial grounds (further referred to as *funerary areas* as formalised in the MARCOMANNIA dataset) identify the primary purpose and use and where substantial parts of funerary rituals have occurred (cremation and terminal deposition of a burial). However, some of the thoroughly excavated funerary areas (e.g. Vachůtová, Vlach 2011, 52–57; Petrauskas 2003) provide information on additional activities within the funerary areas (e.g. funeral feasting or other activities connected with the sacred grounds of the ancestors).

The currently available archaeological knowledge of the Germanic funerary record from the studied region inevitably suffers from several limitations. Foremost, there is still a relatively limited number of available (published) burial grounds (funerary areas) and grave contexts (burials), and considering these numbers with the relevant demographic estimates (cf. Vlach 2018b) and assumed numbers of the respective funerary areas and burials, point out severe underrepresentation within the archaeological record. This phenomenon is primarily the result of the deposition properties and taphonomy of the cremation burials, which rarely reached the subsoil levels and have been significantly exposed to the destructive near-surface transformation processes, above all agricultural activities (ploughing). These adverse effects inevitably led to almost two millennia of large parts of these archaeological components perishing. The general scarcity of the funerary components (in total, 180 records in the MARCOMANNIA dataset) within the studied region inevitably leads to the distribution, reflecting past trends in this archaeological record with decreased representativeness.

As a result, within the up-to-date available knowledge, the funerary context of the Germanic population could be observed with a distinctive disproportionality in the data structure, where a substantial part of the recorded burials is distributed through a limited number of funerary areas. Until now, the largest dataset in terms of the number of individual burial contexts comes from the cremation burial ground in Kostelec na Hané 'Prostřední polány' (Zeman 1961; Vachůtová, Vlach 2011, 46–48). Although most of the field research was carried out here between 1924 and 1931, and this fact has an indisputable influence on the quality of the data available today, with a total number of 431 registered burials, it provides the most substantial find complex from the Late Roman Period within the studied region. Other Middle Danube necropolises represent the foremost subtler collections, including the second-largest Germanic burial ground discovered in Modřice 'Sádky' (231 graves; Mikulková 2014). For example, the burial grounds from Šitbořice 'Padělky od Moutnic' (Droberjar, Kazdová 1993; Vlach 2010; Vachůtová, Vlach 2011, 48–49), Velké Hostěrádky 'Podlipiny' (Peškař, Ludikovský 1978), Velatice 'Zadní půllány' (Jílek, Kuča, Sojková 2011), or Sekule 'Za Humnami' (e.g. Rajtár 2017; Iván, Ölvecky, Rajtár 2019) represent significant sources of knowledge about the development of the material culture and other aspects of the Germanic environment. On the contrary, a more representative number of recorded burials comes from, e.g. the cemetery in Šaratice 'Padělky za humnama' (153 graves; Trňáčková 1960). There, the degree of variability of the observed categories reaches only low values. From the viewpoint of the development at the end of the Late Roman Period, it is related to generally observable trajectories of the development of material culture and its general interpretation (Tejral 1982, 17–18).

5.2.1 Input data

From the methodological perspective, the identification and emergence of a formalised record of a funerary area was based on the occurrence of

22 For example, birituality and stone circular structures in the Wielbark culture (e.g. Kokowski 2006, 177–183, 190–191), or 'bustum' type of burials in the Przeworsk culture (e.g. Jensen, Nielsen 1999).

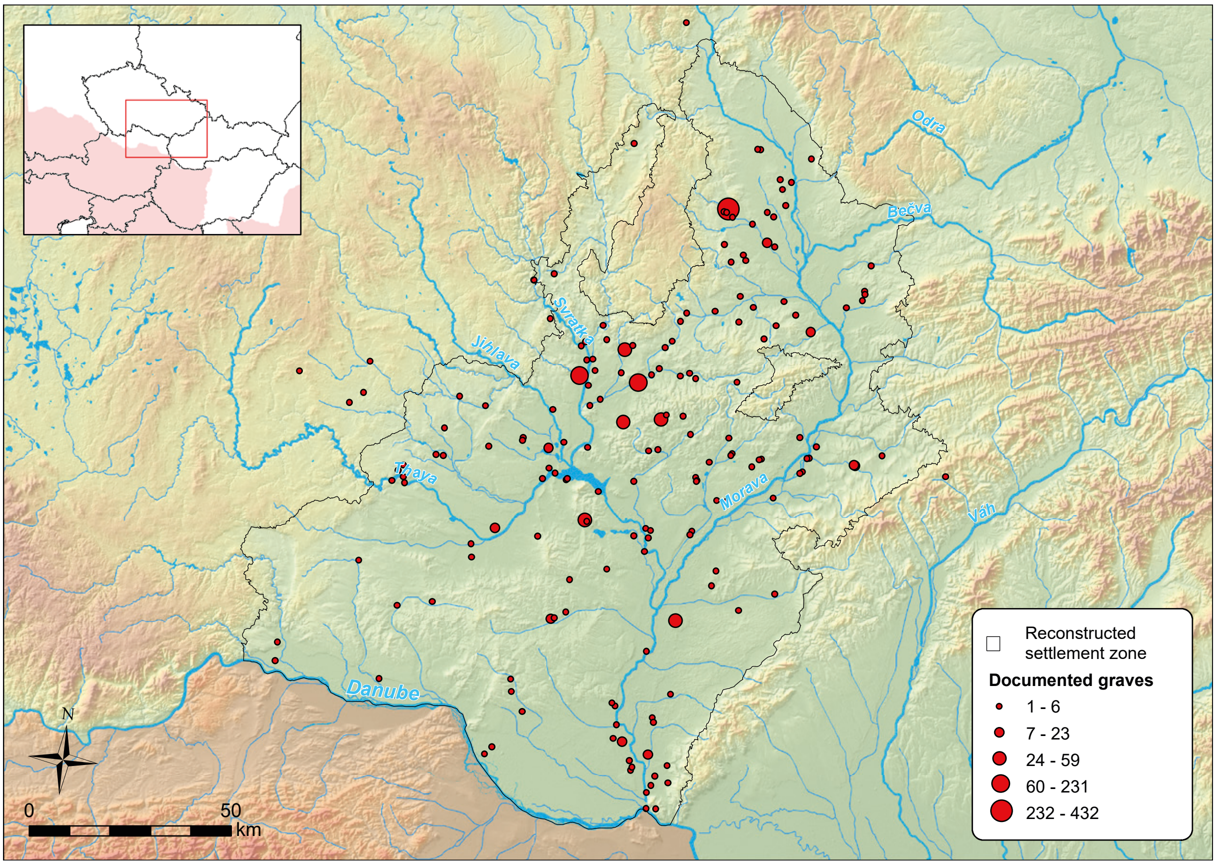
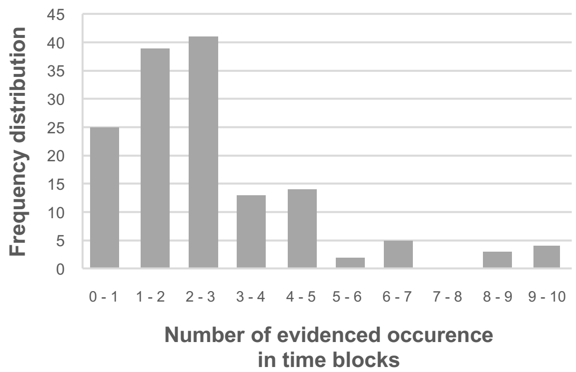


Fig. 5.7. Funerary areas. Quantitative outline of the documented funerary areas differentiated by the number of recorded burials (including Modřice 'Sádky').

one or more documented Germanic burial contexts – a grave. Therefore, a relatively large number of the funerary areas contain only a limited number of recorded (excavated/documented) burials. As a result, the total of 180 funerary areas within the MARCOMANNIA dataset, scattered throughout all parts of the 'Marcomannic' settlement region (Fig. 5.7), shows a distinctive imbalance in this representation, with only 11 containing over ten burial context records. Accordingly, there is only 58 funerary areas containing more than one documented burial context record. This phenomenon inevitably constrains the representativeness of the resulting temporal probability distribution. This state is the result of several factors. Amongst others, the transformation processes involved in funerary burial practices (foremost taphonomy conditions) combined with the later destructive interferences through ploughing and other near-surface activities. As an exceptionally shallow deposition type of archaeological context, the Germanic cremation burials are significantly prone to the proportional reduction of quality and quantity of information extractible. Nevertheless, despite the existing biases, their quantitative characteristics have undisputable significance for specific demographic aspects of the studied Germanic society. The input subset for developing the baseline proxy was eventually based on the 146 records with temporal identification available.



Graph 5.11. Funerary areas. Histogram of evidenced activity in time blocks (count of positive evidence).

	-30 – 0	0 – 50	50 – 100	100 – 150	150 – 200	200 – 250	250 – 300	300 – 350	350 – 400	400 – 430
Aoristic weight	2.9	13.0	18.3	20.8	28.0	16.4	20.1	13.2	8.7	2.9
Foundation (count)	29	14	10	20	24	25	14	8	1	0
Continuity (count)	0	28	37	33	47	24	43	49	32	23
Abandonment (count)	1	5	14	6	47	6	8	25	10	23
Difference (%)	4.8	16.7	8.8	4.0	12.0	-19.3	6.1	-11.3	-7.5	-9.4

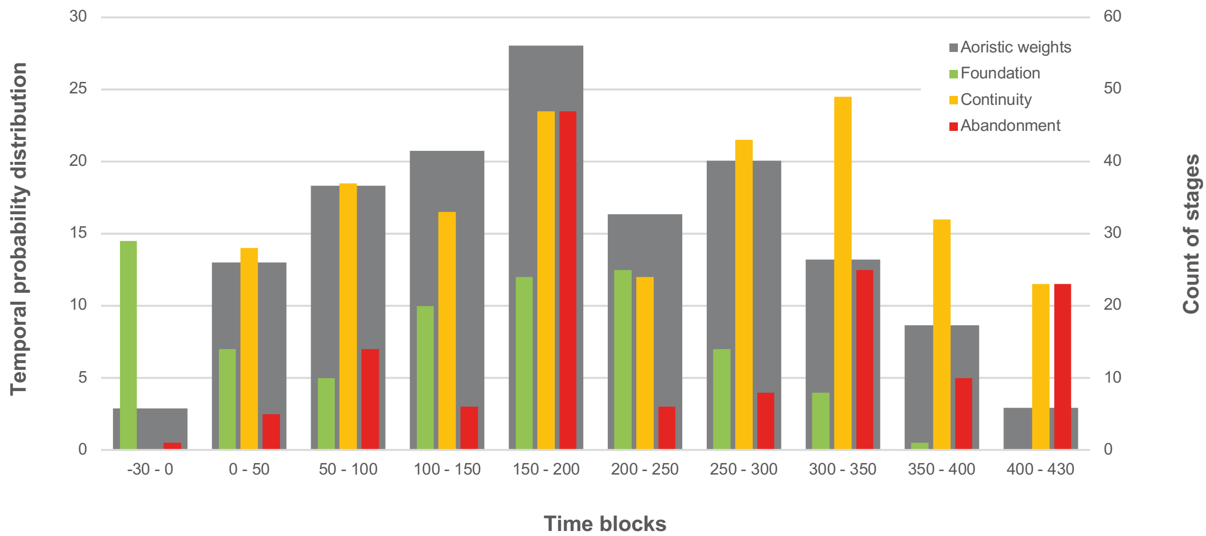
Tab. 5.3. Funerary areas. Quantitative outline of the main temporal distributions.

Based on the available data, the quality of the chronological determination within the subset could be demonstrated in the frequency of positively indicated primary function (Graph 5.11). Notably, the majority of the funerary areas (72%) are dated to periods ranging from one (50 years) to three (150 years) time blocks. Inevitably, this situation results from the overall incompleteness of archaeological information of most of the input objects. Nevertheless, the exceptions stretch for a lengthy period covering several centuries (e.g. Velatice 'Zadní Půllány' or Mikulov 'Rybníky').

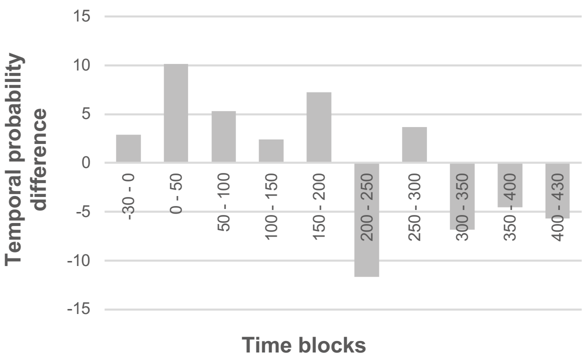
5.2.2 Baseline proxy of the funerary areas

Following the development proxy of residential areas, certain similarities and differences in development tendencies could be noted here (Graph 5.2). The growth observed during the first half of the studied temporal range tends to bear a more linear trajectory with two significant increases – at the turn of the Eras between the first and the second time block (16% of the total difference) and around the middle of the second century AD (time block 150–200 AD). Nevertheless, the first is considerably biased through the available data on the inception phases of the Germanic presence in the Middle Danube region. A significant decrease could be noted between the Early and Late Roman Periods, representing a difference of 19% of the temporal range, only comparable with the increase between the two first time blocks at the turn of the Eras. However, the low probability values during the 1st half of the 3rd century AD are followed by a non-negligible increase in the consecutive time block 250–300 AD. Eventually, from this point, there is a notable gradual decrease up to the terminal point of the period in question.

Like the residential areas, the temporal probability distribution and the dichotomically represented presumed *foundation* and *abandonment* (i.e. inception and cessation of the primary function) could be derived (Graph 5.12, Tab. 5.3). Firstly, a significant peak in the presumed foundation could be observed in the first time block. However, it is foremost the outcome of the number of funerary areas with the assumed beginning of the activity from phase B1, which propagates in a marginal part



Graph 5.12. Funerary areas. The baseline proxy base of the aoristic sum (grey) is complemented by the sum of evidenced *foundation* (green), continuity (orange), and *abandonment* (red) of the archaeological components.



Graph 5.13. Funerary areas. Difference in temporal probabilistic distribution between the consecutive time blocks.

to the first time block. However, the significant increase during the time block 0–50 AD underlines the initial income of the first groups of Germanic migration into the studied region during the initial phases of the Early Roman Period. The *foundation* frequency during the next three centuries shows relative harmonic ('normal' distribution) development with the maximum in the middle (the time blocks 150–200 AD and 200–250 AD). In contrast, the presumed *abandonments* have a much more varied distribution with a significant peak in the time block 150–200 AD. The marked frequencies are also observable during the 2nd half of the 4th century AD and at the terminal time block 400–430 AD. Simultaneously, these results are highly consistent with the analogous outputs for the *residential areas*.

Reflected through the temporal distribution of difference values (Graph 5.13, Tab. 5.3), the results for the *funerary areas* generally identify a positive increase of variable magnitude during the first two centuries AD and the opposite tendency for the following 3rd and 4th centuries AD, with an exception with the positive change to the time block 250–300 AD. The most significant decrease is recorded between 150–200 AD and 200–250 AD.

5.2.3 Burials and graves

From the methodological point of view, the burials or graves generally represent a unique temporal entity margined through the *terminus ante quem* combined with the almost exclusive closeness of the cremation burial (except for the destructive processes moving parts of the context outside, not inside).[23] Their significance and importance for archaeological research in many ways have been considered above, and it is not justified and required to outline the details of the archaeological knowledge on the Germanic burials of the studied region. Additionally, due to their significance in understanding material culture, they often play the role of a demographic proxy in various ways. Except for scant opportunities to contribute towards the research of the health conditions and other aspects of the past Germanic populations through the physical anthropological methods, they are being used in various equations for the assumption of the so-called average burying population size (e.g. Hassan 1981; Acsádi, Nemeskéri 1970, 65–67; Chamberlain 2006; Nikulka 2016, 139–141, Abb. 8).

It is an obvious but essential property of the vast majority of the graves that they almost entirely represent one individual, which is particularly consequential for, e.g. the wealth distribution proxy (see Chapter 8.2) or other demographic estimates. However, exceptions exist in the case of cremation burials with more than one individual,[24] as is attested more rarely in the cremation burial contexts (e.g. woman and a child in Opočno; Pleinerová 1995) such as the tomb of the rich princely grave from Mušov, which contained three individuals (Peška, Tejral 2002), which is presumably the result of multiple individual funerary depositions. Nevertheless, in this chapter, only the general temporal probabilistic tendencies based on the grave contexts are outlined. However, further temporal and formal structures and connotations towards the societal domain are reflected in further detail in Chapter 8.

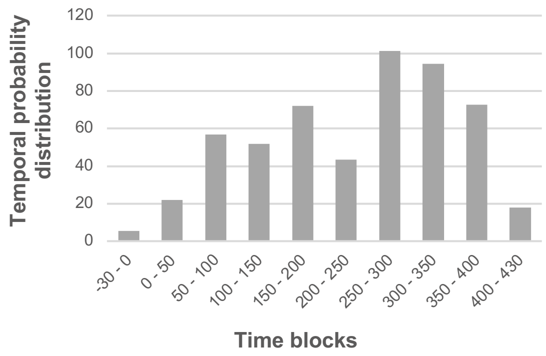
5.2.3.1 Input data

Generally, in burial practices, almost exclusivity has been recorded in cremation, while a relatively small but not marginal part (8%) is represented by inhumation (for more details see Chapter 8). They are confined in practically all the evidenced cases to the spatial extent of well-defined funerary areas containing more than one burial. However, a relatively high number of identified funerary areas contain information about only one grave. In the MARCOMANNIA dataset, there is a total of

23 For that reason, the baseline proxy subderivates of the foundation and abandonment derivation have not been derived as the burials formally represent the outcome of a singular event in the time, despite the fact that their dating is provided as a time interval of one or two sub/phases.

24 The potential of actual differentiation of the multiple individual burial are highly constrained by the limits stemming from the quality of heat-transformed anthropological material.

1,414 Germanic burials from the studied area, regardless of the existing archaeological data and its quality. Nevertheless, the information on some of them has been lost entirely in the past (e.g. Náklo 'Rybářky'; Tejral 1975, 105), is not presently available (e.g. Modřice 'Sádky'), or provides insufficient grave goods composition for a temporal identification (i.e. apart from the 'Roman Period' dating). In the end, 480 burial records contain this property and could be utilised for the baseline proxy construction.

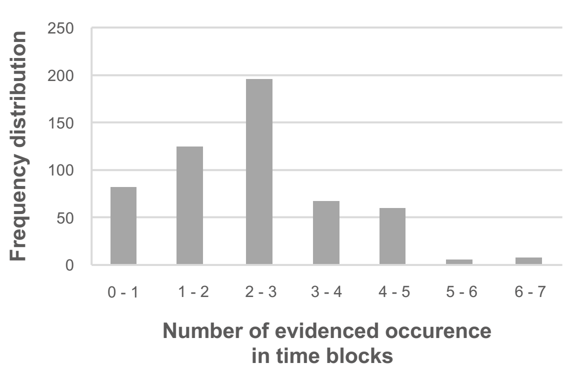


Graph 5.15. Graves. Baseline proxy of the temporal probabilistic distribution based on the aoristic probability distribution.

5.2.3.2 Baseline proxy of the grave contexts

From the dated burials, temporal probabilistic distributions have been derived, from which the following development tendencies could be drawn, which roughly correlate in general with the corresponding *funerary areas* for the first half of the temporal range. From a temporal perspective, based on aoristic sums, a significant increase is indicated during the first three time blocks, followed by a relative stagnation till the 2nd half of the 2nd century AD (Graph 5.14). However, a notifiable discrepancy exists in the distributions during the Late Roman Period (cf. Graph 5.15). After the decrease following the time block 150–200 AD, a staggering increase was recorded in the time block 250–300 AD. However, the high temporal probabilities are significant for the whole 4th century AD, after which the terminal time block 400–430 AD suggests a considerable decrease in burying activities at this stage.

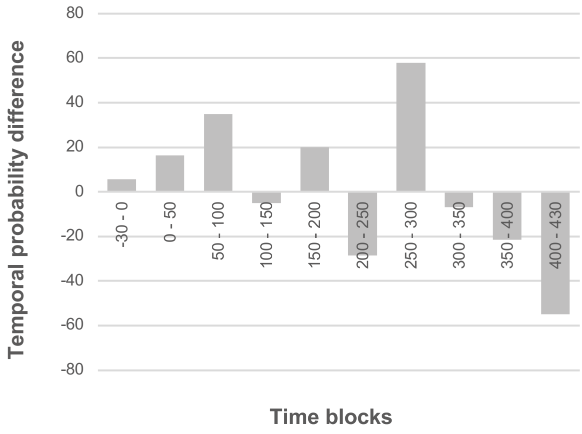
These development tendencies contradict the component-based baseline proxy (Graph 5.12), which suggests a lower overall occurrence during the Late Roman Period than in the second century AD and could be explained through several factors. Primarily, there is a well-observed shift in the number of recorded burials between the Early and the Late Roman Period, which is usually considered a supraregional type of component. In the studied region, such an area of activity is documented in Kostelec na Hané 'Prostřední půllány'. Also, in the case of the funerary areas with proven activities both in the Early and the Later Roman Periods (e.g. Modřice 'Sádky', Velatice 'Zadní půllány', Velké Hostěrádky 'Podliny'), the second temporal frame is almost always more quantitatively represented. Therefore, a relatively higher number of minor funerary areas could be generally assumed for the Early Roman Period. Thus, the aggregation of more residential areas in the use of 'regional' *funerary areas* is often associated with the emergence of higher representations of the Late Roman Period burial context in general. The existing theoretical models in archaeology suggest that this development is an outcome of the population influxes from the western Elbian cultural milieu during the Late Roman Period (Tejral 1982). This additional population would have to be well-distributed through the studied region.



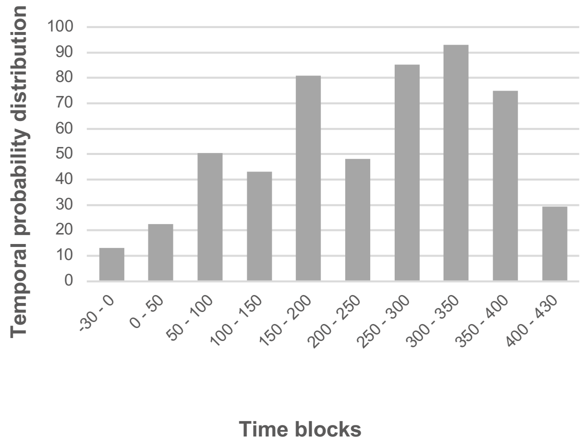
Graph 5.14. Graves. Histogram of proved periods of documented burial contexts.

5.2.3.3 Probabilistic simulation of the burial contexts

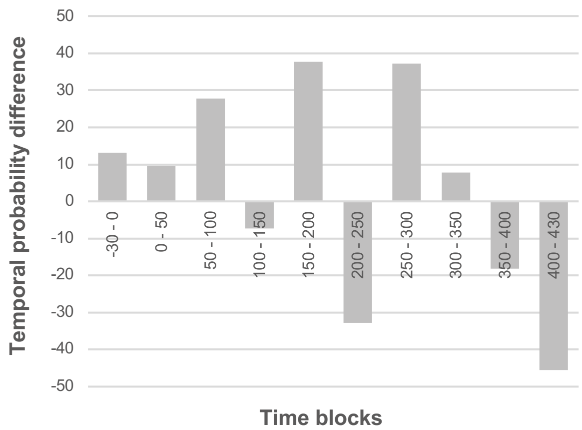
However, the additional computational analogue of the baseline proxy above could be derived from the temporal probabilistic data on the graves – the aoristic weights – assuming that any burial context results from a singular event at a particular time (Graph 5.16). In contrast, the aoristic weights reflect the generated probability of occurrence, often throughout the several time blocks. Indeed, in the case of the specific funerary contexts of the potential lengthy use due to multiple burials, such as the Mušov princely grave (Peška, Tejral 2002), this principle does not apply. However,



Graph 5.16. Graves. Temporal distribution of the difference between the time blocks based on the aoristic probability distribution.



Graph 5.17. Graves. Temporal distribution of the secondary proxy from the probabilistic simulations.



Graph 5.18. Graves. Temporal distribution of the difference between the time blocks from the secondary proxy from the probabilistic simulations.

this is also practically the only situation within the respective dataset. Therefore, one thousand iterations of the probabilistic simulation have been conducted, allowing each object of the analysis (grave) to appear only once in some of the time blocks with the positively deduced potential occurrence regarding the aoristic probability. The resulting development outline (Graph 5.17) generally shows similar tendencies to the one based only on the aoristic calculations. In the overall perspective, the differences between the Early and Late Roman Periods have diminished as the simulation results suggest higher representation for the time block 150–200 AD than in the baseline proxy. The drop, evident in the time block 200–250 AD, is also proportionately higher.

Therefore, the emerging distribution of the differences (change) between the consecutive time blocks (Graph 5.18) shows higher positive or negative values than in the case of an aoristic temporal probability-induced baseline proxy. This is foremost apparent in the differences between the 1st and 2nd half of the 2nd and 3rd centuries AD. Otherwise, the general increase/decrease trends have a similar development as demonstrated in the case of the baseline proxy.

5.3 The find categories of Germanic and Roman origin

Subsequent proxy indicators, either baseline or secondary (see Chapter 5), are based on archaeological information collected on individual movable finds – artefacts. They represent a diverse segment of data within the MARCOMANNIA dataset with substantial quantitative representation, interpretation, and possibilities. The included find categories comprise brooches, coins, bronze vessels, *militaria*, tools, and Samian ware. Their structural and morphological diversity also poses various limits and opportunities for the identification of temporal positions (dating). Simultaneously, both of the two main domains of origin (provenance) – Germanic and Roman (or Roman-provincial) – were included. The documented proportions in provenance in individual find categories naturally vary significantly and logically are dealt with according to the available interpretational frameworks of the Germanic milieu of the Roman Period. From the overall perspective, these selected quantitatively representative find categories contain information that can potentially be used to interpret various aspects of the Germanic societies of the 'Marcomannic' settlement zone.

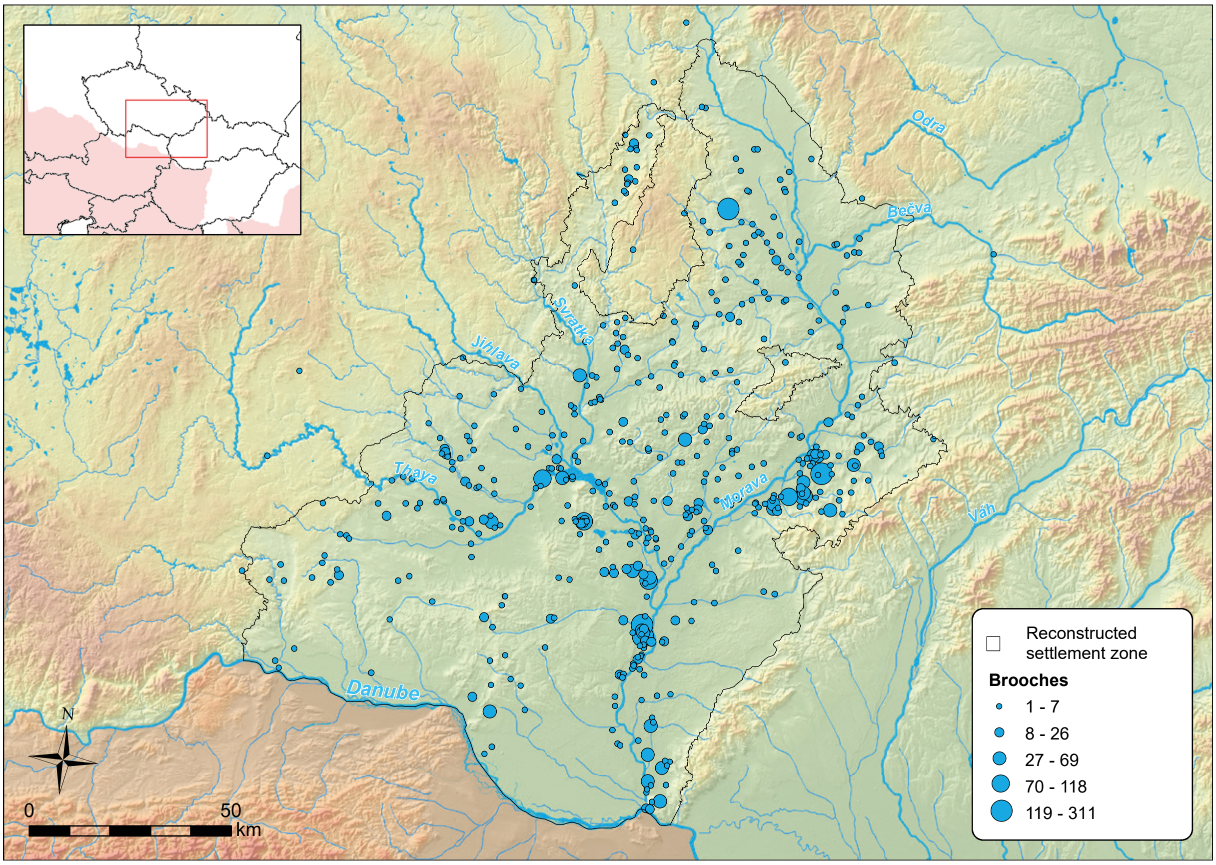


Fig. 5.8. Brooches. The quantified spatial distribution of all the brooches.

5.3.1 Brooches

The brooches of local Germanic or Roman origin represent one of the dominating and pivotal find categories in archaeological research (cf. Droberjar 2017). From the viewpoint of 'archaeological time' and the potential of chronological determination, they provide (alongside Roman coinage and metal vessels) a distinctive medium for dating based on substantial changes and variability in types and forms, allowing the determination of relatively narrow temporal margins of the potential period of use, as they have been a subject of rapid change in style and mode preferences, stimulated by their frequency of use. Simultaneously, such distinctive variability and significant representation within the dominant types of areas of activities have given rise to countless typological evaluations (e.g. Exner 1939; Jobst 1975; Schulze 1977; Cosack 1979; Riha 1990; 1994; Kunow ed. 1998; Schulte 2011) since the seminal work by O. Almgren (1923). However, the detailed typological aspects and their implication are not dealt with in this chapter, and it is the main objective to derive temporal distribution patterns, i.e. the baseline and secondary proxies. Nevertheless, the available typological identification within various classification/typological systems has been collected within the MARCOMANNIA dataset during the data heuristics process. However, a more detailed examination of these aspects goes beyond the scope of this book.

Their primary practical function as clothespins and cloth fasteners is undisputable and provides grounds for further assessments, foremost the demographic connotations. Apart from the practical function of utility, they undoubtedly played decorative functions through costume adornment as well. Indeed, the outstanding quantitative representation throughout Germanic societies generally presupposes other functions, roles, and ways of utilisation. The quantities also suggest potential use as a 'relatively' standardised mean of exchange through barter economic interactions. Nevertheless, symbolic and ritual dimensions also have to be considered as common denominators on the level of an individual within the social space and identity representation (e.g. Heeren 2014).

Their role as a demographic proxy, corroborated by their omnipresence and everyday use within Germanic society, could be well-substantiated. It could be assumed that the proportion of brooches

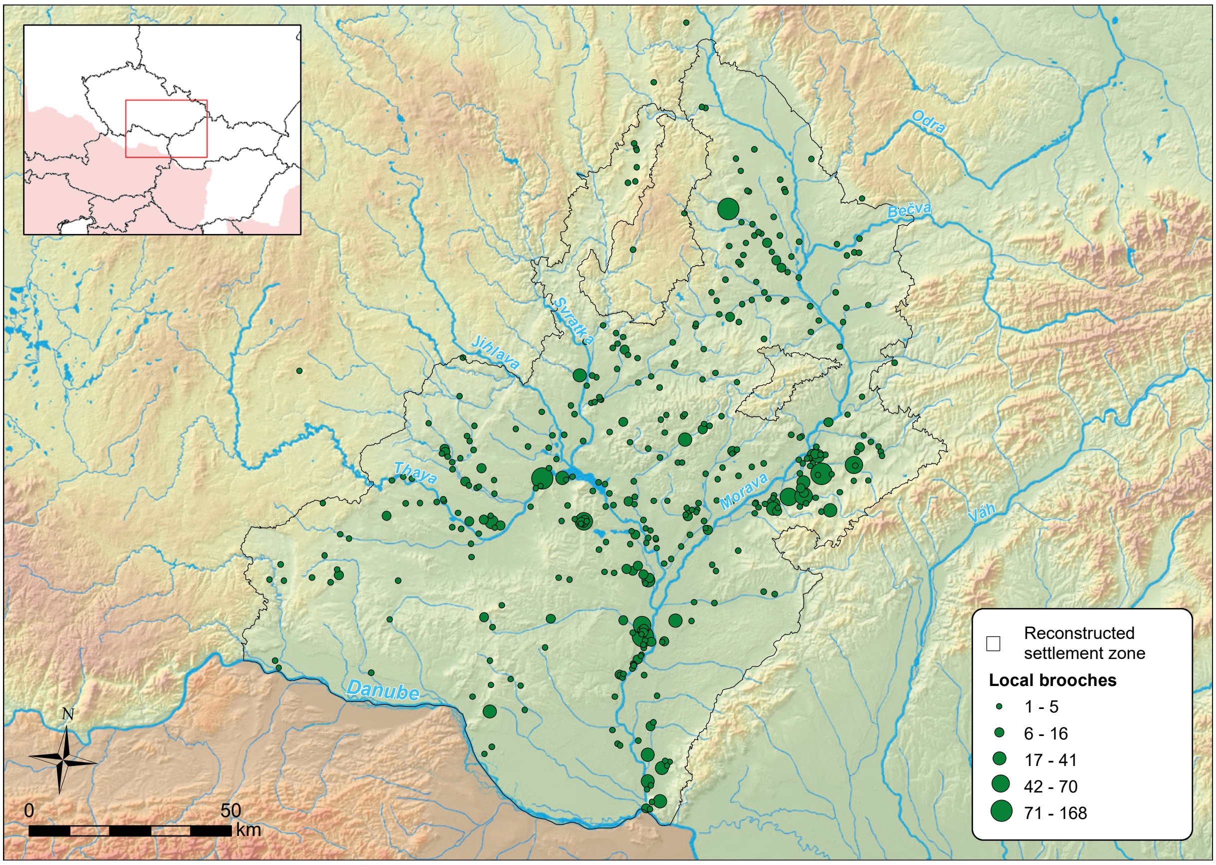


Fig. 5.9. Brooches. The quantified spatial distribution of the brooches of Germanic origin.

within the archaeological record, up to an extent, positively correlates with the respective population size. Therefore, conspicuous patterns of the spatial distributions may provide the basis for the assumptions on the migration processes (e.g. brooches A43, cf. Rajtár 2018). The use was general throughout the entire societal context, vertically or horizontally stratified[25] (cf. Fig. 5.8–5.10), obviously with proportionate scaling of quality and represented value. Unlike other find categories, the subset of brooches contains significant proportions of Roman products, whose representation also changed during the studied period. On that account, the brooches also contain significant explanatory potential regarding Roman-Germanic political and economic interactions. Therefore, the resulting baseline proxies contain an effect of multiple dimensions, and its interpretation possibilities have to be dealt with cautiously.

Changes in qualitative and quantitative parameters of data could be associated with the expansion of the metal detector finds (Komoróczy et al. 2021), which significantly increased the available data on the brooches (Komoróczy, Vlach, Kmošková 2024). The phenomenon has differentiated dynamics within individual respective modern countries, overlapping the extent of the 'Marcomannic' settlement zone regarding the geopolitical situation and the respective legal conditions for its realisation. The last systematic inventory from Moravia by I. Peškař (1972) recorded 447 brooches. So far, the only more substantial published detector inventory is a monograph by T. Zeman (2017a) covering the extent of the middle reaches of the River Morava. His inventory includes the most significant number of brooches, 1,020 items. Outstanding information sources from the Lower Austrian border region with Slovakia and Moravia (cf. Atzmüller 2010) were also obtained through metal detecting. It points out the significance of metal detection and its implication towards the quantitative parameters of archaeological sources of information.

25 In the burial context, they represent one of the most frequent items of the recorded grave goods, which points to their firm position within the composition of a standard costume.

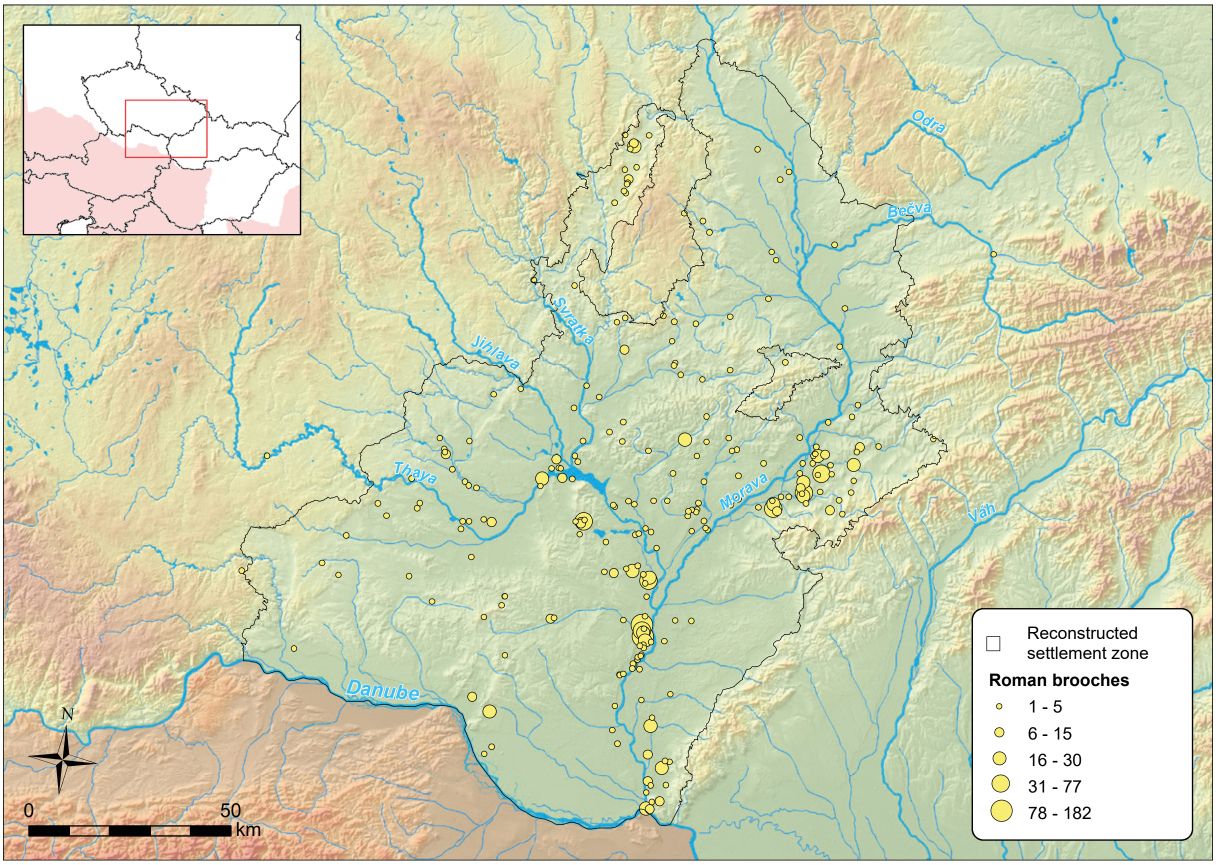
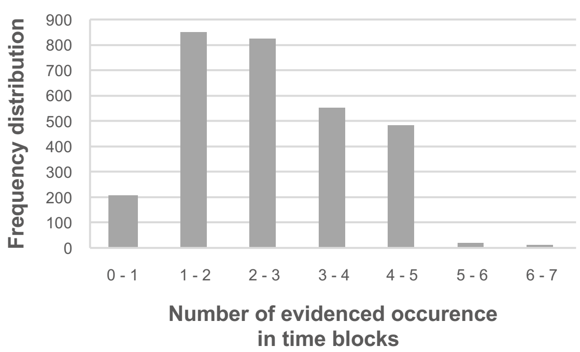


Fig. 5.10. Brooches. The quantified spatial distribution of the brooches of Roman origin.

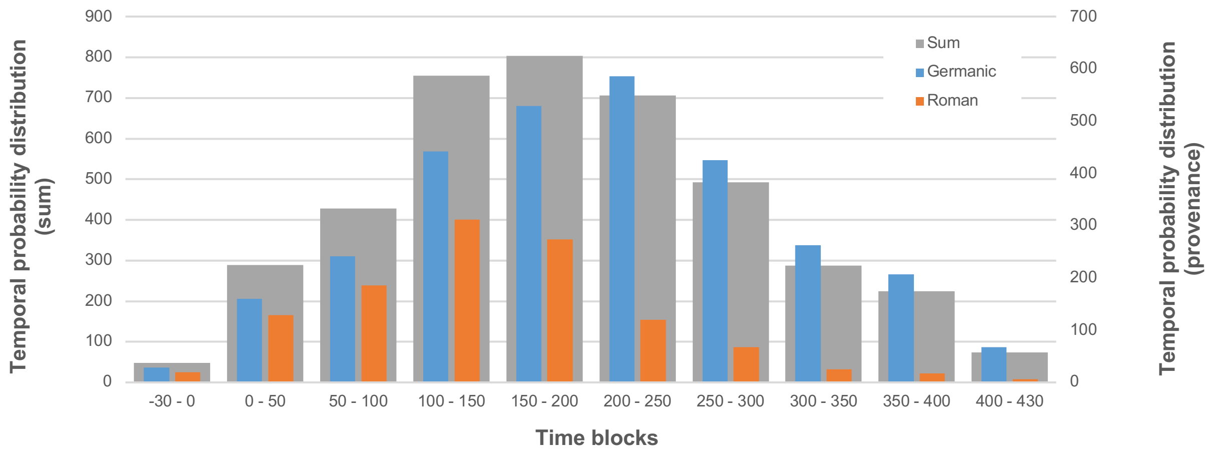
5.3.1.1 Input data

The MARCOMANNIA dataset currently contains 4,006 records of brooches. Unfortunately, 1,100 records lack typological or chronological information, so they cannot be included in the baseline and secondary proxy derivation process. Therefore, from the total, the chronological and typological (either general or detailed) determination is available in 2,906 cases, which were included in the input subset.

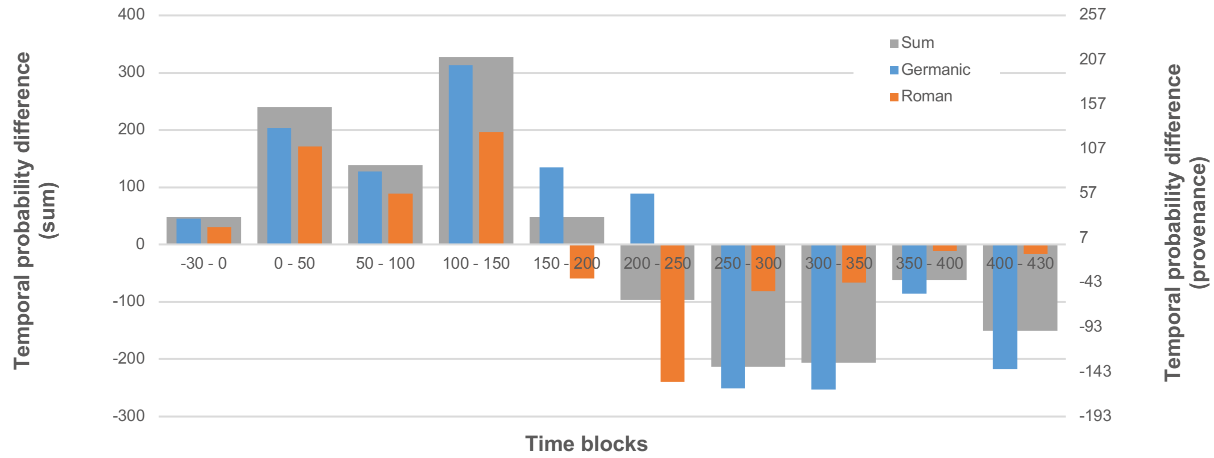


Graph 5.19. Brooches. Frequency distribution of the number of positively identified time blocks.

From this amount, 1,141 brooches of Roman origin were identified, meaning their 39% representation. For example, the same proportion was evidenced within the large assemblage from the middle courses of the River Morava (Zeman 2017a, 64), which suggests the general applicability of the percentage representation to the study region as a whole. The higher chronological sensitivity of the Roman Period brooches varies to an extent during the study, with changes in evidenced typological spectra and their dating possibilities (Graph 5.19). About ⅓ of the input subset is provided with the dating precision up to two time blocks (roughly 200 of them to one time block). Notably, only a few brooch-find records have temporal margins stretching over more than five time blocks. The significant bias in general consideration of this find category and the derived quantitative representations brings the used material. Significant underrepresentation of the iron in the find records (only 6%) is primarily the result of the material durability and its differentiated potential to survive in various types of archaeological contexts. However, this factor, up to an extent, inevitably distorts the resulting temporal probability distribution patterns.



Graph 5.20. Brooches. The baseline proxy of the probabilistic distribution is based on aoristic sums. Two temporal distributions are provided based on the identified origin of brooches.

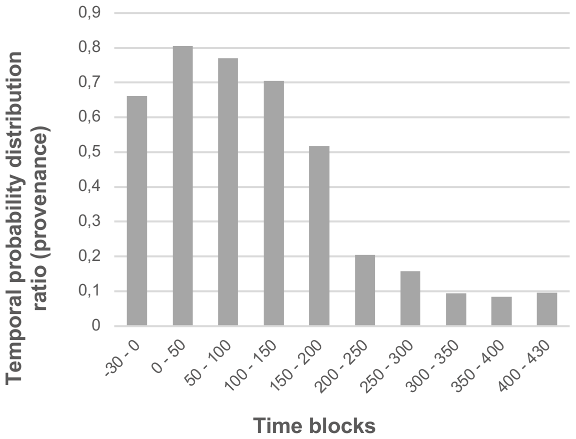


Graph 5.21. Brooches. The difference in the baseline proxy values between the neighbouring time blocks.

5.3.1.2 Baseline proxy of the brooches'

The substantial input subset provided the basis for one of this book's most statistically significant baseline and secondary proxies (Graph 5.20). The total numbers show a generally consistent normal distribution shape through the aggregated temporal probabilities. Although within this relatively uniform shape of the temporal distribution, remarkable patterns through provenance could be observed, implying significant shifts not only in terms of fashion preferences but potentially also in far-reaching implications of the political, economic, and social nature. The gradual decrease in Roman production occurrence is a general tendency observed in archaeological data. However, this trend could be also observed in the western border provinces of the Roman empire during the 2nd half of the 3rd and the 4th centuries AD (e.g. Erdrich 2001; Hoss 2016). The distinct presence of Roman-origin brooches, especially the series of strongly profiled brooches, occurring in the number of typological manifestations throughout the Early Roman Period is clear. In the 1st century AD, the sums of the aggregated temporal probabilities were almost equal to that of Germanic brooches.[26] From the beginning of stage B2, this ratio gradually decreased, and after the 2nd century, they were already a noticeable minority (cf. Tejral 1998). It is reasonable to assume that the Marcomannic Wars and their aftermath played a role in this trend (e.g. Tejral 1983). However, the

26 This, however, does not mean the equal count as it is necessary to take into account the dating possibilities of the brooches at the initial stages of the Roman Period and the nature of the derived temporal probability distributions.



Graph 5.22. Brooches. The ratio between the baseline proxies of the Germanic and Roman-origin brooches.

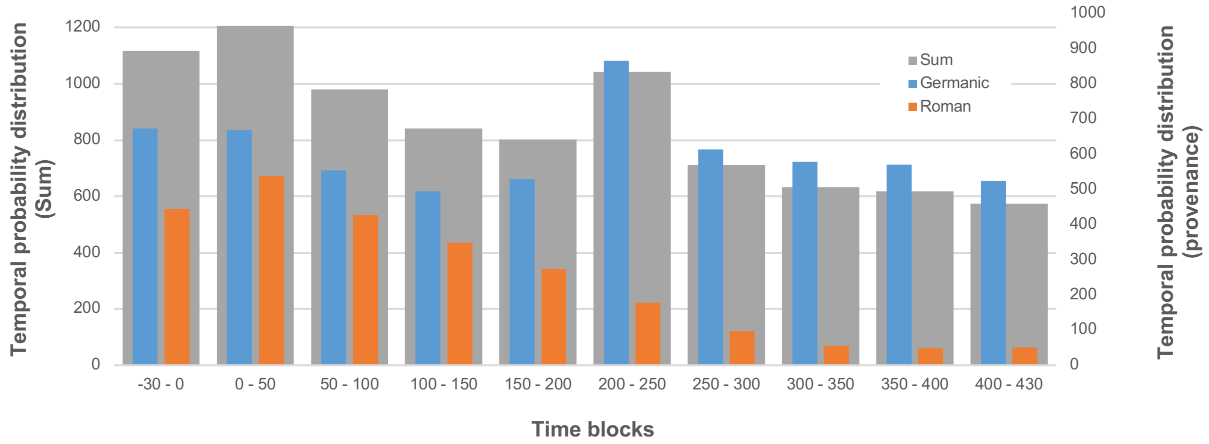
peak of their probabilistic distribution was already reached during the 1st half of the 2nd century AD, which suggests the changes in patterns and means through which this production reached the Germanic milieu. Therefore, no distinctive change between the 2nd and the 3rd centuries AD, such as in the case of metal vessels (see Chapter 5.3.3), can be observed in this case.

The temporal distribution of the differences between the consecutive time blocks of the baseline proxy also provides a further perspective on the development in this specific find category (Graph 5.21). The maximal positive change is evidenced in both provenances during the time block 100–150 AD and marks the end of the predeceasing variable increases in both provenances. The consecutive two time blocks, 150–200 and 200–250 AD, show the same trend in the increase in Germanic and decrease in Roman brooches. They are followed by the two most distinctive decreases of the same composition in provenance. The negative trend continues through the terminal parts of the studied temporal extent.

The ratio between temporal probability distributions of the Germanic and Roman-origin brooches – baseline proxies[27] – underlines significant shifts (Graph 5.22). There are strikingly high proportions of Roman-origin brooches during the first five time blocks until the turn of the 2nd and the 3rd century AD. The peaking ratio during the time block 0–50 AD reaches above 1 : 0.8, i.e. almost parity in both provenances. The distinctive ubiquity of the Roman brooches within the Germanic milieu is inevitably connected with questions regarding the differentiated ways and conditions under which they were transferred to the Germanic context and re/distributed there (see Chapter 6.3).

As was suggested at the beginning of the chapter, the brooches in general potentially contain a 'signal' on the changes in population size (cf. Chapter 7.3) on the grounds of connotation and association towards the level of individuality (i.e. on standard conditions, most of the individuals wore expectably one brooch) and high loss rates, which markedly transpired through the finds from metal detecting. This assumption is also clearly justified by normalising the temporal distribution of all archaeological components (Graph 5.23). Notably, a relatively flat development could be observed in the brooches of Germanic origin. In this type of temporal distribution, not only the gradual decrease of the appearance of Roman production but also in all documented brooches, could be observed in the long-term gradual trend of a relative decrease within the 'Marcomannic' settlement zone. However, under the expectation that the normalised temporal distribution should correlate with the population size, the higher values are observable foremost to the first half of the Early Roman Period, stimulated foremost by the high frequency of brooches of Roman origin. It could be assumed, the volume 'above consumption necessity' potentially suggests their role in economic structures, and their uniformity could have provided the same standardisation as in the case of later Roman coinage (see Chapter 5.3.2). Such a notion would suggest the symmetrical shift in the temporal trend of these two specific categories of Roman origin. As high-quality products and materials from the milieu beyond the Germanic domain, it could be suggested that the Roman-origin brooches would at least partially play a role within the 'prestige economy' of the Germanic chiefdom social organisation (e.g. Earle 2011), either as a medium of redistribution and maintenance of the key social relations (between the retinue, community members and chief), or for aggregation of value, material for further use or as means of exchange. Nevertheless, their significant diffusion and high quantitative representation within the studied context also suggest their limited 'exceptionality' and 'value' in this socio-economic system, corroborated by the contained amount of metal.

27 It has to be noted that the ratio is calculated from the temporal probability distribution values, based on aoristic calculations. Therefore, the results should not be seen as probabilistic ratio not based on individual objects, such as in the case of the Roman coins.

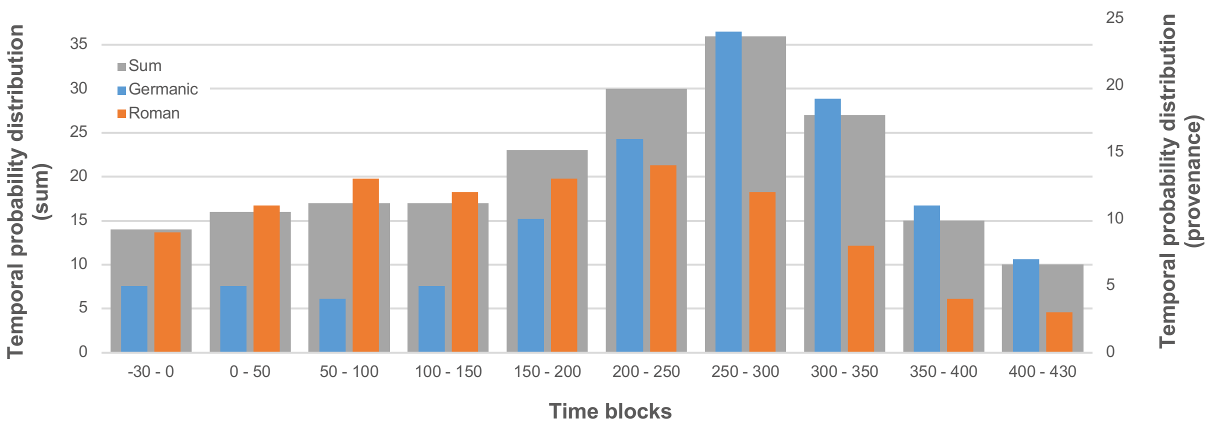


Graph 5.23. Brooches. The baseline proxy of the probabilistic distribution is based on aoristic sums and correlated by the distribution of all dated components.

5.3.1.3 General typological variability

Differentiated perspectives could be additionally drawn from the temporal distributions of the evidenced general brooch identification in the broadest sense (e.g. knee brooch, bent-foot brooch and their countless derivates, crossbow brooches), leaving aside the detailed association of brooches within the frame of many existing elaborate typological systems. Obviously, this approach provides a significant simplification of the complex past reality, where wide range of factors played role. Various constraining phenomena (e.g. availability and affordance of Roman production and its association with military or civilian environment, cultural preferences, available technologies and materials). Nevertheless, it aims to provide underlying trends in variability of this unique find category on temporal scale. In total, 53 such general classification categories have been identified within the MARCOMANNIA dataset. Even despite a substantial simplification, the resulting temporal distributions may highlight the underlying trends in variability in evidenced brooches (Graph 5.24), especially considering provenance differentiation.

Despite significantly different trends in the frequency of the evidenced general identifications, the mean of both provenances equals around ten. On the other hand, the marked differences could be seen in maximum numbers, which in the Germanic production reaches 24 during the time block 250–300 AD and generally dominated during the Late Roman Period. Conversely, the Roman-origin brooches follow a relatively consistent pattern, fluctuating around 12 identifications until the time block 300–350 marked their gradual decrease. Therefore, two

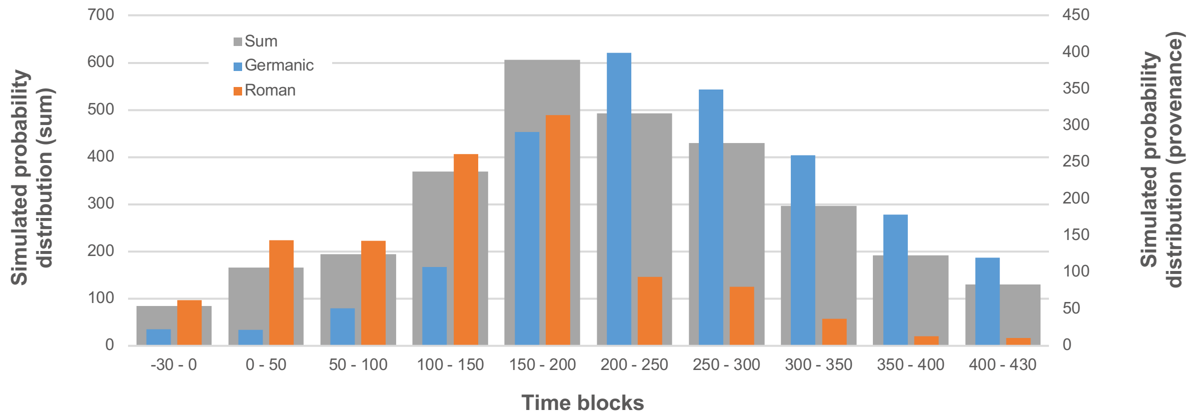


Graph 5.24. Brooches. Temporal distribution of counts of the evidenced general identifications.

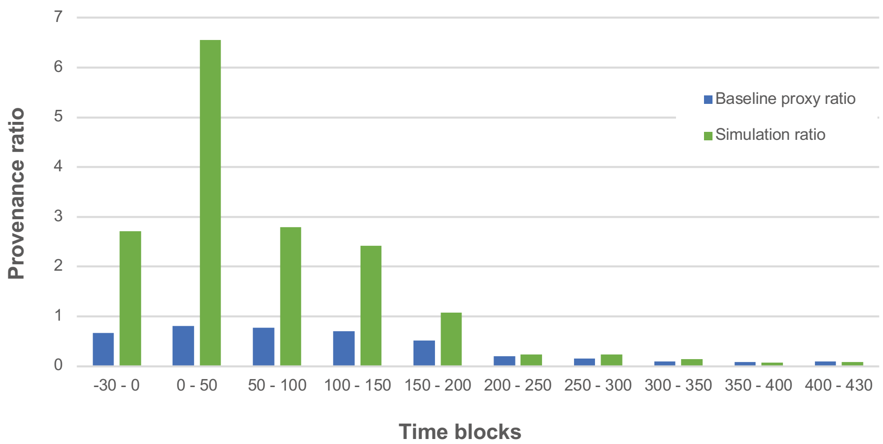
tendencies towards the main baseline proxy could be seen in both provenances. There is either general connection and positive correlations in the case of the Germanic brooches), but also certain independence in the Roman-origin brooches, where the continuity of the variability is apparent in the time block 250–300 AD. However, the decrease in representation of this material started two time blocks earlier.

5.3.1.4 Probabilistic simulation of the brooches

The computational technique of probabilistic simulation modelling has been used to refine the main temporal probability proxy (Graph 5.25), which deals with the biases given by the aoristic calculations that assign potential occurrences within individual time blocks. The presumed period of occurrence (i.e. archaeological dating) of some of these typological categories and their derivates is considerably long, especially during the Late Roman Period (e.g. bent-foot or crossbow brooches and their numerous variants and derivates). Therefore, the principle of the 'one time block' occurrence has been included based on an assumption about the actual use (active presence within the 'living culture') within only one time block, i.e. 50/30 years. It has to be pointed out, that the documented reparations and maintenance of brooches could have significantly prolonged their lifespan (e.g. von Richthofen 1998). However, it could be assumed that the brooches used in their primary function within living culture for two time blocks (i.e. for a maximum of 100 years) might not be an ordinary phenomenon. This find category within the scope could be reasonably short-lived from several perspectives. They have been used daily, and the wear rate was relatively high. It is also corroborated by their most frequent occurrence within the disturbed cultural layers, as mentioned above. Consequently, the results of simulations represent the count of individual brooches from the input subset, unlike the baseline proxy representation through the aggregated probability temporal distribution.



Graph 5.25. Brooches. Results of the probability simulation of the brooches by provenance.



Graph 5.26. Brooches. Comparison of the ratio between Roman and Germanic brooches using baseline proxy and simulation results.

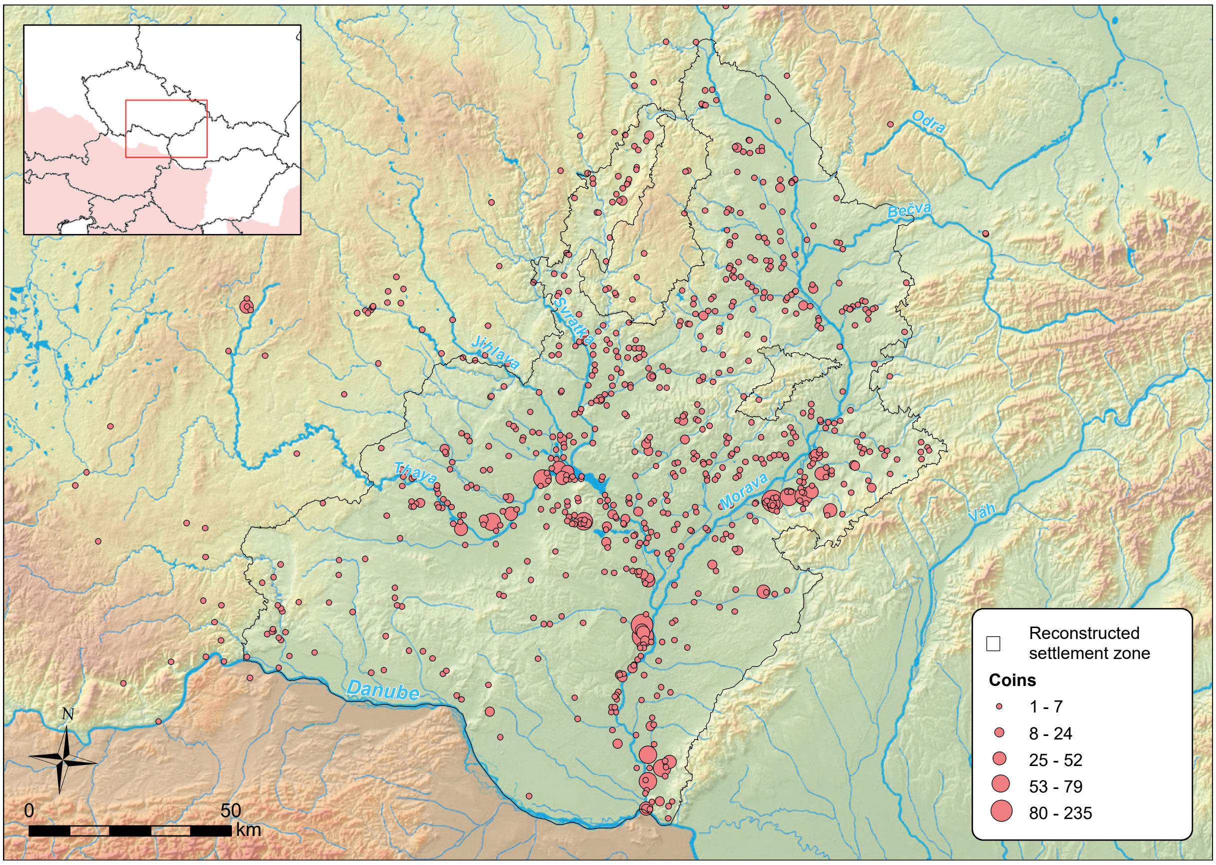


Fig. 5.11. Coins. Quantitative spatial distribution of all coin finds registered per site.

The simulation results also show much more significantly differentiated weight points in the temporal probability distribution of the Roman and Germanic brooches. Foremost, during the Early Roman Period, potentially distinctively higher representations of the Roman-origin brooches were indicated than in the results of the baseline proxy provenance differentiation, going significantly beyond 1 (Graph 5.26), which means that the Roman-origin brooches surpassed the Germanic ones considerably in comparison with the baseline proxy (Graph 5.20). Notably, during the time block 0–50 AD, more than six times greater disproportion was suggested (6.5 : 1; Graph 5.26). However, the ratios reached parity during the time block 150–200 AD, and the balance of brooch origin representation significantly shifted towards the dominance of local production. Furthermore, from the demographic perspective of the secondary proxy, there are lower numbers suggested during the 1st half of the 2nd century AD than anticipated from the baseline proxy, as well as the residential area proxies. Therefore, both approaches (baseline and secondary proxies) provide relatively different results for some periods. However, despite the disparity of quantities, the demonstrated trends are generally similar.

5.3.2 Roman coins

The Roman coins, transferred outside the milieu of their origin and eventually deposited in the 'barbarian' context, pose opportunities and pitfalls to the interpretation possibilities of their function and meaning within the available theoretical models on the complex and multifaceted Roman-barbarian interactions in general. The nature and meaning of this phenomenon have been debated in multiple instances (from extensive amount of related references e.g. Lind 1981; Erdrich 2001; Bursche, Ciołek, Wolters 2008; Horsnæs et al. eds. 2005). Beyond the scoped region, there is extensive evidence of such phenomena in many parts of *Barbaricum*. The Roman coinage in the Germanic contexts in the majority of the respective regions (e.g. Germany: Wigg-Wolf 2008; Poland: Bursche 2002a; or southern Scandinavia: e.g. Bursche 2002b) reach a significant proportion of the available metal material culture, and in this phenomenon the 'Marcomannic' settlement zone is no exception (Fig. 5.11).

Its general interpretation margins within the study region have shifted over the last decades, foremost due to a significant increase in the material base of Roman coinage through metal detecting (e.g. Bursche 2008, 396; Zeman 2017a; Komoróczy, Vlach, Kmošková 2024), which presently provides a substantial information basis towards the evaluation of the quantitative, formal, spatial and temporal aspects. The formalisation and digitalisation of the available information on Roman coinage inevitably preconditions such an approach. Naturally, the series of aspects and issues constrain their interpretation possibilities, such as the context of origin (e.g. hoards, stray finds) and quality of input data (depending highly on the period and find circumstances, including documentation of evidence). However, the almost near ubiquity of this non-local find category of the specific primary function makes the Roman coinage one of the most intriguing baseline proxies in this study with particular implications for understanding 'systemic' aspects of the studied Germanic societal context.

Since the beginning of the archaeological research on the ancient Germanic societies in Europe, there has been a debate including other relevant fields (foremost numismatics, history, or social anthropology) on the actual meaning, function, and use of the Roman coinage within the Germanic context (cf. Bursche, Ciołek, Wolters 2008; Hedeager 1988; 1992). There is no intention to outline it in all relevant details, but some main features and aspects should be summarised and outlined briefly. In a nutshell, after the period of primarily materialistic market economy-based theoretical approaches to understanding coins within the context of pre-state socio-political entities, a new paradigm emerged in the late 1940s, represented by the substantivist school established by K. Polanyi (1968) and his followers (e.g. Reining 1959; Dalton 1965; Hodges 1982; 1988), which disputed the market economy views on the issue (Bursche 2008, 396–397). On the grounds of drivers of such economic structures, it was argued that they were different or absent in the 'primitive' pre-state economies (e.g. need for profit). Simultaneously, the focal point of the role and function of money lies in four main conditions (in general terms, a means of payment and of exchange, standard of value, and value guarantee) for its classification as 'all-purpose money'. It has been observed that in any pre-state economy, only some are met, and never are all. In such situations, they are referred to as 'limited-' or 'special-purpose money' (e.g. Dalton 1965, 48–49; Bursche 2008, 397). Recently, the assumptions on specific ways of use in non-market economies have lead to theoretical concept of 'social currencies' (Graeber 2012). The existing theoretical models concerning societies on the respective levels of complexity point out that applying principles from the market economy is misleading (cf. Bursche, Ciołek, Wolters 2008). For example, an analogous situation could be drawn from an ethnographic parallel of the Zande economy of Belgian Congo, where the currency was used only for external transactions and internal transactions were conducted through the local traditional one (iron spears; Reining 1959; Bursche 2008, 397).

There is no reason to doubt that barter was a primary form of the value (goods and service) exchange form within the Germanic chieftaincies (Bursche 2008, 398–399). None of them developed a monetary system of their own, as in the Celtic societies before. However, the economic power of the Roman Empire emitted and propagated its advances significantly, intentionally (e.g. gifts, subsidies) or as a collateral consequence (i.e. Roman-Germanic trading activities, integration within the local exchange practices). Obviously, the Germanic economy was not a market one and was oriented primarily to subsistence, where the Roman coins played a specific role. The societal alignment of the Germanic chiefdom of the Roman Period reflects the pre-state complexity (foremost the hierarchy of settlement structure and the emergence of the centralisation of power control and administration) but with some properties of the early-state analogues (Grinin, Korotayev 2011; 2017), especially in terms of territory and population size. It is apparent that the actual coin values within the Germanic milieu differed from the environment of origin, as the central authority did not have power there and was inevitably shaped by the local context (Bursche 2008, 398). Simultaneously, the significance of relative 'standardisation' in the Roman coinage, despite the shifts in purity in 'silver' denominations, has also had a structuring effect within the Germanic context, which would potentially propagate in some forms of adjustment of a 'value system' (e.g. Kehne 2008, 79; Kunow 1989, 59) within the margins of applicability of this 'special purpose money'. It is also essential to keep in mind that the archaeological data reflect the fraction finally deposited within the Germanic environment, and the nature of this find category is embedded in circulation, which makes them different from other Roman-origin items (actual 'imports'), which were intended for the end use in the Germanic domain. Therefore, a proportion of coins within the Germanic environment found their way back to the Roman environment as a part of various types of transactions (economic/trading, political, etc.).

The scientific research differentiates various functions, ways of use, and means through which they were transferred into the Germanic context and used before their final deposition (e.g. Bursche 2002b; 2008). Undoubtedly, they played the role of a means of the Roman-Germanic political interactions conducted as various 'loyalty payments' – subsidies, donativa or bribes. Along with it, a proportion of Roman coinage circulations were connected with the military activities either as military salaries of the Germanic mercenaries or as the outcome of the various warfare effects (i.e. direct Roman military presence during the Marcomannic Wars, looting and pillage of the Germanic raiding activities, war prisoners' ransom, 'reparations' and compensations). Substantial implications could be logically associated with the economic aspects. Firstly, their origination from the direct or circumstantial trading activities with the Roman milieu and consecutively within the local Germanic domain (e.g. the differentiated role in the potentially local 'value/goods' exchange activities and accumulation of the value in easily transferable form, material intended for reuse in the local metalworking activities. Within the Germanic context, they are also expected to suit the specific purposes for politically oriented transactions, such as tributes, ransom, dowry, heirlooms and various services (Bursche 2008, 398). Therefore, within Germanic interactions they played role of a 'social currency' (Graeber 2012). Additionally, there was substantial cultural interference and ideological influence through symbolic communication and information dissemination through circulating the Roman coinage within the Germanic milieu on a general scale (e.g. Beare 1964; Wigg-Wolf 2008). Last but not least, they partially assumed a decorative function as a part of the set of visible symbols of an individual (drilled coins used as pendants or that were part of jewellery and ornaments).

The available narrative sources provide little information on the matter, and the only more detailed exception comes from Tacitus,[28] where he briefly addressed the Germanic attitude toward Roman coinage (e.g. Kehne 2008). These passages have been the subject of numerous studies (e.g. Kolendo 2008; Günther 2020), but in general, reflect their certain degree of integration into the Germanic milieu. It also suggests a differentiated relation to the Roman coinage; it does not explicitly testify to everyday and ubiquitous use throughout the Germanic domain. Simultaneously, it suggests their use, at least in economic contact with the Roman milieu, without further differentiating its nature or entities involved on the Germanic side. Attention is also drawn by the geographical implication of the narrative (Günther 2020) as it differentiates the Germanic populations closer (*proximi*) and further (*inferiores*) regarding the stated role of Roman coins. Even though such a statement is not lacking in elementary logic (least-cost principle of ideas), according to the present state of archaeological knowledge, the spatial distribution of the Roman coinage extends over a significant territorial domain of the ancient Germanic world with varying and sometimes outstanding quantities to the north would disprove (e.g. Vistula valley, or Denmark; Bursche 2002b) the geographical determination in their spatial distribution. Yet, proximity does not appear to be a determinant in other Roman 'import' find categories (e.g. metal vessels, brooches).[29]

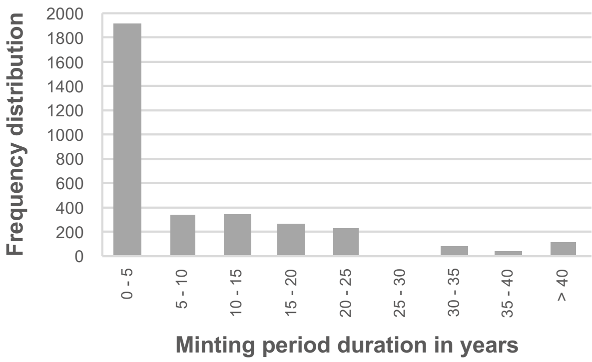
Tacitus's subsequent statement includes the Roman coins in the list of the forms of accepted gifts towards the Germanic milieu.[30] Therefore, according to Tacitus, around the turn of the 1st and 2nd centuries AD, at least some of the Germanic power entities – chiefs – could be considered sufficiently acquainted with the concept of their use and integrated them into the portfolio of the material means to extend the power practices and strategies. This remark is also consistent with the available data for the 'Marcomannic' settlement zone, exhibiting the first more significant increases during the last third of the 1st century AD. However, these narratives have to be considered in the context of the author's agenda, putting some aspects of the Germanic and Roman milieus into sharp contrast to prove it, as well as reflecting the traditional topos of the perception of the culturally different milieu (e.g. Beare 1964; Lund 2007; Rives 2011). These remarks could also be complemented by occasional references (Kehne 2008), e.g. the mention of the help to Marcomanni and Quadi provided through

28 Tac. *Germ*. 5.
29 See Chapter 5.3.1, 5.3.3.
30 Tac. *Germ*. 15.

monetary subsidies along with military assistance[31] or provisioning Cherusks with money instead of such assistance during the reign of Domitianus.[32]

Simultaneously, there are apparent differences in context-based representations and their interpretation possibilities (cf. Bursche, Ciołek, Wolters 2008). In large parts of *Barbaricum*, the primary source of evidence are hoards (e.g. Lind 1981; Dymowski et al. 2020). Notably, within the study region, most coins with the information required for basic temporal projections are evidenced as individual finds, with a relatively minor proportion originating from the hoards, comparing the other regions (cf. Reece 2008). Also, their marginal representation is evidenced within the funerary context and the coin finds are almost exclusively bound to settlement-related contexts (usually a large number of individual stray finds). Also, a relatively large proportion of Roman coinage represents isolated, unstratified 'accidental' finds. It was pointed out previously that the composition of the Roman coinage from settlements noticeably mirrored the spectra from hoards, which was interpreted as the result of the disruption of hoard contexts (Lind 1981).

However, within the studied region, their representation is almost exclusively in the settlement context, and only the scarcity of documented hoards may provide the ground for an assumption of different forms of presence and use of Roman coins. However, in the Middle Danube region, some proportion of the documented coin finds inevitably originated from hoards, but their exceptional quantities, often distributed through the extensive settlement areas (cf. Komoróczy et al. 2018; 2019; Rajtár, Kolníková, Kuzmová 2017) disapprove their dominant origination from disturbed hoard contexts. Also, their distribution patterns have the same features as in Roman-origin brooches, whose presence within the settlement context was bound foremost to the 'culture' layer, which is a result of mixture of processes, also aggregating material culture of everyday activities. Presently, within the MARCOMANNIA dataset, there are only 251 records evidenced for the hoards, i.e. 8%.From the perspective of temporal identification and dating, there is also an embedded issue of a time lag in the chronological position of Roman coinage in the Germanic milieu. This phenomenon also accompanies other find categories, associable with 'prestige goods' (e.g. metal vessels), which could have expectedly been present in 'living culture' for prolonged periods and elevate the question of the temporal shifts between the emergence (coin minting) and its final deposition (*thanatocenosis*) in the Germanic milieu. The period between these stages is essential for their interpretation and could have taken a distinctive amount of time (several centuries), as seen in the well-documented hoard finds. Therefore, there is an intention to explore theoretical possibilities of the phenomenon's impact on the coinage circulation and variability in resulting quantitative distributions within the 'Marcomannic' settlement zone through probabilistic modelling (Chapter 5.3.2.4). Nevertheless, this issue is significantly constrained by the means through which they were moved to the Germanic context, which could have considerably conditioned the length of the presence (circulation) within the Roman milieu.



Graph 5.27. Coins. Frequency distribution of the lengths of identified minting periods by 5-year period.

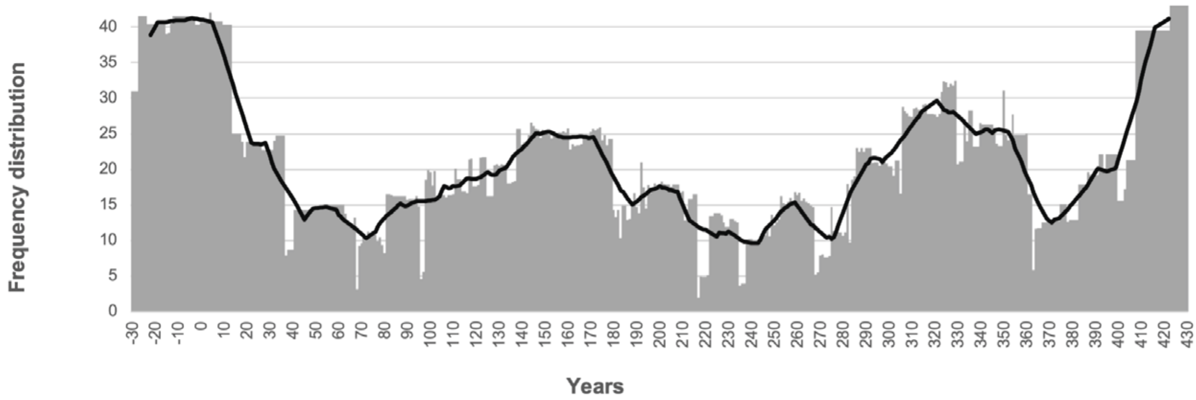
5.3.2.1 Input data

The input data originate from various sources of information (cf. Komoróczy, Vlach, Kmošková 2024). Firstly, the large amount of data comes from the finds published in the inventory by E. Pochitonov (1955). The second main source of Roman coins represents the outcomes of the metal-detecting activities outside professional archaeology provided for documentation (e.g. Zeman 2017a; Komoróczy 2022).[33] Within the MARCOMANNIA dataset, 3718 records of Roman coin finds are distributed through over

31 Tac. *Germ.* 42.

32 Cass. Dio LXVII.5.1.

33 The relevant coin finds with the information on the chronological position, and used in this book, were made available publicly through the PAS (Pajdla et al. 2023a; 2023b).



Graph 5.28. Coins. Temporal outline of the average length of the identified minting periods/years in individual years with a 10-year moving average (black line).

seven hundred sites (spatial point evidence). From them, 3,427[34] are supplied with the determination of the chronological position of the derived minting period (or year) based on an identified ruler or other characteristic features, which were used to establish the baseline secondary proxies.

Regarding the spatial distribution of the input data (Fig. 5.11), considerable coverage could be observed throughout the study region, with varying densities. In addition, some parts of the study region appear relatively underrepresented (e.g. hilly parts of Lower Austria). For example, 793 sites contain information on only one coin find and usually represent accidental unstratified evidence. On the other hand, roughly ⅓ of all the datable coin finds originate from around 20 sites or their spatial clusters (see Fig. 5.11). This effect is undoubtedly, to an extent, caused by the state of knowledge and available material basis, but to a proportion, it reflects some of the past distribution patterns. The frequency distribution of the identified duration of the minting period or date also shows a dominating part of the coins to be dated to a time frame shorter than five years (Graph 5.27, 5.28). Longer intervals of up to 25 years are counted on orders of lower hundreds, whereas intervals beyond this threshold are generally rare. The mean duration of the identified minting periods is 8.6 years, with a standard deviation of 10 years.

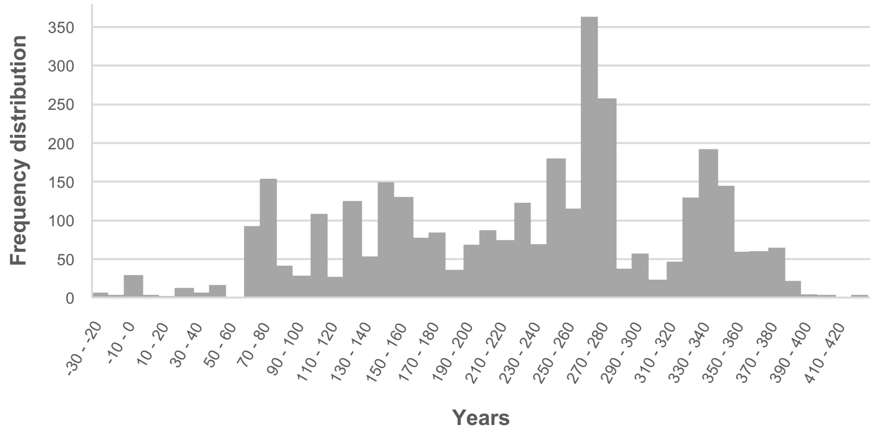
It is also necessary to state that information compiled into the MARCOMANNIA dataset was structured primarily to derive the baseline and secondary proxies. The project-based methodological approach was not designed to collect a complete set of numismatic information, such as the text of obverse and reverse, and these details were beyond the data requirements of the analytical framework. Additionally, the spatial aspects of the Roman coinage within the study region are further explored in the Chapter 6.3.

5.3.2.2 Baseline proxy of the Roman coinage

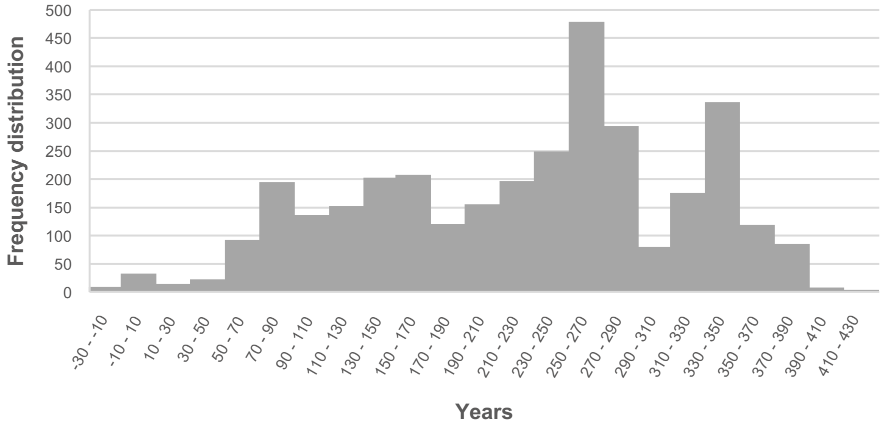
From the constructed temporal quantitative distribution perspective, it is considered less productive to distribute and analyse these data according to the ruling/dedicated individual, as it is one of the standard ways of plotting. This approach contains several drawbacks. First, it suffers from unevennesses in the length of identified reign/minting periods, which restricts even temporal evaluation. Therefore, more quantitatively oriented approaches were employed. Firstly, there was an established standard histogram (evenly distributed intervals of 10 and 20 years; Graph 5.29, 5.30) based on calculated means of the established absolute chronological margins of the identified minting period or directly used singular dates in particular cases. However, this representation reveals some shortcomings, above all, the undervaluation of long reign periods, where larger quantities of only reign period identifications are available, which leads to isolated peaks in the mean value of such cases (e.g. in the case of Trajan or Hadrian).

As could be expected, the 10-year temporal distribution shows significant fluctuations in the quantitative of the temporal development (Graph 5.29), which are more 'smoothed' in the 20-year representation (Graph 5.30). However, some structuring tendencies are discernible from both. On the other hand, the baseline proxy has been established from

34 Either individual or 'aggregated' (with no additional information) record types.



Graph 5.29. Coins. Frequency distribution (10-year histogram) based on the average value of the identified minting period.



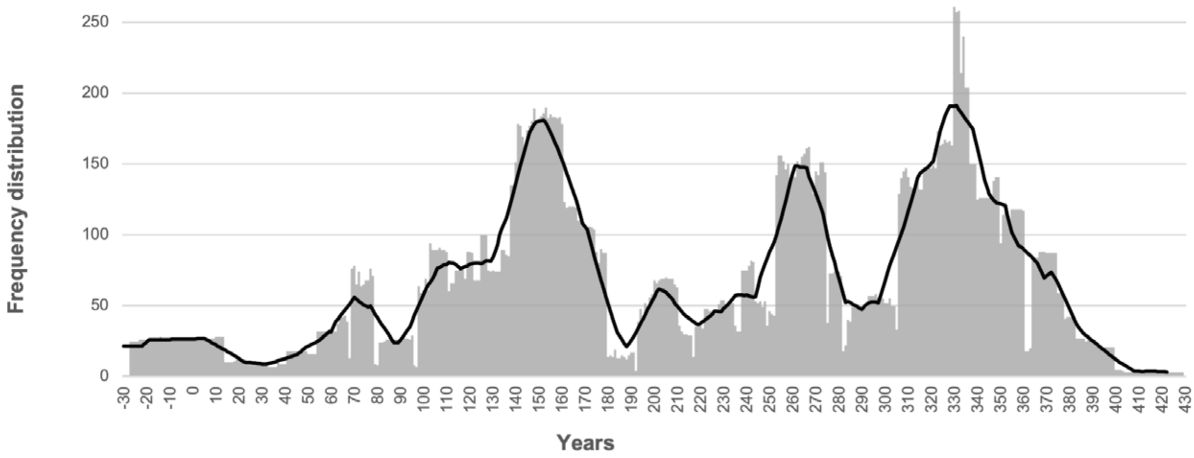
Graph 5.30. Coins. Frequency distribution (20-year histogram) based on the average value of the identified minting period.

the minting period values as the 50/30-year time block aggregation pays little regard to the short-term fluctuations and rather underlines the general development tendency in the Roman coinage temporal frequency distribution (Graph 5.31, 5.32).

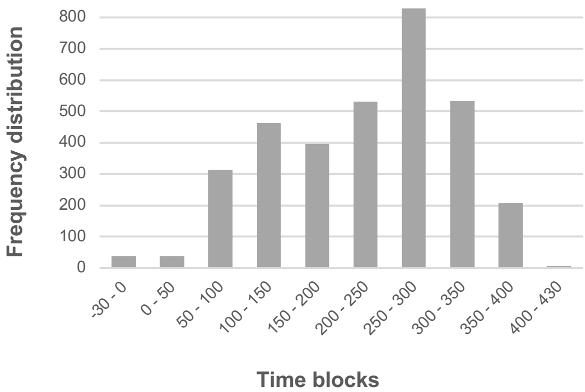
The onset of the more pronounced occurrence of the Roman coinage within the studied context of the 'Marcomannic' settlement zone of the Middle Danube region could be associated with the decades after the half of the 1st century AD with the issues of Nero, reaching the local climax at the end of this century in the Flavian coinage (foremost Vespasianus but also Domitianus). From an overall perspective, the preceding Augustan, Tiberian, and Claudian coinage have only marginal representation. The development through the 2nd century AD is characterised by the gradual increase of already elevated and stably present emissions of the emperors Trajan, Hadrian, Antoninus Pius and Marcus Aurelius. The first marked decrease after the almost one-century-long gradual increase could be seen in the timeframe 180–190 AD, mainly concerning the emissions of the Commodus coinage.[35] Its significance also propagated to the first decrease in the baseline proxy representation. Although the number inevitably includes the coins directly connected with the Roman military presence in the Middle Danube Germanic territory during the offensive phases of the Marcomannic Wars (cf. Komoróczy et al. 2022), their spatial distribution throughout the settlement zone suggests the pattern is not significantly distorted or biased by that.

After the short-term drop of the post-Marcomannic Wars coinage, a significant increase could be observed in issues, mainly in the coinage by Septimius and Alexander Severus. Further development throughout the 3rd century AD, represented by the turbulent epoch of political instability and rapid change in political representation, followed steady linear growth until the middle of the century (represented foremost

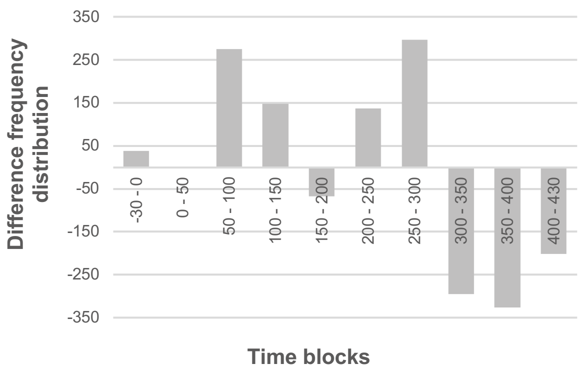
35 However, this is a phenomenon which could be observed throughout the territories either outside or inside the Roman Empire in the hoards of denarii (Reece 2008, 62–65).



Graph 5.31. Coins. Quantitative development of recorded identified coin evidence (yearly resolution) based on summarising the identified minting periods with a 10-year moving average.



Graph. 5.32. Coins. Temporal probability distribution (baseline proxy).



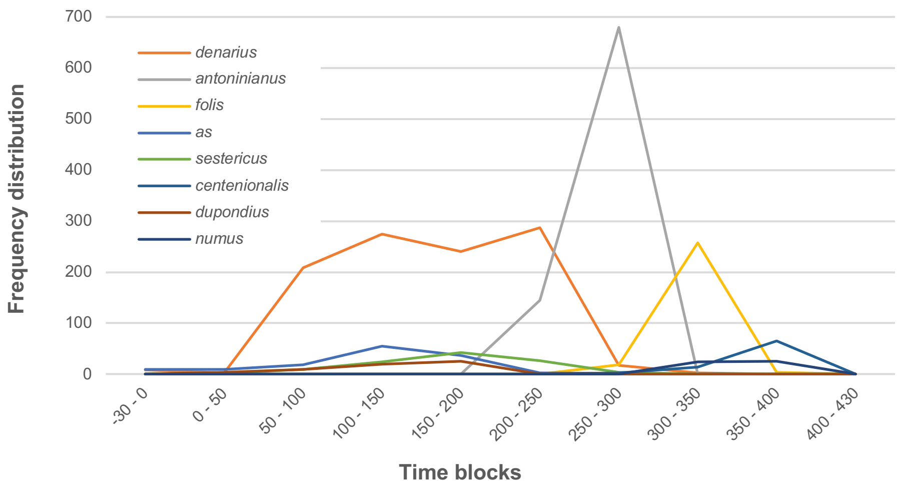
Graph 5.33. Coins. Difference between the neighbouring time blocks of the baseline proxy.

by Gordianus III and Philippus Arabs). This trend was followed by an exceptional quantitative increase until the 280s (represented mainly by Gallienus, Claudius II Gothicus, Aurelianus and Probus) when the evidenced quantities reached their peak. A significant change in quantitative distribution is evident around the turn of the 2nd and the 3rd centuries AD, where the second and most significant drop in evidenced Roman coinage occurs. Nevertheless, it was soon replaced by the onset of the last significant peak represented by the coinage of Constantines till the 360s. The gradual decrease until the turn of the 4th and the 5th centuries AD is represented by lower quantities of coinage by Valens, Valentinianus I, and Gratianus. It is notable, that the 3rd century AD peak is not evidenced in Bohemia (Militký 2008).

From the perspective of the difference (change) in quantities of the neighbouring time blocks (Graph 5.33), the underlying temporal distribution pattern and structural changes emerge even more distinctively. The two major increases could be attributed to the time blocks 50–100 and 250–300 AD, which reflect the change in fundamentally different denominations (*denarii* and *antoniniani*). On the time scale, the chronologically first drop of a lesser magnitude is associated with the time block 150–200 AD. The consequent and more significant decreases in quantities represent the 1st half of the 4th century AD, where the vast majority of the derived proxies also exhibit the same trend.

Time block	SUM	*Denarius*	*Antoninianus*	*Folis*	*As*	*Sestericus*	*Centenionalis*	*Dupondius*	*Aureus*	*Maiorina*	*Numus*
-30 – 0	17	8	0	0	9	0	0	0	0	0	0
0 – 50	20	3	0	0	9	3	0	4	1	0	0
50 – 100	260	209	0	0	19	9	0	9	14	0	0
100 – 150	378	275	0	0	55	24	0	20	4	0	0
150 – 200	345	240	0	0	37	42	0	25	1	0	0
200 – 250	462	287	145	0	3	27	0	0	0	0	0
250 – 300	726	18	680	19	2	4	3	0	0	0	0
300 – 350	298	3	0	257	0	0	14	0	0	0	24
350 – 400	113	0	0	4	0	0	65	0	1	17	26
400 – 430	0	0	0	0	0	0	0	0	0	0	0
SUM	2619	1043	825	280	134	109	82	58	21	17	50

Tab. 5.4. Quantitative distribution of the identified coin types through the time blocks.



Graph 5.34. Coins. Temporal outline of the evidenced denominations.

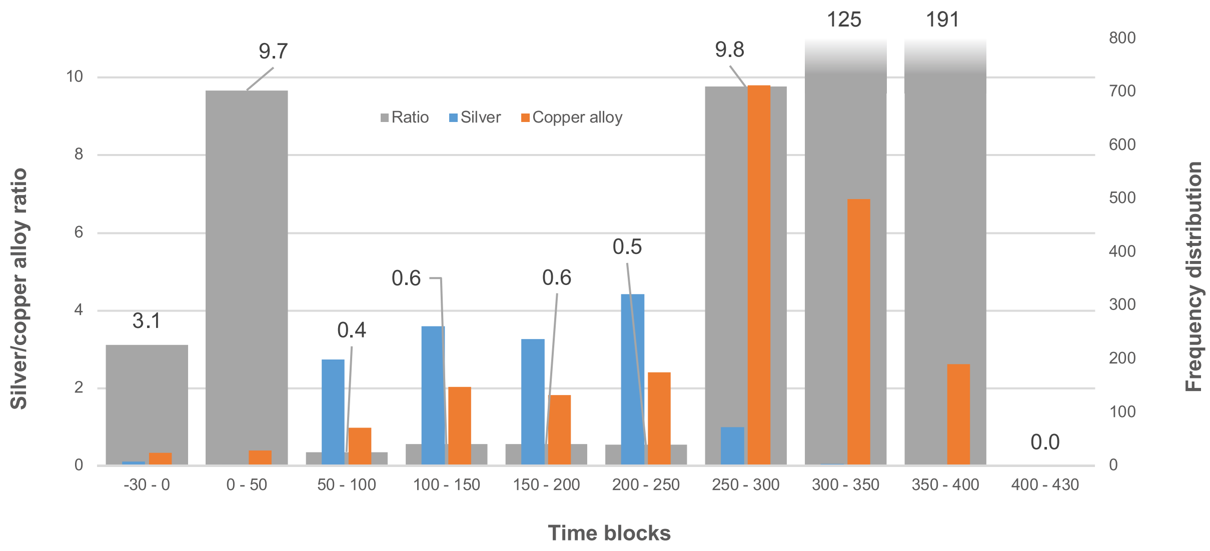
5.3.2.3 Denominations, material and value

A specific perspective provides the temporal quantitative distribution of denominations. Of the total of 3,707 coin-find records, the identified denomination is available in 2,810 cases. From them, the temporal outline could have been conducted in the case of 2,619 records (Tab. 5.4). From the 2nd half of the 1st to the 1st half of the 3rd century AD, the most numerous are *denarii*, representing a trend visible throughout the Roman Period Germanic environment (e.g. Bursche 2008, 396) following the claims by Tacitus regarding the preferences in denominations.[36] Within the MARCOMANNIA dataset, a little over a thousand records comprise roughly one-third of all coin-type identified evidence, consistent with the generally observable trend during the respective periods.

Conversely, the second most numerous denomination – *antoniniani* – spans exclusively through the 3rd century AD due to his introduction by Caracalla in 215 AD and has significant accumulations in the time blocks 200–250 and 250–300 AD. It emerged during the decrease of *denarii* and has been significantly outnumbered by them, generally ascribed to the loss of the denomination value and inflation, compensated through the production of large amounts of coinage (Bland 2012). Other categories are far less represented, whereas *folis* only substantially increased in 300–350 AD. The third most quantitatively representative denomination is *folis*, evidenced foremost during the time block 300–350 AD, which also applies to the less represented *centenionalis*. Other denominations provide less significant proportions quantitatively and above the hundred records reached only *as* and *sestertius* with similar temporal frequency distribution with a minor difference by one time block, showing a gradual increase through the first two centuries AD with a drop in the 1st half of the 3rd century AD.

Crucial implications to understanding Roman coinage in the role of the means of adjusted and 'localised' proxy value exchange system as a 'special-purpose money' are the recorded compositions of the represented metals, foremost copper alloys and silver. The functioning of such a financial system in its primary settings requires ratios with significantly higher propositions of the copper alloy over silver, as evidenced in the Roman milieu (Wigg-Wolf 2008,

36 Tac. *Germ*. 5.



Graph 5.35. Coins. Temporal distribution of the ratios between the copper alloy and silver coins.

37–38), which should be at least above 1 : 5. The value of the silver coinage (*denarii*) was far too great to be a basis of everyday transactions and served more conveniently as a mean for storing value. In this regard, all the recorded information in the MARCOMANNIA dataset exhibits a ratio of 1 : 1.8, which is far below the threshold for its functioning. For example, the comparable ratio of 1 : 1.3 has been recorded in the context of North-West Germany *Barbaricum* (cf. Berger 1992).

Nevertheless, their representation changed significantly over time, as is apparent from the respective Graph 5.34. Therefore, a temporal outline of the respective ratios was additionally established, from which it is evident that the ratio has shifted considerably during the scoped temporal extent (Graph 5.35). Since the first more pronounced onset of the Roman coinage in the 'Marcomannic' settlement zone, evidenced after the mid-1st century AD, there has been a two centuries-long period of a strikingly low ratio, which even goes below the 1, and it oscillates within a relatively narrow and consistent range between 1 : 0.4 and 1 : 0.6. Hence, it could be assumed that in such a proportionality setting, using Roman coinage within the Germanic milieu does not apply meaningfully to their use within everyday exchange activities. The amount of value stored in silver coinage would comply only with more substantial transactions. It is also particularly notable for the continuity of this trend before and after the turbulent period of the Marcomannic Wars, a turning point in most of the derived baseline and secondary proxies. The described trend changes around the mid-3rd century AD in the time block 250–300 AD, when the ratio reaches 1 : 9.3 and *antoniniani* appear[37] in more significant quantities within the Germanic context. Such conditions would theoretically comply with the applicability of Roman coinage use within the Germanic internal exchange system. The consecutive time blocks, 300–350 and 350–400 AD follow the same trend of the disappearance of silver coinage and significant representation of the copper alloy ones (the latter also includes *folis* denomination in larger quantities) (Fig. 5.12).

Another perspective, vital for understanding and interpreting the Roman coinage within the studied context, provides the recalculation of the simple quantities into the presumed aggregated theoretical value based on their actual value (Graph 5.36), primarily given by the Roman market economy. These estimates have been derived from the quantitative representation (normalisation) of individual denominations and the respective value towards the most valuable one – *aureus* (1). Consecutively, the normalised values were deduced for a *denarius* (0.04), *sestertius* (0.01), *maiorina* (0.02),

37 This denomination was quantitatively differentiated on the presumed silver content development to reflect more accurately the 'value' reality, where the coins in the time block 200–250 AD were considered to be silver and those from the consecutive time block 250–300 AD as copper alloy. Inevitably such a simplification biases the resulting ratios.

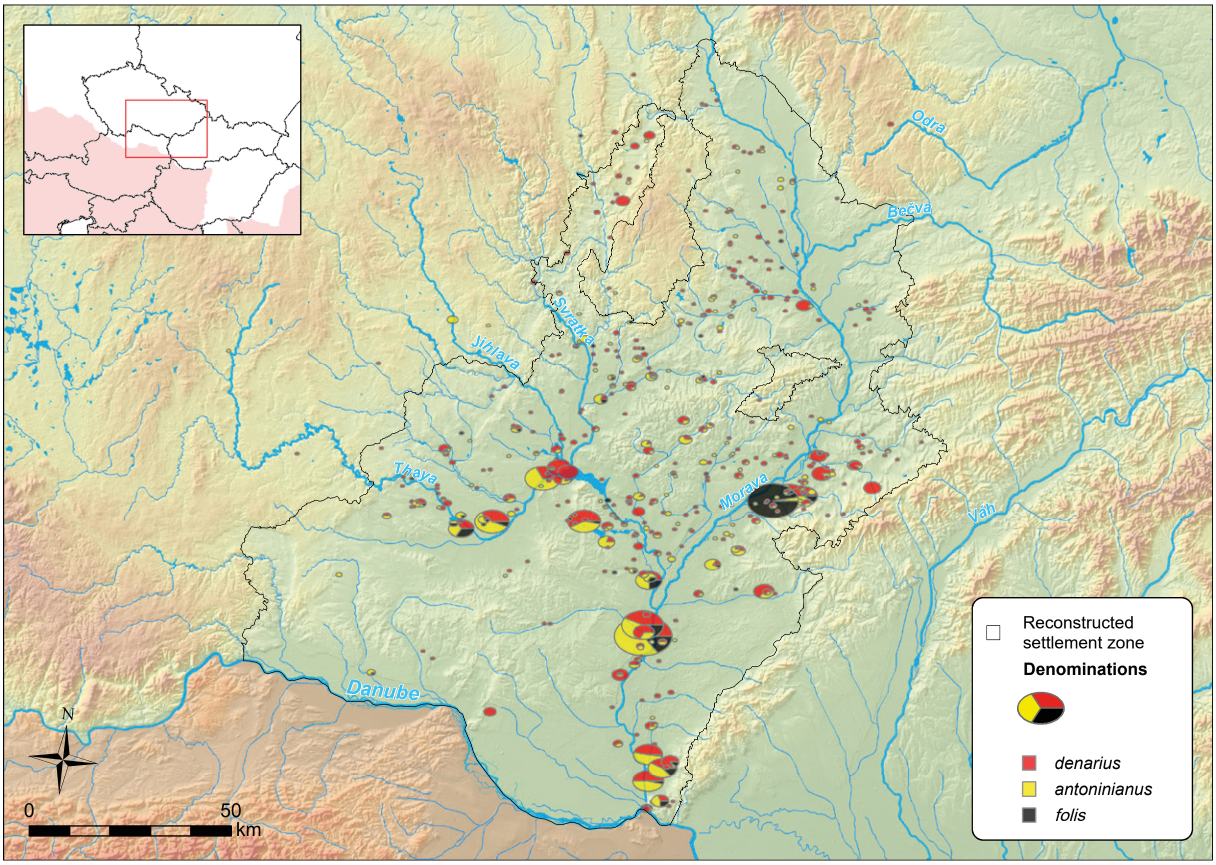
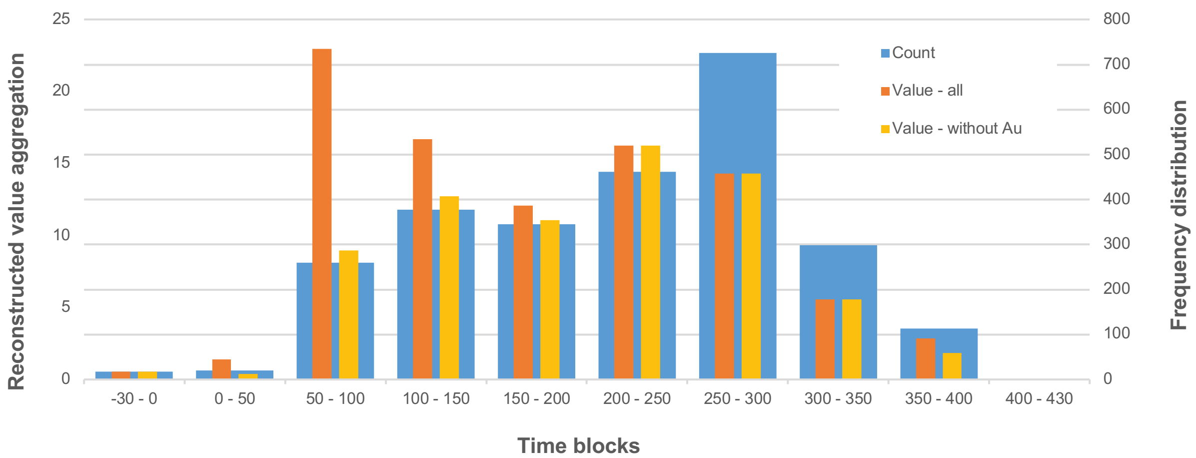


Fig. 5.12. Coins. Quantitative distribution of the three main evidenced denominations (*denarius*, *antoninianus*, *folis*).

folis (0.02), *centenionalis* (0.02), *nummus* (0.005), *dupondius* (0.005), *as* (0.0025). Naturally, the actual value has shifted throughout time, especially in the case of *denarii*, which encountered a gradual decline in silver content (e.g. Pense 1992). It began during the reign of Nero and, by the mid-3rd century AD, reached half of the silver content. This stage, swiftly followed by almost complete debasement, also exhibits the practical disappearance of *denarii* from the 'Marcomannic' settlement zone. Therefore, for the last time block of their occurrence within the studied region (i.e. 200–250 AD), their potential value was halved (0.02). The same applies to the *antoninianus*, from the viewpoint of the Roman market



Graph 5.36. Coins. Temporal distribution of the recalculation of the quantitative distribution to the standardised coin value estimates (differentiated quantifications for all denominations and exclusion of the gold denominations).

economy, officially counted as two *denarii* (i.e. 0.08), which would reflect a theoretically significant resulting value regarding their high quantities during the time block 250–300 AD. However, the turbulent economic development caused substantial fluctuations in the silver content, which was relatively high at the beginning (around 50–60%) but decreased significantly by the last decades of the 3rd century AD (e.g. Bland 2012). Therefore, evaluating the evidenced quantities of this denomination during the time block 250–300 AD is complicated and biased by many uncertainties. For approximation reasons and under the expectations of a significant loss of its actual value, it was preset as half of a *denarius* (0.02). For the previous time block (200–250 AD), this denomination estimate was set closer to the original value (i.e. 0.06).

The most significant increase of the reconstructed and aggregated coin values appears directly during the 2nd half of the 1st century AD (time block 50–100 AD), resulting from 14 registered *aureii*, which highly exceed all other time blocks. Notably, it substantially surpasses the most significant quantitative peak of *antoniniani* during the 2nd half of the 3rd century AD. However, they are outliers that considerably affect the estimated aggregated value and are outlined separately (cf. Graph 5.36). The following 2nd century and the 1st half of the 3rd century exhibit minor fluctuations in the count and values as this temporal segment consists foremost of *denarii*. The next significant shift is notable during the time block 250–300 AD with the onset of large quantities of *antoniniani*, gradually replacing *denarii* in the position of a 'leading' denomination. Despite large quantities, an aggregated reconstructed value is below the preceding 150–200 AD time block. However, if the officially established value were in effect (i.e. two *denarii* or even one *denarius*), the resulting estimated aggregated value would be considerably higher than in any other time block. Therefore, its lower estimated value is more consistent with the previous time blocks, and the significant increase would be difficult to justify within the existing archaeological models of the Germanic society's development and explain the causes of such an outstanding increase. The same trend is evident in the case of the peak of *folis* during the time block 300–350. In contrast, the estimated aggregated values follow a somewhat 'exponentially shaped' decrease trend. From a general viewpoint, the shift from quality (and higher values) to quantity (and lower values) of the Roman coinage is apparent throughout the scoped temporal extent, consistent with the general development of the trade market and monetary system within the Roman Empire and the neighbouring Middle Danube provinces.

5.3.2.4 Probabilistic modelling of coinage life cycle

The various approaches towards the temporal distribution of the evidenced quantities of the dated Roman coinage exhibit several significant shifts and provide a unique insight into the development of this specific find category in the Germanic context. Nevertheless, aggregated from the identified minting period or year, these outlines reflect rather distributions during the initial phases of the coin life cycle, connected foremost with the environment of origin. As evidenced, the coexistence of the coins has spanned even several centuries. For example, it was also suggested by L. Lind (1988, 205), that inflow of denarii continued up to the 260's. Therefore, the actual amount of the circulating Roman coinage in the Germanic environment is an inevitable outcome of several aspects, foremost the continuity of coin circulation and the time lag between the actual minting of a coin, its circulation within the Roman environment, transfer to the Germanic environment, followed by the next stage of circulation, and the eventual terminal deposition (*thanatocenosis*). Therefore, an inevitable time lag stemming from individual stages of the circulation process has to be anticipated. Nevertheless, the simulation results do not aspire to provide the approximation to one 'ideal' scenario but rather to provide the basis for consideration of the potentially differentiated quantitative temporal distributions, which could be further aligned and compared with other proxies and theoretical models.

The underlying theoretical assumptions and input data were compiled into the computational framework of an agent-based simulation model with an implicit environment representing bipartite environments (Roman and Germanic) on a shared time scale on the Y axis (Fig. 5.13). The probability calculations apply indiscriminately to all input data in the simulation setup and iteration process. However, the dynamics of a Roman coin life cycle were significantly conditioned by a wide range of factors, such as the direct intentions and propagation of the Roman administration's foreign policies or conflict periods. However, the analysis of the composition of the *denarii* hoards throughout *Barbaricum* exhibits the features that point out their shipment from the provincial administration treasuries rather than

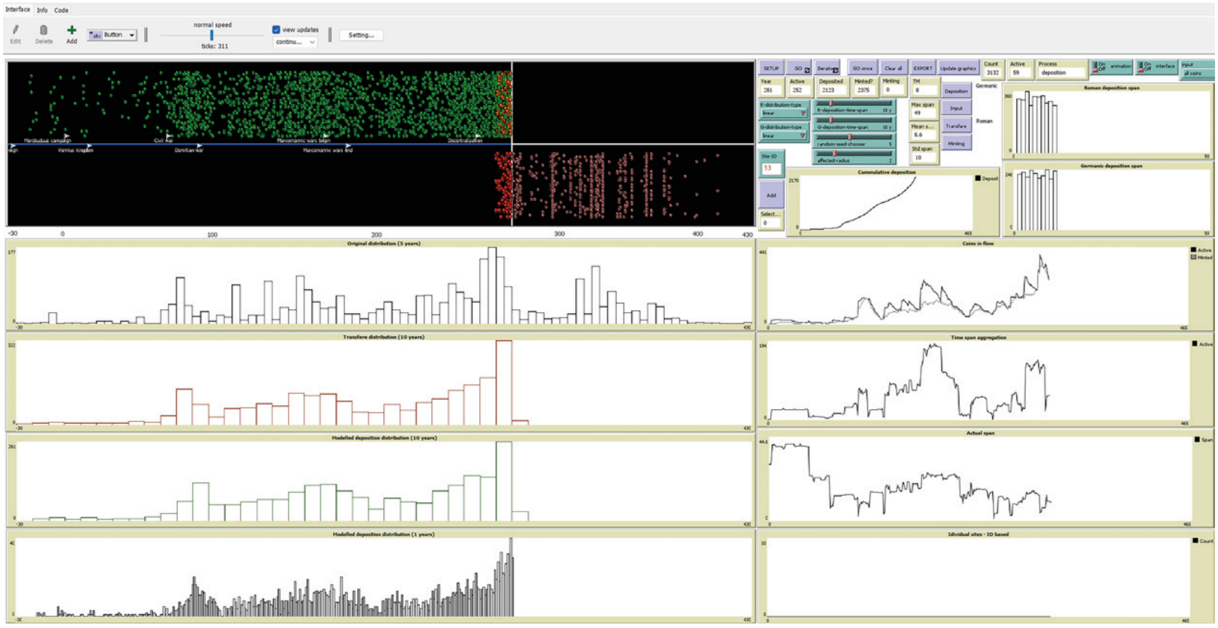
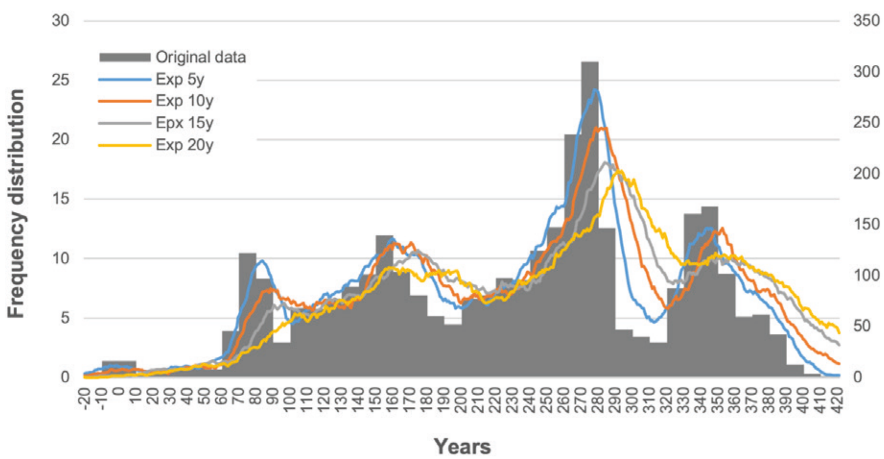


Fig. 5.13. The interface of the simulation model with 'environment' divided into the implicit Roman and Germanic environments as a time scale, complemented with variable settings monitors and output plots.

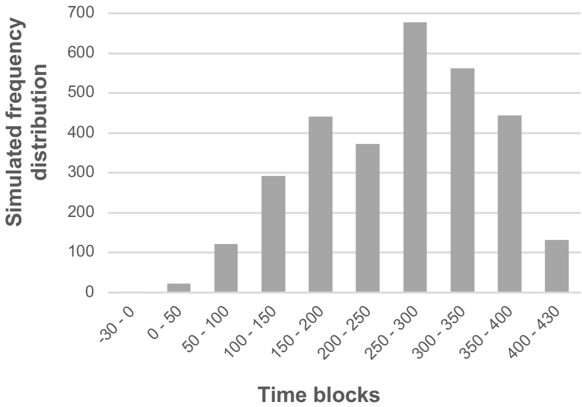
the bulk shipments from the production points (Reece 2008, 61–62).

During the simulation model setup phase, the initial point of emergence of each input object (coin agent entities) is determined based on the identified minting period or year, which varies substantially throughout the dataset (Graph 5.37). This random assignment is calculated randomly without a specific probability distribution. During the simulation process through a time scale, once 'minted', they are supplied with the timespans for the circulation period within the Roman and afterwards within the Germanic environments. However, these probabilities are calculated according to the exponential distribution. Four arbitrary thresholds have been tested with 5, 10, 15, and 20 years of base values (mean of exponential distribution). They represent the differentiated probability of circulation period lengths for both environments with combined duration means of 12 (STD 5), 22 (STD 10), 32 (STD 15), and 42 (STD 20) years, respectively. The use of the 'maximum' settings of the 20-year base value is sufficiently substantiated by the hoard compositions, suggesting the contemporaneousness of the coins minted over 200 years apart.

The results of the simulations show, even at 'minimum' settings (5 years), a significant 'smoothing' effect, which removes substantial fluctuations



Graph 5.37. Coins. The temporal outline of the Roman coinage in the Germanic context *thanatocenosis* at the exponential type of the probability distribution.



Graph 5.38. Coins. Probability modelling temporal distribution (secondary proxy) through the time blocks using the mean base of 20 years.

contained in temporal distributions based on the simple averages of the minting period determination (cf. Graph 5.29, 5.30). However, the overall tendency for development remains predominantly unchanged. More significant temporal shifts are, although, apparent at the 'maximum' simulation settings (20 years), which suggest more homogeneous temporal frequencies (Graph 5.38) and a more gradual (linear) onset of the Roman coinage in the Germanic environment between the time blocks 0–50 and 150–200 AD, which is followed by an only marginal decrease during the 1st half of the 3rd century AD. however, the peaking quantities during the time block 250–300. AD Additionally, the resulting shifts from coin circulation led to potentially significant amounts of Roman coinage circulating and deposited within the 2nd half of the 4th century AD, consisting up to an extent by the *antoniniani* minted in large quantities during the time block 250–300 AD. Such development is also attested by the denominational compositions from individual sites, where *foles* frequently appear alongside the *antoniniani*. However, it has to be pointed out that the large amounts of input data originate from uncontextualised near-surface find contexts through metal-detecting, and the actual frequencies of simultaneously circulating coins could only be addressed as more substantial information in this regard becomes available.

5.3.3 Metal vessels

Metal vessels of Roman origin retain a specific position in studies on Roman-barbarian interactions (e.g. Eggers 1951; 1955; Wielowiejski 1988; Kunow 1983; Lund Hansen 1987; Becker 2010; Schuster 2010). The funerary areas traditionally represent the primary context of the origin of the metal vessels from the studied region of the 'Marcomannic' settlement zone (e.g. Tejral 1967; Jílek 2012) and culturally related neighbouring regions to the west (e.g. Karasová 1998), west (e.g. Kraskovská 1976; 1978; Krekovič 2000). Therefore, the numerous objects show signs of heat exposure. They usually originated from the shallow deposited and ploughed-up cremation graves, not necessarily destroyed by detectorists. However, the last few decades have brought up a number of these pieces of evidence from the settlements, which are also in accordance with the brooches of local and Roman origin, which are usually distributed through the remains of the cultural layer and only in limited amounts from the actual archaeological objects (e.g. Jílek 2012; Zeman 2017a; Komoróczy, Vlach, Kmošková 2024). Nevertheless, their natural degradation into small, often unidentifiable fragments inevitably impacts the quality and representativeness of the available archaeological data and knowledge.

The general assumption gathers that the metal vessels represented a 'prestigious' commodity, which served as manifestations of wealth and status. Their appearance in the Germanic context results from the various means and ways through which they were transferred and used within the Germanic milieu (traditionally referred to as results of trading activities, warfare booty, political gifts, and bribes). Therefore, the resulting baseline proxy contains information on various domains of the internal (economic performance and 'buying power') and external processes and interactions (diplomacy and political interactions). Nevertheless, substantial amounts of metal vessels were potentioally transferred as a result of looting during raids and warfare. Exceptional find contexts associable with this type of activity, such as Neupotz, Hagenbach or Lingenfeld (Petrovszky 2006a; 2006b; 2006c) and others, highlight the potential of significant representation of this phenomenon in particular periods, inevitably propagating into derived baseline proxy. Above all, the pivotal conflict of the Marcomannic Wars (cf. Erdrich 2020 et al.) provided extensive opportunities for a proportionate increase of the metal vessels, originating from the looting and warfare booty. For example, there is a surviving narrative on a skirmish between Roman troops and Germans who wanted to transport their booty across the Danube in 171 AD (Dobiáš 1964, 203).

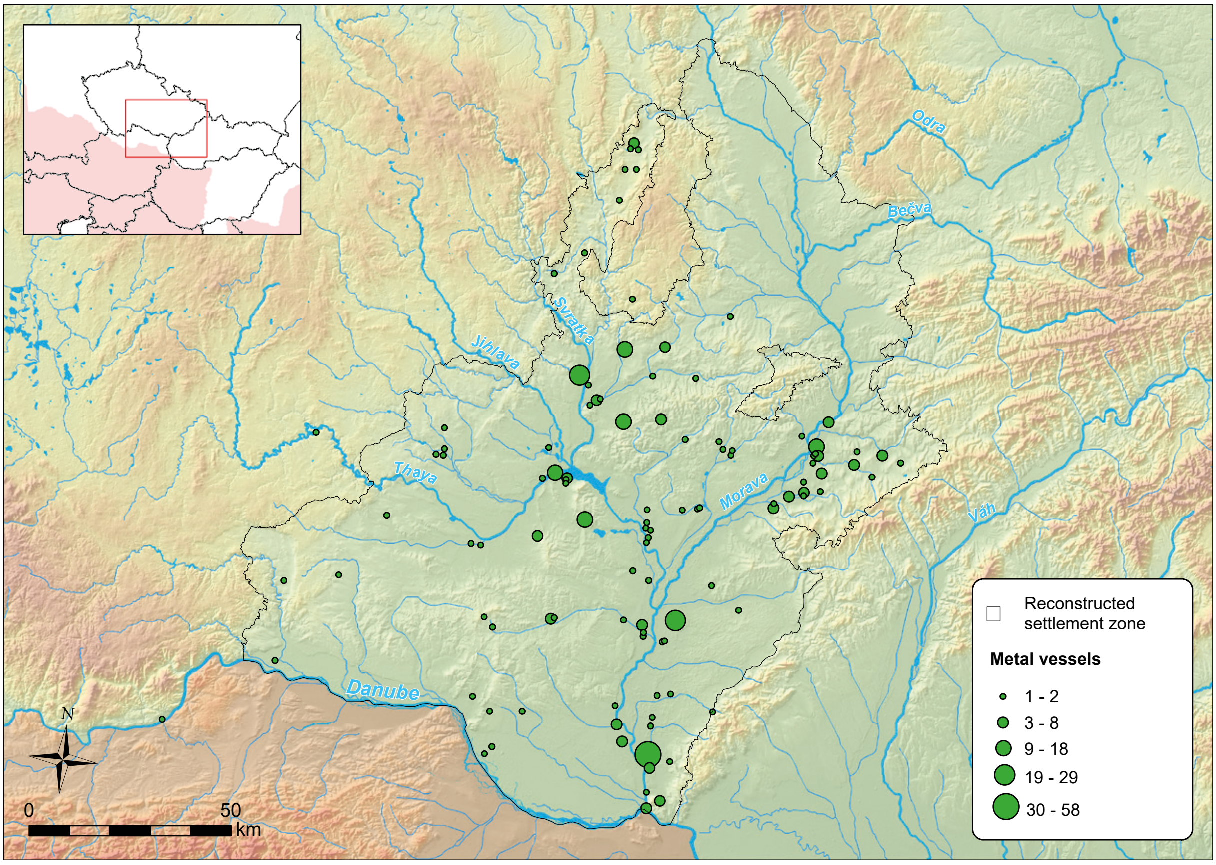


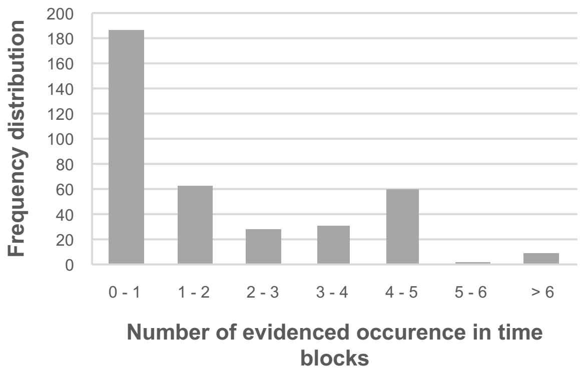
Fig. 5.14. Metal vessels. Quantitative outline of the spatial distribution of the registered records.

Concerning the basic properties of the chieftainship's organisation structure and power exercise over the population (e.g. Earle 1987; 1997), the metal vessel presumably played an important role in the power control practices through the redistribution of 'prestigious' and other goods. Their frequent co-occurrence with other 'valuable' items (e.g. often together with *militaria*; see Chapter 5.3.4) within the funerary context implies the accessibility of these objects to the armed retinue members. Nevertheless, an important perspective provides the phenomenon of the Germanic warrior's service in the Roman army, in magnitude oscillating according to multifaceted interactions and relations with the neighbouring 'super-power'. Therefore, a proportionate reflection of the acquired behavioural patterns could have propagated into the compositions of the grave goods, foremost in burials with weapons, which resemble those from the Roman military environment (cf. Gorecki, Reichert 2023). Therefore, the recorded frequencies of probability distributions of this find category result, up to an extent, from this phenomenon. The evidenced selectivity within the archaeological sources for the studied region (cf. Jílek 2012) suggests (e.g. as well as in the case of Samian ware or Roman brooches) that the bulk purchases were organised by authorities with sufficient means. This is also attested by the spatial distribution of the evidenced metal vessels, which does not show the pattern reflecting the proximity of the provincial grounds (Fig. 5.14).[38] Nevertheless, the same chiefly authorities have been the recipients of the political and diplomatic gifts from this find category. This, however, does not diminish the role of the existing trade routes in their dispersal through the settlement zone, which is also suggested by their spatial distribution along the axial regional rivers and the course of the regional and long-distance trade routes (foremost the Amber Route).

As this find category has always enjoyed an exceptional amount of attention in archaeological research for many reasons (trade relations and economic

38 Not to mention the situation in the regions further to the north (Poland, Germany, Scandinavia). Therefore, the distance and proximity of the source could not be considered as structuring in their distribution patterns.

aspects, diplomatic interactions), there have been substantial research activities by many scholars into the explanation and interpretation of this find category within the Germanic context of the Middle Danube region (e.g. Eggers 1955; Tejral 1967; 1970b; 1983; 2015; Kunow 1983; Lund Hansen 1987; Erdrich 2001; Völling 2005; Jílek 2012). The vital point in the scientific research on the metal vessels in the Germanic context is a consideration of the presumed period and aspects of the use between their production, transition into the Germanic environment, and eventual deposition within the archaeological contexts (e.g. Kunow 1983; Lund Hansen 1987; Erdrich 2001; Völling 2005), reflected through 'short' and 'long' chronology (Jílek 2012, 12–14). These two viewpoints provide different methodological perspectives on dating possibilities, and the potential discrepancies could be tested through probability modelling, like the find category of the brooches (see Chapter 5.3.1).



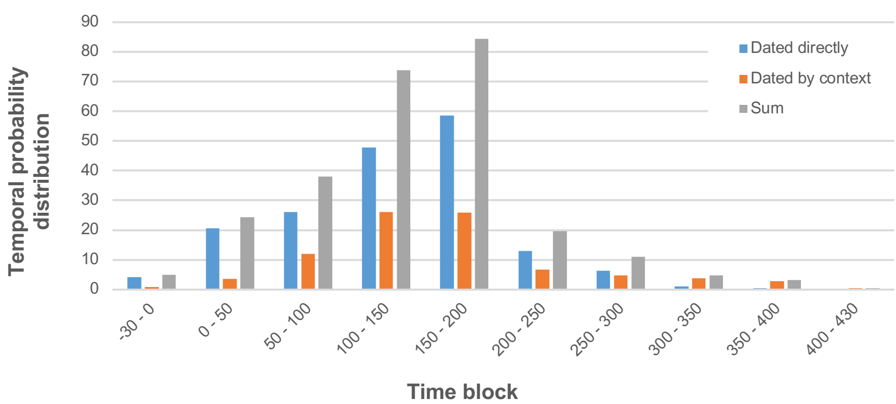
Graph 5.39. Metal vessels. The outline of the frequency of the number of time blocks into which the evidenced metal vessels could be dated.

5.3.3.1 Input data

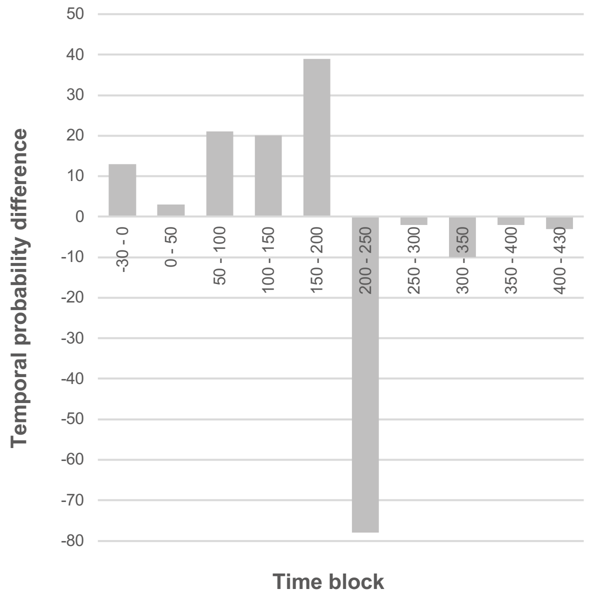
Currently, 385 records representing individual fragments of metal vessels or their uncountable aggregation based on available information have been registered in the MARCOMANNIA dataset. However, this number is not exceptionally high, and available information is distorted in many aspects, amongst others, by how it was registered and published. Therefore, from this number, there are 266 find records that contain any information on their dating. The chronological sensitivity of this specific find category is underlined by the high frequencies of the documented dating of more narrow margins (Graph 5.39) of their occurrence (but mostly production), but the period of their circulation and eventual deposition could be naturally even substantially longer.

5.3.3.2 Baseline proxy of the metal vessels

Despite the given limits, some characteristic temporal trends can be observed from the probability evaluation of the metal vessels subset from the MARCOMANNIA dataset (Graph 5.40). They have appeared since the beginning of the Germanic presence in the area, although in limited amounts. However, there is an apparent gradual increase up to the 2nd century AD, almost along with exponential growth. It reached the second highest probability value already during the 1st half of this century and is peaking in its 2nd half. Despite these values implying that it is an outcome of the whole Early Roman Period developmental trend, it has been suggested earlier that the exceptional quantities of the Roman metal vessels in the Germanic context of the studied area could be well-attributed to the plunder, pillage or loyalty rewards within the extensive long-term conflict of the Marcomannic Wars (e.g. Freising, Tejral, Stuppner Hrsg. 1994; Erdrich et al. 2020). The apparent changes in multiple aspects of the Roman-Germanic relations and interaction are reflected through an exceptional shift that is notable at the beginning of the 3rd century AD (e.g. Tejral 1970a; 1983; 2015), and the metal vessels gradually disappeared towards the end of the studied temporal extent. This trend intersects with the generally



Graph 5.40. Metal vessels. The baseline proxy of the probabilistic distribution is based on aoristic sums. The outline is differentiated by the type of dating information.



Graph 5.41. Metal vessels. The Difference in total values from the baseline proxy.

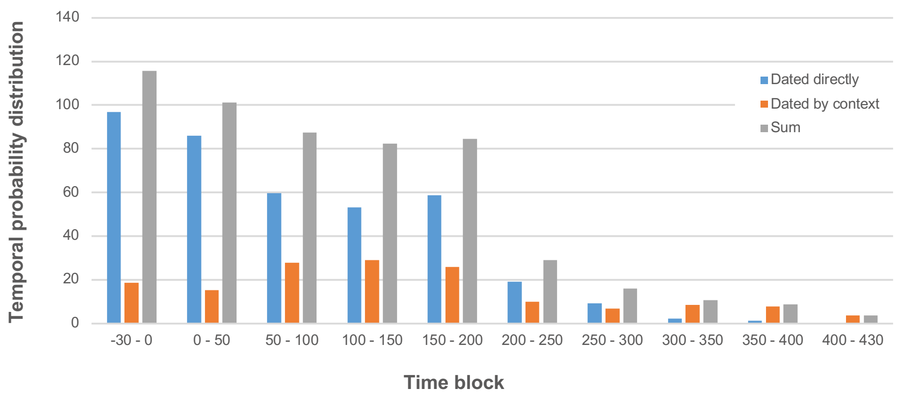
observed 'impoverishment' of the burial context during the Late Roman Period. Nevertheless, if the occurrence of the metal vessels in the Germanic context is supposed to be correlated with the frequency of Germanic warriors in service in the Roman army (cf. Gorecki, Reichert 2023), the alignment with the baseline proxy of militaria would be expected (Chapter 5.3.4). Therefore, the resulting temporal probability patterns originate from various causes and drivers, including the transfer of drinking habits from the service in the Roman army.

The difference in the probability distribution values between the neighbouring time blocks (Graph 5.41) underlines the varying increasing tendency during the 1st two centuries AD, where the most significant growth is evidenced between the time blocks 50–100 and 100–150 AD. The sharp negative change between the 2nd half of the 2nd and the 1st half of the 3rd centuries AD represents the most significant structuring signal in the data, which is followed by marginal decreases towards the end of the period in question.

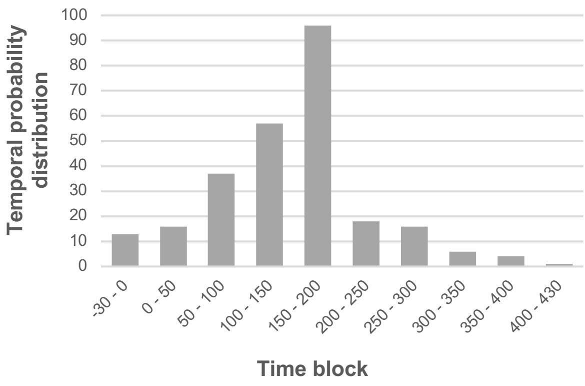
Recalculation of the aoristic sums according to the amount of the simultaneously active components provides another perspective (Graph 5.42). It generally shows significantly higher values for the first two centuries AD than the Late Roman Period. However, in contrast to the baseline temporal distribution, with the highest relative rates of aoristic sums during the initial phases of the first century AD with a mild gradual decrease towards the 2nd half of the 2nd century AD. Therefore, the rate of occurrence of the metal vessels was generally most frequent during the stages of development, which are relatively thinly represented in the archaeological record (phases B1). This correlation is also apparent in other find categories as the burials are their primary context of origin.

5.3.3.3 Probability modelling of the metal vessels

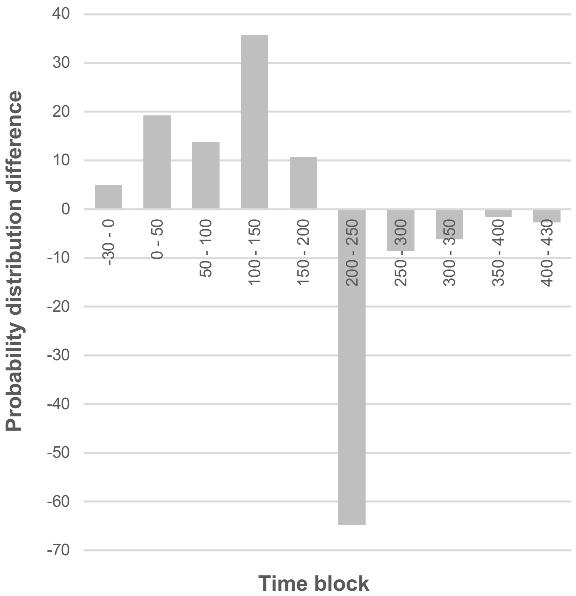
A probabilistic simulation approach has also been applied, which allows exploration of additional ways the potential occurrence within the Germanic context as an alternative (secondary proxy) to the temporal probability distribution of the baseline proxy (see Graph 5.43). The simulation framework is based on the assumption of the occurrence of individual objects of analysis (metal vessels find records with dating information). The effect and impact of the issues connected with the persistence of the metal vessels ('long' and 'short' chronology), through the establishment of the probability simulation framework where in each iteration (simulation), for the input objects (metal vessel records) have been randomly generated the occurrence only in one time block. From the result, it is apparent



Graph 5.42. Metal vessels. The baseline proxy of the probabilistic distribution is based on aoristic sums and correlated by the distribution of all dated components. The dated records are differentiated by the type of dating information.



Graph 5.43. Metal vessels. Simulated probability distribution.



Graph 5.44. Metal vessels. Difference of the simulated probability distribution between the neighbouring time blocks.

that mainly due to the consistently narrow margins of their dating, both proxies are in general alignment regarding positive and negative changes, as well as their trends (Graph 5.44).

The most significant difference in the baseline and the secondary proxy distribution is, however, observable in the magnitude during the 2nd century AD, where the probabilistic simulation favours a more significant increase in the 2nd half of the 2nd century AD. Therefore, the 'short' chronology-oriented simulation computation approach would also highlight the increases during the time blocks 50–100 and 150–200 AD, during which the more intensive influx through military activity or various nature could be expected to impact its magnitude (i.e. the participation of the Middle Danube Germanic chieftaincies on the winning side at the battle of Cremona and the raiding activities during the Marcomannic Wars).

5.3.4 Militaria

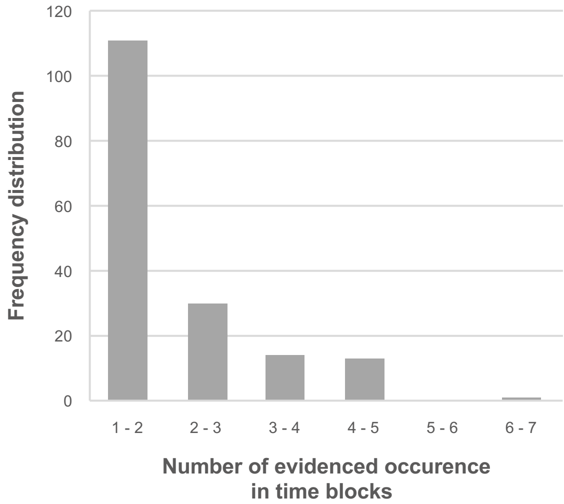
Traditionally, the find category in archaeological records, and foremost the burial context, has been recognised as a sign of the 'warrior' societal segment (e.g. Vencl 1984a; 1984b), and the Germanic societies of the Roman Period are not an exception (e.g. Raddatz 1985; Schultze 1991; Hedeager 1992, 121–137; Carnap-Bornheim 1994; Droberjar, Peška 1994; Erdrich 1994; Bemmann, Hahne 1994; Burmeister 2009). They are also found in other contexts (residential areas), such as hoards or bog deposits in the northern environment and occasionally in residential areas, but usually, they are most significantly dispersed through the funerary context. Concerning the ambiguity contained within the other derived proxies, the so-called *militaria* provides, in a way, relatively straightforward associations and connotations within the manifestation of power, dominance, coercion, control, and foremost, the violence either of institutionalised (warfare), ritual or individual (e.g. revenge, robbery). The warfare itself is deeply embedded within the various practices of the chiefdom as a type of social organisation (e.g. Carneiro 1981; 2017; Grinin, Korotayev 2011; Gavrilets, Anderson, Turchin 2010; Junker 2015). For example, the Bronze Age battelfield in Tollense valley, pushes boundaries of what was expected before within the warfare and violence in Prehistory (but already at the level of more or less advanced chiefdoms). And not only through the figures and estimates, but also the network of involved individuals from even significant distances (e.g. Jantzen et al. 2011). Throughout the featured period of interest, there are generally considered a few events of a warfare nature exceeding the characteristics of occasional raiding activities.[39]

39 Notably, apart from the extensive conflict of the Marcomannic Wars in 166-–80 AD (Erdrich et al. 2020; Komoróczy et al. 2020), there are only scant and inconclusive evidence on other Roman-barbarian conflict with the potentially direct occurrence within the studied region. Foremost they are based on the accounts from the narrative sources. Most notably, there is mentioned a conspicuous campaign against Marobuduus in 6 AD (e.g. Salač 2006; Vlach 2018a) and the Domitian's Germanic-Sarmatian Wars during the 80s AD (Jones 2002, 135–137, 150–154).

The central assumption of the established *baseline proxy* is that more significant occurrences would point out the elevated occurrence of armed conflicts, elevating the respective artefact occurrence and importance. Expectedly, such conflicts would also result in increased occurrence in archaeological record, either in residential or, foremost, the funerary context. Therefore, the resulting temporal probability distribution (*militaria* baseline proxy) inevitably represents an aggregation of various processes, events, and practices within the living context, containing all sorts of power and conflict emanations that happen to transpire in the archaeological record through various distortive effects of archaeological transformations. Their status symbol role could also be drawn from their presence in splendidly furnished burials, including weaponry made of silver from Germany, e.g. Gommern (Becker 2010), Leuna (Schulz 1953) or Hassleben (Schulz 1933). Weaponry and armaments could also be found in women's burials in Iron Age societies (e.g. Bochnak 2019). Despite the significant internal variability and multifaceted interpretation aspects of this find category, it could be justifiably interconnected with forms and frequencies of internal or external conflict and the 'general' level of violence.

5.3.4.1 Input data

For the proxy establishment, the archaeological evidence formalised and designated in the MARCOMANNIA dataset as the *militaria* – offensive (sword, spear, javelin) and defensive weapons (shield, protective armour) and other components (e.g. spurs) has been included.[40] Eventually, there are 408 records with such find category designation, where the most frequently appearing basic categories are spearheads, arrowheads, javelins, swords, shield components, spurs, and parts of protective armours,[41] either of Germanic or Roman origin. Nevertheless, only 169 records contain information on their chronological position and could be used for the temporal probabilistic distribution. Unsurprisingly, more than half of the records originate from the funerary areas (56%), which usually provide their chronological margins based on context dating. The rest of the records come from the residential areas (34%) and undefined types of activity areas (10%). The outline of the condition of the dating quality (number of evidenced time blocks for each dated



Graph 5.45. *Militaria*. Frequency distribution of the number of time block dating.

record) shows relatively high potential (Graph 5.45) as many of them have their chronological position derived from the temporal margins of burials. Therefore, the majority is dated with margins of the one time block and about half of this amount is provided with wider chronological margins. The input subset also shows clear dominance in the *militaria* of the local Germanic origin, whereas only 38 records represent the finds of Roman origin. The finds originate from 165 sites (Fig. 5.15), providing relatively solid grounds in the spatial representation perspective. It is apparent that the aggregation of the various type of militaria represents a mixture, obscuring many specific aspects. Nevertheless, here are explored the general development patterns and the detailed and differentiated aspects would be beyond the scope of this book. These aspects will be part of a dedicated study on the find category.

5.3.4.2 Baseline proxy of *militaria*

This specific find category exhibits relatively steady development throughout the studied period (Graph 5.46, Tab. 5.5), with a slight and steady increase during the first two centuries and a gradual decrease during the subsequent period. A notable exception represents the time block 150–200 AD. This significant peak results from several factors, manifesting themselves in differentiated weight. From the perspective of unique find context, the

40 Notably, the input subset did not include the multi-purpose and relatively frequent category of a 'knife' and 'axe' (total 256 and 14 records in the MARCOMANNIA dataset), which are included in the find category of 'tools'.

41 So far, these are the only known protective armours of the Roman origin registered within the MARCOMANNIA dataset.

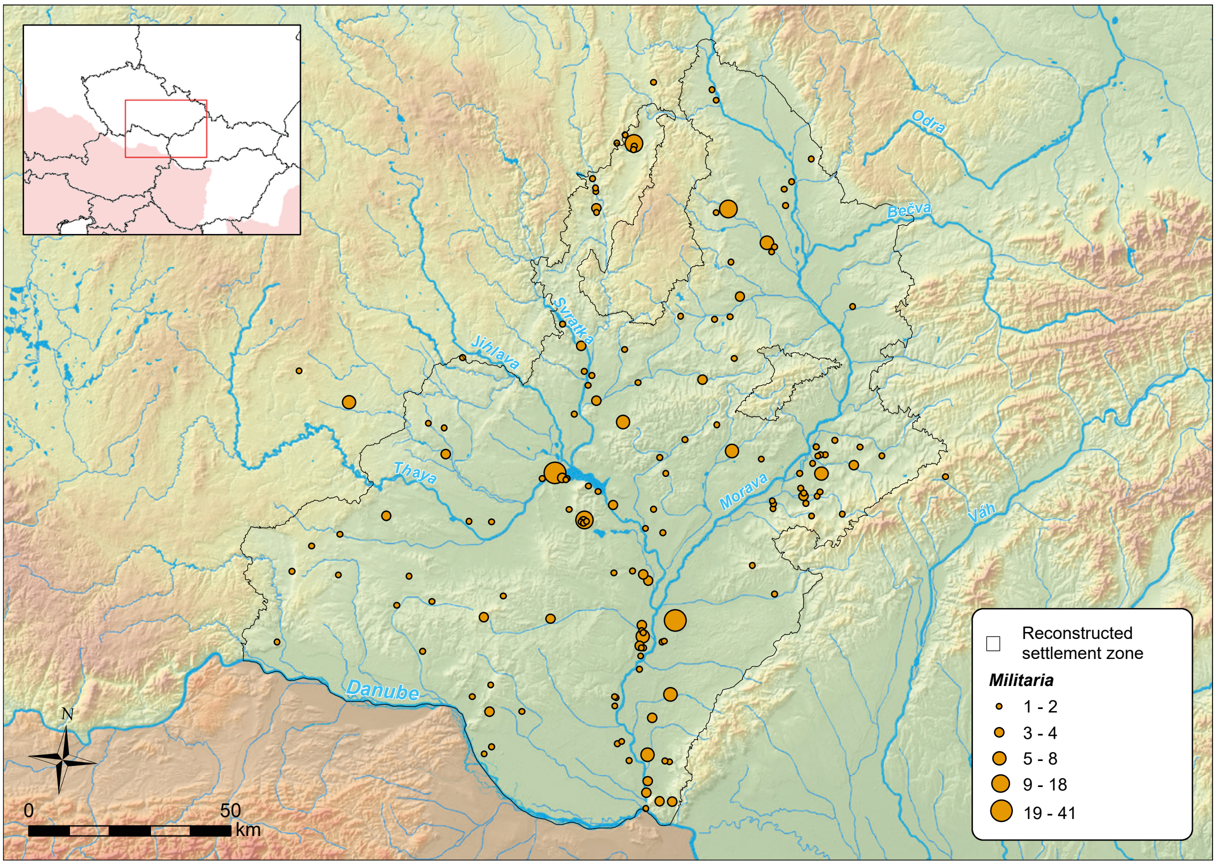
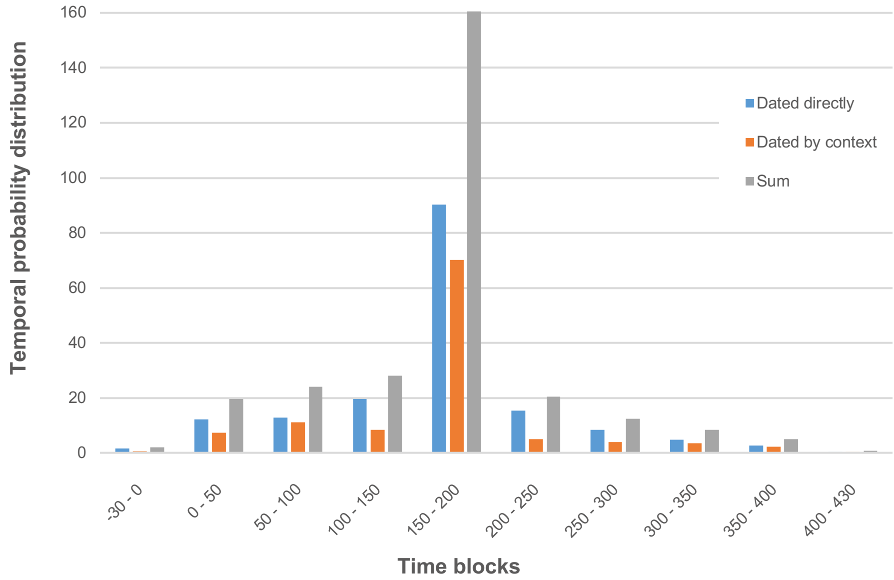


Fig. 5.15. *Militaria*. Quantified spatial distribution of the find category *militaria*.

splendidly furnished princely tomb discovered in Mušov (princely grave; Peška, Tejral 2002) contained, amongst other find categories, large assemblages of weaponry and armaments (cf. Droberjar, Peška 1994; Peška, Tejral 2002). Such a burial context could be well associable with the highest levels of social organisation structure, corresponding with a 'paramount' chief of a larger political entity within the studied region.[42] In total, within the MARCOMANNIA dataset, they represent 41 records. Therefore, the parallel aoristic sums were produced excluding this particular context, and despite the difference (decrease at about ⅓ of value), the value for the time block 150–200 AD is still outstanding. Therefore, another explanation must be sought, and in this particular case, the most straightforward one could be observed in both narrative and archaeological sources. One of the most extensive Roman-barbarian conflicts of the Roman Period – the Marcomannic Wars (166–180 AD; e.g. Friesinger, Tejral, Stuppner Hrsg. 1994; Erdrich et al. 2020) took place within the respective time block, and the significant increase of *militaria* occurrence could be, *prima facie*, explained through the long-term nature of the conflict, which with various intensity inflicted the most of the parts of the Middle Danube region. It is logically inevitable for these turbulent and warfare times to propagate into the archaeological record, as it is evident from the probabilistic temporal distribution. The significant increase is seen, above all, within the funerary record, which could be potentially the result of military casualties during the armed clashes, presumably within the expeditionary phases of the Marcomannic Wars between 172 and 180 AD, during which the Roman army units undertaken an extensive operation in the 'Marcomannic' settlement zone (cf. Komoróczy et al. 2020). Nevertheless, the iron for such increase could be originating from the local

42 In the past, the rich princely grave from Mušov was even associated with the prominent political figure – Ballomarius. From the narrative sources's information, he is considered to have been a leader of the Germanic tribal coalition during the first phases of the Marcomannic Wars, and who also led the group of chiefs in negotiations with Pannonian governor Iulius Bassus presumably in 166 AD (Cass. Dio LXXI.3.).



Graph 5.46. *Militaria.* Temporal distribution of sums of aoristic weight. The values are differentiated according to the dating possibilities (based on artefact identification/dating of the context).

	-30 – 0	0 – 50	50 – 100	100 – 150	150 – 200	200 – 250	250 – 300	300 – 350	350 – 400	400 – 430
Germanic	3.7	26.7	28.3	29.3	151.8	20.2	15.1	12.4	12.0	4.9
Roman	0.1	0.9	1.6	7.6	30.9	5.2	4.5	3.3	2.4	0.5
Total	3.8	27.6	29.9	37.0	182.7	25.4	19.6	15.7	14.4	5.4
Normalization	50.0	82.3	55.2	31.5	160.5	30.3	18.0	18.4	14.0	5.7
Difference (%)	1.1	6.6	0.7	2.0	40.5	-43.7	-1.6	-1.1	-0.4	-2.5

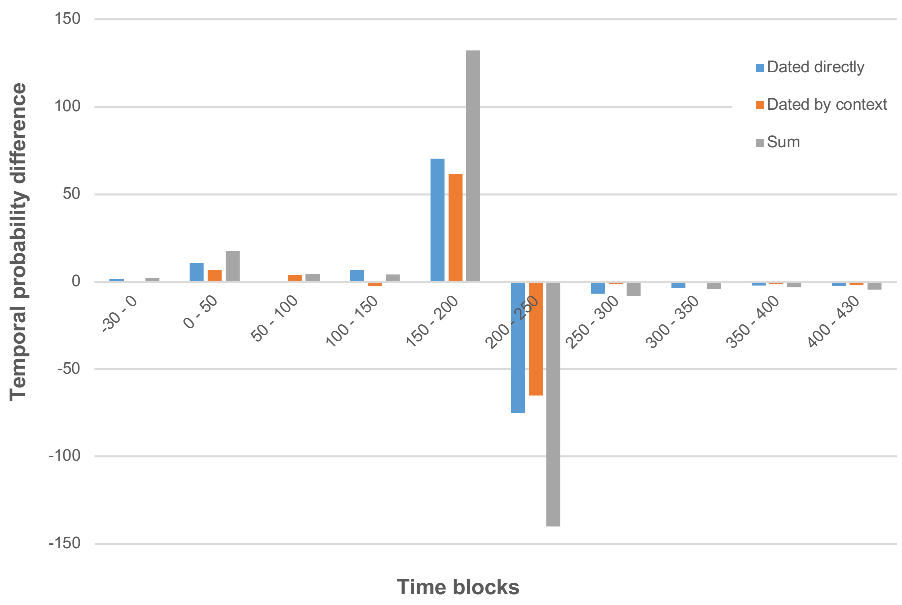
Tab. 5.5. *Militaria*. Quantitative outline of the baseline proxy with differentiation of the *militaria* of the Germanic and Roman origins.

sources to a limited extent, as suggested by low frequencies during others time blocks. Therefore, it could be assumed, that the probably increased local iron smelting performance was in substantial extent complemented by the iron material, which got to the Germanic environment from the large-scale raiding and looting in the Middle Danube province during the initial stages of the Marcomannic Wars.

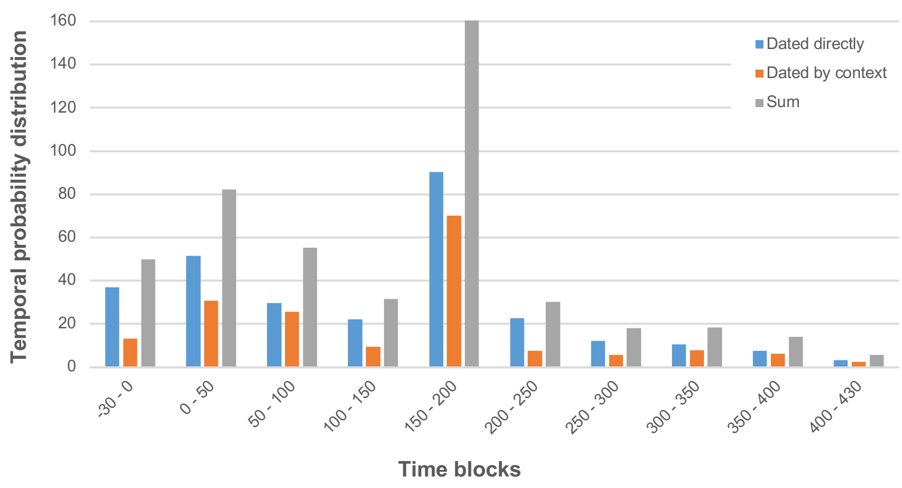
As in the case of brooches or Roman coinage, probabilistic simulation was also applied to this find category to cope with the dating issues. However, its results show an identical temporal distribution. Nevertheless, apart from the extreme singularity of the time block 150–200 AD, there is apparent relative uniform representation throughout the studied period, with only limited rates of increase and decrease during the Early and Late Roman Periods (Graph 5.47). Therefore, this phenomenon reflects the uniform propagation of the societal segments connected with the power roles (foremost retinue members).

Slightly different temporal probability distribution development produces the original values' calibration according to the amount of evidenced archaeological components (Graph 5.48). The conspicuously high values during the first two time blocks (BC 30 to 50 AD) surpass even the highly represented time block 150–200 AD and point to the elevated presence of *militaria* within the phase of the advance of the first groups of the Germanic populations, which is scarcely represented in the archaeological record. According to the narrative sources, some of the retinues under the chiefs who had decided to relocate to the Middle Danube region initially ventured into these territories.

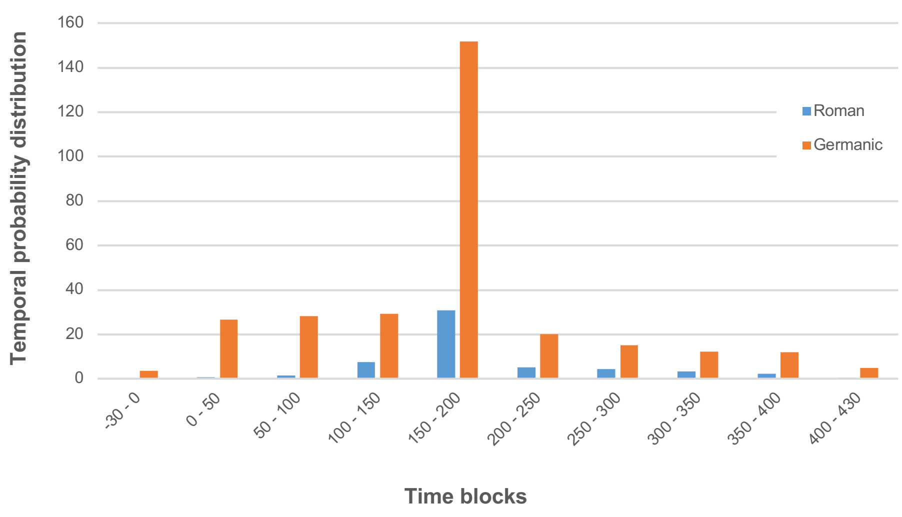
The normalisation of the *militaria* baseline proxy towards the general evidence of the archaeological components provides an essential perspective reflecting the ratio instead of aggregated probabilities. The secondary temporal distribution shows some marked differences, foremost during the Early Roman Period, suggesting more complex development. Considering relatively low numbers in population size and settlement structure density, the time block 0–50 AD constitutes a local peak with a gradual decrease towards the still most significant peak at the time block 150–200 AD. Therefore, the occurrence of *militaria*



Graph 5.47. *Militaria*. The difference between time blocks differentiated by the dating type.



Graph 5.48. *Militaria*. Temporal probability distribution correlated with the component occurrence.



Graph 5.49. *Militaria*. Temporal probabilistic distribution differentiated by the representation of the provenance using all available (datable) items.

in the archaeological record is significantly higher and variable than during the Late Roman Period. However, the resulting temporal distribution and its dynamics are caused foremost by the composition of grave goods and are relatively well-correlated with this secondary proxy indicator (see Chapter 8.2.3).

The baseline proxy was constructed using all the available finds of *militaria* regardless of their origin to provide a general outline of the find category occurrence in the Germanic context *per se*. However, it is indispensable to further differentiate the subset by the identified environment of origin, i.e. Germanic or Roman manufacturing (Graph 5.49) Despite the significantly lower representation of Roman products, it shows a gradual increase from the beginning of the Early Roman Period, with the peaking value coinciding at the Germanic *militaria* climax during the time block 150–200 AD. At this stage, the representation of the Roman-origin *militaria* reaches a comparable level to that of the Germanic *militaria* during the three previous time blocks. During the Late Roman Period, the development of both origin categories was proportionally equal (20–30% of Roman origin items). The mean representation of Roman-origin *militaria* within the studied period is 17%. Therefore, the increase of the Roman origin *militaria* during the key time block 150–200 AD could be seen in warfare consequences in general (booty, plunder and raiding) but also in the service of the Germanic warrior in the Roman army, as it is corroborated by narrative, epigraphy and archaeological sources.

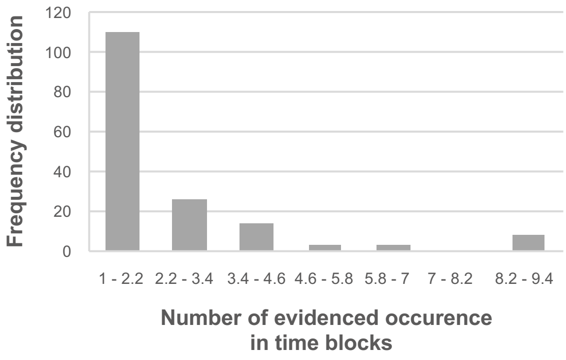
5.3.5 Tools

Despite the frequent occurrence and substantial quantitative representation throughout the archaeological record of the Germanic societies of the Middle Danube region, as well as for the rest of the ancient Germanic world, the find category of 'tools' has traditionally attracted relatively limited attention within archaeological research. Apparently, it is caused by several factors, foremost the formal and temporal variability in diagnostic features and properties, leaving only limited options for more refined relative chronological differentiation for most of the artefacts counting into the 'tools' find category. Nevertheless, in the past living context, tools were indispensable drivers of subsistence, production and maintenance, used on an almost permanent basis. Therefore, the outline of the quantitative development of this find category and the resulting baseline proxy could enhance the explanatory potential towards at least two fundamental dimensions of Germanic societies in general. Firstly, they represent essential means for a wide range of production activities with the respective skill requirements and, in general, economic performance. Secondly, the everyday presence within past activities could circumstantially correlate with population size, as the fundamental logic would suggest that more people would inevitably need more tools to fulfil their baseline needs. Naturally, both dimensions are interwoven and mutually dependent.

The find category itself represents a highly variable segment encompassing a large variety of types and forms of artefacts, consisting of almost all the 'standard' materials (copper alloys, iron, stone, bone and antler, wood), and some are equally variable regarding the function and use interpretation possibilities. In practice, they range from single-purpose tools (e.g. keys intended for locking and opening padlocks, a ploughshare for ploughing) to multipurpose ones (e.g. knives, axes, drills, needles). However, most of the designated identification of 'tools' reflect relatively narrow uses. The internal diversity and relative temporal uniformity of the find category, regardless of the origin, naturally led to relative marginal attention to this find category in archaeological research. Obviously, some types exhibit higher variability, as well as some chronological sensitivity. For example, tools such as keys (Kokowski 1997), scissors (Bezzenberger 1924; Knaack 1978), etc., exhibit variability in forms. In some cases, coupled with the temporal sensitivity, they have provided the grounds for the emergence of relatively elaborate typological systems.

5.3.5.1 Input data

By the time of this publication of this book, there had been a total of 759 records with the find category identification as a 'tool'. However, the association of the registered find types is not always straightforward. The 'knife' category is sometimes considered to have an inevitable overlap with the find category of *militaria* (Chapter 5.3.4), foremost in the case of sizable specimens. Also, the 'razors' often stand between the categories of personal hygiene accessories (along with combs) and tools. However, in this publication, quantitatively, 'knives' (253 records of the whole subset) rest entirely in the non-weaponry category regardless of whether they could be used in this sense or for mere hunting or interpersonal violence, as it applies to many others, primarily non-weapon types of artefacts. However,



Graph 5.50. Tools. Frequency distribution of the number of time blocks in dating possibilities.

only 164 records have temporal information from the 'tool' find category subset. Furthermore, this information was supplemented by the dated context of origin, which provided the additional temporal identification to the 260 records. Eventually, a subset of 424 records was available to derivate the *baseline proxy*.

Nevertheless, the relatively small number of the directly dated tool records show favourable dating conditions, with a large proportion dated with the precision of one time block (Graph 5.50). The variability within the find category underlines over 50 recorded find types, despite many of them being only in limited numbers. The ubiquitous character of this category is also propagated through almost equally (ratio 48 : 52%) distributed origins from the residential and funerary areas. However, only a fraction of the tool subset comes from the Roman environement (13 records, 0.02 %). The tool subset of 759 records is spatially distributed through 200 sites (Fig. 5.16). They are relatively evenly and 'thinly' spread throughout the study region, with apparent concentrations in the conspicuous funerary areas (e.g. Kostelec na Hané 'Prostřední Pololán'; Šitbořice 'Padělky od Moutnic', Velké Hostěrádky 'Podlipiny' and others).

5.3.5.2 Baseline proxy of the tools

Several structures are observable in the archaeological data from the resulting baseline proxy temporal distribution (Graph 5.51, Tab. 5.6). Foremost, there

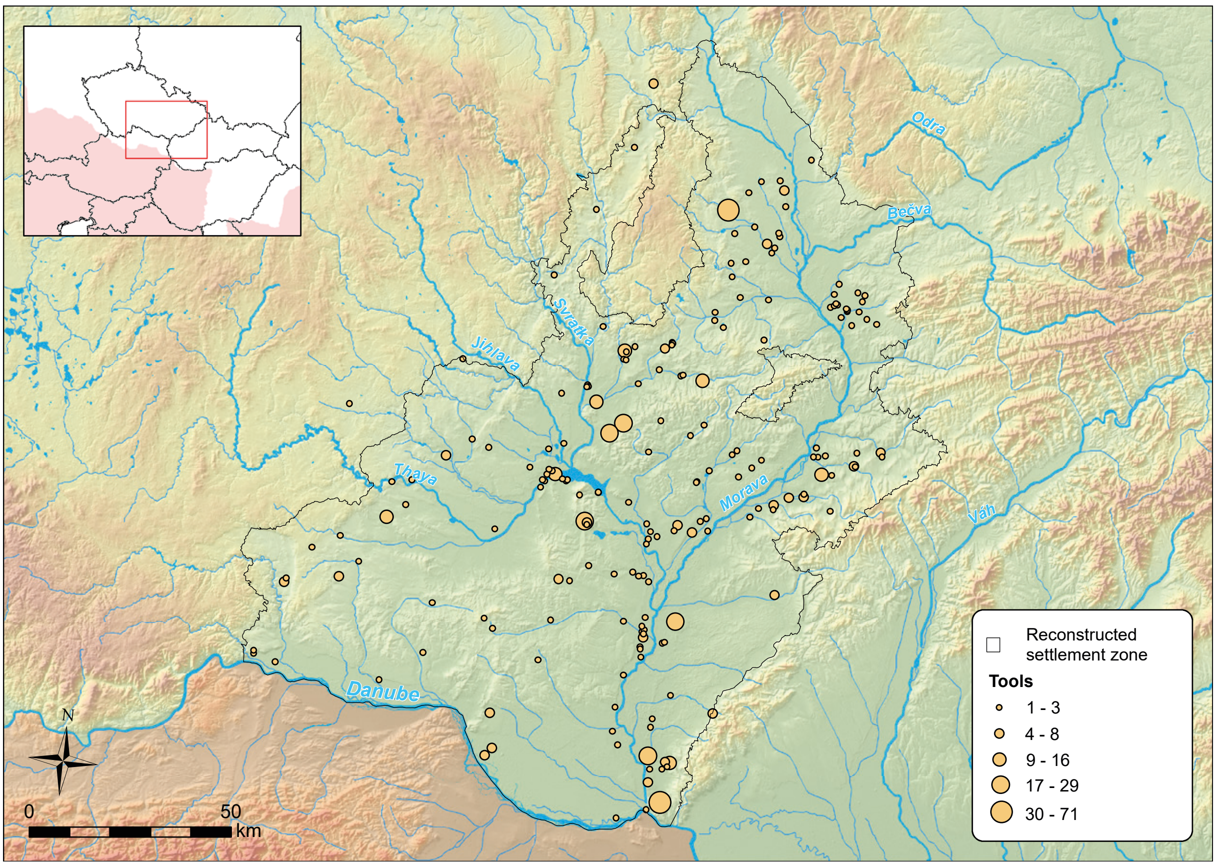
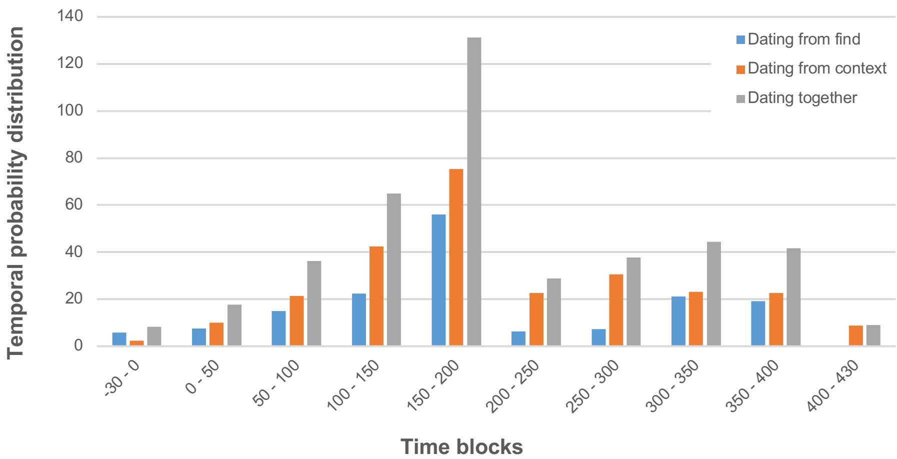


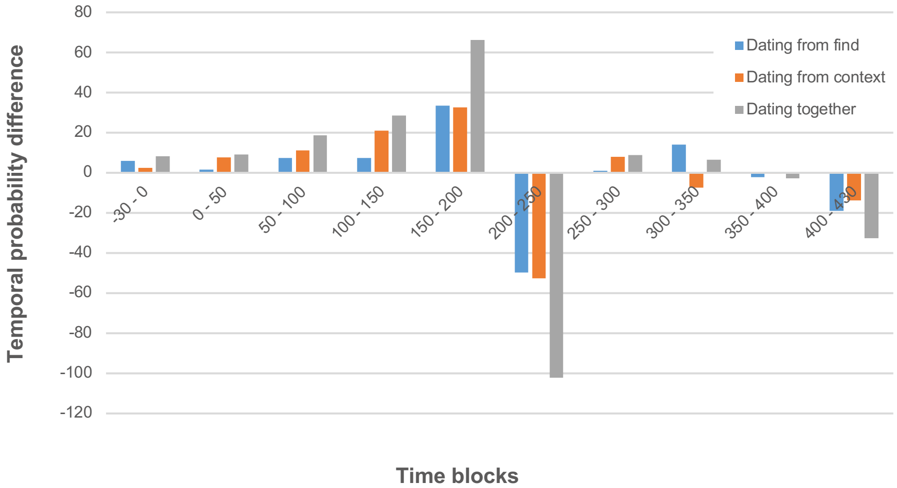
Fig. 5.16. Tools. Spatial distribution of the find category from the MARCOMANNIA dataset.



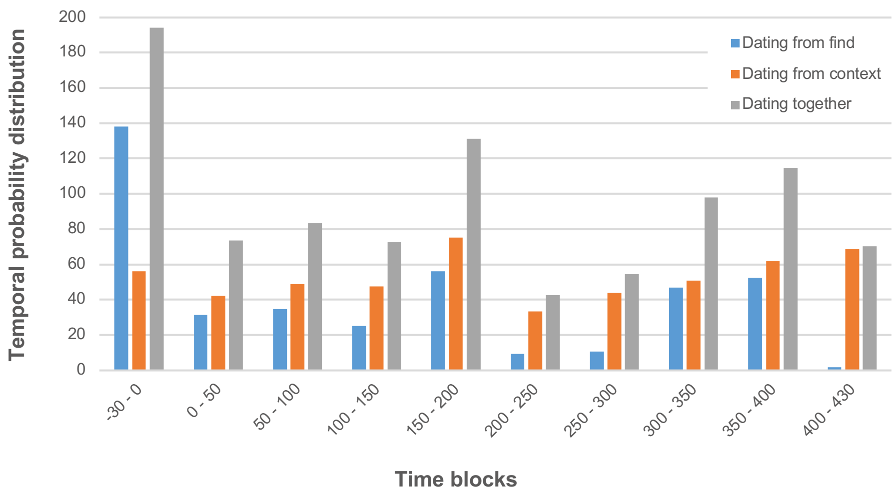
Graph 5.51. Tools. Temporal probabilistic distribution (baseline proxy).

	-30 – 0	0 – 50	50 – 100	100 – 150	150 – 200	200 – 250	250 – 300	300 – 350	350 – 400	400 – 430
Aoristic sum	8.3	17.6	36.3	65.0	131.2	28.9	37.8	44.4	41.8	9.1
Normalization	194.2	73.6	83.4	72.5	131.2	42.6	54.5	97.8	114.7	70.3
Difference (%)	2.9	3.3	6.6	10.1	23.3	-36.0	3.1	2.3	-0.9	-11.5

Tab. 5.6. Tools. Quantitative outline of the baseline proxy.



Graph 5.52. Tools. Temporal outline of the differences in the probabilistic distribution.



Graph 5.53. Tools. Temporal distribution of the probabilistic distribution correlated by the occurrence of all the dated archaeological components registered.

was almost precisely exponential growth during the Early Roman Period, which stopped during the time block 150–200 AD, followed by relative significant scarcity with a slightly increasing tendency during the Late Roman Period. In individual time blocks, there is apparent variability of both types of temporal identification. However, they generally follow a similar pattern in time, validating the resulting baseline proxy.

The temporal outline of the difference values between consecutive time blocks provides another perspective on the proxy development structure (Graph 5.52). The most conspicuous change is evident between the Early and the Late Roman Periods, reflected through most baseline proxies. However, its magnitude is clearly higher than in the essentially demographic ones (residential and funerary areas and their featuring contexts). On the other hand, it is comparable with the decrease evidenced in the temporal probabilistic outline of the metal vessels (cf. Chapter 5.3.3).

The recalculation of the baseline proxy notably points to its dependence on the general occurrence of archaeological components throughout the studied context (Graph 5.53). The overall tendency is relatively flat, with no general development tendencies regarding growth and decline. The notable peak in the first time block of -30–0 BC/AD is well explainable through the scarcity of archaeological data from the respective period, indicated exclusively through the noncontextual evidence. Nevertheless, compared with other baseline proxies, it still suggests a relative overrepresentation of the tools within the time block. This observation also implies that initial groups arriving in the studied region were well-equipped in advance to successfully establish the initial basis to produce all the necessities in this region subsequently. Also, the time block 150–200 AD exhibits a higher representation of the find category in the archaeological record, pointing to increased production activities in general. Eventually, the results corroborate an initial assumption that the tool baseline proxy provides additional correlation to the Germanic population size.

5.3.6 Samian ware

The traditionally prominent place amongst the imported Roman-origin goods is the high-quality Roman pottery *terra sigillata* or Samian ware. The possibilities emerging from its diagnostic features, chronological sensitivity, and good representation within the Germanic context make it a prominent segment of all the imported goods from the Roman environment. Extensive long-term research is reflected through dating possibilities, far more exceptional than any other pottery production. These properties make it a particularly suitable basis for deriving a proxy, which could reflect development in several aspects. Besides the activity of the respective production region and workshops, this category underlines the general economic activities, conditions, and geopolitical conditions. However, its occurrence is a result of several factors and aspects. Foremost, the political-diplomatic aspects could be well-anticipated in connection with the ways and means through which Roman production flowed into the 'Marcomannic' settlement zone.

Within the Germanic settlement territories of the Middle Danube region to the east (e.g. Kuzmová 1997; Kuzmová, Roth 1988) and the west (e.g. Droberjar 1991; Stuppner 1991; Klanicová 2007) of the Lesser Carpathians, as well as within the neighbouring territories (Bohemia, e.g. Halama 2007; 2018 or Poland, e.g. Tyszler 1999), considerable research activities have been conducted concerning the Samian ware finds. Through them, quantitatively based temporal development charts were established, pointing out both general similarities and the local specifics in development.

The available archaeological information based on the studied spatiotemporal context has experienced a substantial increase in tendency during the last three decades. For instance, the study by E. Droberjar from the beginning of the 1990s was based on the 409 fragments of Samian ware from the territory of Moravia (Droberajar 1991, 34, Abb. 10, 12). After thirteen years, the summarisation on the subject by S. Klanicová from the same region counted 589 fragments (Klanicová 2007, 175, Tab. 1). From Lower Austria, the first exhaustive compendium by M. Pollak (1980) listed 50 fragments of the Samian ware.[43] The PhD thesis by A. Stuppner (1994) counted 226 fragments. The Slovakian Záhorie region has significant information sources on the Samian ware, especially in its southern parts (Fig. 5.17).

From the perspective of the spatial distribution of the archaeological information on Samian ware (cf. Fig. 5.17), it is evident that the present state of knowledge is significantly distorted as some regions (southern Záhorie region, middle reaches of the River Morava) or particular sites (e.g. Zohor

43 According to the information from the MARCOMANNIA dataset.

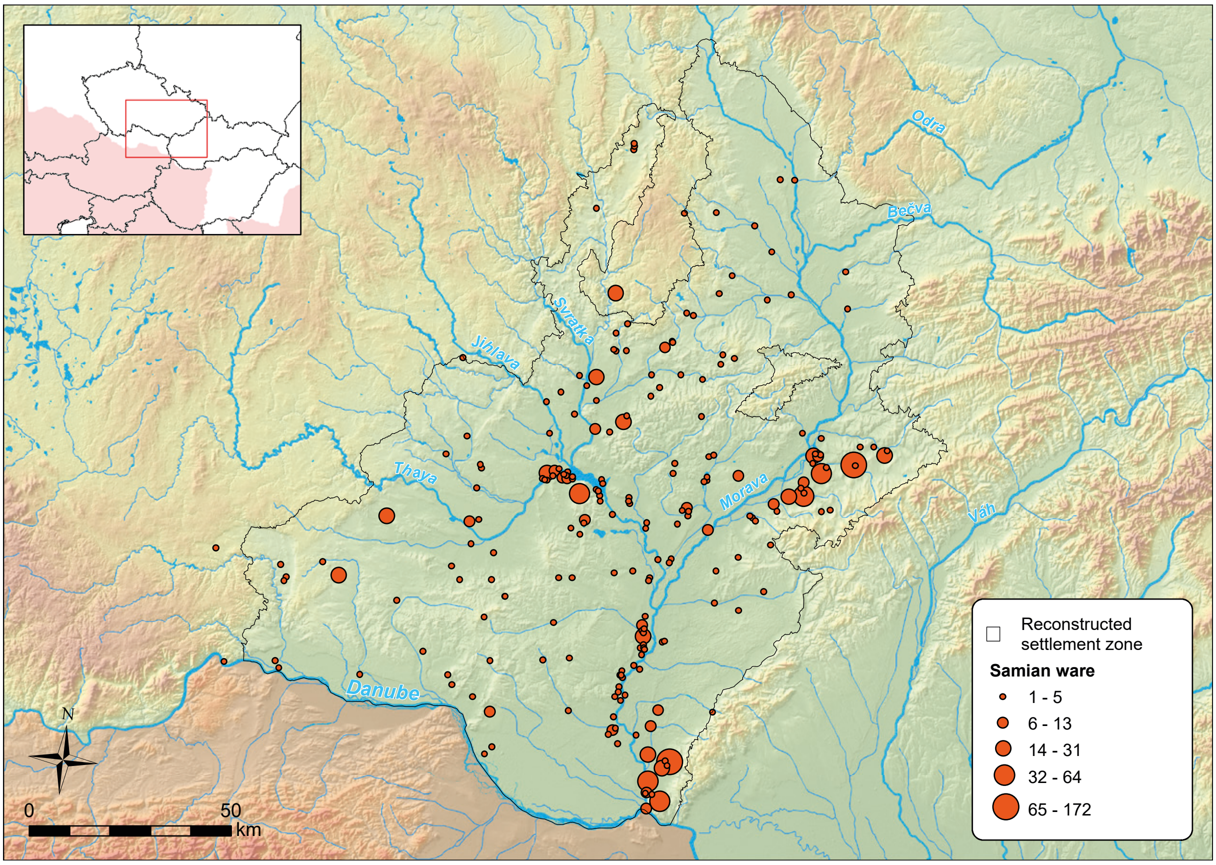


Fig. 5.17. Samian ware. Quantitatively based spatial distribution of all the Samian ware finds within the studied region.

'Piesky', Elschek 2014; Bratislava-Dúbravka 'Veľká lúka', Elschek 2017) provide substantially higher numbers than the rest of the studied area. This effect is connected with various intensities in the engagement of field activities. Conversely, some regions, otherwise providing good coverage of archaeological knowledge (e.g. the Přerov region; Kolbinger 2013), show only limited representation of Samian ware.

5.3.6.1 Input data

Samian ware represents a spatially well-represented category (Fig. 5.17), however, with significant unevenness in recorded quantities, which stems predominantly from the state of the present archaeological knowledge. To fully exploit the information potential, the respective records have been formalised in parity mode, a data collection method where one fragment is represented by one record, to unlock the complete potential of this find category.[44] Presently, the MARCOMANNIA dataset holds a total of 1,290 records. From that amount, 881 could be identified at least for the production centre or, in 259 cases, associated with a particular potters or their distinctive groups (i.e. Bernhard 1981). The Samian ware subset is spatially distributed through 218 sites within the 'Marcomannic' settlement zone (Fig. 5.17). The assemblage of the material from the central military base at Mušov-Burgstall was not included. They straightforwardly represent the result of activities independent of the processes through which it was imported and consumed within the Germanic environment.

On behalf of the primary differentiation of the context of origin, the dominant part of available records comes from residential areas (90%), and the relative minority originates from funerary regions (6%). Regarding the shapes registered, their identification is available in 638 of all Samian ware records. By far, the leading forms represent the types of Drag. 37 (75%), in significantly lesser proportions, Drag. 18/31 (7%) and only 3% in types 32, 33, and 54. Nevertheless, this perspective was not involved in quantitative evaluation and simulation processes to generate the respective baseline proxy.

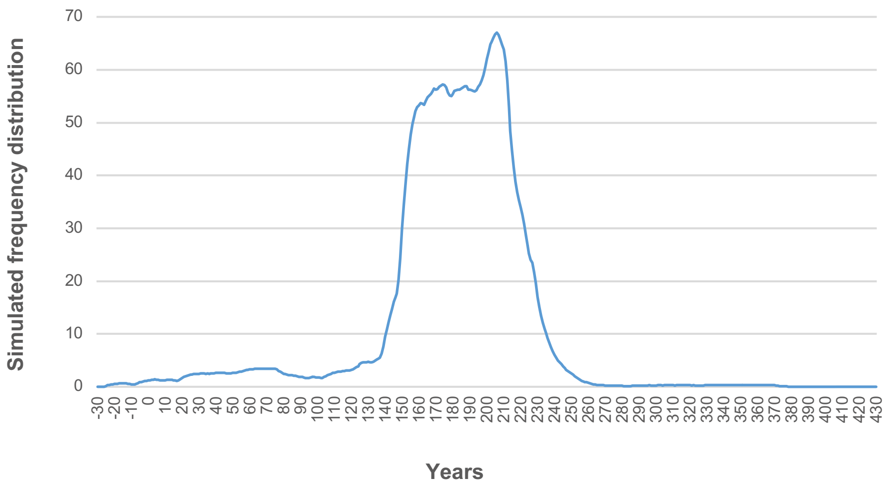
44 The formalisation of the pottery categories within the MARCOMANNIA dataset for most of the cases (without diagnostic features) is conceived through their aggregation into records representing the multiple individual fragments.

5.3.6.2 Probabilistic simulation of Samian ware

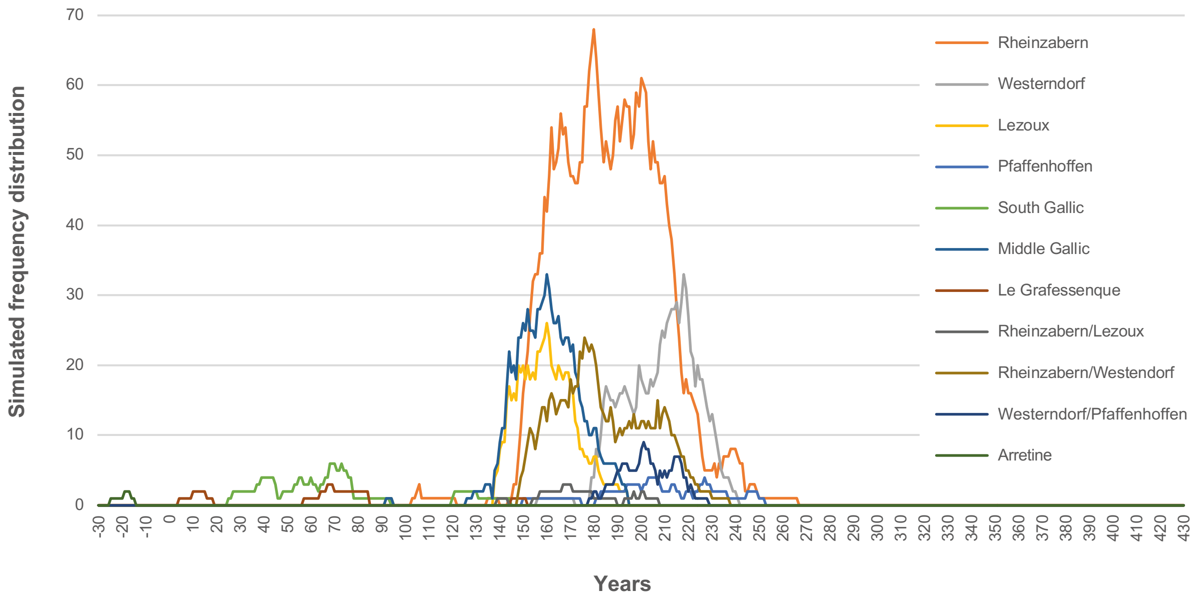
Like in the case of the Roman coinage in the Germanic context, establishing the temporal quantitative probabilistic distribution (baseline proxy) has been conducted by different approaches than the other baseline proxies based on relative chronological system dating (Chapter 3.3), mainly due to the specific temporal identification means (activity of production centres/regions and individual identified potters and their groups) and represented through absolute chronological scale. Therefore, a probabilistic simulation framework was established where input data consisted of the temporal identification with yearly resolution Samian ware records. The main objective is to develop the approximation of the quantitative temporal distribution of the finds in the terminal deposition stage (*thanatocenosis*), which is methodologically most consistent with the actual quality of archaeological evidence.

The approach also provides an opportunity to implement and address the potential effects of the issue of the temporal shift/lag implication of the long-distance transport of the goods from the western provinces, as well as for the duration of the use within the Germanic context until its final deposition within *thanatocenosis*. However, the naturally embedded constraints in the durability of this material category, resulting from nearly 'daily' use, would not suggest an excessively long lifespan (e.g. Orton, Tyers, Vince 1993, 207–209) and only limited duration of the presumed temporal lags. Therefore, in this case, there were not applied various simulation settings (scenarios), as the limited yearly represented lag (generally estimated between 1 to 10 years of the use period and discarded through accidental destruction or its wear; cf. Schiffer 1987; Arnold 1988; Skibo 1992) in each of the distinguished phases (production, transfer, use) would lead to insignificantly different results. However, numerous examples of the reparation of Samian ware in the Germanic context (Droberjar 1991, 34) suggest thorough utilisation and potentially lengthy periods of its active use. It could be assumed that Samian ware was not part of ordinary tableware, and its occasional use could have prolonged its presence in a 'living' context.

Therefore, the eventual setting of the iterative simulation comprised the exponentially distributed probabilities for transition phases. The first – transport – was conceived as an even probability distribution from one to three years, as the dynamics in this regard could be assumed only with difficulty and, therefore, were kept to a reasonable minimum. The consecutive phase of the presence within the Germanic context was preset with an assumption of a lengthy period of use of 5 years as the mean value. This setting results in half of the analysis objects being transferred to *thanatocenosis* during the five-year period, 84% after ten years, and 94% after 15 years of use. The quantitative yearly distribution (Graph 5.54) is based on one thousand random-based probability simulation runs. The simulation results also provide a production centre/region differentiated temporal development pattern with yearly resolution throughout the studied period (Graph 5.55). Regardless of the relatively insignificant quantitative distributions outside the 2nd half of the 2nd century AD and the 1st half of the 3rd century AD, the general tendencies of the quantitatively conceived temporal outline could be drawn. Therefore, the resulting distribution also includes outlying cases, such as specimens which have been last produced and exported from the centres during



Graph 5.54. Samian ware. Aggregation of the simulation results of the probabilistic temporal distribution.

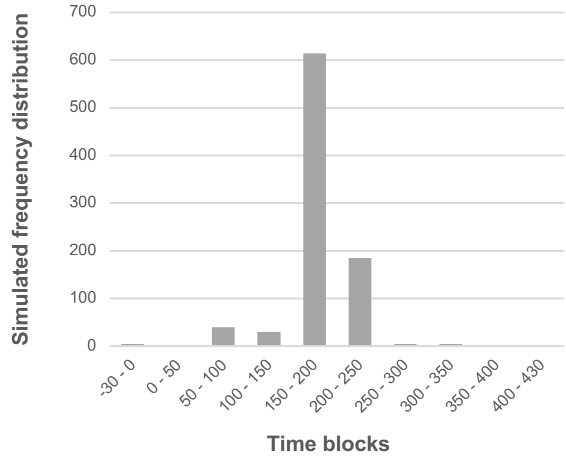


Graph 5.55. Samian ware. The modelled yearly temporal distribution of quantities according to the individual identified production centres and regions. The graphic outline omits insignificantly represented centres in Trier and Heiligenberg.

the 230s (Pfaffenhofen, Rheinzabern, Westerndorf), which could have ended up in *thanatocenosis* around the mid-3rd century AD.

The aggregation of the individual identifications of the production centres or potters provides an insight into the development of the whole material category *per se* (Graph 5.55). With the given settings, this outline reflects low temporal proximity of production and transfer to the Germanic environment. The inception of the simulated period up to the mid-2nd century AD is characterised by the insignificant occurrence of the products of La Graufesenque (Tejral 1974, 83). Nevertheless, the sudden staggering increase took roughly from 140 AD, steeply rising further 25 years and reaching its maximum by 165 AD, associated foremost with the production centres in Lezoux and Rheinzabern (e.g. Droberjar 1991; Klanicová 2007. However, with different proportions in the military and Germanic contexts (Klanicová 2008). Further decades represent a minor oscillation with gradual stability until around 200 AD, where a further minor increase is observable in the probabilistic simulation results, resulting from an additional influx of the production centre in Westerndorf . Its sharp decline is discernible for the year 210 AD and its end in 235 AD in simulated frequencies. Further, the gradual decrease hits the marginal amounts between 245 and 255 AD. Naturally, the simulation results are also consistent with the present state of knowledge and existing research results (cf. Droberjar 1991; Klanicová 2007), as well as in the neighbouring regions (e.g. Kuzmová, Roth 1988; Halama 2018).

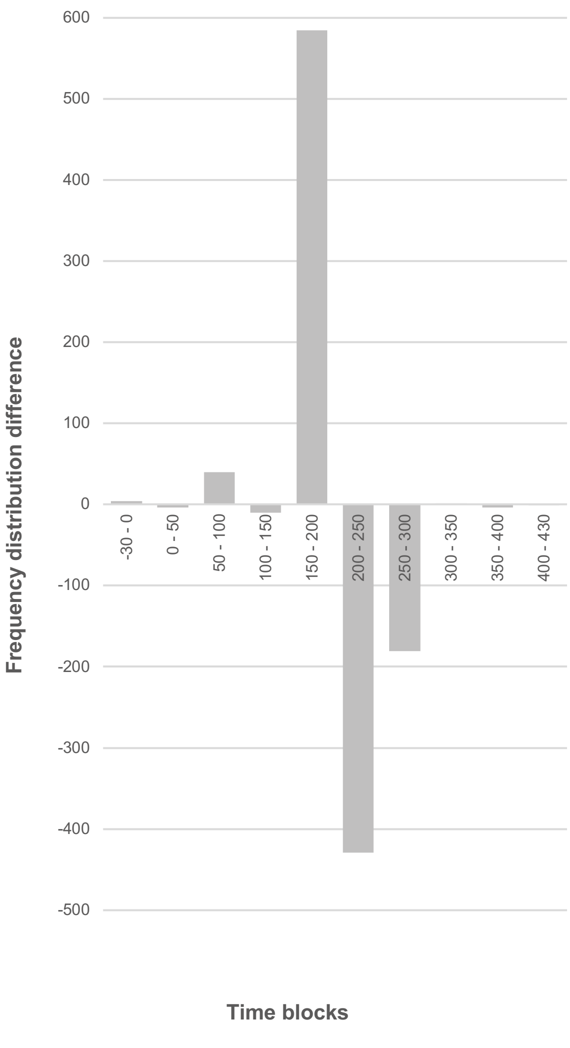
The detailed temporal distribution was then transformed into the time block structure to achieve a baseline proxy (Graph 5.56) compatible with other baseline proxies. Despite the loss of yearly temporal resolution achieved through the probabilistic simulations, which may itself provide insight into the



Graph 5.56. Samian ware. Translation of the yearly simulation results (Graph 5.54) into the 50-year baseline proxy development chart.

issues connected with its stages of lifespan (production and transfer into the Germanic context, period of use, ultimate deposition context and time), the resulting baseline proxy would provide additional quantitative temporal distribution within the Germanic context.

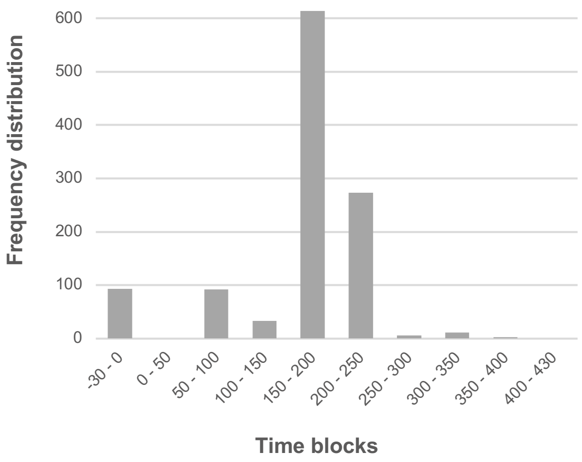
In general, the dynamics of the quantitative aspects of the Samian ware are particularly relevant within the interpretational frameworks of the ways and means through which it was procured and distributed within the Germanic context of the 'Marcomannic' settlement zone. Foremost in connection with the turbulent epoch of the Marcomannic Wars (cf. Erdrich et al. 2020), when a large part of the influx occurs (cf. Tejral 1970a). Therefore, the conflict itself has not interfered with its dynamics. The magnitude of positive change after the half of the 2nd century AD would suggest a highly centralised and organised procurement and bulk purchase nature, resulting in a sudden and significant turnover in occurrence patterns. An individual-based conducted trading activities would hardly result in such quantitative changes. Simultaneously, such an influx results from a series of factors. Foremost, the attitudes of the Germanic decision-making class in the procurement of 'foreign' goods provided to maintain the power position and further extend the power strategies through their redistribution. Nevertheless, due to its near ubiquity in the Germanic context, its accessibility was higher and proportionately its 'value' in redistribution systems, through which it has diffused to the terminal nodes of the power system on a community level.



Graph 5.57. Samian ware. Difference (change in consecutive time blocks) in aoristic weights probability distribution.

Furthermore, the volume of the peak time block 150–200 AD (47% of all difference, Tab. 5.7) is spatially distributed throughout the studied region (218 sites; Fig. 5.17), testifying to the robust redistribution networks within the Germanic environment at the time. However, the magnitude of the influx during the warfare period was potentially conditioned by military activities. There is a notable difference in the composition of the Central Gaul and Rheinzabern/Westerndorf production in both contexts. Multiple evidence from the Roman military installations presumably directly impacted by the conflict shows higher frequencies of Central Gaul production. Accordingly, Mušov-Burgstall provides testimony for the domination of Lezoux production (59% of all fragments and 83% with identified production origin; Droberjar 1993; Klanicová 2008), whereas the production of the latter dominates in Germanic context (e.g. Droberjar 1991; Klanicová 2008). Based on data from the MARCOMANNIA dataset, the representation of Rheinzabern and Westerndorf is nearly 80%. Despite the temporal overlap, the difference suggests different distribution patterns.

The disappearance from the archaeological record is then connected with the decline of the production centre in Rheinzabern caused by the large-scale Alemannic invasions of the area between upper reaches of the rivers Rhine and Danube during the 230s AD (Gabler, Vaday 1986, 133; Gabler 1987, 86), resulting in a reduction of the overall influx (decrease by 34% of all difference). However, the simulation scenarios with exponentially distributed potential 'transfer' period between production and introduction into the Germanic context reaching 60 years (mean 20 years), as attested by exceptional contexts (e.g. Piercebridge, Ward 1993), the occurrence of the Severan Samian ware could be expected to be in use up to the end of the 3rd century AD.



Graph 5.58. Samian ware. Temporal probability distribution normalised by the component occurrence.

From data distribution and shaped, as well as compared with other baseline proxies drawn from available movable archaeological finds of Roman origin from the MARCOMANNIA dataset (e.g. brooches or metal vessels), the Samian ware-based baseline proxy is most significantly polarised and unevenly distributed on a temporal scale. Over 90% are aggregated within two time blocks (150–200 and 200–250 AD). The results also overlap with the distributions and quantitative models based on data from Moravia earlier (Droberjar 1991, Abb. 11). The ascertained difference outline derivate shows the proportionate peaks (Graph 5.57) of bipolar character with a uniform peak in increase (150–200 AD) and reductions in subsequent two decreases (200–250 and 250–300 AD).

Eventually, normalisation of the baseline proxy by all dated archaeological components (Graph 5.58) provided only marginal differences to the original temporal probability distribution (Graph 5.56). Only marginal increases in the time blocks -30–0, 50–100, and 200–250 AD could be observed, leaving the data structure unchanged.

5.4 Technology and material aspects

A critical perspective for understanding the development of the studied context could be drawn from the temporally differentiated representation of the available indicators of the technological parameters and capacities within the 'Marcomannic' settlement zone. Simplistically, the study of technological aspects of archaeological material is usually the domain of the natural scientific methods conducted on the metal artefacts (foremost the material composition and production techniques; e.g. Voß, Hammer, Lutz 1998; Hložek, Komoróczy, Trojek 2012), as well as other materials (e.g. bone and antler, MacGregor 1985). The respective studies usually focus on individual metallic artefacts of particular importance (e.g. Komoróczy, Vlach, Hložek 2014), sets of the same type or find category (e.g. Komoróczy, Vlach, Zelíková 2017), collections from particular sites (e.g. Hložek 2017), regions (e.g. Goláňová et al. 2020) or the elements of interpretative potential (e.g. Droberjar, Frána 2004). Nevertheless, there is no such natural scientific data in the MARCOMANNIA dataset at present,[45] and the approach chosen for the derivation baseline proxies intends to understand more general perspectives based on selected underlying parameters (variability in material culture and representation of the featuring materials) of the quantitatively representative data. The depth and width of the information used proportionally condition the interpretation possibilities of the approach. Still, their quantities, as well as spatial representation, are potentially a counterbalance to these deficiencies.

5.4.1 Variability in material culture and technological implications

An additional valid proxy indicator, for which a sufficient number of inputs exist in the MARCOMANNIA dataset, draws its methodological substantiation in the assumption that the occurrence frequencies of the types of identifiable movable archaeological material are correlated with the state of technological capacities (in the sense of conditioning of production potential) of the 'Marcomannic' settlement zone Germanic populations. Nevertheless, the variety of the temporally available products is presumably simultaneously associable with population size, which is circumstantially in alignment (positively correlated) with overall economic output and performance. Within chiefdom societies, the population size and its capabilities provide the indispensable economic basis of a chief's sources (through tribute, levies, etc.) to maintain and extend his power and exercise his power strategies (Earle 2011; Grinin, Korotayev 2017).

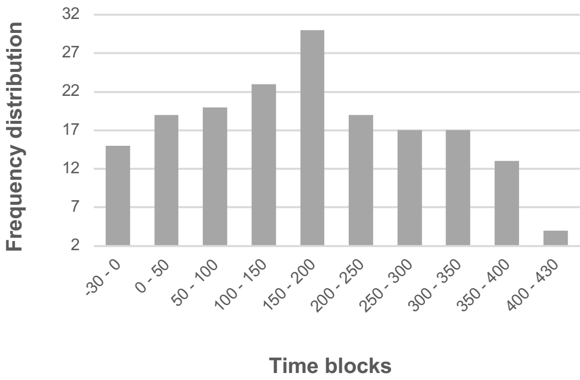
45 But for the future phases of development of the MARCOMANNIA dataset it is planned that we will provide opportunities for broadening the potentially addressable research questions regarding the technological aspects of the studied Germanic societies.

5.4.1.1 Input data

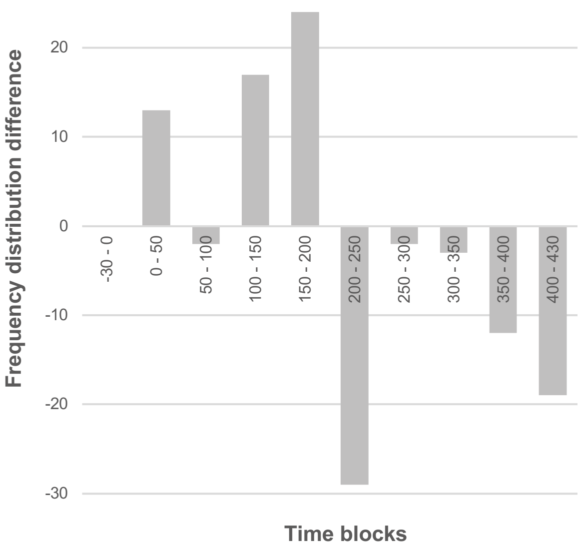
Within the MARCOMANNIA dataset, 222 individual artefact-type identifications exist within the find categories. Consequently, there are currently 154 type identifications in the domain of movable finds of Germanic origin (i.e. excluding the Roman origin finds). For temporal quantification of the variability, 2,042 records of movable finds are available. The number of movable find records with the type identification is significantly higher (7,749), and only around ¼ have been dated. The respective subset of the technology baseline proxy encompasses considerable variability in various aspects (material, manufacturing procedures, type of use, etc.). Despite that, the input subsample is sufficiently representative in size, and additional temporal data for the input objects, based on the dating of the immovable finds – archaeological contexts, was unnecessary. Furthermore, the resulting information is biased through the broader brackets of dating, which tends to be overrepresented on the time scale and, in most cases, is analogous to the timelines based on movable finds dating.

5.4.1.2 Baseline proxy of the technological capacities

The development trajectory tends to be observable in several other baseline proxies (residential areas, burial grounds) with different tendencies. However, several specific aspects of the data distribution can be noted, especially during the Early and Late Roman Periods. Foremost, the distinction in the terminal time blocks differs significantly, suggesting an advanced initial stage of development and considerable reduction in the disponible spectrum during the terminal stage. This trend is evident in the archaeological material (generally on the subject cf. Tejral 1993) and implies significantly different economic conditions on both ends of the studied period. As the broader spectrum of the material culture could be associated with the manifestation of the higher-positioned social strata, a conclusion can be drawn that the structure observed in empirical data reflects the differentiated structure of mobility. Therefore, the incoming Germanic populations during the initial phases of the Early Roman Period were represented by the respective societal entities, propagating themselves in the archaeological record accordingly. Conversely, the terminal phases of the Late Roman Period resulted in the remaining parts of the population being in lower societal conditions.



Graph 5.59. Technology. Baseline proxy indicator of the temporal development of the technological conditions and economic performance of the studied context.



Graph 5.60. Technology. Difference in temporal probability distribution of the technological conditions and economic performance of the studied context.

Furthermore, the development of the baseline proxy (Graph 5.59) follows an almost linear increase until the outstanding increase during the 2nd half of the 2nd century AD, implying a notable increase in the breadth of Germanic-origin artefacts and circumstantially diversification of the local production output, manifested through the archaeological data. After a considerable drop recorded from the 1st half of the 3rd century AD, the proxy shows that relatively comparable representation could be suggested for the Late Roman Period until the mid-4th century AD. Therefore, the general 'impoverishment' phenomenon, mainly suggested through the characteristics and composition of the grave goods (cf. Kolník 1961, 244; 1975, 356) within the burial context of the Late Roman Period, is counterbalanced by the archaeological data from other activity areas and is not apparent from a general perspective. Therefore, it also suggests the relative stability of the production system itself, which had to encompass consumption requirements within the Germanic society of the Middle Danube region. Foremost, the significant parts of the material culture were produced on the community level (e.g. pottery, objects from organic material), and foremost, the production of metal objects, in general, was organised through the principle of keeping key production segments under the control of the prominent societal power entities – chiefs.

Nevertheless, through the difference representation (Graph 5.60), the most significant bipolar changes could be observed between the 2nd half of the 2nd and the 1st half of the 3rd centuries AD (time blocks 150–200 and 200–250 AD). A decrease of almost the same magnitude is evident for the terminal time block 400–430 AD. It also corroborates the assumption of the significant reduction in already low technological conditions in the studied region based on the breadth of the represented variability in the archaeological finds during the terminal phases of the Late Roman Period (Tejral 1975; 1982; 1989).

5.4.2 Material representation

Along with the other proxy indicator on technological capacities, a cross-sectional perspective on the manifestation of prominently represented materials could also be employed. As most movable find records are supplied with this 'primary' information type, general spatiotemporal tendencies could be inferred, potentially correlating with several aspects of the studied Germanic societies. Foremost in economic (the local production capacities) and political (influx of Roman production). Nevertheless, despite these unevenness and biases, quantitative representation perceived regardless of the find categories may provide additional correlations to the general economic development trajectory. The available information basis is also significantly distorted and biased through the specific processes within the 'living' context, especially recycling and hoarding (for various purposes), which considerably influence the overall volumes of metal in circulation and use. For example, the Roman coins in the Germanic context, in a certain proportion, also provided a valid source of material for local production activities. The high reuse and recycling rates of Roman products of copper alloys could be independently suggested through the documented elemental compositions, where amounts of zinc could be traced (Droberjar, Frána 2004; Komoróczy, Zelíková, Vlach 2017; Voß, Hammer, Lutz 1998).

5.4.2.1 Input data

From the total number of movable find records, the majority, 98%, contain information on primary or primary/secondary material they are made of. However, the disproportional representation could be seen in the evidenced material categories preserved in the archaeological record – copper alloy, iron, precious metals, glass, stone, and bone/antler. As evident from Table 5.8, by far, the most significant part is the artefacts of various metallic categories – including 'metal (unidentified)' – i.e. 62%. The sizable category of pottery, in general, was not included as the records in the table of movable finds represent only 'aggregation' records, regardless of

Material (primary/ secondary)	No. of records	Clay	Amber	Stone	Bone	Metal (unspecified)	Led	Antler	Glass	Copper alloy	Silver	Gold	Iron
Antler	26									1			
Led	27												1
Slag	33												1
Gold	48			2									
Resin	124												
Stone	133												
Glass	493											1	
Silver	1088									4		36	1
Bone	1398							3		30			10
Iron	1413				3	1			1	9	18		
Metal (unspecified)	1506										1	1	
Clay	4315												
Copper alloy	6737		1	5	1		3		16	1	56	2	27
Total	**17341**	**0**	**1**	**7**	**4**	**1**	**3**	**3**	**17**	**45**	**75**	**40**	**40**

Tab. 5.8. Material representation. Quantitative distribution of the records regarding identified primary and secondary materials. The primary materials are in rows, and the complementary secondary material is in columns.

how many individual pottery-related records are contained in the particular table for pottery formalisation (see Chapter 3.2.1, 4). Of the 4,315 records with 'clay' primary material identification, 3,621 belong to this category. The rest consists mainly of records of technical ceramics (e.g. spindle whorls, nozzles) and building materials (daub). Higher numbers could also be seen in bone (apart from anthropological material from the funerary context) or glass (foremost being beads).

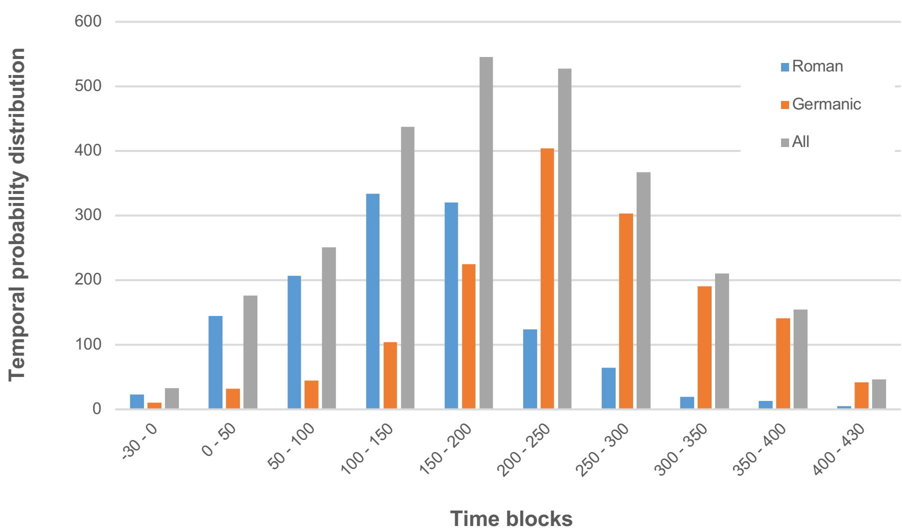
Indeed, there are significant differences in the conditions of various material categories and movable finds representation based on their durability, specific lifecycle aspects (reuse and recycling) and diagnostic features for determination and dating. For instance, the brooches have been produced from both generally represented materials – copper alloys and iron and such distinction is significantly conditioned by provenance. Typically, a far more significant proportion of the finds with temporal differentiation is made of copper alloys than iron ones. Furthermore, in the composition of the Roman production influx, the most significant part consists of copper alloy artefacts (39%). This phenomenon is caused foremost by the temporal durability and resistance to decay of this material, as well as the extensive extraction of the respective archaeological material through metal detecting activities (cf. Komoróczy 2022; Komoróczy, Vlach, Hložek 2014; Komoróczy, Vlach, Kmošková 2024).

5.4.2.2 Baseline proxy of copper alloy

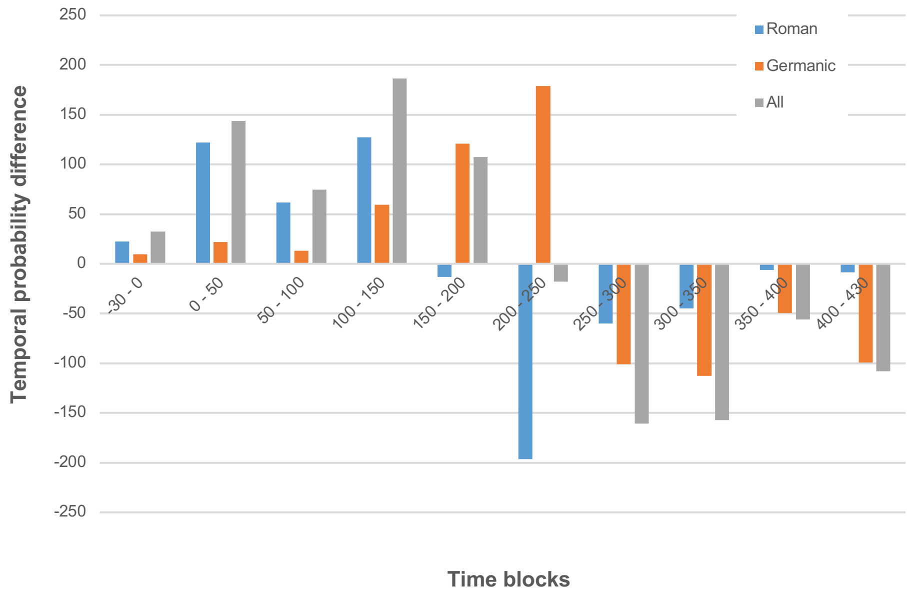
Concerning the proportionality within the metal 'primary' identifications, the copper alloy stands out throughout the whole metallic period of the Middle Danube region, as well as the Roman Period. Obviously, the material category per se is a gross and overt simplification of the heterogeneous alloys with variable alloying element compositions. However, the gradually increasing volume of spectrographic data will enable robust and 'Marcomannic' settlement zone-wide analysis and evaluation of this material dimension. Notably, almost half (3,323 records, i.e. 49%) are brooches. The proportion additionally underlines the ubiquity of this artefactual category, circumstantially corroborating its potential to correlate with one of the main demographic properties (population size), as well, up to an extent, the economic and diplomatic relations as a large part of the copper alloys' records consists of those of Roman origin (3,738 records, i.e. 55%).

The temporal probability distribution of the copper alloy baseline proxy (Graph 5.61) generally exhibits even development with an accelerating increase during the Early Roman Period until the time block 150–200 AD, where its marginal peak is located. A more gradual decrease is apparent by the 2nd half of the 3rd century AD. Therefore, it differs distinctively from other baseline and secondary proxies, consistently indicating an obligate drop by 200–250 AD time block. Both terminal time blocks are represented at the significance margin. The temporal probability distribution difference (Graph 5.62) underlines a differentiated development of the proxy during the 2nd century AD with presumably non-coincidental transition in the general quantitative shift in representation of this material.

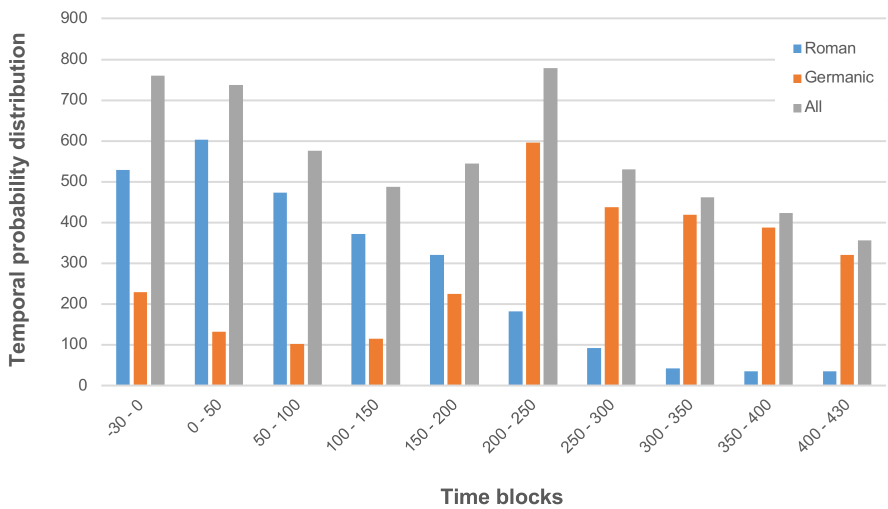
However, a significant proportionality of Roman-origin items is embedded within this material category (39% of records). Therefore, paying attention



Graph 5.61. Copper alloys. Temporal probability distribution of the evidenced artefacts.



Graph 5.62. Copper alloys. Difference in the temporal probability distribution of the evidenced artefacts.



Graph 5.63. Copper alloys. Temporal probability distribution of the registered artefacts correlated by the general occurrence of the archaeological components.

to the development trajectories regarding the evidenced origin of the copper alloy movable find records is essential in context of relative occurrence normalised by the all documented archaeological contexts (Graph 5.63). At first sight, there is an apparent contradictory development of both origin-based copper alloy subsets. The initial growth during the Early Roman Period consisted mainly of Roman-origin movable finds, reaching its climax already during the time block 100–150 AD with an even course towards the subsequent time block. The first marked drop is apparent during the 1st half of the 3rd century AD. The development of the Germanic-origin copper alloy movable finds with relatively insignificant representation during almost the entire duration of the Early Roman Period is shaped conversely. The first notable increases in the consecutive time blocks 100–150 and 150–200 AD are analogous to the period of the culmination and initial stagnation of the Roman production's representation.

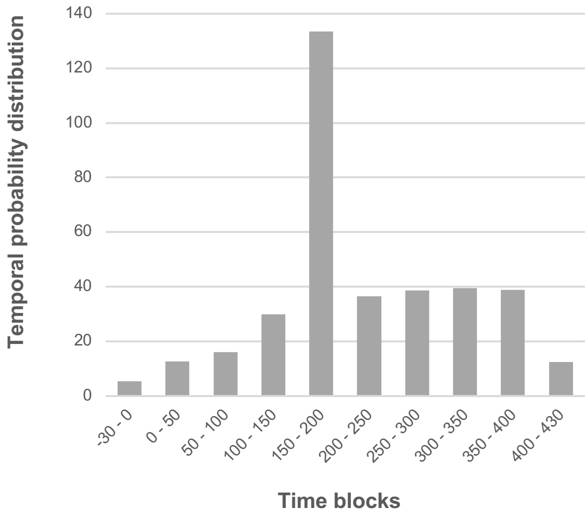
The temporal probability distribution correlated by the component occurrence shows an apparent relatively even distribution with some minor developmental tendencies and particular oscillations. From this, it could be ascertained that its correlation is relatively significant with the baseline demographic proxies, such as residential and funerary areas or brooches. Notably, the copper alloy baseline distribution is closely related to the temporal probability distribution of the brooches (see Chapter 5.3.1), as more than half of them are made of this material. Nevertheless, it shows relatively strong representations during the Early Roman Period, foremost consisting of Roman-origin items. However, the copper alloy artefacts recorded from the Late Roman Period are not significantly fewer, including its terminal time block 400–430 AD, i.e. the phase C3/D1.

5.4.2.3 Baseline proxy of iron

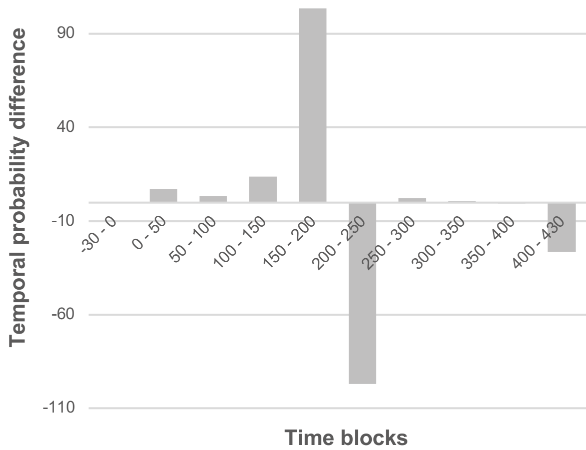
Regarding the material representation in the past 'living' context of the Iron Age Germanic societies, an indispensable place is held by iron for many reasons. Foremost, the availability and affordability of the respective raw materials. Nonetheless, its survival rate and proportionately limited possibilities of correct archaeological determination are significantly constrained through corrosion processes. Hence, the accordingly limited quantities are represented in the archaeological record and data within the MARCOMANNIA dataset. As a result, only 1,413 records with this material distinction are registered there (8% of all movable find records; 14% of metal movable find records).[46] Of this amount, only 366 records contain information on the temporal position of the artefact. Despite the limited representativeness, the wide spread of the material could provide additional insights. In the current state of the dataset, there is only a marginal representation of the iron artefact records with an indication of Roman origin (28 records, 2% of cases).

The temporal probability distribution of the iron baseline proxy (Graph 5.64) and the difference distribution (Graph 5.65) suggests an exceptional recorded peak in the time block 150–200 AD, which is incomparable to the other values. In terms of material type, it is also closely connected with the development tendencies of the *militaria* (see Chapter 5.3.4) and tools (see Chapter 5.3.5) baseline proxies. Apart from the effect of an exceptional assemblage of iron objects from the princely grave of Mušov, the phenomenon is caused by several aspects. Firstly, by the narrow bracket of the dating of the archaeological material based on its presence within the grave goods of the significantly represented burial layer of the 2nd half of the 2nd century AD in general. However, the surging temporal probability distribution could be associated with the large-scale looting of the provincial grounds during the 'offensive' phase of the Marcomannic Wars. However, once this singularity is left out of consideration, the whole temporal probability distribution provides non-standard tendencies' development. Notably,

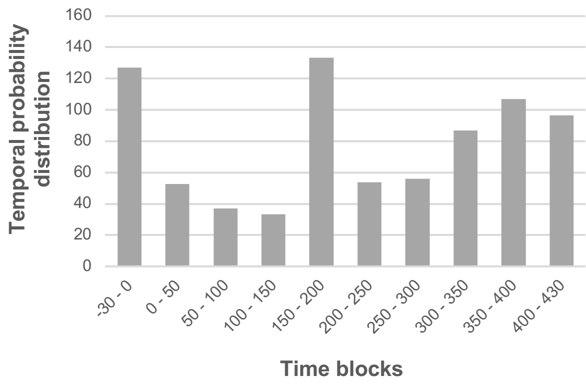
46 Additional quantities of iron artefacts are presumably contained within the general material identification as a 'metal (unidentified)' (1,506 records), which usually results from the quality of the input information sources.



Graph 5.64. Iron. Temporal probability distribution of the evidenced artefacts.



Graph 5.65. Iron. Difference in the temporal probability distribution of the recorded artefacts.



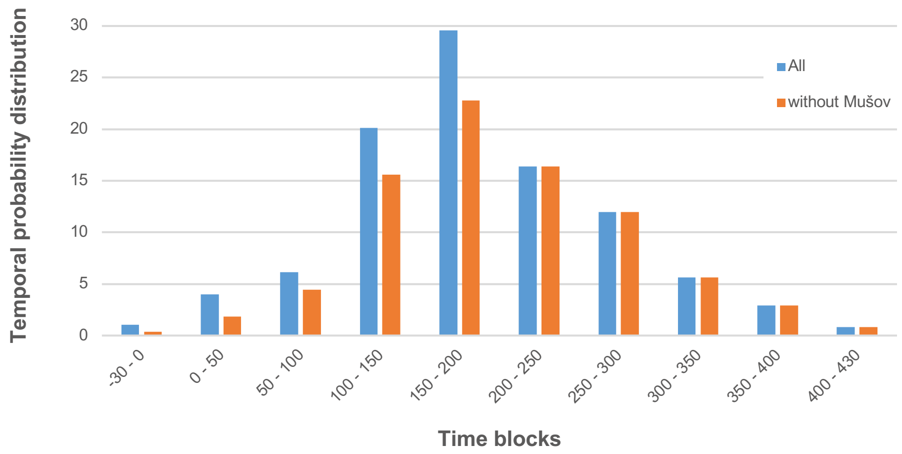
Graph 5.66. Iron. Temporal probability distribution of the recorded artefacts correlated by the general occurrence of the archaeological components.

a reverse development from the other proxies can be observed after gradual development during the Early Roman Period. The temporal probability distribution even surpasses the highest values from the first two centuries AD, except for the extreme peak. The flattened tendency during this period only ended in the terminal time block of the period in question.

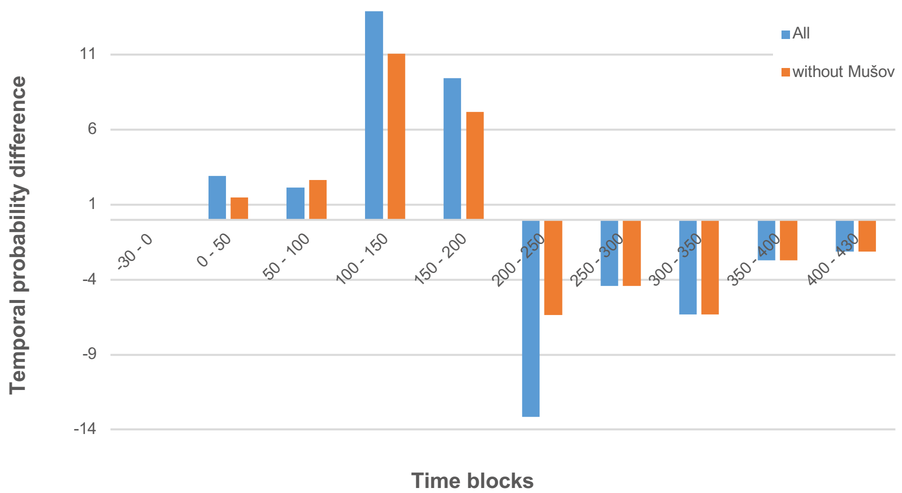
The correlation of the baseline proxy towards the general component outline (Graph 5.66) again highlights the central peaking tendency. However, the substantial proportions in the representation of iron material within the archaeological record are notable also for the Late Roman Period and the inception of the Germanic presence in the Middle Danube settlement zone. It is apparent the gradual decrease of the proportion during the Early Roman Period till the central peak in the time block 150–200 AD, and the following increase with maximum in the time block 350–400 AD.

5.4.2.4 Baseline proxy of precious metals

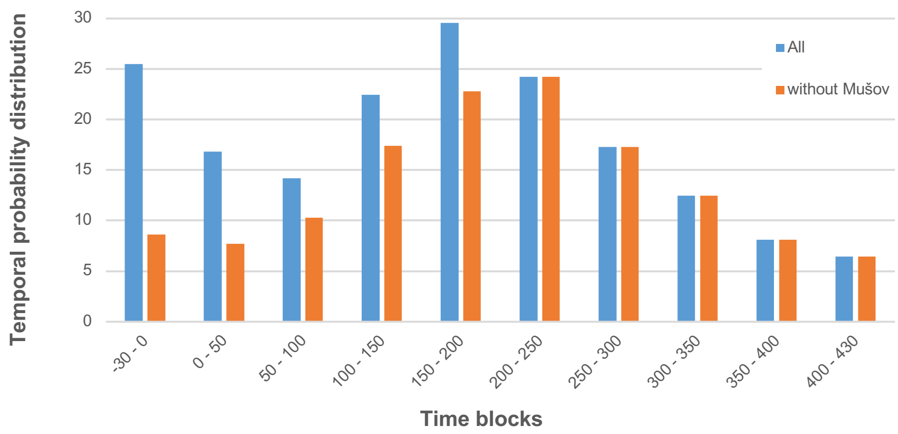
Another cross-sectional baseline proxy has been based on the subset of the movable finds made of precious metals in general. One of the main underlying assumptions regarding this baseline proxy is the potential of reflecting the higher strata of the studied Germanic societies, which could be correlated with the temporal probabilistic distribution of the recorded occurrence of these material categories. The MARCOAMNNIA dataset contains the recorded gold or silver material used either as primary or secondary material. The subset excluded the coin finds, which represent a specific category of exclusively external origin, even though Roman coinage made of precious metals naturally provided a vital input into the local origin luxury objects and garments production. The rarity and scarcity of precious metals (aside from the Roman coins) throughout the material culture of the 'Marcomannic' settlement zone is illustrated



Graph 5.67. Precious metals. Temporal probability distribution of the dated items made of or with the composition of precious metals with and without the Mušov princely grave.



Graph 5.68. Precious metals. Difference of the temporal probability distribution of the dated items made of or with the composition of precious metals with and without the Mušov princely grave.



Graph 5.69. Precious metals. Temporal probability distribution of the dated items made of or with the composition of precious metals correlated by the occurrence of the prominent archaeological components with and without the Mušov princely grave.

by their representation as high as 0.014 % within the MARCOMANNIA dataset movable finds table.

Their occurrence could be related to the dynamics and properties of this specific environment. The extraordinarily furnished so-called princely grave from Mušov (cf. Peška, Tejral 2002) naturally raises the values of the subset. However, only to a marginal extent (Graph 5.67), that does not establish any significantly dissimilar structures in the development tendency (Graph 5.68). Nevertheless, despite the relative decrease from the Early to the Late Roman Period, the signs of this specific environment are present, especially in the recalculation of aoristic sums proportionately to the number of recorded archaeological components (Graph 5.69).

The correlation by the general component occurrence provides insight into the proportionality of Germanic societies' unique and quantitatively marginal segment. Excluding the princely grave from Mušov, it exhibits the same dynamics and the baseline form of the proxy. Proportional increases at the beginning of the Early and the end of the Late Roman Period are comparable. They suggest its stable representation throughout the archaeological record, potentially also within the past 'living' context.

5.5 Statistical evaluation of the proxies

The proxies, emerging from the extensive collection and evaluation of quantitatively representative archaeological data within the MARCOMANNIA dataset (Chapter 5), could be considered a set of multidimensional inputs. They should also be mutually compared and evaluated through statistical exploration of their similarities to investigate their interpretation connotations regarding vital areas of the Germanic societies of the 'Marcomannic' settlement zone. The derived baseline proxies represent the primary temporal development patterns drawn foremost from the aoristic calculations. They are complemented by their 'secondary' derivates (e.g. the mean number of items per burial, pit house floor area, Gini index), including the additionally rectified and enhanced temporal distributions through the probabilistic modelling techniques (e.g. Roman coins, brooches, burial contexts), could be considered a set of the time series, whose shape and characteristics reflect development tendencies in various aspects of the Germanic societies of the 'Marcomannic' settlement zone. The wide array of diverse proxies (Tab. 5.9) on various aspects could be used for the exploration of the development patterns of the main 'domains' of the studied Germanic societies in the areas of demography, economy, and socio-political aspects in general. However, in this chapter, only general observations will be described, and their connotations and utilisation into interpretation are the subject of the final summarising within Chapter 10. A total of 28 variables (baseline and secondary proxies) were established through the process (Tab. 5.9). From their overall outline, it is apparent that most of their dynamics follow differentiated shapes and paths (Graph 5.70). However, many of the derived trends have comparable patterns.

5.5.1 Correlation

For the primary comparison, the *Pearson r* correlation method (also known as the product-momentum correlation), based on linear regression of pairs of input variables, was applied to identify underlying structural similarities. In this evaluation, the actual values are assessed equally, where their 'significance' takes

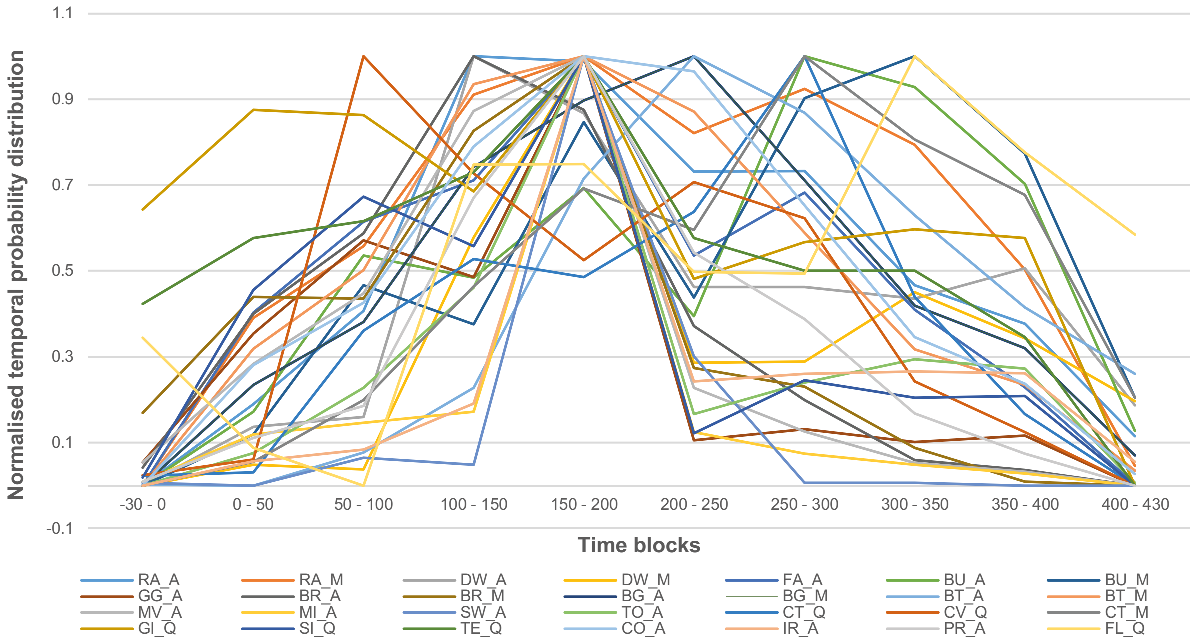
ID	Abbreviation	Proxy type	Description	Chapter
1	RA_A	Baseline	Aoristic sum of the residential areas	5.1.2
2	RA_M	Secondary	Probabilistic modelling of the residential areas	5.1.2
3	PH_A	Baseline	Aoristic sum of the pit houses	5.1.3
4	PH_M	Secondary	Aoristic sum of the pit houses	5.1.4
5	FA_A	Baseline	Aoristic sum of the funerary areas	5.2.2
6	BU_A	Baseline	Aoristic sum of the burials	5.2.3
7	BU_M	Secondary	Probabilistic modelling of the burials	5.2.4
8	WG_Q	Secondary	Quantification of the burials with militaria	5.3.4
9	GG_A	Secondary	Average of the registered grave goods items	8.2
10	BR_A	Secondary	Aoristic sum of the Roman brooches	5.3.1
11	BR_M	Secondary	Probabilistic modelling of the Roman brooches	5.3.1
12	BG_A	Secondary	Aoristic sum of the Germanic brooches	5.3.1
13	BG_M	Secondary	Probabilistic modelling of the Germanic brooches	5.3.1
14	BT_A	Baseline	Aoristic sum of all the brooches	5.3.1
15	BT_M	Secondary	Probabilistic modelling of all the brooches	5.3.1.3
16	MV_A	Baseline	Aoristic sum of the metal vessels	5.3.3
17	MI_A	Baseline	Aoristic sum of the militaria	5.3.4
18	SW_A	Baseline	Aoristic sum of the Samian ware	5.3.6
19	TO_A	Baseline	Aoristic sum of the tools	5.3.5
20	CT_Q	Baseline	Quantification of the Roman coinage	5.3.2
21	CV_Q	Secondary	Quantification of the Roman coinage value	5.3.2
22	CT_M	Secondary	Probabilistic modelling of the Roman coinage	5.3.2.4
23	GI_Q	Secondary	Quantification of the Gini index	8.2.2
24	WI_Q	Secondary	Quantification of the *wealth index*	8.2.1
25	TE_Q	Baseline	Quantification of the technology	5.4.1.2
26	CO_A	Baseline	Aoristic sum of the copper	5.4.2.2
27	IR_A	Baseline	Aoristic sum of the iron	5.4.2.3
28	PR_A	Baseline	Aoristic sum of the precious metals	5.4.2.4
29	FL_Q	Secondary	Average floor area of the pit houses	7.1

Tab. 5.9. General proxy evaluation. The outline of the input variables based on the derived baseline and secondary proxies with the coding and explanation.

Variable	RA_A	RA_M	PH_A	PH_M	FA_A	BU_A	BU_M	WG_Q	GG_A	BR_A	BR_M	BG_A	BG_M	BT_A	BT_M	MV_A
RA_A	1.000	**0.932**	**0.914**	0.791	**0.889**	0.592	0.559	0.154	0.578	0.742	0.701	**0.931**	0.616	**0.950**	**0.908**	0.741
RA_M	**0.932**	1.000	0.795	0.702	**0.900**	0.777	0.732	0.325	0.499	0.596	0.560	**0.907**	0.688	**0.875**	**0.881**	0.580
PH_A	**0.914**	0.795	1.000	**0.882**	0.711	0.512	0.517	0.131	0.522	0.679	0.651	0.754	0.463	0.801	0.756	0.721
PH_M	0.791	0.702	**0.882**	1.000	0.677	0.505	0.603	0.480	0.621	0.553	0.634	0.657	0.513	0.683	0.786	0.689
FA_A	**0.889**	**0.900**	0.711	0.677	1.000	0.581	0.532	0.408	0.791	**0.807**	**0.807**	**0.841**	0.460	**0.914**	**0.846**	0.803
BU_A	0.592	0.777	0.512	0.505	0.581	1.000	**0.968**	0.480	0.183	0.094	0.078	0.527	0.638	0.406	0.555	0.122
BU_M	0.559	0.732	0.517	0.603	0.532	**0.968**	1.000	0.600	0.199	0.033	0.052	0.513	0.695	0.372	0.585	0.107
WG_Q	0.154	0.325	0.131	0.480	0.408	0.480	0.600	1.000	0.511	0.055	0.229	0.158	0.266	0.133	0.348	0.203
GG_A	0.578	0.499	0.522	0.621	0.791	0.183	0.199	0.511	1.000	**0.852**	**0.911**	0.455	-0.022	0.663	0.523	**0.915**
BR_A	0.742	0.596	0.679	0.553	**0.807**	0.094	0.033	0.055	**0.852**	1.000	**0.958**	0.616	-0.002	**0.834**	0.568	**0.971**
BR_M	0.701	0.560	0.651	0.634	**0.807**	0.078	0.052	0.229	**0.911**	**0.958**	1.000	0.573	0.012	0.788	0.603	**0.983**
BG_A	**0.931**	**0.907**	0.754	0.657	**0.841**	0.527	0.513	0.158	0.455	0.616	0.573	1.000	0.769	**0.948**	**0.954**	0.589
BG_M	0.616	0.688	0.463	0.513	0.460	0.638	0.695	0.266	-0.022	-0.002	0.012	0.769	1.000	0.537	**0.805**	0.028
BT_A	**0.950**	0.875	0.801	0.683	**0.914**	0.406	0.372	0.133	0.663	**0.834**	0.788	**0.948**	0.537	1.000	**0.896**	0.804
BT_M	**0.908**	**0.881**	0.756	0.786	**0.846**	0.555	0.585	0.348	0.523	0.568	0.603	**0.954**	0.805	**0.896**	1.000	0.606
MV_A	0.741	0.580	0.721	0.689	0.803	0.122	0.107	0.203	**0.915**	**0.971**	**0.983**	0.589	0.028	0.804	0.606	1.000
MI_A	0.594	0.502	0.560	0.797	0.721	0.218	0.323	0.652	**0.879**	0.653	0.796	0.536	0.281	0.639	0.697	0.791
SW_Q	0.575	0.476	0.513	0.770	0.648	0.169	0.306	0.600	0.759	0.550	0.687	0.597	0.426	0.640	0.747	0.687
TO_A	0.781	0.713	0.800	**0.931**	**0.809**	0.498	0.570	0.599	**0.838**	0.693	0.780	0.646	0.377	0.732	0.764	**0.818**
CT_Q	0.776	**0.843**	0.535	0.398	0.711	0.739	0.641	0.060	0.167	0.321	0.274	**0.811**	0.766	0.697	0.773	0.271
CV_Q	0.689	0.675	0.421	0.225	0.746	0.412	0.297	-0.082	0.486	0.658	0.510	0.699	0.323	0.755	0.560	0.551
CT_M	0.662	0.780	0.605	0.596	0.514	**0.914**	**0.921**	0.360	0.037	0.023	0.026	0.655	**0.854**	0.467	0.696	0.068
GI_Q	0.349	0.437	0.244	0.278	0.642	0.223	0.175	0.519	0.754	0.609	0.685	0.301	-0.123	0.456	0.309	0.619
WI_Q	0.597	0.562	0.530	0.592	**0.829**	0.286	0.276	0.532	**0.985**	0.846	0.884	0.465	-0.017	0.667	0.511	**0.888**
TE_Q	0.723	0.724	0.595	0.606	**0.874**	0.328	0.303	0.425	**0.838**	**0.820**	**0.877**	0.683	0.222	**0.809**	0.698	0.839
CO_A	**0.936**	**0.889**	0.758	0.677	**0.891**	0.452	0.436	0.184	0.581	0.726	0.697	**0.986**	0.671	**0.982**	**0.949**	0.704
IR_A	0.676	0.638	0.669	**0.905**	0.706	0.482	0.606	0.721	0.709	0.476	0.614	0.631	0.544	0.633	0.799	0.632
PR_A	**0.922**	0.801	**0.833**	**0.836**	**0.878**	0.360	0.380	0.269	0.734	**0.805**	**0.842**	**0.880**	0.531	**0.941**	**0.923**	**0.852**
FL_Q	0.413	0.391	0.636	0.698	0.095	0.496	0.605	0.179	-0.079	-0.060	-0.026	0.289	0.503	0.178	0.386	0.062
Observed correlations	**8**	**7**	**3**	**4**	**12**	**2**	**2**	**0**	**7**	**8**	**7**	**8**	**2**	**9**	**8**	**7**

no part in the statistical calculation.[47] The resulting matrix quantifies the statistical similarities of the inputs and reflects the interpretational possibilities and reasonable assumptions about the mutual connections (Tab. 5.10). In this approach, the general shapes of the trends are considered in similarity measures instead of

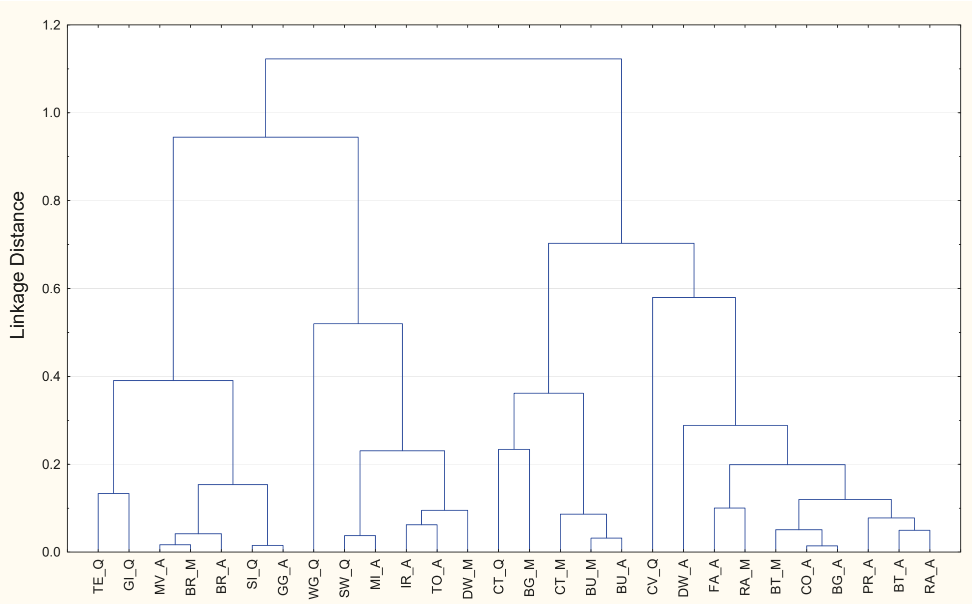
47 The threshold of statistical significance was established at the *p-value* of 0.005.



Graph 5.70. General proxy evaluation. Outline of the selected and normalised (0–1) baseline and secondary proxies.

MI_A	SW_Q	TO_A	CT_Q	CV_Q	CT_M	GI_Q	WI_Q	TE_Q	CO_A	IR_A	PR_A	FL_Q
0.594	0.575	0.781	0.776	0.689	0.662	0.349	0.597	0.723	**0.936**	0.676	**0.922**	0.413
0.502	0.476	0.713	**0.843**	0.675	0.780	0.437	0.562	0.724	**0.889**	0.638	0.801	0.391
0.560	0.513	0.800	0.535	0.421	0.605	0.244	0.530	0.595	0.758	0.669	**0.833**	0.636
0.797	0.770	**0.931**	0.398	0.225	0.596	0.278	0.592	0.606	0.677	**0.905**	**0.836**	0.698
0.721	0.648	**0.809**	0.711	0.746	0.514	0.642	**0.829**	**0.874**	**0.891**	0.706	**0.878**	0.095
0.218	0.169	0.498	0.739	0.412	**0.914**	0.223	0.286	0.328	0.452	0.482	0.360	0.496
0.323	0.306	0.570	0.641	0.297	**0.921**	0.175	0.276	0.303	0.436	0.606	0.380	0.605
0.652	0.600	0.599	0.060	-0.082	0.360	0.519	0.532	0.425	0.184	0.721	0.269	0.179
0.879	0.759	**0.838**	0.167	0.486	0.037	0.754	**0.985**	**0.838**	0.581	0.709	0.734	-0.079
0.653	0.550	0.693	0.321	0.658	0.023	0.609	**0.846**	**0.820**	0.726	0.476	**0.805**	-0.060
0.796	0.687	0.780	0.274	0.510	0.026	0.685	**0.884**	**0.877**	0.697	0.614	**0.842**	-0.026
0.536	0.597	0.646	**0.811**	0.699	0.655	0.301	0.465	0.683	**0.986**	0.631	**0.880**	0.289
0.281	0.426	0.377	0.766	0.323	**0.854**	-0.123	-0.017	0.222	0.671	0.544	0.531	0.503
0.639	0.640	0.732	0.697	0.755	0.467	0.456	0.667	**0.809**	**0.982**	0.633	**0.941**	0.178
0.697	0.747	0.764	0.773	0.560	0.696	0.309	0.511	0.698	**0.949**	0.799	**0.923**	0.386
0.791	0.687	**0.818**	0.271	0.551	0.068	0.619	**0.888**	**0.839**	0.704	0.632	**0.852**	0.062
1.000	**0.962**	**0.912**	0.211	0.272	0.227	0.569	**0.818**	0.759	0.629	**0.926**	0.815	0.179
0.962	1.000	**0.846**	0.231	0.263	0.256	0.441	0.675	0.687	0.667	**0.922**	**0.812**	0.213
0.912	**0.846**	1.000	0.389	0.384	0.482	0.557	**0.818**	0.786	0.704	**0.938**	**0.865**	0.438
0.211	0.231	0.389	1.000	0.702	0.794	0.155	0.224	0.445	0.754	0.373	0.602	0.230
0.272	0.263	0.384	0.702	1.000	0.306	0.372	0.528	0.574	0.721	0.226	0.576	-0.179
0.227	0.256	0.482	0.794	0.306	1.000	0.004	0.100	0.245	0.553	0.543	0.460	0.657
0.569	0.441	0.557	0.155	0.372	0.004	1.000	0.786	**0.866**	0.402	0.434	0.447	-0.254
0.818	0.675	**0.818**	0.224	0.528	0.100	0.786	1.000	**0.840**	0.581	0.669	0.698	-0.088
0.759	0.687	0.786	0.445	0.574	0.245	**0.866**	**0.840**	1.000	0.770	0.669	**0.819**	0.016
0.629	0.667	0.704	0.754	0.721	0.553	0.402	0.581	0.770	1.000	0.665	**0.930**	0.211
0.926	**0.922**	**0.938**	0.373	0.226	0.543	0.434	0.669	0.669	0.665	1.000	**0.808**	0.459
0.815	**0.812**	**0.865**	0.602	0.576	0.460	0.447	0.698	**0.819**	**0.930**	**0.808**	1.000	0.306
0.179	0.213	0.438	0.230	-0.179	0.657	-0.254	-0.088	0.016	0.211	0.459	0.306	1.000
6	**4**	**9**	**2**	**0**	**3**	**1**	**8**	**9**	**7**	**5**	**16**	**0**

Tab. 5.10. General proxy evaluation. Correlation matrix of all the input variables (the fields with p-values below 0.005 in **bold**).



Graph 5.71. General proxy validation. Cluster analysis of the input proxies.

statistical proximity in individual descriptors (i.e. time blocks) of variables, as is the case of cluster and factor analyses.

There is apparent diversity in the frequency of positive correlation of the proxy trajectories (Tab. 5.10). From the explanatory perspective, the significance holds both high and low counts. Highly correlated proxies highlight underlying tendencies in various direct or indirect data trend representations. Conversely, the proxies with marginal correlation to others potentially reflect unique trends independent of the tendencies in other proxies. Firstly, multiple positive correlations could be observed in the baseline proxies of residential (including simulation-based temporal probabilistic distribution) or funerary areas (12 positive correlations), brooches (BT_A; 9 positive correlations), tools (9 positive correlations), and militaria, as well as the secondary – technology (9 positive correlations), copper alloy materials and foremost the precious metals (16 positive correlations). They represent a group of indicators, crossectionally describing the main development tendencies in archaeological data. For example, there is also a tight correlation between the Germanic brooches and the residential area probabilistic distribution. It again corroborates the expectation about the brooches as a proxy to the population size development (see Chapter 5.3.1).

Simultaneously, the shape of some proxies is distinctively different from the rest, and statistically meaningful correlation could be found only in minimum cases, such as the dwellings floor area (FL_Q), Roman coins in general (CT_Q, CV_Q_CT_M), Gini index or the secondary proxy of Germanic brooches (BG_M), which exhibit significantly different tendency in shape of development trajectory from the aoristic based temporal distribution (BG_A). These proxies reflect specific development tendencies, foremost independent from the potentially demography-oriented proxies. For example, the baseline proxy of the burial contexts (Chapter 5.2.3) positively correlates only with coin quantities (CT_M), which also tend to peak during the 3rd century AD. On the other hand, the development pattern of their reconstructed values (CV_Q) bears no similarities to the others.

5.5.2 Multivariate statistical evaluation

The derived baseline and secondary proxies and their temporal probability distribution have also been tested for their mutual statistical similarities through multivariate statistics (cluster and factor analysis). This evaluation provides an alternative insight along with a linearly correlated evaluation from the previous chapter. First, powerful exploratory multivariate Cluster analysis was used to analyse the input data. Likewise, Factor analysis was performed to provide a representative comparison of the derived proxies through the latent dimensions – factors. In this case, the analysis is conceived with the time blocks as objects and individual proxies as variables.

5.5.2.1 Cluster analysis

In general, four comparably represented (large) clusters can be observed at the Linkage distance of

Factor	Eigenvalue	% Total variance	Cumulative eigenvalue	Cumulative variance
1	17.610	62.892	17.610	62.892
2	4.589	16.391	22.199	79.283
3	2.630	9.394	24.829	88.677
4	1.536	5.487	26.366	94.164

Tab. 5.11. General proxy validation. Factor analysis Eigenvalue outline and representation of the variance.

around 0.55 (Graph 5.71).[48] The first cluster distinguishes distinctive similarities between the proxies on metal vessels and Roman brooches (based on aoristic and modelling-based) and wealth index and grave goods. The proxies on technology (TE_Q) and the Gini index (GI_Q) had a less pronounced alignment. Therefore, the cluster binds proxies that generally reflect the influence of Roman-origin products (brooches; BR_A, BR_M), social complexity ('wealth' and Gini indices), and technology. Within the second cluster, only low similarities could be observed in the proxy on the frequency of documented 'weapon graves'. Otherwise, there is a relatively high statistical similarity between the development pattern of the proxies on the Samian ware (SW_Q), *militaria* (MI_Q), and tools (TO_Q), coupled with the occurrence of iron material and modelled pit houses (PH_M). The third cluster reveals similar patterns between the burials (BU_A, BU_M) and Roman coinage quantities (CT_Q). Within the cluster is also a weaker association of the Germanic brooches. The fourth cluster contains one of the least similar proxies of the reconstructed Roman coin values (CV_Q), as well as the second least similar proxy on the pit houses (PH_Q). The remaining variables in this cluster have foremost demographic connotations, i.e. residential (RA_A) and funerary (FA_A) areas, Germanic (BG_A) and all brooches (BT_Q) or copper alloy material (CO_A).

Variable	Factor 1	Factor 2	Factor 3	Factor 4
RA_A	0.274	**0.826**	0.310	0.352
RA_M	0.320	**0.705**	**0.572**	0.214
PH_A	0.174	0.674	0.215	0.487
PH_M	0.182	0.397	0.300	**0.792**
FA_A	0.612	0.628	0.351	0.293
BU_A	0.133	0.269	**0.928**	0.045
BU_M	0.059	0.178	**0.930**	0.242
WG_Q	0.412	-0.369	0.582	0.548
GG_A	**0.824**	0.227	-0.025	0.492
BR_A	0.689	0.616	-0.222	0.265
BR_M	**0.712**	0.485	-0.196	0.440
BG_A	0.158	**0.848**	0.332	0.309
BG_M	-0.342	0.536	0.633	0.325
BT_A	0.389	**0.842**	0.142	0.323
BT_M	0.150	**0.716**	0.389	0.521
MV_A	0.677	0.515	-0.180	0.460
MI_A	0.517	0.196	0.086	**0.810**
SW_Q	0.340	0.249	0.078	**0.845**
TO_A	0.495	0.336	0.292	**0.719**
CT_Q	0.049	**0.748**	0.593	-0.061
CV_Q	0.459	**0.736**	0.183	-0.210
CT_M	-0.172	0.420	**0.850**	0.218
GI_Q	**0.911**	0.036	0.145	0.110
WI_Q	**0.866**	0.231	0.075	0.391
TE_Q	**0.752**	0.447	0.142	0.341
CO_A	0.285	**0.833**	0.235	0.352
IR_A	0.302	0.228	0.378	**0.839**
PR_A	0.355	0.713	0.110	0.587

Tab. 5.12. General proxy validation. Factor analysis factor score outline in individual input variables.

5.5.2.2 Factor analysis

The representation of the individual input proxies through the latent dimension of factor analysis can further illuminate the mutual relations and similarities of the derived baseline and secondary proxies. The analysis results provided four factors with an Eigenvalue above one and with a cumulative variance of 94%. The first 'strongest' factor contains almost 63% of the variance in the data, significantly more than the following factors, reflecting 16, 9, and 5% of the variance, respectively (Tab. 5.11). Therefore, it is evident that more significant structures in data are contained within the first two factors, which hold explanatory potential for almost 80% of the variance in data. Dominantly positive correlations could be observed with only marginal negative correlations of low magnitude below – 0.37.

Using the rotation of factor varimax normalised, the four resulting factors and their loadings provide the 'maximalised' variance and interpretation possibilities (Tab. 5.11, 5.12). From the resulting factor loading, the **first factor** could be interpreted foremost as a reflection of societal complexity. It suggests significant structural connections among the grave goods occurrence (GG_Q), Roman brooches (modelled but with high loadings also in aoristic based), Gini index (GI_Q), 'wealth' index (WI_Q)

48 The distance measure of *1-Pearson r* was used for the Cluster analysis.

and technology (TE_Q). It is apparent that many of these proxies are closely connected to each other through the origin and source of the data. A weaker positive correlation could also be noted in funerary areas (FA_A), which is a relatively less representative proxy, and metal vessels (MV_A). The low negative correlation is present in the case of the modelled distribution of the Germanic brooches (BG_M). This also underlines the connection between the variability recorded in the funerary areas (FA_A) and the presence of the Roman-origin objects.

The **second factor**, which describes 16.4% of the total variance in data, couples the proxies, which could be generally considered to reflect the main demographic variable – population size. Apart from the residential areas (aoristic or modelling-based), the total or Germanic brooches (BT_Q), copper alloy (CO_A) and precious metals (PR_A) also correlate with the quantitative and qualitative properties of the Roman coinage (CT_Q, CV_Q). A weaker positive correlation could also be observed in the proxies on pit houses (PH_A) and funerary areas (FA_A). Therefore, this factor expresses the complex connection between population size and specific economic and socio-political aspects. Nevertheless, the development of the population size is an underlying trajectory, up to an extent, like many other proxy trends.

The following **third factor** describes a relatively low proportion of variability (9%), but it reveals the firm connection between the quantitative development of the dated available burials (BU_A, BU_M) and the quantitative distribution of the Roman coin finds. The last **fourth factor** reveals correlations among modelled probability distribution of the pit houses (PH_M), *militaria* (MI_A), Samian ware (SW_Q), tools (TO_A) and iron (IR_A). Obviously, this key material type is justifiably expected to be significantly aligned with the material categories with a dominating proportion of this material. Furthermore, there is also a distinctive shape in the temporal probability distributions in these proxies, with an exceptional peak within the time block 150–200 AD.

Chapter 6

Spatiotemporal aspects of the Germanic settlement structures

This chapter explores selected spatiotemporal aspects of the archaeological information contained in the MARCOMANNIA dataset (above all residential areas/settlements as well as other quantitatively well-represented entities of the dataset – components, objects, artefacts) and environmental data regarding their temporal dimension given by the consensually established time blocks (see Chapter 3.3). From the perspective of representativeness, the landscape's physical properties (foremost the geomorphology) provide (almost) complete knowledge due to its general stability.

6.1 Boundaries and internal structuring of the settlement territory

From the perspective of any spatially oriented analysis and modelling of the region of interest, it is essential to outline its boundaries formally. Such an attempt has many pitfalls regarding the actual meaning of such boundaries, as well as multifaceted perception, understanding, and reflection of the spatial dimension in the past reality. It is intended to leave the details on these aspects simple. In this place, it plans to generate essential delimitation of the region based on the archaeological data regarding the residential areas (see Chapter 5.1). Therefore, this constructed spatial entity would result from the spatial distribution of the more or less stable presence of the Germanic communities, even though a wide range of activities naturally occurred within the 'off-site' space. A significantly lesser amount of information is available for such activities, which could have left only minimal traces in the archaeological record.

In order to establish the spatial delimitation itself, the principles of affordance (cf. Zipf 1949) were acquired through the least-cost calculation, which is central in many theoretical approaches (e.g. Herzog 2014; Surface-Evans, White 2012). A layer was created for each time block of the represented residential areas with spatial and temporal information, and it was eventually summed up. As a result, locations or regions with more enduring or stable habitation are more significantly represented. This approach also suppresses the effect of unevenness in the primary data on residential areas. During each calculation, the least-cost distance layer resulted from the spatial distribution of points (sources of anisotropic movement), regardless of whether only one or a cluster of large numbers are present in particular regions. Therefore, the only situation leading to an artificial underrepresentation within this analysis is the complete absence of residential activity from specific regions or areas. Despite many well-developed procedures and techniques available (Herzog 2014; 2022; Verhagen et al. 2013; Verhagen, Polla, Frommer 2014), the calculations used standard unmodified tools (*cost distance*). Primarily, no additional specific assumptions were present for this analysis, as the actual paths or corridors are not the objective but rather a buffer zone. Subsequently, this spatial entity was internally differentiated using the reclassification (*natural breaks/jenks* method) of the cost distance values into five classes (Fig. 6.1). The maximum boundary was set to the values corresponding with the residential areas, which are the most outlying regarding their position and proximity to the core parts of the region along the main rivers.

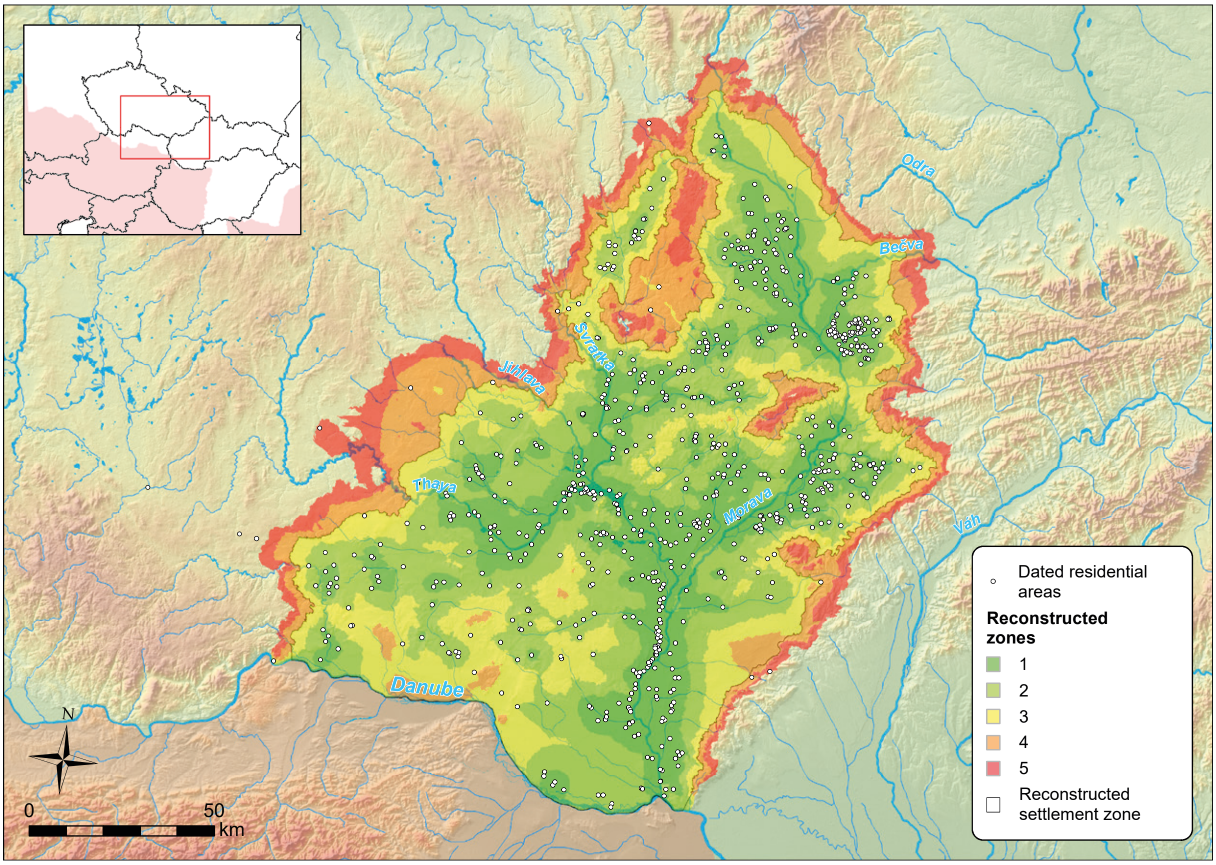


Fig. 6.1. Settlement region. The summed least cost-based layers are based on the residential areas' spatial and temporal distribution and density (see Chapter 6.2, 7.3.1).

The resulting area covers 16,000 km^2 and overlaps for most of the parts with the manually created boundaries of the 'Marcomannic' settlement zone (e.g. Komoróczy et al. 2020, 176; Rajtár 2014, 111), and it naturally contains the low-lying areas of the regions, especially along the axial rivers. As geomorphology is the calculations' primary driver and constraining parameter, the settlement region is outlined by more significant mountain ranges. Notably, the elevation along the boundary line has an average of 362 m ASL (with a standard deviation of 109.7 m). Naturally, this property has its spatial aspects, and it develops in individual regions, especially from the south (the most low-lying area in the Vienna basin) to the north, where the settlement area is clearly outlined through significant mountain ranges. Nevertheless, its variability is given foremost by the spatial distribution of the evidenced residential areas, and the reconstructed boundary reflects various geomorphological contexts. In the Upper Moravian Ravine, the northeast part of the boundary reaches relatively low elevations.

As a result of the summarisation of the temporally differentiated subset of the residential areas, the internal space of the settlement territory can be structured and evaluated in general terms of representation of archaeological sources (Tab. 6.1). Some significant correlations are apparent there, especially regarding the representation of the residential areas and their properties (size, geomorphological aspects). It could be well-anticipated that zone 1 (5,200 km^2) would contain the most considerable amount of all the point evidence within the MARCOMANNIA dataset (66.1%), foremost in the case of the residential area (81.8%). This zone is also characterised by the lowest mean elevation and slope gradient values. The consequent zones contain an exponentially decreasing amount of archaeological evidence, whereas the first and the second zones contain practically all the relevant evidence (96.7% of residential areas and 88.4% of all types of evidence). In mean elevation, each gradual zone is elevated by 50 m ASL. Apparently, the outlying zones 4 and 5, with a mean slope gradient above 6 degrees and an elevation of 400 m ASL, provide only limited conditions for implementing the subsistence strategies and foundation of settlements (Fig. 6.2).

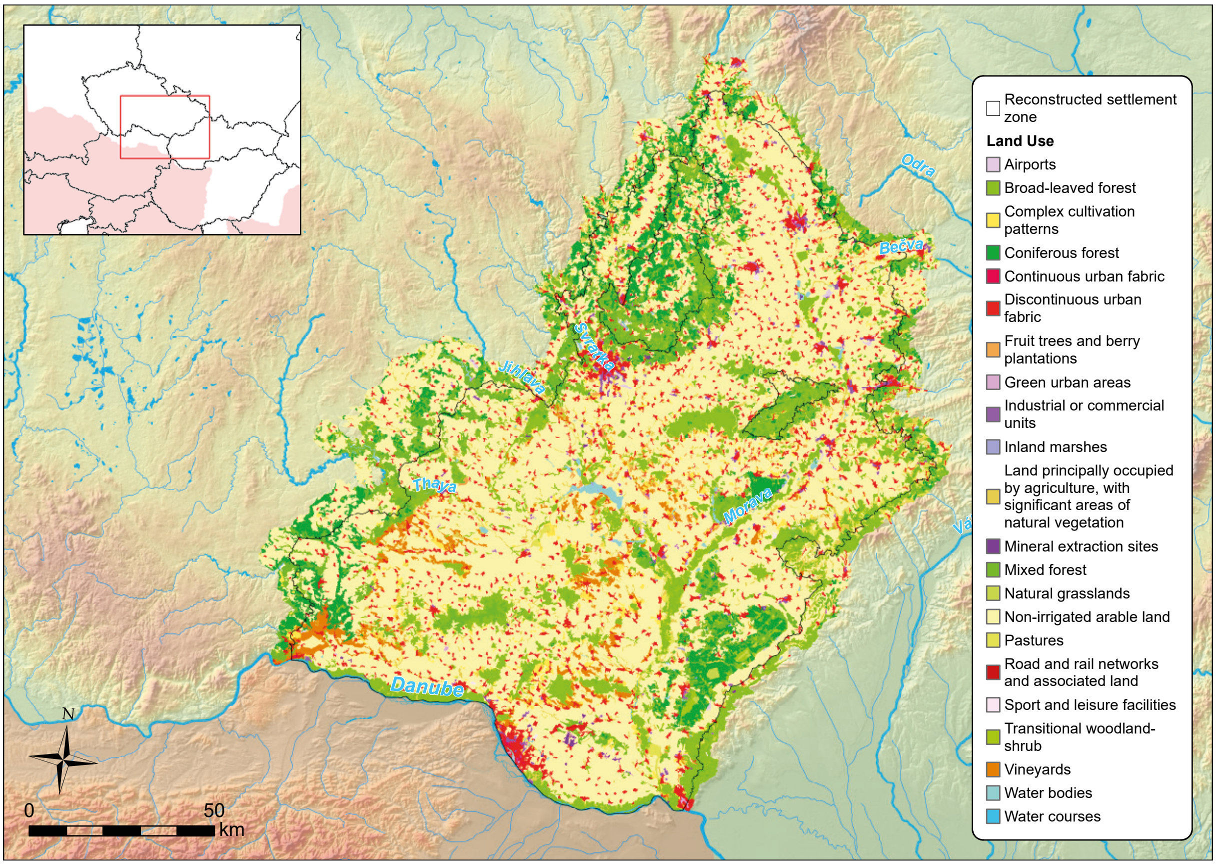


Fig. 6.2. Settlement region. Distribution of land use within the defined zones.

It must be pointed out that land use (Copernicus) significantly conditions the state of knowledge. The higher elevations are more significantly covered with wooded areas and meadows, considerably limiting the possibility of detecting archaeological components (Tab. 6.2). Regardless of the regions transformed directly through anthropogenic activities (build-up areas, artificial water bodies, etc.), the most significant proportion by far is covered with the areas with active arable agricultural activities (in total over 50%), which are followed by various types of forests (broad-leaved, coniferous, mixed) which together represent almost 30%. Other classes cover rather heterogeneous and less defined categories of land use. In individual zones, there is a well-anticipated change in the ratio between arable land and forests. From the first to the fifth zone, the arable land decreases more than five times in size.

Nevertheless, it is essential to point out that dependency on the known archaeological evidence is not significantly correlated to the proportion of arable land, which is one of the vital preconditions for their detection through various means (e.g. remote sensing, field survey). The third zone still contains 48% of this type of land use and simultaneously has a minority of archaeological sites (6%). Therefore, from this perspective, the spatial distribution of the evidence corroborates the actual representation of the residential areas within the actual state of knowledge within the outlying regions.

Apart from the regions located at higher elevations, there are also areas within the low-lying regions that have been partially or entirely inaccessible and unavailable for archaeological knowledge. Such voids represent the military training areas throughout the study region. In Moravia, there are two: Březina (150 km^2) and Libavá (227 km^2). In Lower Austria, the military training area of Allentsteig (157 km^2) partially intersects with the studied region. Particularly, the military area Záhorie (276 km^2) potentially contains large numbers of archaeological sites as it is located within the low-lying areas that are suitable for the settlement activities of the Germanic populations. Also, the neighbouring regions, especially along the lower River Morava, have high densities of archaeological evidence in general, and such could be expected, at least

	Count		%				Geomorphology		
Zone	Residential areas	All evidence	Residential areas	All evidence	All evidence cumulative	Area (km²)	Slope mean	Elevation mean	Elevation range
1	643	1357	81.8	66.1	66.1	5237	2.4	201.5	379
2	117	458	14.9	22.3	88.4	6470	3.9	251.5	479
3	19	118	2.4	5.7	94.2	4255	5.2	301.3	539
4	3	38	0.4	1.9	96.0	2891	6.3	395.3	637
5	3	28	0.4	1.4	97.4	1960	7.1	426.0	713
Outliers	1	54	0.1	2.6	100.0				
Total	**786**	**2053**							

Tab. 6.1. Settlement region. Quantitative representation of the identified residential areas within the reconstructed internal zones. They correspond with the reconstructed zones in Figure 6.1.

	Zones										
	km²					%					
Type of land use	1	2	3	4	5	1	2	3	4	5	Average
Non-irrigated arable land	3582	3989	2021	1100	752	69.1	62.1	47.8	38.1	38.4	51.1
Broad-leaved forest	348	595	599	420	258	6.7	9.3	14.2	14.6	13.2	11.6
Coniferous forest	66	278	363	462	318	1.3	4.3	8.6	16.0	16.2	9.3
Mixed forest	96	255	387	445	293	1.9	4.0	9.2	15.4	14.9	9.1
Discontinuous urban fabric	413	437	268	116	84	8.0	6.8	6.3	4.0	4.3	5.9
Land principally occupied by agriculture, with significant areas of natural vegetation	162	241	192	146	124	3.1	3.8	4.5	5.1	6.3	4.6
Complex cultivation patterns	140	180	107	24	12	2.7	2.8	2.5	0.8	0.6	1.9
Vineyards	92	233	121	15	0	1.8	3.6	2.9	0.5	0.0	1.8
Pastures	68	44	50	66	63	1.3	0.7	1.2	2.3	3.2	1.7
Transitional woodland-shrub	30	66	56	63	31	0.6	1.0	1.3	2.2	1.6	1.3
Industrial or commercial units	82	30	30	5	8	1.6	0.5	0.7	0.2	0.4	0.7
Water bodies	72	10	7	7	8	1.4	0.2	0.2	0.2	0.4	0.5
Fruit trees and berry plantations	32	52	11	4	3	0.6	0.8	0.3	0.1	0.1	0.4
Natural grasslands	3	7	14	9	1	0.1	0.1	0.3	0.3	0.1	0.2

Tab. 6.2. Settlement region. Spatial distribution of land use within the extent of the reconstructed zones.

partially, in the case of the Záhorie military training area. Therefore, these voids are the primary results of missing archaeological knowledge. Other extensive areas with specific conditions for the visibility of archaeological material and contexts represent the alluvial landscapes, often with more significant proportions of woodland or forest formations, resulting from the specific geomorphological processes (cf. Brown 1997).

This outline was intended as a brief and generally oriented insight into some specific aspects of the 'Marcomannic' settlement region. The full-fledged spatial analyses of data from the MARCOMANNIA dataset are beyond this book's scope and will be dealt with in further specifically oriented publications. The research agenda is oriented at this instance foremost on the 'attribute-type' (i.e. non-spatial) dimension of input data. Therefore, the applied tools from the category of spatial analysis (or geostatistics) are primarily employed in individual topics without further consideration of environmental factors (e.g. geomorphological properties, hydrological conditions or soil quality). However, a detailed analysis of correlations between the distribution of the Germanic settlements within the studied region has already been conducted elsewhere (Vlach 2018b).

6.2 Regionality and spatial pattern in settlement structure

Aside from the baseline proxy on the Germanic residential areas, providing the general development trends throughout the 'Marcomannic' settlement zone (Chapter 5.1), there is also the possibility to analyse data spatially and to outline perspectives regarding the differentiation of internal spatiotemporal patterns. Despite its significant extent of more than 16,000 km², the geographic and cultural characteristics define a coherent entity. However, internal variability in the temporal development of the studied region is apparent in the archaeological record. Inevitably, individual regions of the 'Marcomannic' settlement zone have undergone various development pathways from the emergence of the settlement structure since the beginning of the Early Roman Period to its decline at the turn of the 4th and the 5th centuries AD. Therefore, the objective is to investigate its spatial differentiation and explore spatiotemporal patterns in the available archaeological data.

Indeed, spatiotemporal settlement structure development results from a series of drivers, which are more or less difficult to estimate and identify.

Many left no traces in the archaeological record or surviving narrative sources, such as political decision-making (e.g. initiatives to settle and control regions with strategic or economic significance). Undoubtedly, local development would be tightly connected with the active entities of the chiefdom organisation structure, which could play a role of a driver of population movements in context of changing geopolitical conditions, as organised relocations are corroborated in narrative sources (e.g. Mrozewicz 2013; Steinacher 2019). Conversely, some could be gathered from environmental data, such as climatic conditions (e.g. Torbenson et al. 2024) and preconditions of fulfilling the needs of the primary subsistence, such as the quality of soils (e.g. Vlach 2018b, 59–61, Graph 3). Emerging 'regionality' in spatial patterns potentially represents differentiation in various conditions of the Germanic society (demographic, economic, geopolitical, social, etc.). Substantial limits and differentiation of the knowledge base lie in the past and present land use (Chapter 6.1).

6.2.1 Input data and method

There are many potential approaches towards partitioning the study region to differentiate temporal trends. However, the settlement zone, outlined by the main geomorphological constraints (see Chapter 6.1), is a generally 'fluid' environment of the mutually interconnected low-lying regions and ravines along the main rivers, the Morava, Dyje, Jihlava and Svratka, that constitute the primary environmental context of the Germanic settlement activities. Apart from a few distinctive 'bottleneck' corridors (Spytihněv Gate, Vyškov Gate or Boskovice Furrow), there are limited internally delimitating features (e.g. Ždánice Forest or Chřiby). Therefore, to achieve a spatially balanced evaluation of the spatially differentiated development of the 'Marcomannic' settlement structure, an evenly spaced structure of a hexagonal grid has been established (Fig. 6.3). It allows for complete space coverage (no gaps) and maintains a more convenient, almost 'rounded' shape to reflect the principles of centrality and least-cost affordance (Christaller 1933). The

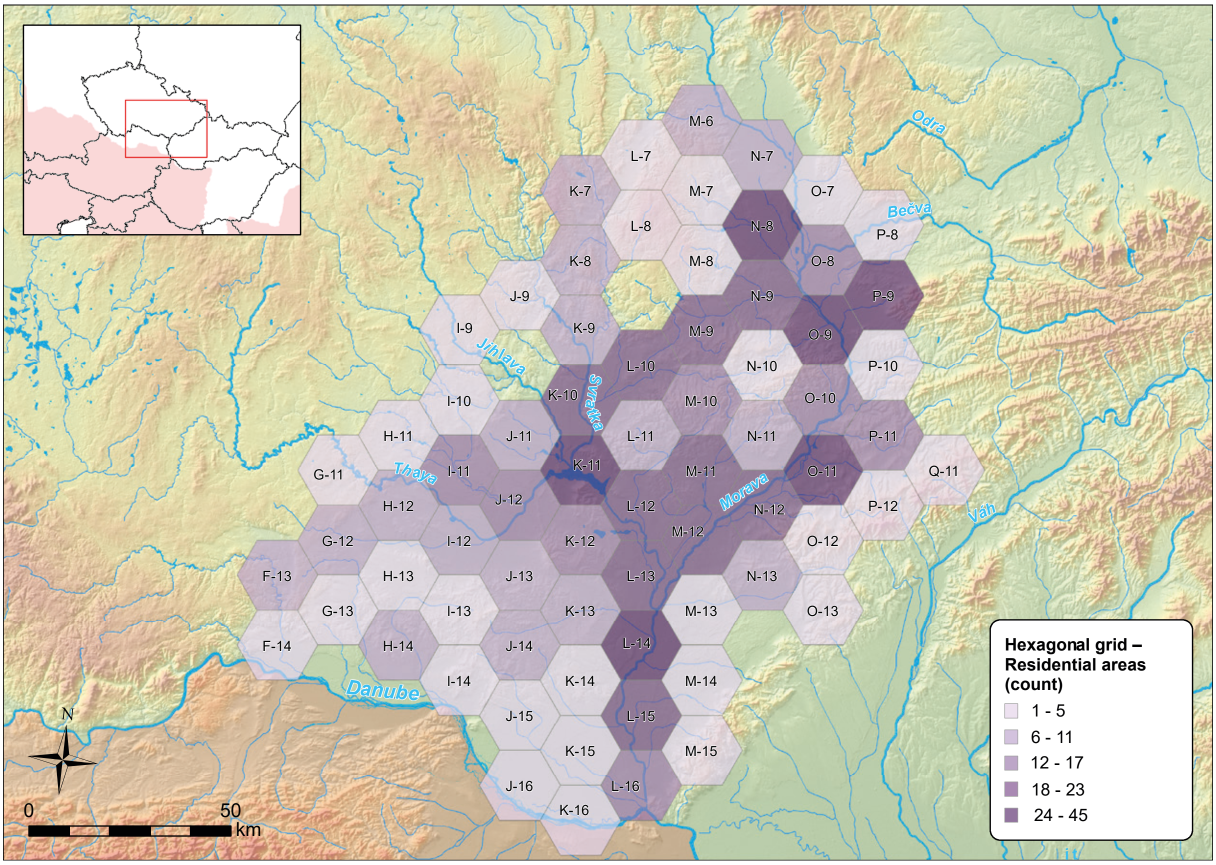


Fig. 6.3. Regionality of the settlement structure. Distribution of the hexagonal grid over the reconstructed boundaries of the 'Marcomannic' settlement zone with the quantity of documented residential areas within hexagons and their ID.

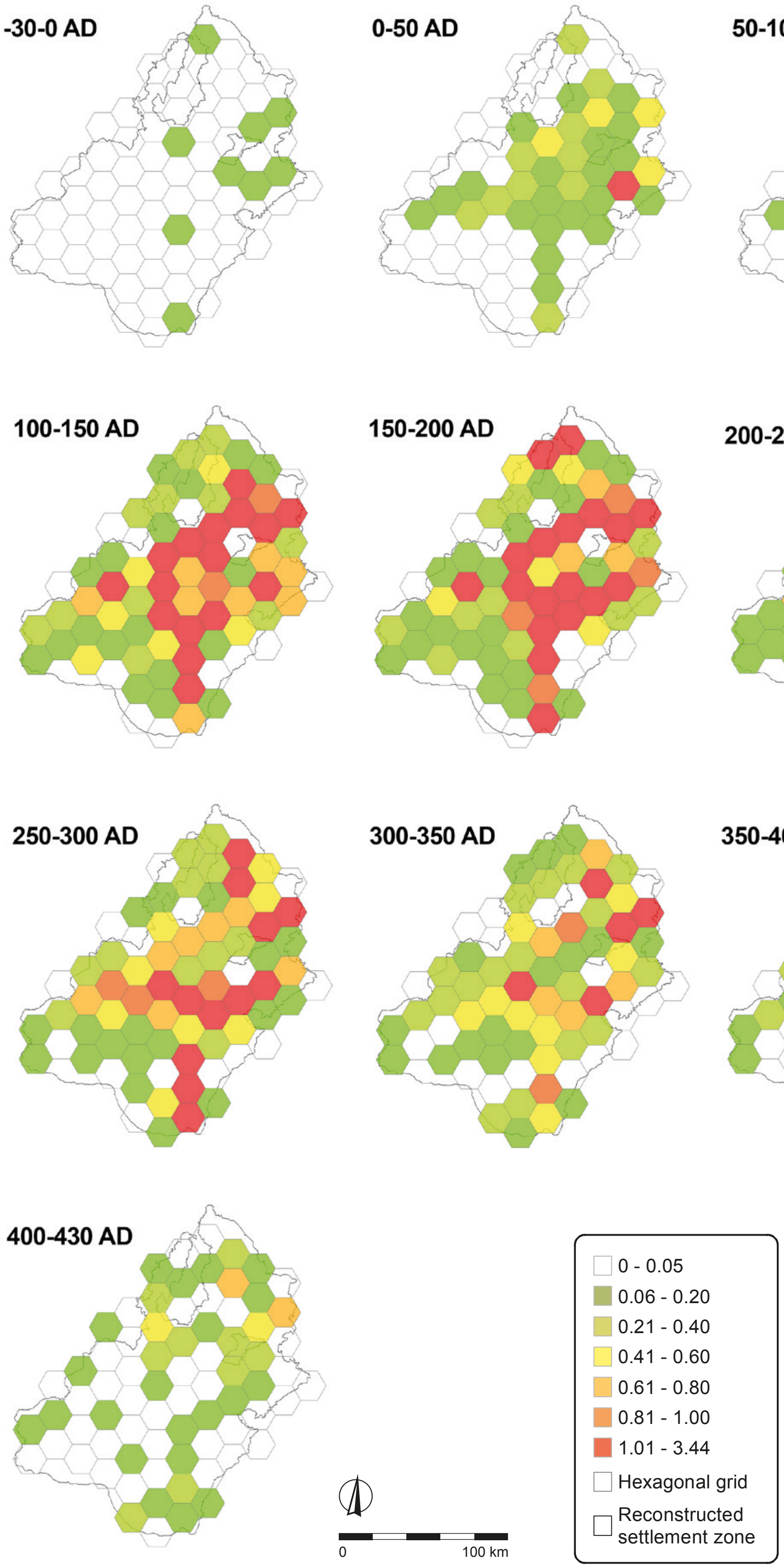


Fig. 6.4. Regionality of the settlement structure. Temporal development of the probabilistic aggregations normalised by the uncertainty index.

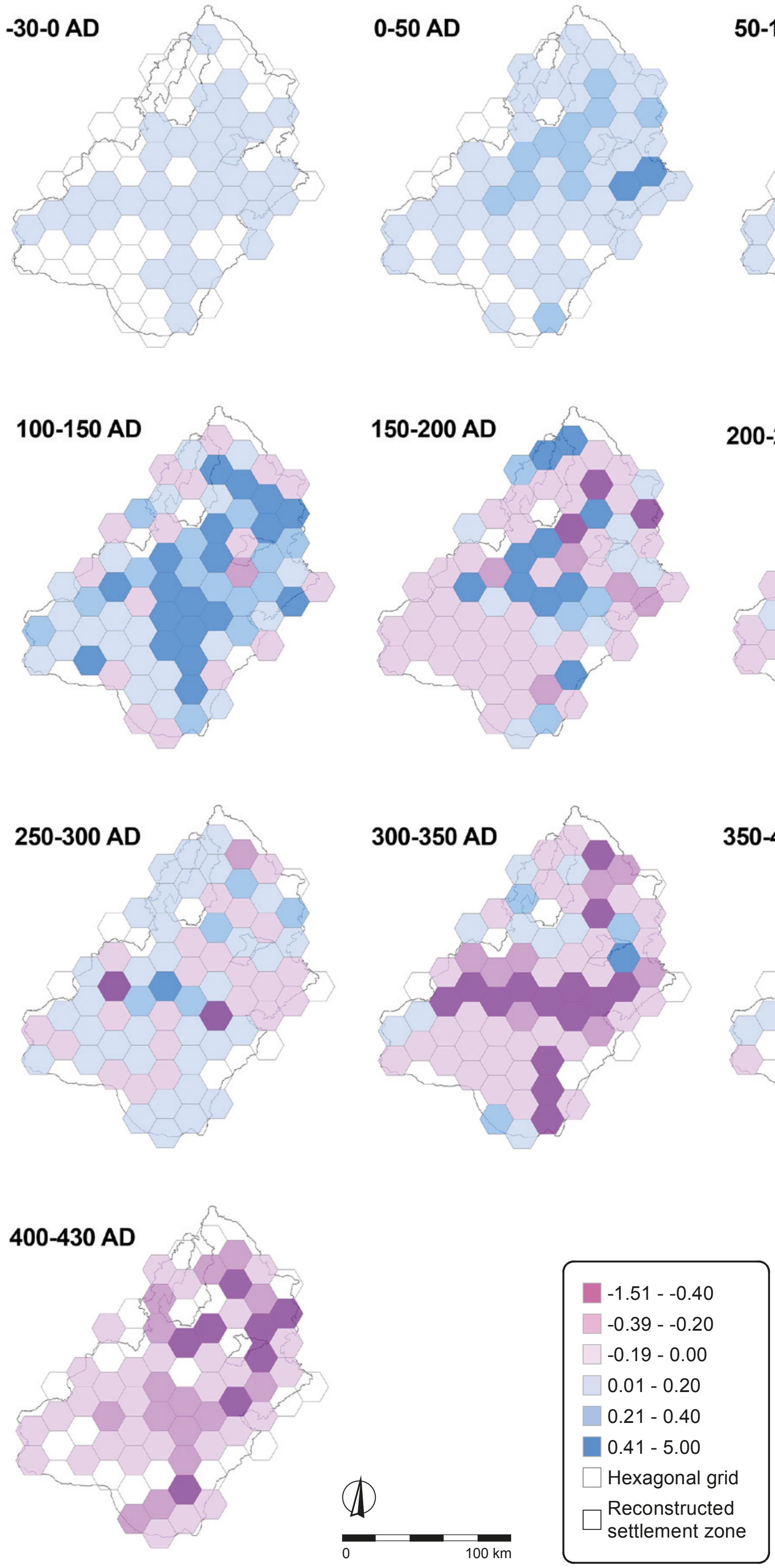


Fig. 6.5. Regionality of the settlement structure. Temporal development of the difference in previous and current values of the probabilistic aggregations normalised by the uncertainty index.

alignment of the grid was adjusted spatially to align with the analysis results in Chapter 6.3, where four distinctive spatial aggregations were calculated based on the distribution of the recorded selected subsets of the Roman-origin artefacts. Therefore, a hexagon side size was set to 20 km, which suggests the affordance principle, resulting in an average diameter of 40 km. The data regarding spatiotemporal aspects of the documented residential areas conditioned the approach. After filtering out the hexagons with no recorded residential areas, 71 entities were left to allot archaeological data.

The input consisted of the residential areas' subset with temporal identification, and there are presently 773 points of evidence (see Chapter 5.1). The weight of their input is furthermore conditioned by the uncertainty index evaluation (see Chapter 4.5) to compensate for imbalances between the available archaeological knowledge in various regions through point representations and to generate the spatiotemporal patterns concerning the ascertained quality of the archaeological data and the resulting 'reliability' and precision of temporal identification of the residential areas. As a result, the aggregated temporal probabilities for individual hexagons may show higher values in lesser numbers of individual residential areas, providing better quality of the input information.

6.2.2 Spatiotemporal patterns in residential area data

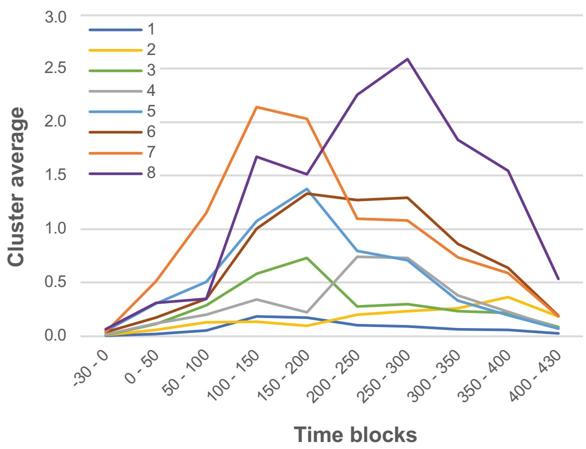
As transpired in the case of the baseline proxy on the residential areas (see Chapter 5.1.2), the hexagonal time-block-based differentiation implies the generally comparable trends (Fig. 6.4). Apart from the actual aggregated temporal probability distribution, an additional perspective provides the differences between the consecutive time blocks (Fig. 6.4), i.e. the magnitude of change. The initial parts of the study period up to the beginning of the 2nd century AD follow the growth tendencies suggesting rather an extensity than intensity, whereas the more pronounced increases and the complete habitation of the settlement zone is evidenced for the 1st half of the 2nd century AD (time block 100–150 AD). Nevertheless, the first minor decreases in the peripheral regions are apparent. During the subsequent time block 150–200 AD, an outstanding peak of documented *abandonments* in the baseline proxy also spatially propagates through the notable parts of the region. Nonetheless, the time block is also characterised by an increase in settlement structure (recorded *foundations*; cf. Chapter 5.1.2). These results also partially reflect the post-Marcomannic Wars increase during the beginning of the Later Roman Period (e.g. Droberjar 1997). As a result, some of the central parts of the studied region exhibit relatively significant increases. However, in the subsequent time block 200–250 AD, a significant decreasing tendency is recorded in either central or peripheral parts of the studied region, particularly within the broader region of the Morava-Thaya confluence and some 'bottleneck' regions (e.g. Vyškov Gate, Boskovice Furrow) and along the axial rivers of the region in general.

The period of relative stability could be assumed for the consecutive time block 250–300 AD. However, the distinctive decrease in settlement structure is demonstrated for the subsequent time block 300–350 AD, when the most significant changes occurred along the lower and middle reaches of the rivers Morava and Thaya. This and the consecutive time block 350–400 AD also reflect the shift in weight point from the southern and central parts of the studied region to the northern one (Fig. 6.5).

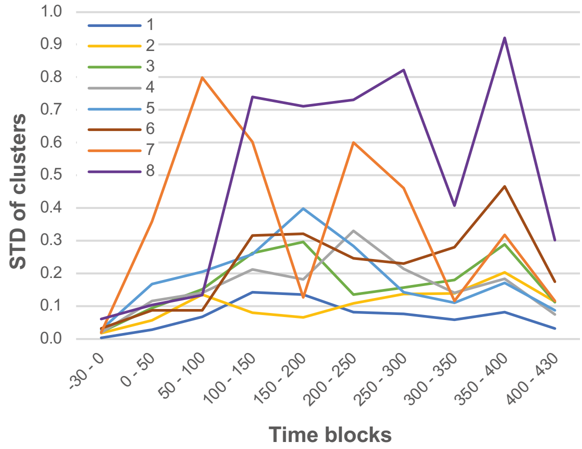
6.2.3 Structures in spatiotemporal data

The aggregated temporal probabilities within the hexagonal grid represent a series of 71 unique trends, which would be challenging to comprehend. Therefore, well-established 'classification' multivariate statistics of cluster analysis have been applied in this case. The *K-means* approach was selected to obtain a particular number of clusters based on the simple 'elbow' rule. As a result, eight clusters have been separated and are generally aligned from the less to more quantitatively represented (Fig. 6.6, Graph 6.1). However, the derived clusters represent an approximation with consistency given by their variability, as apparent through the standard deviation (Graph 6.2). Therefore, the higher variability in particular time blocks reflects a more significant probability dispersion. The highest variability could be observed in the last two clusters, 7 and 8, suggesting their proportionate heterogeneity of the input data is substantial.

The first two clusters (1 and 2) are most significantly represented (together 52% of the hexagons) and spatially represent primarily the areas of peripheral nature and with less suitable conditions for primary subsistence (higher geomorphological variability, lower quality soils, cf. Vlach 2018b, 59–61, Graph 3). Their trajectories have a 'weak signal' of either decrease (1) or increase (2) throughout the scoped period. Clusters 3 and 4 show the same



Graph 6.1. Regionality of the settlement structure. Outline of the aggregated temporal probability development for the established clusters.



Graph 6.2. Regionality of the settlement structure. Outline of the variability (STD) in temporal probability development in time blocks for the established clusters.

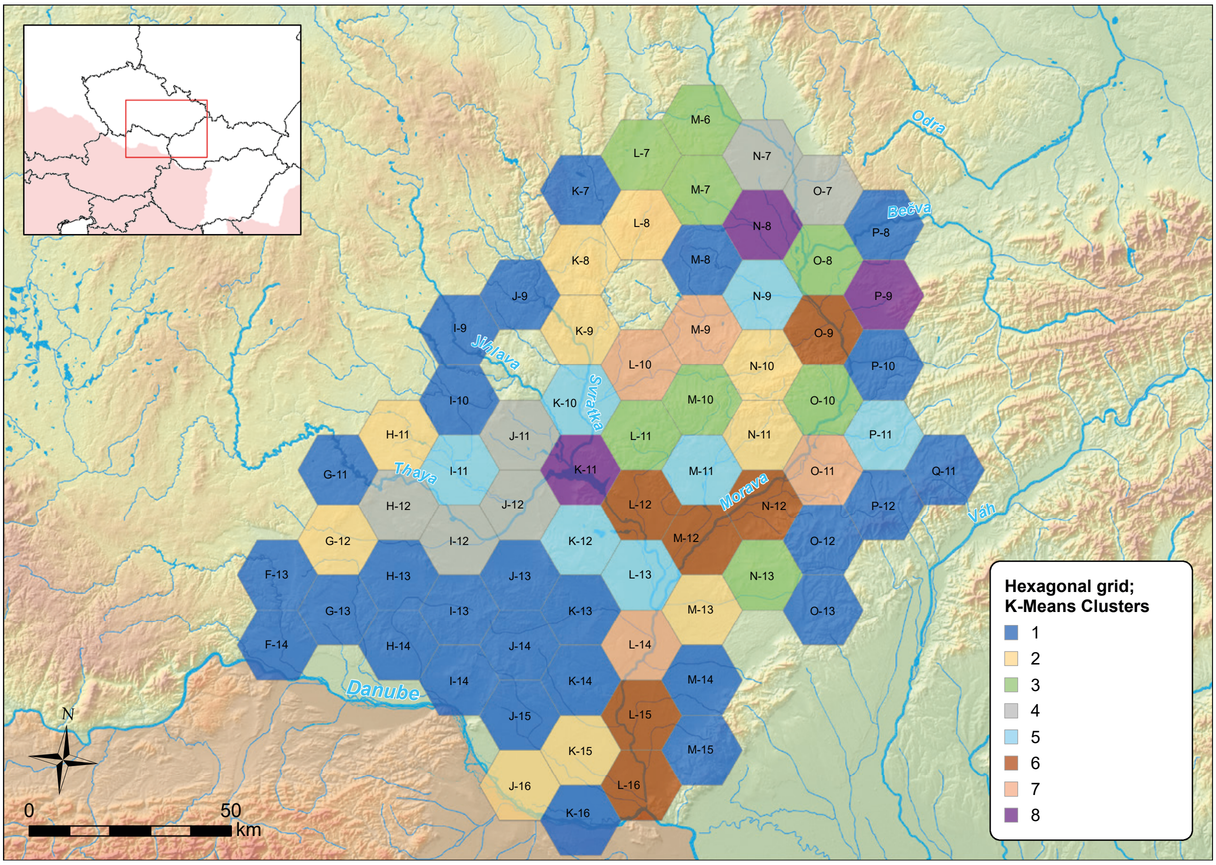


Fig. 6.6. Regionality of the settlement structure. Hexagonal representation of the spatial distribution of the generated clusters.

duality in temporal development with more significant changes between the time blocks 150–200 and 200–250 AD. Cluster 6 has a relatively uniform, normal-like shape, and its Early Roman part corresponds with Cluster 5. However, there are already more significant STD values during the Later Roman Period in these clusters, suggesting higher variability in individual input objects. Cluster 6 also covers some of the most noteworthy core parts of the 'Marcomannic' settlement zone, including the lower ('Zohor–Děvín–Stupava' exceptional aggregation of archaeological components) and middle reaches of the River Morava, or the Spytihněv Gate communication corridor. The highest aggregated probabilities and lower spatial representation show clusters 7 and 8, suggesting substantial increases during the Early Roman Period, peaking during the time block 100–150 AD with stagnation to the 2nd half of the 2nd century AD. Afterwards, the trajectories go in the opposite direction and cluster 8 peaks in the time block 250–300 AD. In these clusters, observable higher STD values reach 0.8 of probability aggregation, and more varied individual development trends are present.

Based on the assumption argued in connection with the residential area baseline proxy (Chapter 5.1), the subset provides one of the most significant proxies for the population size. It is substantiated also by the comparable temporal patterns of other 'demographic' proxies (e.g. funerary areas or brooches). Correspondingly, it could be assumed that the magnitude of changes within the hexagonal distribution could be associated with the past population dynamics, where significant differences between time blocks reflect major shifts in population size and structure, either immigration or emigration. Conversely, more evenly shaped trends could instead suggest intrinsic demographic development trends.

Significant changes in settlement structure are generally assumed between the 2nd half of the 2nd and the 1st half of the 3rd centuries AD, which could be associated with the pre- and post-Marcomannic Wars development, where the sharp decreases are observable in clusters 3, 5, and 7 (19 hexagons in total), presumably to an extent due to the direct (destruction of the settlement, war atrocities) or indirect (population flight) impact of the Roman military operations in the Middle Danube region on the local demographic conditions during the Marcomannic Wars. On the other hand, the hexagons of clusters 4 and 8 exhibit an increase. These opposite but simultaneous trends, either an increase or decrease, could be associated with increased mobility and 'post-war restructuring' of the Germanic settlement patterns (cf. Chapter 6.4). Therefore, the results may partially reflect the potential effect and outcomes of the 'withdrawal' strategy of the impacted Germanic populations, which would be logically expected in such a situation. Nevertheless, all demographic-relevant proxies corroborate unquestionable drops in population size for the time block 200–250 AD (see Chapter 5.1, 5.3.1).

Despite the general decreasing tendency during the Late Roman Period, some clusters exhibit an increase. The most conspicuous trend in this regard is apparent for the broader region of the extensive regional burial ground in Kostelec na Hané 'Prostřední pololány' (Zeman 1961), which is not only consistent with its dating but the assumptions on the argued immigration wave of the Germanic populations of the Elbian cultural milieu (cf. Tejral 1993, 490–493) into the region. Such development could also be seen in the Middle and Lower reaches of the River Thaya, an epicentre of the Roman military occupation during the Marcomannic Wars (Komoróczy et al. 2020; Komoróczy, Vlach 2022).

6.3 Spatial distribution of the Roman origin finds and socio-economic implications

(Marek Vlach – Balázs Komoróczy)

The spatial distributions of individual artefacts within the MARCOMANNIA dataset contain significant potential in investigating horizontal and vertical socio-economic patterns within the Germanic societies of the 'Marcomannic' settlement zone. The key segment of archaeological data for understanding chiefly organisation structures throughout the studied context consists, amongst others, of items of Roman origin – so-called 'imports' (e.g. Eggers 1951; Tejral 1970a; 1974; Lund Hansen 1987; Kunow 1983; Erdrich 2001), as its prominent part would justifiably fall within the category of 'prestigious goods', a vital part of the 'prestige economy' of chieftaincies (e.g. Earle 2001; Roscoe 2022). Therefore, this category holds the potential to enrich understanding of the spatial structuring of 'power' and its economic aspects, which are observable in the archaeological record of a relatively homogeneous layer of settlement structure only to a limited extent. The principal assumption of this analysis lies in the expectation that the non-causal spatial structures and patterns within the data on the representative subsets of Roman-origin finds could provide valid insights into societal, economic, and political domains and could be put into context with existing theoretical models of social anthropology (e.g. Wright 1977; Flannery 1998; Spencer 1987; 2010). As pointed out in many circumstances, the various segments of Roman production could have been transferred into the Germanic environment through different means and ways, providing further biases to their interpretation possibilities. However, the analysis is also based on the assumption that the non-accidental structuring occurrence of these items are potentially imprinted into the spatial dimension of archaeological data, where clustering in spatial patterns could suggest the places of higher significance, which are not based only on individual sites or contexts of exceptional importance, but rather their aggregated information potential combined.

The results are inevitably constrained by the present state of archaeological knowledge and, foremost, by its spatial coverage, distorted by various effects and aspects (see Chapter 4). The outreach of professional archaeology towards the metal-detecting community has been developed to a different extent in individual regions (e.g. Komoróczy 2022; Komoróczy, Vlach, Kmošková 2024), distorting the calculated densities. However, with the spatial coverage of so far available archaeological information, it could also be assumed to be improbable to expect that exceptional densities of archaeological finds in most of the low-lying regions of the 'Marcomannic' settlement zone would be omitted entirely. Therefore, the present results of the generated density patterns can be considered representative and credible regarding the general structuring tendencies. Also, the temporally undifferentiated subset of Roman production evidence within the Germanic context may help to reflect long-term tendencies. Nevertheless, the variability would naturally shift on the time scale. The resulting patterns may also provide additional perspective on the ways in which the Roman objects flowed into the Germanic environment.

6.3.1 Input data

To derive spatial patterns, the qualitatively and quantitatively representant subsets of the Roman imports – brooches (Chapter 5.3.1), coins (Chapter 5.3.2), metal vessels (Chapter 5.3.3) and Samian ware (Chapter 5.3.6) – presently available in the MARCOMANNIA dataset, were included as input. Within this group, the Roman coins stand out on the grounds of their connotations towards potential functions in the Germanic context and their use as 'special purpose money', and were not intended for the *prima facie* end use and consumption, as the other categories. Therefore, they play a unique role in understanding the Roman-Germanic interactions and due to the significant value stored in them, have the potential to corroborate the spatial patterns in 'power' alignments. The mentioned find categories were included as a whole without filtering the available information regarding localisation or temporal identification. Therefore, the information potential of the respective find records without temporal identification could have been included and enabled the exploitation of a substantial amount of data. As a result, the calculation of densities was eventually based on the 7,010 find records, which consisted of mainly the 5,710 records of the metallic finds and 1,300 records of pottery – the Samian ware finds.

6.3.2 Spatial analysis and pattern identification

Each input point distribution layer was used to calculate spatial patterns through the *kernel density* tool, where the counts of the record finds were used (Fig. 6.7–6.10). It is already apparent at this stage that they tend to follow relatively similar spatial patterns with conspicuous densities in several regions of the 'Marcomannic' settlement zone. To combine these four layers, the principles of fuzzy membership (e.g. Baxter 2009) were applied (the tool *Fuzzy overlay* with the search radius of 20 km and OR[49] setting). Based on the resulting density distribution (Fig. 6.11), four distinctive concentrations could be identified (designated here as the 1st order clusters; densities above 1.5 records per km^2) generally in the southern and central parts of the studied region and are located on the same hydrological system of the axial rivers of the 'Marcomannic' settlement zone (the Morava and Thaya), which interconnects them.

Cluster 1 (Fig. 6.11) consists foremost of an outstanding aggregation of archaeological material on the left bank terraces of the River Morava from the cadastres of Zohor, Bratislava-Dúbravka, Děvín and Stupava. The long-term archaeological interest in this region has brought up exceptional archaeological data on higher societal strata through the multiple activity areas (e.g. Kraskovská 1959; Elschek 2007; 2014; 2017; Turčan 2012). The following cluster 2 (Fig. 6.11) is represented foremost by the large quantities of the metal-detector finds (Atzmüller 2010), and the contextual archaeological data are scarce. However, some of the available information, such as the geophysical prospections on the cadastre of Drösing (Groh, Sedlmayer 2017), testify to the significant presence of archaeological contexts, however, with no conclusive evidence on the corresponding features of the presence of elites. This cluster also has the highest combined density, as well as the most extended history of metal-detecting activities.

49 In this approach, the result is an evenly weighted combination of all input layers, since it is essential to incorporate the individual density distributions, not simply to sum them up.

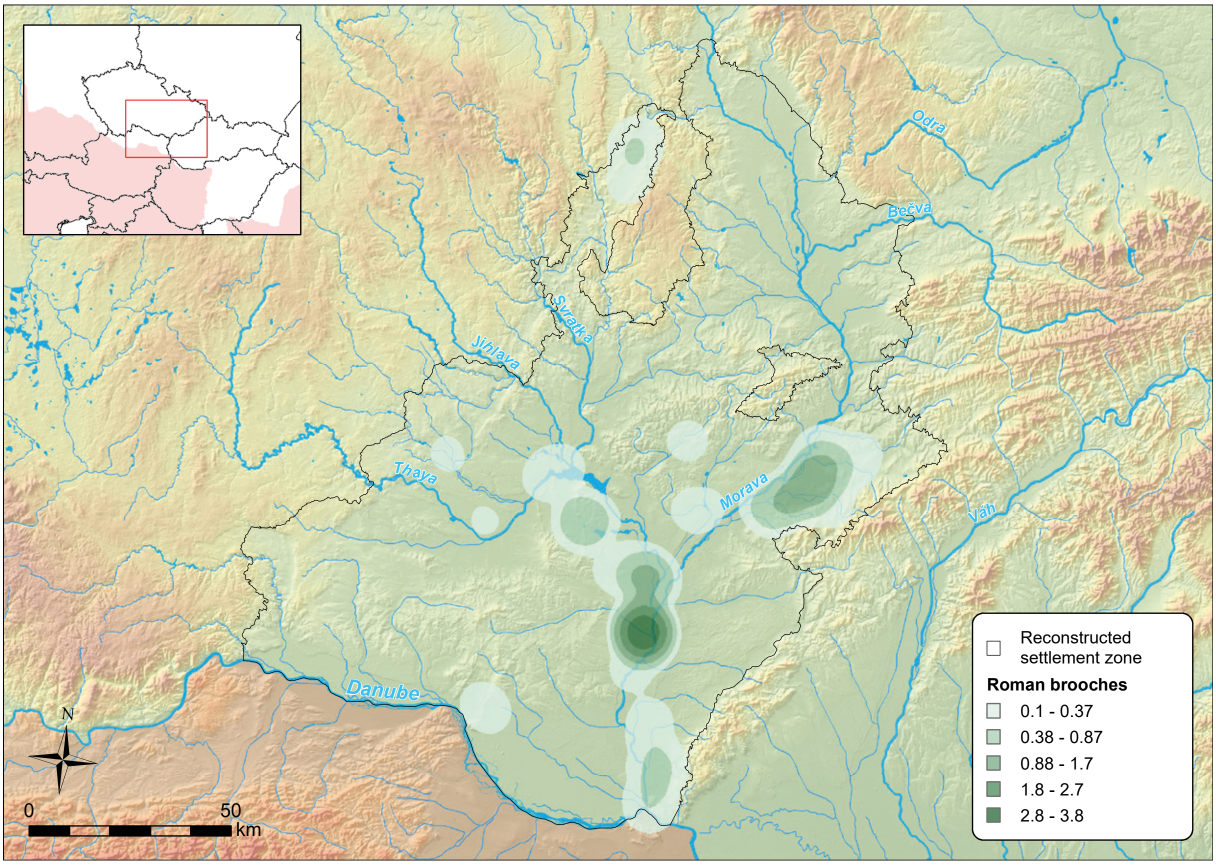


Fig. 6.7. Kernel density distribution of the Roman brooches.

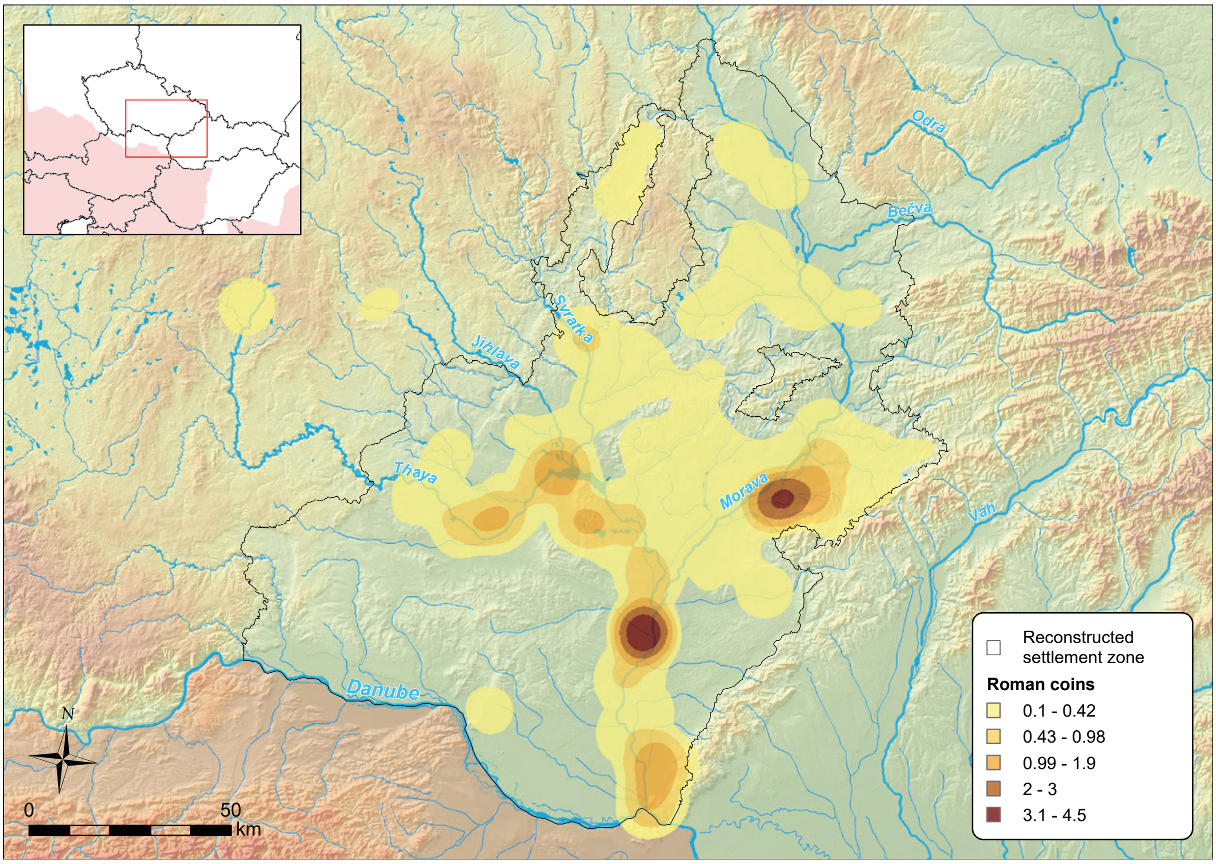


Fig. 6.8. Kernel density distribution of the Roman coinage.

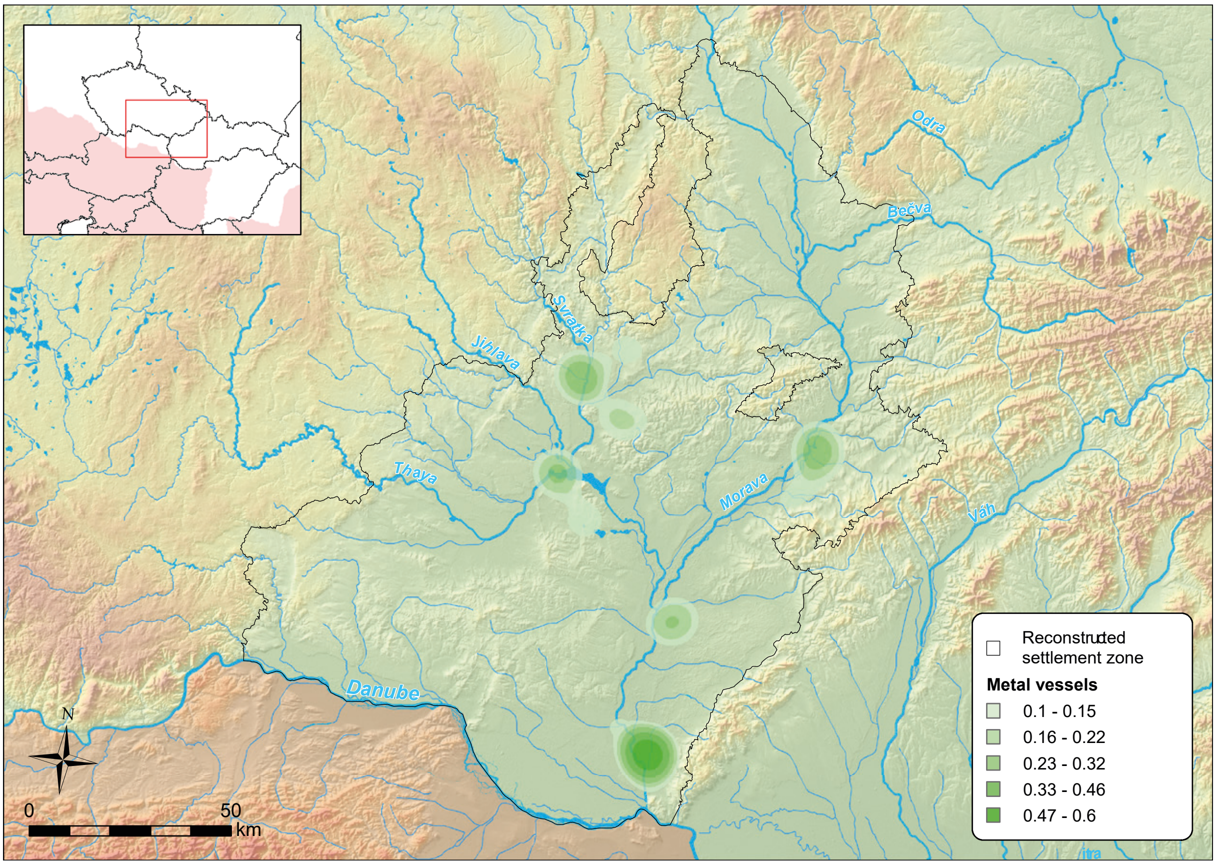


Fig. 6.9. Kernel density distribution of the metal vessels.

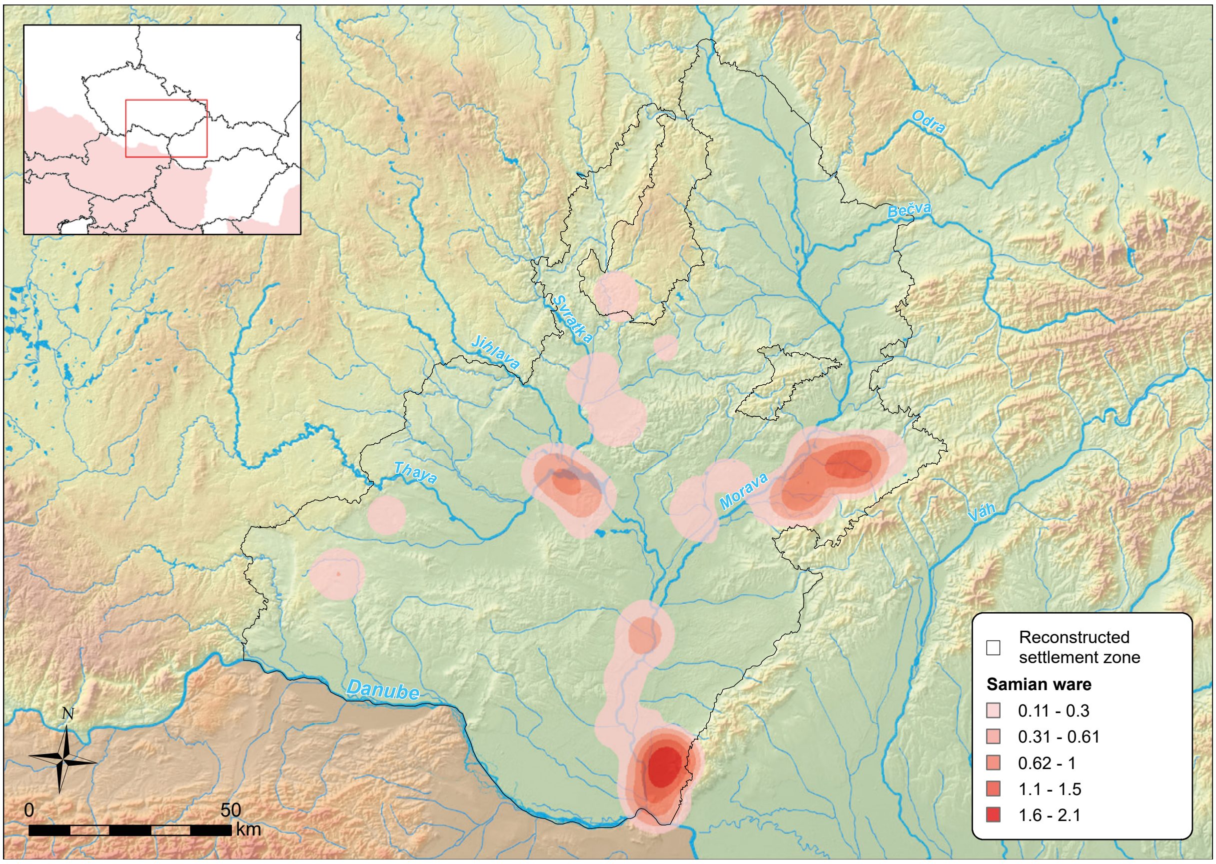


Fig. 6.10. Kernel density distribution of the Samian ware.

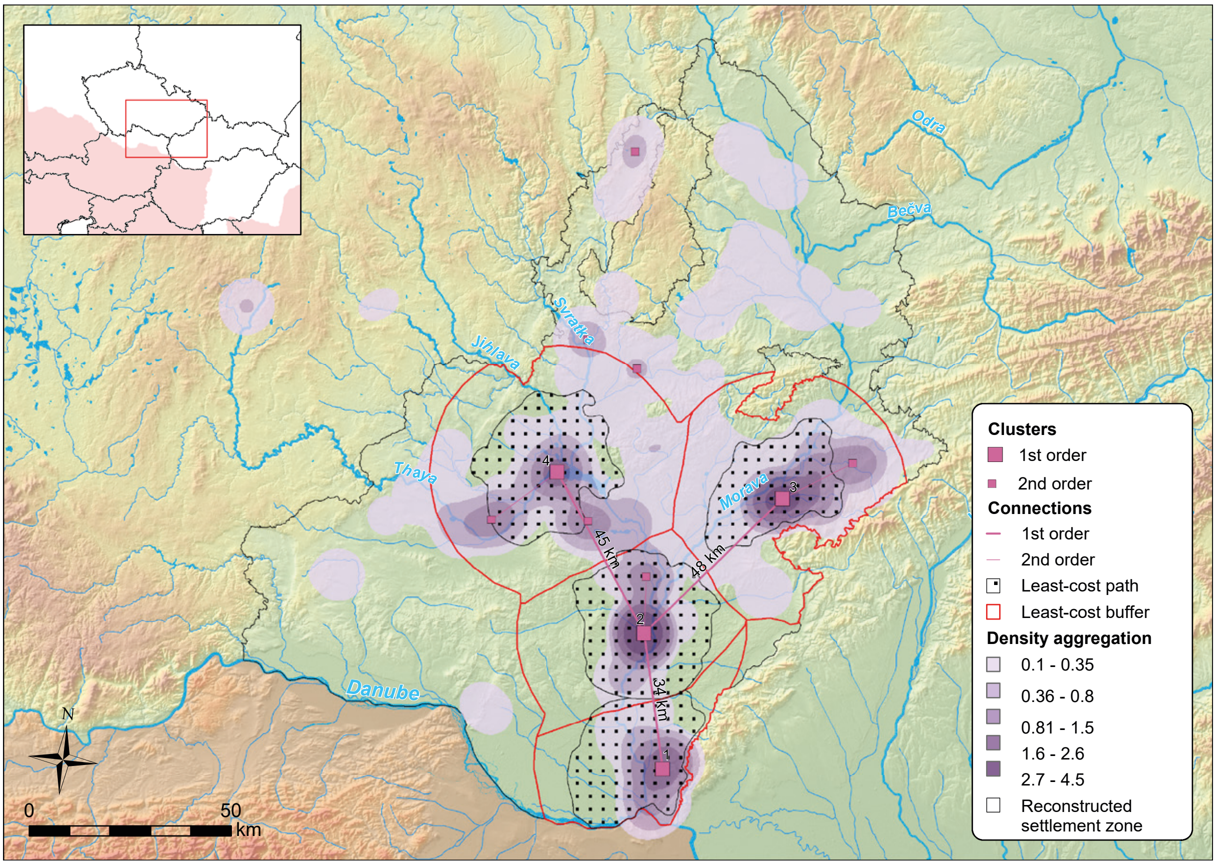


Fig. 6.11. The resulting spatial density of the selected Roman imports with the delimitation of the least-cost hinterland of the identified centre points of the density clusters.

Similarly, cluster 3 (Fig. 6.11) stems foremost from the quantities of archaeological finds originating from metal-detecting (Zeman 2017b). The spatially extensive cluster with a maximum diameter axis generally aligned along the River Morava includes foremost the cadastres of the Strážnice, Tvarožná Lhota, Petrov and others. The last identified cluster 4 (Fig. 6.11) is generally located in the confluence region of the rivers Thaya, Jihlava and Svratka. It encompasses the higher volumes of the respective archaeological data not only from the Mušov region (e.g. Komoróczy, Vlach 2022) but also from other adjacent cadastres (Drnholec, Pasohlávky, Brod nad Dyjí, Dolní Dunajovice, or Klentnice). In this case, it is necessary to take into account the influence of the Roman military presence, attested through exceptional traces in the archaeological record (e.g. Komoróczy et al. 2020), towards the bias of the ways through which the Roman production emerged in this region. Nevertheless, substantial archaeological data on Roman-origin artefacts is bound to locations with documented Germanic residential areas (e.g. Drnholec 'Holenická pole'; Komoróczy et al. 2019).

There is also a marked absence of such concentrations generally throughout the northern part of the studied region (foremost Upper Moravian Ravine). This phenomenon could be partially explained by the chronological weight point of most input find categories of imports (except for the Roman coinage) during the Early Roman Period. The more significant representation of Germanic settlement activities, compared to the rest of the studied area, is observed during the Late Roman Period (cf. Chapter 6.2), where the general occurrence of the Roman origin products within the Germanic context is relatively lower.

Apart from the four identified distinctive 1st-order clusters, there could be discerned 'weaker' concentrations in density distributions (Fig. 6.11), constituting the 2nd-order clusters (densities between 0.8 and 1.5 evidence per km^2). They are mainly dislocated within the delimited least-cost zones or on their outskirts and could be associated with the potential reflection of more local significance. In some cases, they could be theoretically associated with the 1st-order clusters based on the least-cost principles, which would condition their accessibility within a reasonable time and effort. They could also be observed in the northern parts of the Dyje–Svratka Ravine on the southern outskirts of Brno (Modřice, Rebešovice and Rajhrad) and around the cadastre of Vážany nad Litavou at the 'entrance' to the Vyškov Gate, a vital connection with the Upper Moravian Ravine. Furthermore, the less significant and discernible 2nd-order clusters can be identified to the southeast (Mikulov-Mušov region; Komoróczy et al. 2021) and southwest (Hevlín, Dyjákovice) of the 1st-order cluster 4. Further to the north, an undisputed significance has been attested for the 'transitional' region of Boskovice furrow (the area of Jevíčko; e.g. Droberjar 2014). Comparable structures are also identifiable for the 1st-order clusters 2 (Bernhardsthal) and 3 (the cadastres of Vlčnov and Dolní Němčí; Droberjar 1988; Zeman 2017b). Regardless of their lesser significance, they are still conspicuous points connected to the main 1st-order identified density clusters.

6.3.3 Explanatory potential of the spatial patterns

Notably, the identified 1st-order clusters have relatively even spacing between 34 and 48 km (Euclidean distance), suggesting the least-cost affordance (accessibility) principles in the spatial analysis results (cf. Herzog 2022). The least distance is recorded between clusters 1 and 2[50] (34 km), while the northernmost clusters 3 and 4 have almost even 45 and 48 km distance along the axial river courses from cluster 2. Therefore, the clusters were complemented with spatial delimitation based on the least-cost path principles using the identified central points of the main density clusters as sources of movement. The anisotropic movement buffers naturally follow the geomorphological structure of the region, foremost consisting of the low-lying flatlands of the alluvial landscapes and adjoined terraces (Fig. 6.11; black line polygons with dots). Therefore, a simplistic analysis setting (tool *cost distance*) was used, as only basic informative delimitation within the uniform environment along the axial rivers of the region was required. The anisotropic movement calculations were additionally limited (cropped) through the least-cost allocation boundaries (*cost allocation* tool; Fig. 6.11; red line polygons), which partition the space between these points.

The results show that the mean distance from the centre points to the boundaries of the calculated least-cost buffer is 18 km. Therefore, the spatial analysis results imply propagation of the hypothetical organisational territory unit, where all the locations are accessible within one-day walking distance, generally estimated around 25 km, oscillating typically between 20 and 35 km and constrained by multiple factors of landscape permeability (e.g. Verhagen, Polla, Frommer 2014). The results fit well in the theoretical model by C. Spencer (2010, 7119–7120), where the territory of an administrative unit within the chiefly organisation would comply with roughly half this distance in radius.[51] Despite this, we so far lack distinctive features of the more stable seats of power and 'regional administrative centres' as the prominent entities in settlement hierarchy (e.g. fortifications, hillforts, exceptional building complexes of elites), within this theoretical concept, the spatial patterns within the results corroborate the essential least-cost aspects. Despite the absence of distinctive features allowing for the identification of a more permanent place of aggregated political, economic, and military power in the archaeological record from the settlements, series of circumstantial evidence, foremost the funerary record (e.g. a rich princely grave from Mušov or 'warrior' graves), may suggest their presence.

Nevertheless, the geomorphological variability and constraints resulted in relatively heterogeneous polygons of least-cost allocation with varying sizes and shapes (Fig. 6.11). Notably, their sizes are negatively correlated with the count of evidenced 2nd-order clusters, which is consistent with the assumption of respective sub-partitioning and subdividing of the larger regions. The least size cluster, 1 (1,120 km^2), has no identified 2nd-order cluster. The following in a northern direction – cluster 2 (1,800 km^2) – has one, as well as cluster 3 (2,200 km^2). The largest cluster, 4 (2,900 km^2), has two or perhaps 3 (Vážany nad Litavou region) such entities within the cost allocation boundary. Furthermore, in the case of large distances between clusters 2, 3 and 4, it should be taken into account that along these links (connections) are located some of the identified 2nd-order clusters, which 'compensate' for the gaps, as there could be implicated a location of a potentially minor regional organisation entity.

50 It is also apparent that these two concentrations are located on the opposite banks of the River Morava.

51 For example, such assumptions have been confirmed for the spatial distribution patterns within the region during the Early Middle Ages (cf. Hlavica 2023).

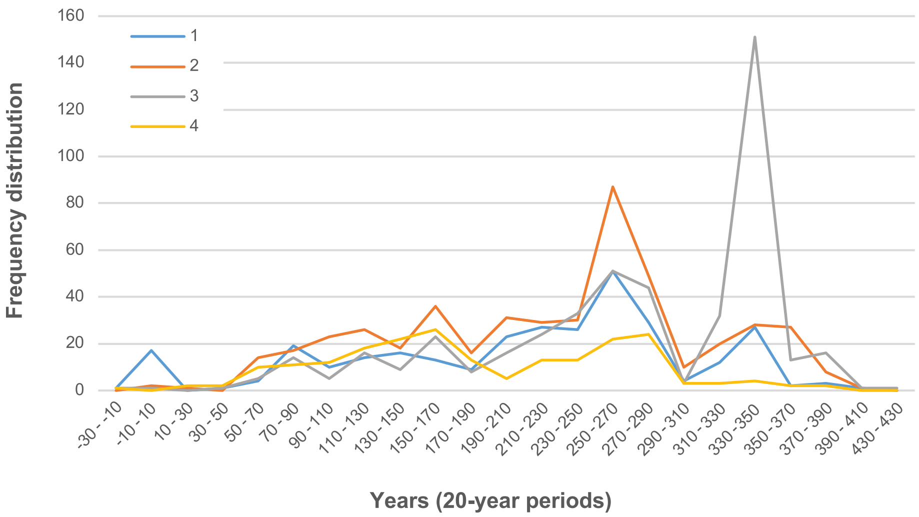
From a temporal perspective, all the identified density clusters contain evidence of the activities during most of the studied period. However, from the respective baseline and secondary proxies on the quantitatively representative archaeological finds of Roman origin, it is evident that the weight point of the presumed economic activities took place foremost during the Early Roman Period. Therefore, the importance of such places lasted over the studied period but also shifted over time. In contrast, the Roman coinage also covers more significant parts of the Late Roman Period (Fig. 6.8), testifying to the importance of these exceptional regions (1st-order clusters) during the whole Roman Period. Therefore, despite temporal irregularities, they are some sort of 'epicentres' in the long-term perspective, which were up to the extent partially 'immune' to political shifts (foremost spatial) in the chiefly power structure organisation and control of these niches of significant importance has changed over time.

It would be tentative to associate these (at least economic) 'hot zones' with the actual political entities of the chiefly organisation structure. The identified clusters 1 and 4 would undoubtedly bear such pieces of evidence, as the wider region centred around Zohor, Děvín and Stupava resembles multiple phenomena of the presence of elites in residential (e.g. Elschek 2017), funerary (Elschek, Rajtár, Varsik 2011) and other activity areas, significantly counterweighted by the archaeological knowledge from the wider Mušov region (cf. Komoróczy, Vlach 2022), e.g. the rich princely grave from Mušov (Peška, Tejral 2002), settlement Pasohlávky 'U vodárny' (Komoróczy, Vlach 2010) or Drhnolec 'Holenická pole' (Komoróczy et al. 2019a) and many others (cf. Stuchlík ed. 2002). The other cases provide inconclusive contextual evidence so far, such as density cluster 2, i.e. 'Drösing agglomeration' (e.g. Groh, Sedlmayer 2017). These 'centres' could be, therefore, interpreted as locations (or somewhat spatially limited 'micro-regions') where the Roman production was aggregated in significantly higher amounts and, through these points, entered the Germanic settlement zone and from which it was further distributed throughout the whole 'Marcomannic' settlement zone.

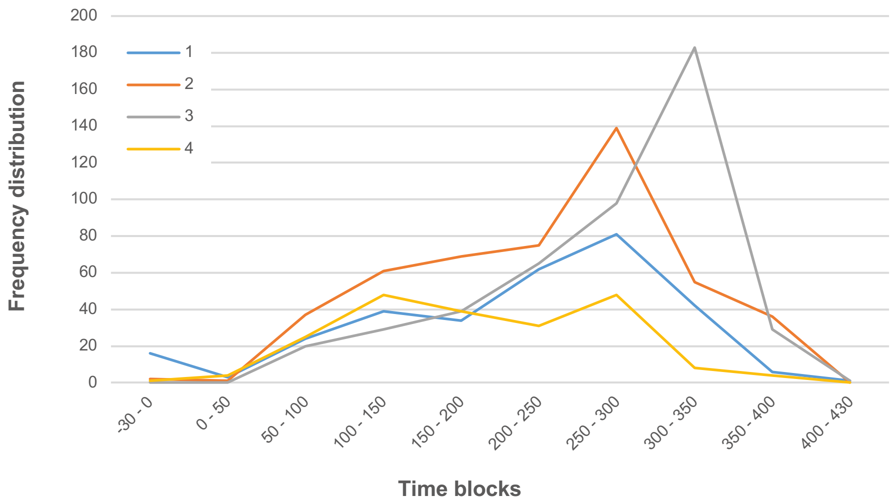
Further perspective on the resulting patterns is connected with the phenomenon of relative uniformity and distinctive selectiveness of the types and forms of the evidenced Roman origin production, such as exceptional representations of the strongly profiled brooches (e.g. A68 and A84, Samian ware, bowls Drag. 37; Kuzmová, Roth 1988; Droberjar 1991; Stuppner 1994), metal vessels (e.g. the sets of wine drinking utensils E161/162 or östland buckets E39-42; e.g. Jílek 2012), contrasting significantly with the widths of spectra available in the Roman environment. Particular selectivity is also well-noted for the Roman coinage (see Chapter 5.3.2). Despite their spatial distribution practically encompassing the entire extent of the 'Marcomannic' settlement zone (Fig. 6.8), the identified typological spectra are generally the same within the entire studied region. Therefore, it is assumed with good reason that the main volume of Roman goods was not obtained on an individual (household) basis, which would inevitably lead to a much higher typological variability. Conversely, these observations indicate the organised procurement of these objects, which could have been conducted on the Germanic side only by higher-positioned segments of the society represented by variously positioned chiefs, either directly on the Roman borderland trade market or transferred through the trade routes. Such an expectation would fit entirely within the theoretical framework of the chiefdom-type societies, where access to high-quality products implies a significant source of revenue for exercising the power strategies for those who had control over its flow (e.g. Earle 1997; 1987; Grinin 2017).

Important implications towards the interpretation possibilities could also be drawn from the overlap of density distribution in the case of the Roman coinage. Notably, the sites of the '1st order' cluster 1 contain 52% (1,917 records, from which 1,465 have temporal identification) of all the coin find records in the MARCOMANNIA dataset. As pointed out in the respective Chapter 5.3.2 and argued in other instances before (e.g. Bursche 2008; Kehne 2008), despite being within the group of Roman-origin find categories, their role within the Germanic environment was more complex and multifaceted than in others (i.e. brooches, metal vessels, and Samian ware), which has been 'imported' with the primary intention of their consumption in this milieu. The coins additionally provided a specific form of standardisation and are considered to fulfil the role of the 'special-purpose money' (e.g. Bursche 2008, 397) and could have operated in these centres within something of a 'secondary economy' (Kehne 2008, 78–79), conducted and organised presumably by highly positioned representatives, who had to power over resources.

The significant spatial structures in empirical data for the studied region corroborate this presupposition. Therefore, the aggregation of the



Graph 6.3. The frequency distribution of the Roman coin finds within the identified 'centres' with a 20-year resolution.



Graph 6.4. The frequency distribution of the Roman coin finds within the identified clusters with normalisation to the time block structure.

Roman-origin products indicates the conditions where the Roman coinage used for specific types of transactions regarding the other articles of the Roman production *sensu* 'special-purpose money' are met in these locations. This assumption could have applied to the identified 'centres' in varying temporal frequencies. However, the expectable amounts of potentially circulating aggregated value of the Roman coinage were relatively steady during most of the studied period (cf. Chapter 5.3.2.3). The assumption of an altered and shifted temporal distribution is also corroborated by the phenomenon's probability modelling and simulation results (see Chapter 5.3.2.4).

Nevertheless, the temporal distribution of quantitative representation of this find category in individual 'centres' offers insight into activity and shift with wight points of significance of individual 1st-order clusters (Graph 6.3). Each exhibits the coverage through the temporal extent of the more significant occurrence of the Roman coinage in the 'Marcomannic' settlement zone (see Graph 6.4) as their temporal trends differ in particular periods. Despite the development during the 1st half of the 1st and the 2nd century AD being comparable, including the significant drops during the 80ties of the 2nd century AD and the turn of the 3rd and 4th century AD, the Later Roman Period bears the sign of differentiated intensity in Roman coinage circulation. The most significant contrast between clusters 2 and 3 in representing the *antoniniani* and *foleis* peaks is evident. Specifically, the latter produced the most significant increase among the identified 'centres'. Notably, the identified cluster 4 shows limited quantities from the perspective of the whole studied region, and their representation during the 3rd and 4th centuries AD is marginal. The comparison allows for assumptions of increased instability in the economic and political conditions during the Late Roman Period, leading to marked shifts in the weight point of the presumed economic activities. During the 4th century AD, the most significant quantities and presumed activities could be assumed for cluster 3.

Along with the key raw material sources, the control over critical communication hubs, routes, and corridors has invariably provided a unique opportunity to generate resources and obtain revenues, not only in chiefdoms. The commodity flow through economic 'veins' provided an opportunity to gain income through taxation, for example, as suggested for the 'Vannius kingdom'.[52] The resulting spatial pattern corroborates these principles as ¾ of primary clusters are located along the River Morava, considered the main course of the long-distance ancient 'highway' of the Amber Route (Čižmářová, Měchurová eds. 1997). In addition, clusters 1 and 2 are located near its confluences with the Danube and Thaya. Notably, the most significant concentrations of the coin finds could be observed at clusters 1 and 3 along this long-distance trade route (Fig. 6.11).

Through the theoretical models of the vertical structuring of the protohistoric power organisation entities (cf. Roymans 1990, 17–45) at various stages of the complexity of a chiefly social organisation, such conspicuous patterns could suggest the propagation of the phenomenon of a 'redistribution centre' (e.g. Earle 1991; 2011) within the archaeological record. In theory, such places with higher amounts of 'prestigious' goods and values in general, amongst other characteristics, would be inevitably connected with the localisation of power and administrative centres. In chiefdoms, at any level of complexity, play an indispensable role in integrating political power with the associated organisational capabilities of individual chiefs.

However, it is necessary to keep in mind that these results are based on a representative but still relatively 'biased' sample consisting of the selected find categories. Simultaneously, some regions and areas are expectedly under or overrepresented due to many factors and aspects. Therefore, further increase of the foremost well-datable metallic material culture on the topic will fill the gaps in the present state of knowledge. Eventually, the identified arrangements in spatial patterns suggest the presence of non-random structures in archaeological data with significant interpretation potential.

6.4 Development of the network properties of the Germanic settlement structure

The spatiotemporal distribution of documented residential areas (Chapter 5.1) of the 'Marcomannic' settlement zone, contained in the MARCOMANNIA dataset, holds, amongst others, the explanatory potential of some of the underlying structural aspects of sociopolitical complexity through the tools and techniques of network science (e.g. Brughmans 2010; 2013; Brughmans et al. eds. 2023; Brughmans, Peeples 2017; 2023). In this case, it is mainly within the domain of spatial network analysis (Brughmans, Peeples 2023, 237–259). Using the selected basic metrics (betweenness centrality, closeness centrality, clustering coefficient, eigenvector centrality, and degree distribution) of a generated network structure can provide additional quantification of the developmental properties of the Germanic settlement structure. In principle, archaeological research has always dealt with its data in terms and principles of network science. However, the full-scale analytical potential has been made available with the establishment of network science, coupled with the advances in computational tools and approaches in general (e.g. Barabási, Réka 1999; Brughmans, Peeples 2023).

Obviously, the present knowledge base on the spatial and formal aspects of the Germanic settlement structure of the 'Marcomannic' settlement zone suffers from various biases, and available data results from multiple archaeological transformations (cf. Neustupný 2009). There is an omnipresent issue of genuine or seeming spatial relations among geographical distributions of entities of analysis. However, the available subset of residential areas represents substantial information, which could provide additional but methodologically circumstantiated insight into the past development patterns through the network structure characteristics. From a theoretical perspective and general assumptions, the spatial distribution, proximity, accessibility, and communication requirements were not marginal factors, and their importance substantiates the following approach. Thus, it could be justifiable to expect the existence of interconnections between contemporaneous residential areas, at least within the so-called 'day travel distance'. Such connections must have existed among the directly neighbouring residential areas, and the archaeological data from

52 Tac. *Ann*. XII.29.

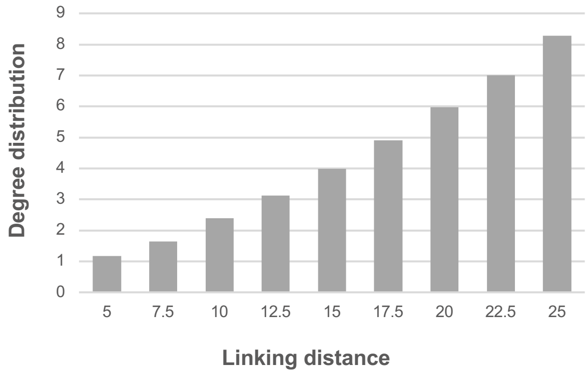
exceptionally examined regions testify to the relatively high density of settlements in the landscape (cf. Vlach 2018b, 55–57).

6.4.1 Input data

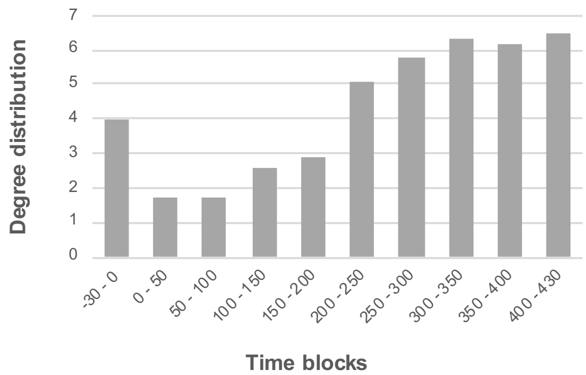
As the input data, a subset of the dated and localised residential areas from the MARCOMANNIA dataset was employed (see Chapter 5.1). Thus, a total of 773 records that complied with these requirements were included in the analysis. The NetLogo software (with the network extension) was used to establish the network structures and calculate the network metrics. A range of preset linking distance (radius) thresholds was applied to each of the input entities (residential area) – nodes to establish a connection (edge). These thresholds were arbitrarily preset to linearly increasing values of the 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5, and 25 km. Furthermore, only the principle of an undirected network is used in the objectives of the analyses, where all the input nodes have equal weight (Brughmans, Peeples 2023, 74, 98). The networks have been, in all the cases, established on the principle of *Euclidean distance*, not employing the costs resulting from the geomorphological variability of the landscape. An important aspect of the network analytical evaluation was the incorporation of the *uncertainty index* (cf. Chapter 4.5), providing a corrective, where the residential areas substantiated by 'less' abundant and quality information have a more limited impact on the established networks. In practice, for each scenario of tested linking distances, the search radius for establishing connections was multiplied (limited) by the *uncertainty index* (normalised to the range 0–1). The resulting network metrics for the temporal distribution patterns through the time block framework were calculated as averages of the values from individual linking distances.

6.4.2 Exploration of network structure properties

Several basic methods and metrics—*degree distribution*, *betweenness centrality*, *eigenvector centrality*, *closeness centrality,* and *clustering coefficient*—have been used to evaluate the spatial dimension of the available Germanic residential areas through the reconstructed network structures (cf. Brughmans, Peeples 2023). Indeed, there is a far wider range of available network science tools and methods. However, only the above-mentioned were used for the primary evaluation of the spatial network properties. Nonetheless, they already represent a powerful set of tools for exploratory analysis.



Graph 6.5. Residential area networks. *Degree distribution* in individual linking distances.



Graph 6.6. Residential area networks. Temporal outline of *degree distribution*.

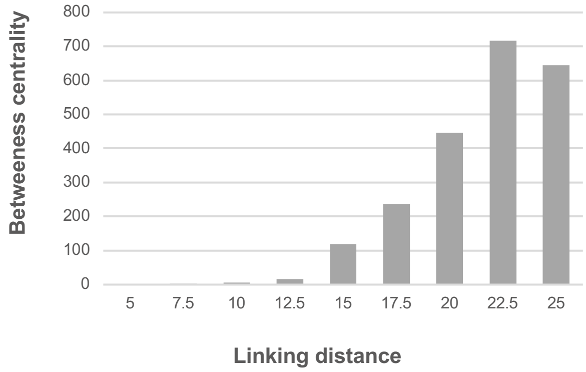
One of the most straightforward but effective methods of representing each node's significance is *degree*, which is expressed as a simple total of connections (links) to other nodes in a network. Therefore, the more links through which an edge is interconnected with others, the more significant it is within the network structure. From a network perspective, the probabili distribution of all node degree values is *degree distribution* (Brughmans, Peeples 2023, 109–110). In this analysis, the principle is well-underlined by the outline of the resulting *degree distribution* in individual linking distances (Graph 6.5), where an almost linear trend could be observed (Graph 6.6).

After the inception time block (-30–0 BC/AD), which is significantly biased by the absence of archaeological evidence for the relative-chronological stage A (e.g. Salač, Bemmann Hrsg. 2009; Tejral 2009), the least representative values for the studied spatiotemporal extent are recorded for the 1st century AD, reaching an average of 2 links per node. This clearly suggests a minimal magnitude of interconnection and a more pronounced dispersal pattern during the respective period. The gradual increase during the 2nd century AD, reaching an average of 3 edges per node, foreshadows the substantial increase during the time block 200–250 AD and persistently high values between 5 and 6.5 edges per node for most of the Late Roman Period. Such development implies an increase in the density of residential areas despite the lower reconstructed population size during this period (cf. Chapter 7.3).

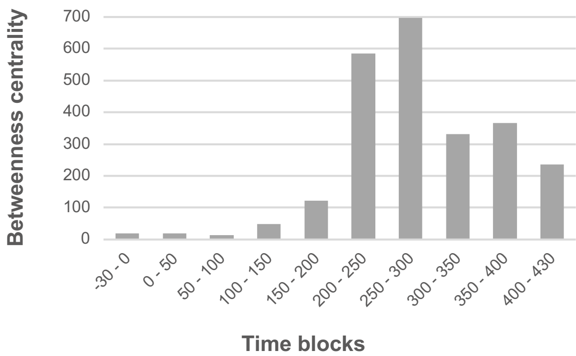
One of the most frequently employed network science metrics is *betweenness centrality*, which represents one of the most effective centrality measures. Rather than closeness, it measures how important a node is regarding the 'least-distance movement' through the network. It is calculated through the shortest paths from all nodes to all nodes. As a result, the nodes with high betweenness centrality are located on the frequently used, shortest paths (Brughmans, Peeples 2003, 138). Therefore, in the case of the spatial network of the settlement structure, the high value of *betweenness centrality* would represent the entities which are well interconnected and have a higher probability of movement through them. Eventually, the metric for the whole generated network is a simple summarisation of the individual calculated *betweenness centralities*.

The asymmetrical effect of the preset linking distances is more significant in this case (Graph 6.7), and under the given conditions of the input data, more substantial structures emerge from the linking distance of 15 km, reaching the maximum at the linking distance of 22.5 km. A significantly varied distribution could be observed from the perspective of the temporal distribution of the generated networks (Graph 6.8). For most of the Early Roman Period, low values of the metric are calculated till the time block 150–200 AD, which is followed by a significant increase during the 3rd century AD. Despite the further decrease, relatively high values are recorded for the last three time blocks.

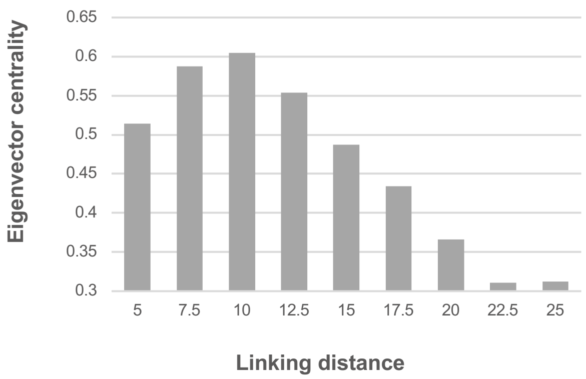
Furthermore, the relative importance of nodes compared to others could be effectively expressed through *eigenvector centrality*. The method for nodes and network evaluation assigns significance values based on a node's connectedness to its neighbours according to their significance in the network structure. Therefore, the metrics are not a result of the simple number of connections, as in the *degree distribution*, but rather of the quality of interconnectedness and the resulting 'importance' of its connected neighbours (Brughmans, Peeples 2023, 137).



Graph 6.7. Residential area networks. *Betweenness centrality* in individual linking distances.

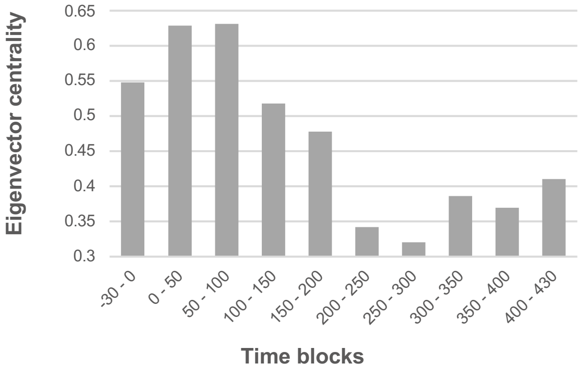


Graph 6.8. Residential area networks. Temporal outline of *betweenness centrality.*

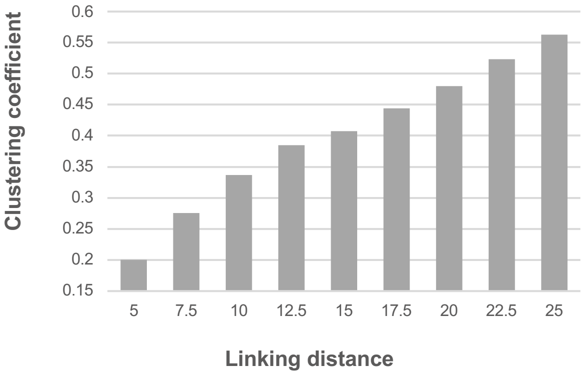


Graph 6.9. Residential area networks. *Eigenvector centrality* in individual linking distances.

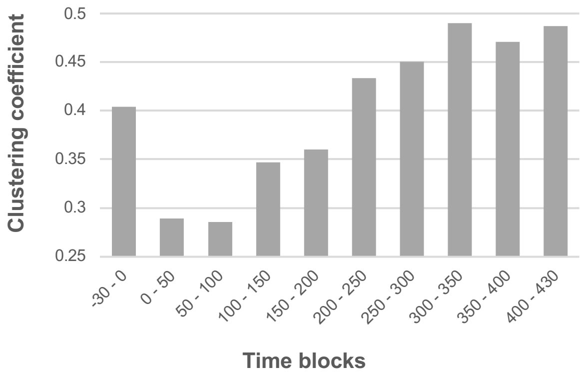
From the perspective of linking distance, the *eigenvector centrality in this analysis* is generally higher in lower linking distances, where the maximum is reached at the linking distance of 10 km. It gradually decreases and reaches minimal values in the linking distances of 22.5 and 25 km (Graph 6.9). The temporal distribution shows the general trend of the



Graph 6.10. Residential area networks. Temporal outline of *eigenvector centrality*.



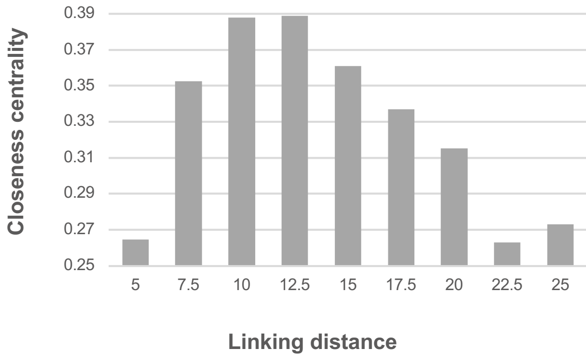
Graph 6.11. Residential area networks. *Clustering coefficient* in individual linking distances.



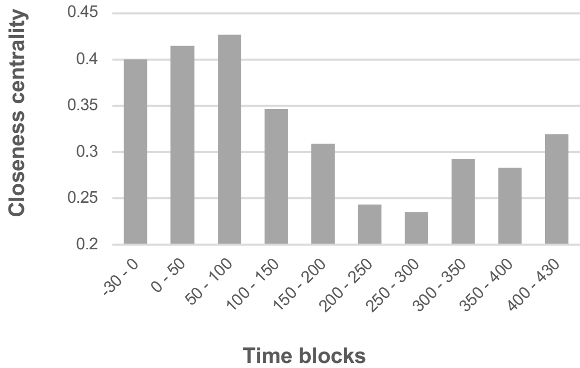
Graph 6.12. Residential area networks. Temporal outline of *clustering coefficient.*

relatively more distributed importance of individual nodes during the Early Roman Period and the opposite during the Late Roman Period (Graph 6.10).

vital perspective is also provided by the network metric called *clustering coefficient*, which is calculated as a fraction of all the links it is directly connected to over a maximum number of links



Graph 6.13. Residential area networks. *Closeness centrality* in individual linking distances.



Graph 6.14. Residential area networks. Temporal outline of *closeness centrality*.

that can exist between those neighbours (Watts, Strogatz 1998). In essence, it provides an indication of the level of local clustering. In this case, the *clustering coefficient* follows relatively comparable trends to *degree distribution* (cf. Graph 6.5). Nevertheless, the increase through the preset linking distances tends to show a resemblance to logarithmic growth (Graph 6.11). As a result, the temporal distribution patterns also resemble each other (Graph 6.6, 6.12), but their interpretation possibilities differ (Brughmans, Peeples 2023, 114–115).

The last network evaluation method used here is represented by the *closeness centrality*, which is calculated as the mean distance from a node to all other nodes (Brughmans, Peeples 2003, 138). Therefore, this metric is essential for the evaluation of the proximity of a node to others in a network. The linking distance in individual thresholds (Graph 6.13) has relatively similar properties as in the case of the *eigenvector centrality*. It reaches minimum values in the lowest (5 km) and highest linking distances (22.5 and 25 km). The temporal development (Graph 6.14) started with relatively high values, which decreased during the 2nd century AD. They reached minimum values during the 3rd century AD, and a moderate increase characterises further development during the following century.

6.4.3 Structures and trends in residential area networks

From an overall perspective, remarkable development tendencies are embedded in the resulting network analysis of the employed measures. Generally, the contrasting development of the *betweenness centrality*, *eigenvector centrality, and declining clustering coefficient* underlie significant changes in settlement patterns *over* time. They reflect a more decentralised network structured during the Early Roman Period, with relatively equal influence of network nodes, which is underlined by high *eigenvector centrality*, *closeness centrality*, and *clustering coefficient*, coupled with relatively low *betweenness centrality*. These network development properties could be translated into more dispersed and relatively autonomous communities with limited centralised authority during the initial time blocks till the turn of the 1st and 2nd centuries AD. Nevertheless, higher interconnectedness (closeness centrality) could be indicated in these clusters, reflecting more tight local kinship-based ties. During the following 2nd century AD, the related trends in reconstructed network metrics suggest tendencies towards centralisation, foremost through an increase in *betweenness centrality*, which indicates the appearance of settlement entities in more prominent positions in the network structure, suggesting an increase in hierarchy and the rise of regional centres. A decrease in the *clustering coefficient* implies the gradual weakening of the local ties and a shift towards the centralised political entities. Perhaps the most striking manifestation of the centralisation trend in the archaeological record could be represented by the princely grave from Mušov.

It is noticeable that the time block 150–200 AD, during which an extensive conflict of the Marcomannic Wars took place, represents a turning point not only via multiple baselines and secondary proxies (Chapter 5.5) but also through the reconstructed network properties. In this regard, it is remarkably consistent with the residential areas baseline proxy trends, which justifiably underlines significant changes (*Abandonments*) in this period. However, most of the development patterns of the network metrics show development trends (either increase or decrease) that are already observable during the preceding time blocks. Nevertheless, these structural changes could have been speeded up, and the pivotal time block 150–200 AD of the conflict period served as a catalyst, resulting in the significantly different reconstructed network (and societal) properties of the Late Roman Period. Hence, it suggests that the expected post-war changes (recorded *Foundations* during the time block 200–250 AD) allowed for continuing the ongoing trends.

The consecutive development of reconstructed networks and their properties during the Late Roman Period conversely shows the tendencies towards further centralisation through high values of reconstructed *betweenness centrality*, with the influence concentrating around particular nodes. They are further underscored by declining *eigenvector* and *closeness centralities* and lower values of the *clustering coefficient*. Therefore, the results show an increase in network homogeneity, which means the presence of highly influential nodes (settlements). This structural trend is further corroborated by an increase in *degree distribution* supporting the growing scale and interconnectedness of the system. This could also imply a potential increase in vertical hierarchical structures, which are also embedded in the archaeological record (funerary record; cf. Chapter 8) as well as narrative sources (differentiation of the sociopolitical entities, cf. Chapter 9). However, such trends are also intriguing in the context of the reconstructed population size (Chapter 7.3) and their distribution patterns (Chapter 7.3.1) throughout the studied region, which attest to its decrease compared to the previous 2nd century AD. Simultaneously, such development is leading to the structure being more vulnerable to instability in the case of the removal of dysfunctional, highly prominently situated and interconnected nodes. Generally, the later stages of the Late Roman Period (4th and the beginning of the 5th century AD) show the trend of weakening of the centralisation and emergence of more locally oriented ties of communities. Nevertheless, the connectivity during this period (*degree distribution* and *clustering coefficient*) remains relatively high, implying the trend of 'clustering' of the settlement structure.

One of the striking connotations of such spatiotemporal development patterns could be observed in the restructuring of the quantitative and qualitative properties of the structural changes in the funerary areas (cf. Chapter 5.2; 8), where the shift from a higher number of relatively 'smaller' to a lesser number of 'larger' necropolises could be seen. The adjoined effect, coupled with the observed development in the *clustering coefficient*, represents a potentially higher network fragmentation, i.e. the emergence of more 'local' clusters. Amongst others, these 'densifying' trends, in general, could also be put in context with the emergence of one of the first large-scale specialisations and the emergence of production centres of the locally produced potters-wheel-thrown fine ware of the 'Jiříkovice-type'. Such activities, whose results have swiftly spread over the whole 'Marcomannic' settlement zone, have been conducted presumably in multiple places, and their distribution inevitably required an established communication network. Nevertheless, this particular segment of archaeological data has not yet been sufficiently investigated, and further research in this regard may provide additional grounds for dedicated analysis. However, the network characteristics, as reconstructed for the Late Roman Period, might be considered a prerequisite to the emergence of such a phenomenon.

Consequently, the network analysis results contributed further to the interpretation possibilities of the apparent changes in the archaeological record between the Early and Late Roman Periods. Through further elaboration, they hold the potential to explain the emergence of specific economic phenomena (e.g. specialised pottery production), sociopolitical complexity (hierarchical structures) or apparent changes in the burial context (extensive funerary areas of the Late Roman Period). Nevertheless, the biases stemming from the 'incompleteness' of the input data on the Germanic settlement structure may have influenced the results and interpretation margins of the network analysis. Simultaneously, the result provides insight into the development of the whole 'Marcomannic' settlement zone, and inevitably, there would be variability in the development of the local level in particular sub-regions.

Chapter 7

Demography of the Germanic populations of the 'Marcomannic' settlement zone

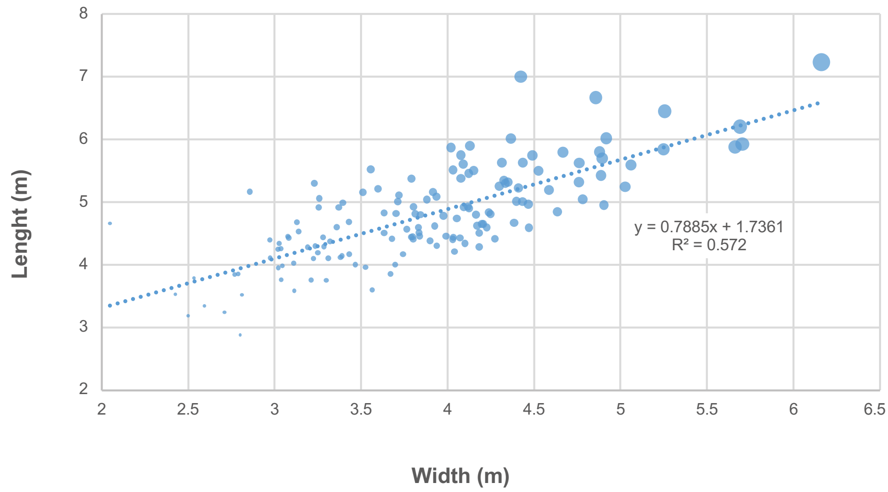
One featured area of research interest in this book is the exploration of selected aspects of the archaeological demography of the Germanic populations of the 'Marcomannic' settlement zone. This area has not been fully acknowledged in the past for several good reasons. Significant obstacles in examinations and population studies of physical anthropology stem from the almost exclusive dominance of cremation burial rites. The process produces highly transformed anthropological and other material, which provides only a limited source of information (e.g. Cerezo-Román, Wessman, Williams eds. 2017). This significantly limits the application of diagnostical methods of physical anthropology. Despite these unfavourable conditions, the number of burial grounds has been anthropologically evaluated (e.g. Peškař, Ludikovský 1978; Droberjar, Kazdová 1993, 143).

Recently, the subject has been dealt with through computational approaches by the leading author of this book (Vlach 2018b), which raised several research questions and issues of archaeological demography. This research also represented the first stepping stone in the direction of the emergence of the research project's conception, which eventually was supported (see Acknowledgements in Chapter 1). One of the underlying assumptions of the research project was based on large-scale data collection, through which some of the issues of archaeological demography could be tackled. Within the presently available data from the MARCOMANNIA dataset, several 'subsets' of specific componential, contextual and artefactual categories with justifiable connotations to the population size and structure properties were utilised for demographic approximations. Nevertheless, the derived proxies on the subject and circumstantial and their implications to the demographical context are substantiated by various theoretical and methodological perspectives (e.g. Petersen 1975; Hassan 1981; Neustupný 1983; Chamberlain 2006; 2009; Bocquet-Appel ed. 2008; Séguy, Buchet, Bringé 2008; Renfrew 2009; Drennan, Berrey, Peterson 2015; Séguy 2019; Schmidt et al. 2020; Burmeister, Gebühr 2023).

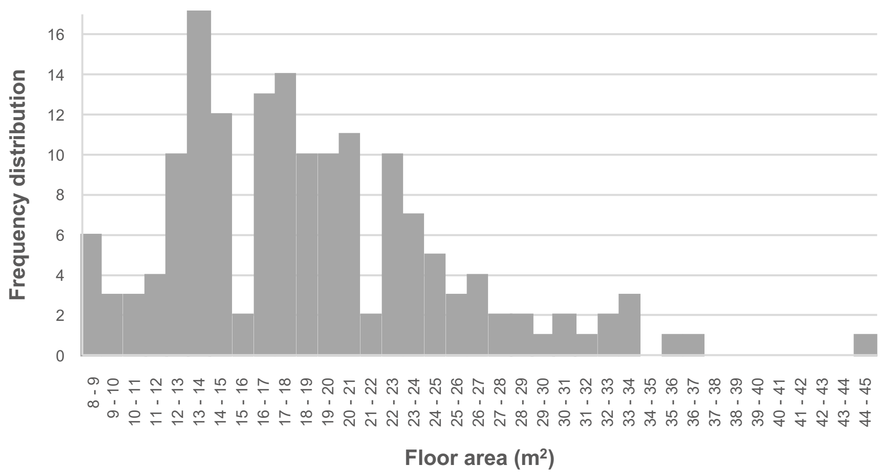
7.1 The floor area estimator and household size

The concept of approximation of the size of a household/family unit (from a general perspective) through the parameter of the 'living' floor area represents one of the traditionally and frequently used means for estimating population size. It was introduced first by R. Naroll (1962), and the ethnographical study and available data from various contexts resulted in the so-called 'Naroll's constant', defined as an area of 10 m^2 per person. The subsequent critique and elaboration of the concept led to a series of estimates, generally below the 'Naroll's constant' (cf. Brown 1987). Significant variability in the floor area metric in various cultural contexts has also been pointed out, suggesting the limited applicability of the concept and its cautious use (e.g. LeBlanc 1971). However, most of the further research argues for a lower required area from the constant by Naroll, mainly intersecting around the mean value of 6 m^2 per person, with an STD of 4 (Brown 1987, 33).

As pointed out elsewhere (Chapter 5.1.5), within the studied spatiotemporal context, pit houses are considered the primary type of housing units associable with a socio-economic entity of



Graph 7.1. Pit houses. Linear regression of the documented length and width (the symbol size is based on the floor area).

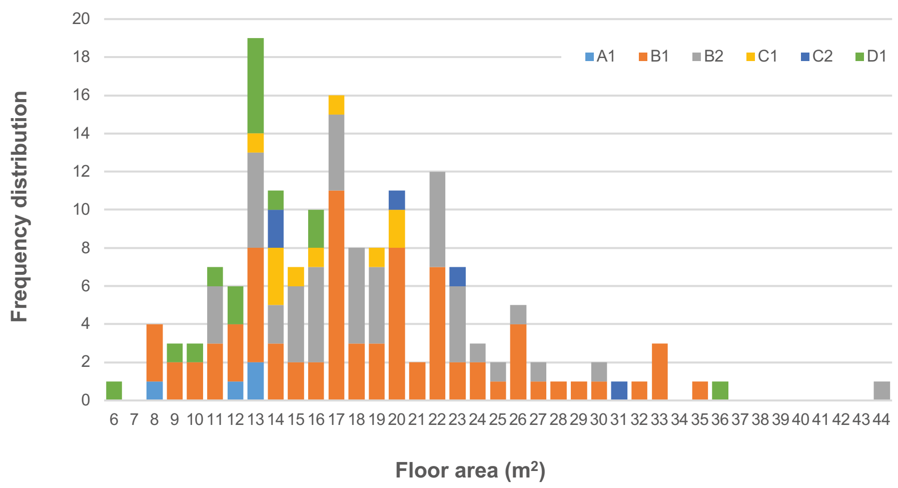


Graph 7.2. Pit houses. Histogram of all the evidenced floor-area sizes of the pit houses (one m² resolution).

a household within the Germanic settlement zone of the Middle Danube region (Fig. 5.5), as well as elsewhere (e.g. Bohemia). Therefore, despite embedded constraints (especially the variability in the studied context and general applicability of the index) of the method, the available formalised information on the pit houses from the 'Marcomannic' settlement zone constitutes a tentative opportunity to explore the quantitative implication of the 'floor area' concept application. Within the MARCOMANNIA dataset, 164 pit house records contain length and width (usually maximum dimensions) information (cf. Graph 7.1), i.e. the primary data for floor area estimates. In the cases with information missing but available ground plan, a polygon outlining its borders has been digitalised and information derived. There are records for the projection of this variable, which also possess chronological information. From that number, however, only 82 records also have the identification of the temporal probability distribution.

The general outline of the recorded floor-area sizes (Graph 7.2) shows a relative heterogeneity with margins of the highest frequencies (2nd and 3rd quartile), ranging from 13.8 to 22.4 m² (average 18.6 m², median 17.8 m², standard deviation 6.4). The 1st and the 4th quartiles extend between 5.9 and 35.3 m². The phenomenon may potentially suggest various connotations and relations within the past anthropic context, e.g. in the social dimension (social status correlation), economic (wealth correlation), technological aspects (typological classes and differences in supporting structure), demographic (family/household size in various stages of development) or potentially also climatic (i.e. the necessity of larger protected/sheltered area to compensate the effect of unfavourable climatic conditions).

The histogram-based outline of all the documented pit house floor areas shows several structures in their distribution. Foremost, two conspicuous gaps in distribution (from 15 to 16 m² and



Graph 7.3. Pit houses. Outline of the typologically differentiated floor areas (m²).

	All types	A1	B1	B2	C1	C2	D1
Count	164	4	78	47	10	5	15
Average	18.6	11.6	19.4	19.6	16.1	20.6	14.2
STD	6.4	2.5	6.4	5.8	2.6	7.6	6.7
Median	17.8	12.6	18.9	18.4	15.6	20.3	13.4

Tab. 7.1. Pit houses. Summarisation of the typologically differentiated floor areas.

from 21 to 22 m²) could be caused by quantitative deficiencies of the input data, and only further archaeological research may provide further justification or rejection. Therefore, from the quantitative representativeness perspective, the three more pronounced clusters of the 'living' areas emerge (12–15, 16–21, and 22–24/26 m²). The third cluster is the least represented. However, the others could be potentially a result of some of the abovementioned factors. Nevertheless, the floor area distribution is generally comparable with the western Germanic environment (cf. Leube 1973). The outliers are represented through the exceptionally high (above 35 m²; e.g. Modřice 'Za humny', Procházka 2000; Bratislava-Dúbravka 'Veľká lúka', Elschek 2017) and low (below 10 m²; Zlechov 'Padělky', Zeman 2006; 2010; Vlčnov - Dolní Němčí 'Dřínky', Droberjar 1988) floor areas. However, such deviations on both sides of the axis could stem from incorrect identification during the field research and processing.

From the 'living' floor area demographic perspective and implications, the average area (18.6 m²) would comply with the three persons per dwelling. If the calculation were to apply to the adult household members (cf. Brown 1987), there would be compliance with the generally anticipated household size estimator from the floor area of 6 m², which is, therefore, between 4 and 6 members on average. Hence, the general requirements of a 'standard' household would be relatively below the estimated 6 m² per person. Then, the value distribution above the 3rd quartile would provide sufficient capacities. In this regard, the more sizable households (i.e. above 25 m², 22 pit houses, 13% of input objects) could be potentially connected with wealthier social strata as such households would provide capacities for larger family units, potentially including an enslaved person. Vice versa, the low occurrence of 'living areas' below 12 m² would pose a challenge to the housing interpretation concept, and their primary use should be sought elsewhere.

The variability of spatial alignment of the postholes of the supportive structure has been dealt with in the past and conceptualised into the typological schemes (cf. Kolník 1962; Droberjar 1997, Abb. 11; Leube Hrsg. 1998). The typological variability and connection with the chronological phases of the Roman Period have been suggested earlier (Droberjar 1997). However, based on the available dataset, it is also possible to put this information into the context of the floor area. The outlined distributions of the floor-area sizes within the individual typological classes show several marked phenomena (Graph 7.3, Tab. 7.1). Firstly, there is a significantly uneven distribution of the evidenced typological classes within the subset, and by far, most substantially are represented types B1 and B2 (125 records).

Nevertheless, it is apparent that the consistency in floor area, on average around 20 m^2 (including comparable STD), could be observed in the typological categories of generally B and C2, all of them consisting of the six post-holes, despite different structures (however with the dominant representation of the 'standard' post-hole structure of type B). Therefore, such a structural relationship (despite internal variability of the typological classes) could be a justifiable basis for suggesting that these types served as a habitation unit (a household) with sufficient spatial dimensions and capacity. The other types (A1, C1 and D1), with distinctively constrained floor areas, could have sheltered other 'non-habitation' functions and the different purposes within the complex fabric of Germanic settlement activities (e.g. storage buildings, stables, workshops, etc.).[53] In this regard, type D has been assumed to be more likely connected with economic activities earlier (cf. Kolník 1962, 366–368; Droberjar 1997, 21–22). Simultaneously, this average is evidenced only in the typological categories with the six-post structure (B1 and B2). In contrast, the potentially less complex constructions with four (C1), two (A1) or none (D1[54]) posts have, on average, between 12 and 16 m^2 (Tab. 7.1). However, these typological classes are also considerably less represented in the empirical data.

The relatively small subset (84 records) of the respective data containing the temporal information could also be used to establish a time block-based temporal probability distribution of the average of the evidenced floor areas (Graph 7.4). The first three time blocks (BC 30–100 AD) are burdened by a low representation of the input data (with no contextual evidence of the Germanic presence during the phase A, and the outline for the first time block is a result of probability distribution calculation reflecting the phase B1 with marginal overlap to this time block), reflected through the high values of STD. From the time block 100–150 AD (18 m^2), the lower values testify to more consistency in data. The development shows a relative decrease for the 3rd century AD (17 m^2) and more elevated floor areas at the beginning of the 4th century (19 m^2), with a further gradual decrease to the final time block 400–430 AD (17 m^2).

Despite the limited representativeness, a tempting association of the peaking floor area at the Late Roman Period time block 300–350 AD could be associated with the onset of the instability and general deterioration of the climatic conditions without improvement until the terminal stages of the Roman Period in the Middle Danube region (cf. Torbenson et al. 2024). One of the potential responses to such adverse external factors could be an increase in roofed areas to shelter humans and animals more effectively. However, only the further broadening of the primary information based on the subject could validate this notion. On the other hand, during the 3rd century AD, relatively low values (below 17 m^2 on average) were observed, less than in prior and posterior centuries. Following the above-mentioned assumed connotation, the 3rd century AD experienced favourable agroclimatic conditions. Both correlations may provide substantiation of the formulated assumption about the development of the floor area and climatic conditions within the studied context of the 'Marcomannic' settlement zone.

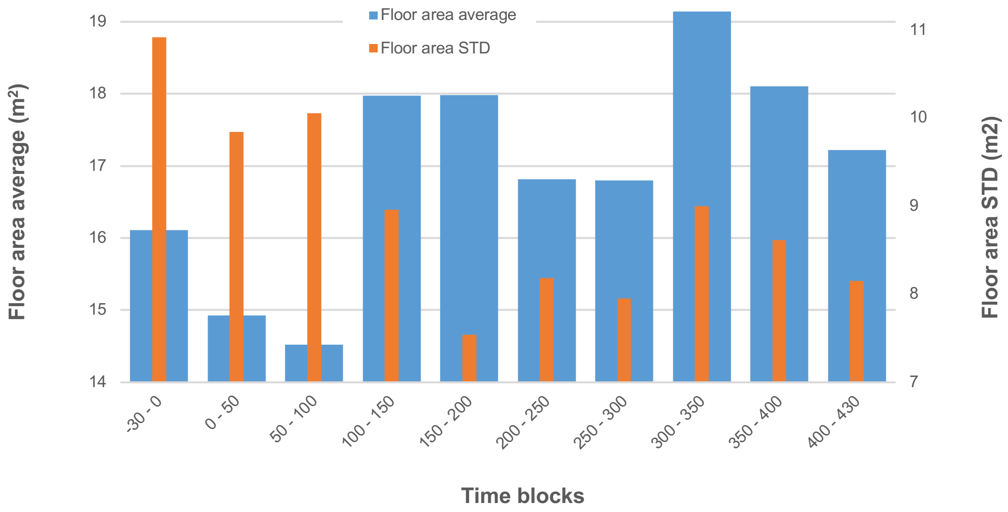
However, from the ascertained calculation of the potential number of inhabitants transpires with foremost is the corroboration of the interpretation of the respective contexts as a representation of a household inhabited by a family unit. The resulting living area is at a lower margin of general considerations regarding the space requirements of an Iron Age household. However, it is still within the acceptable parameters for housing purposes.

7.1.1 Socio-economic implication of the floor area size (Gini coefficient)

In multiple approaches of the research towards the wealth inequity and its distribution through past societies (e.g. Kohler, Smith eds. 2018), the residential areas, respectively, the households and their potential quantitated income variable have been utilized to derive the general property of the wealth distribution through the *Gini coefficient* (Gini 1912; Kohler et al. 2017) and its shape through the Lorenzo curve. Along with the proxy from the world of the 'living', data from the funerary milieu is equally or even more often used. The application of this method in the case of the funerary record of the 'Marcomannic' settlement zone is addressed further in Chapter 8.2.2. Eventually, for the whole dataset of the recorded floor size areas (164 records), the Gini coefficient of 0.188 has been calculated, which generally suggests a rather uniform distribution of inequity in this category of data. This number is low not

53 Especially in connection with archaeological finds indicating production activity – loom weights, production waste etc.

54 However, in this case a completely different type of building technique could be also considered, such as a log house with no posts required as a supportive structure.



Graph 7.4. Pit houses. Temporal outline of the floor areas.

only for the generally acceptable ranges for propagation of the wealth inequity in advanced chiefdom-type societies (e.g. Kohler et al. 2017, Fig. 2; Kohler, Higgins 2016; Gurven et al. 2010, Tab. 3) but also in comparison with the results of corresponding evaluation on the basis of the more complex and represented information sources – recorded burials of the Middle Danube *Barbaricum* in scope. Therefore, despite existing variability in the frequency distribution of the recorded floor areas of the pit houses (i.e. households), the respective derived Gini coefficient suggests a very limited reflection of the assumed wealth distribution within the studied Germanic societies in floor areas.

7.2 Community size from the archaeological record

In archaeological demography, funerary areas or 'necropolises' traditionally constitute one of the critical contexts used to derivate various demographic properties (cf. Chamberlain 2006; 2009), including life tables (e.g. Acsádi Nemeskéry 1970; Neustupný 1983; Stloukal et al. 1999; Séguy, Buchet, Bringé 2008). However, an almost exclusive cremation burial rite significantly constrains the possibility of even fundamental anthropological determinations regarding sex or estimated age at death. Such limits, therefore, leave only a few opportunities for the demographic proxy derivation, one of which counts the so-called 'burying population size' (cf. Acsádi, Nemeskéry 1970, 65; Nikulka 2016, 139–141, Abb. 8). Despite there are several objections towards the concept regarding its inputs (high uncertainty of the actual and recovered burials, the effect of infant mortality or age restrictions for burials, problem of the population stationarity, or life expectancy estimates), it represents one of the long-standing methods to approximate the aimed variable. It could also be used to compare individual funerary areas and approximate the quantitative aspect of the 'burying population size' concept on the temporal scale.

From the methodological perspective, it is difficult to associate this variable with a settlement/community size, as the actual population burying their deceased in a particular burial ground could represent one or more residential areas, i.e. settlements. On the contrary, the opportunities for assumptions about the community size and variability from the context of individual settlements are significantly limited, where the main issue is the possibility of assumptions and estimates regarding the number of contemporaneously existing households or the residential area extent, that could provide grounds for estimates of the number of inhabitants (e.g. Petersen 1975; Hassan 1981; Chamberlain 2006; 2009). However, this approach is, by far, more relevant with distinctively delimitable areas through the fortification systems or environmental barriers.

7.2.1 Input data

Primarily, it has to be pointed out that the state of knowledge in the case of thoroughly excavated residential areas provides a limited basis for such reconstructions. Only a minimal amount of archaeologically thoroughly explored, documented, and published funerary areas are available to evaluate the dynamics of the societal development patterns. From the temporal probability evaluation, their distribution pattern could provide further insight into spatiotemporally differentiated development

Site	No. graves	Min. duration	Max. duration	Burials/ year (min.)	Burials/ year (max.)	Acsádi/ Nemeskéri 1970	Gejvall 1960	Rosing 1976	Asch 1976
Pohořelice ‚Mlýnské'	21	50	100	0.4	0.2	15	8	10	9
Hevlín ‚Schindereiäcker'	29	50	100	0.6	0.3	18	11	14	13
Mikulov ‚Rybníky'	36	250	350	0.1	0.1	33	3	4	4
Jevíčko ‚U statku'	42	50	100	0.8	0.4	23	16	20	19
Šitbořice ‚Padělky od Moutnic'	47	250	300	0.2	0.2	32	4	5	5
Velatice ‚Zadní půllány'	48	250	300	0.2	0.2	32	4	6	5
Sekule ‚Za humnami'	58	150	200	0.4	0.3	26	8	11	10
Velké Hostěrádky ‚Podlipiny'	59	150	250	0.4	0.2	28	8	10	9
Náklo ‚Jáchymov, Dělnice'	100	100	100	1.0	1.0	35	25	31	30
Šaratice ‚Padělky za humna'	153	50	100	3.1	1.5	65	57	72	69
Modřice ‚Sádky'	229	250	300	0.9	0.8	48	21	26	25
Kostelec na Hané ‚Prostřední pololány'	448	200	250	2.2	1.8	73	50	63	60
Average	**106**	**150**	**204**	**0.9**	**0.6**	**35.7**	**18.0**	**22.5**	**21.6**
STD	**124**	**87.9**	**99**	**0.9**	**0.6**	**17.7**	**18.1**	**22.6**	**21.7**
Sum	**1270**								

Tab. 7.2. Burying community size. Outline of the various results of the calculated average size of the buying population through different approaches (see Nikulka 2016, 139–141, Abb. 8) applied to the funerary areas with over ten documented graves from the studied region.

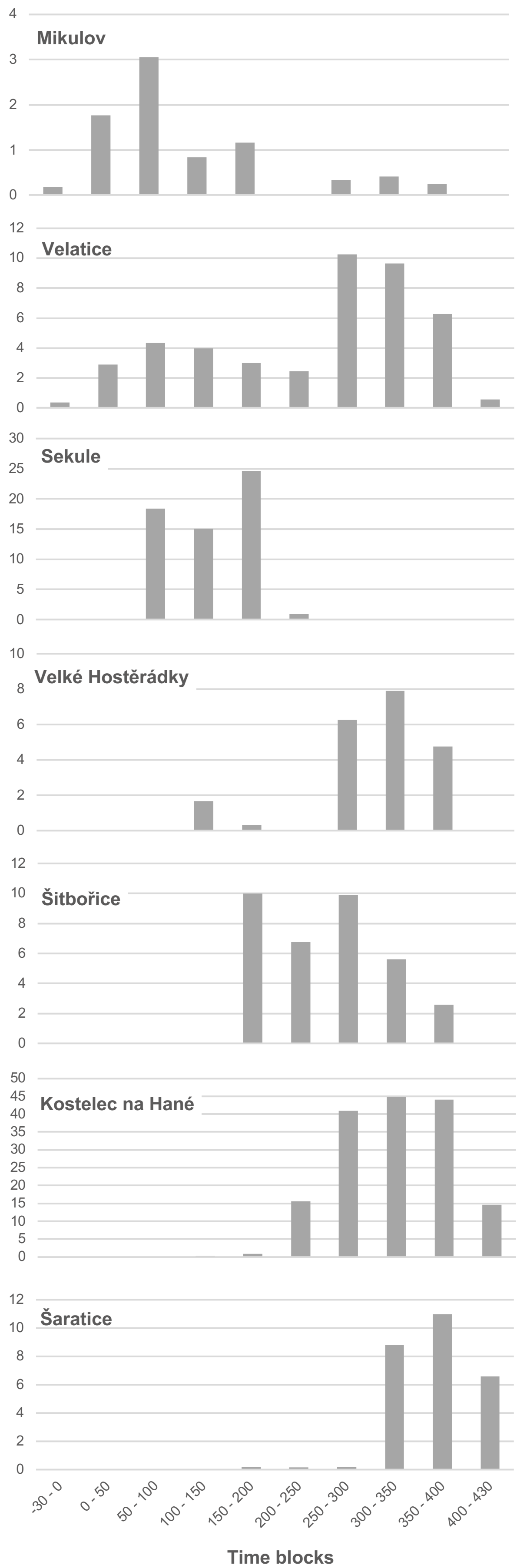
in time, which is unavailable. Eventually, 13 funerary areas have qualified for the criterion of containment of ten or more identified burials (see Tab. 7.2). Their outline is based on the sum of aoristic weights; therefore, the y-axis value could provide a reference for quantitative comparison of the representation of the individual funerary areas.

7.2.2 Burying population approach

Four different approaches have been used to calculate the size of the burying population (Gejvall 1960, 43; Acsádi, Nemeskéri 1970, 65; Asch 1976, 47; Rösing 1976, 91) based on the documented activity (period of use) and the number of individual burials/graves (Tab. 7.2). The differences in particular approaches to approximating the size of a burying community inevitably result in more or less pronounced variability in the figures generated. It is apparent that the equation by G. Acsádi and J. Nemeskéri deviates more from the rest, and the higher similarities in the results of the calculations could be observed in the case of the larger funerary areas (Kostelec na Hané 'Prostřední pololány' and Modřice 'Sádky'). It is also apparent that larger communities have used these necropolises, potentially distributed through several residential areas within the neighbouring region.

The relevant existing estimates enable approximation of a community/settlement population size to a mean value of 25 individuals with variability through STD of 20. Such assumptions and estimates also corroborate the previous estimate (cf. Vlach 2018b, 52–53, Tab. 1). Despite individual cases suggesting significant concentrations of the Germanic population during the studied period (e.g. 'agglomeration' Mikulov-Mušlov, Komoróczy et al. 2020; Drnholec 'Holenická pole', Komoróczy et al. 2019a; Zohor 'Piesky'; e.g. Elschek 2014; Elschek, Rajtár, Varsik 2011), the dominant part of the residential areas consisted of the approximately 50 inhabitants (i.e. ten households regardless of their existence at the same time). Presently, an 'average Germanic settlement' represents a spatial entity of roughly between 1 and 3 ha (e.g. Tejral 1993, 473; Šedo 1991) and could be generally assumed, however, only as a general average. A distinctive variability has been observed in multiple parts of the studied region, justifiably reaching significantly greater population sizes (e.g. an extensive 'agglomeration' Mikulov-Mušlov; Komorócy et al. 2020). However, further research activities are expected to shed more light on vertical differentiation within the settlement structure, as it has convincingly been suggested presently, reflecting differentiated population sizes and circumstantially also the densities.

Through the temporal probability distribution methodological framework, it is apparent that the documented activity at the individual funerary areas differs significantly in time and intensity (Graph 7.5). The pattern of this distribution has various tendencies, from the more intensive short-term activities (e.g. Kostelec na Hané 'Prostřední pololány' or Šaratice 'Padělky za humna') to varying long-term and with lesser intensity (e.g. Velatice 'Zadní půllány' or Mikulov 'Rybníky'). This significant variability, although drawn from a relatively small sample of thoroughly examined funerary areas available, underlines the varying quantitative properties of the

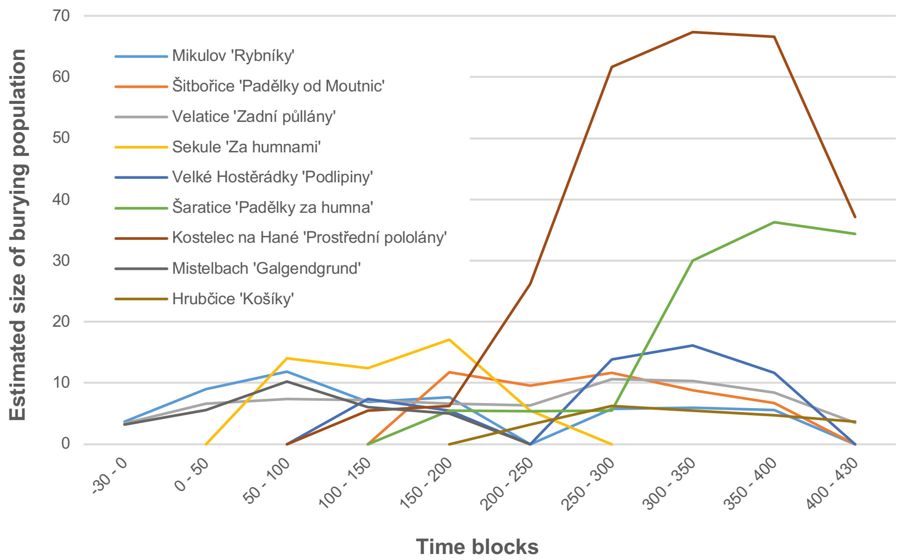


respective communities using individual areas of activity. For the funerary areas with internal temporal probabilistic patterns (Graph 7.6), the 'burying population size' could be calculated individually, using the same equation (Acsádi, Nemeskéri 1970, 65) as for the whole period of use (Tab. 7.2), using the duration of the time blocks. In this approach, which undoubtedly has its respective methodological pitfalls, the known number of burials is interpolated based on changing reconstructed temporal probabilities, and the 'sizes' are calculated for the individual time blocks (Graph 7.6).

Despite the significant bias from the quantitative representativeness, the resulting outline provides a relatively seamless development trajectory. The distinguished and well-known funerary areas from the studied region of the 'Marcomannic' settlement zone testify to differentiated temporal probability patterns throughout the studied period (Graph 7.7). The temporal distribution pattern reveals an underlying variability on an individual site level. Within the established methodological framework, the estimated size of the burying population could also be outlined through the time block framework on the temporal scale, based on the calculated temporal probability distributions for the individual funerary areas (Graph 7.6). Despite the limited number of input objects, the aggregations provide a consistent trend in the variables in question. The outline generally reflects the continuity of activity in all cases, except for the funerary area Velké Hostěrádky 'Podlipiny'.

In general, there is a noticeable increase in the reconstructed average size of the 'burying population' during the studied period (Graph 7.7). As in the case of several other derived proxies, there is a linear increase from the beginning of the studied period till the time block 50–100 AD, from 3 to 10 of the average size of the 'burying population', where the flattening of the temporal trends begins. The further development stage starts in the time block 200–250 AD, reaching a peak in the time block 300–350 AD with an average above 20. Subsequently, the change towards the end of the studied period is relatively marginal. Observable temporal patterns provide potential suggestions for the underlying processes within the 'Marcomannic' settlement zone. The estimated sizes for the initial parts of the Early Roman Period

Graph 7.5. Outline of the temporal probability distribution of activity in the case of representative burial grounds from the studied region.

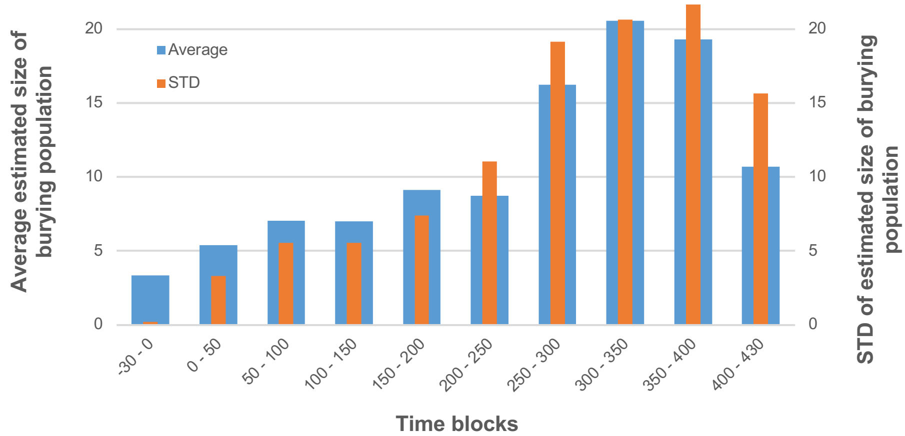


Graph 7.6. Burying community size. Temporal development of the reconstructed size of the burying population of the selected funerary areas.

are consistent with the reconstructed development of the population size of the 'Marcomannic' settlement zone (Chapter 7.3). The divergence of the further development could be explained through the stabilisation of the demographic conditions, where the increase in settlement structure was more extensive than intensive, i.e. resulting in relatively even community sizes in proportionately emerging funerary areas. The Late Roman Period development contradicts most demography-related proxies (except for the baseline proxy of burial contexts).

Yet, there still needs to be more sources regarding the initial phases of the Germanic presence in the Middle Danube region, associable generally with the stage B1 (e.g. Tejral 2009; Zeman 2017a), and its dynamics could have differed from the reconstructions. Along with the size, there is also an apparent shift in variability, reflected in the STD values (Graph 7.7). The reconstructed variable during the Early Roman Period shows consistently lower numbers, about half or a third of the averages. In contrast, the Late Roman Period reflects a high rate of variability through STD, surpassing estimated averages in the time blocks 250–300 AD and 350–400 AD. A significant drop in variability is then observable during the terminal time block 400–430 AD. As pointed out earlier, this trend partially contradicts the baseline population size proxies and aligns with the one on the grave frequency and temporal probability distribution (see Chapter 5.2.3).

Such observation could corroborate the well-established assumption of the emergence of 'supra' regional funerary areas. Either way, such development could be explained by the size of a community consisting of one 'larger' or several 'smaller' residential areas (i.e. settlements). Nevertheless, the combined influence of both scenarios should also be considered. However, the relative scarcity



Graph 7.7. Burying community size. Temporal distribution of the average burying population size in active funerary areas.

of representative archaeologically explored residential areas persists (see Chapter 5.1), enabling their further investigation in future with growing archaeological knowledge. Yet, the archaeological record has no transparent evidence for increasing an average 'settlement' population size. Either way, the structural changes in assumed proportions imply changes in settlement structure spatial patterns, inevitably connected with adjustment of the societal arrangements, given by the affordance parameters towards the expectable social relation density (cf. Neustupný 1998; 2009; Flannery 1972) within the various parts of the studied region. Notably, the first significant increase in the average size of the 'burying population' is evident between the 1st and 2nd halves of the 3rd century AD, not directly due to the extensive conflict of the Marcomannic Wars. From the results, it could be assumed that the general characteristics of the residential context persisted and more pronounced increases in the population size of the studied region, as is well-corroborated by the simulation results of the residential area data, independently imply external and more pronounced, population influxes into the region, happening presumably during the 2nd half of the 3rd century AD, i.e. the time block 250–300 AD (Graph 7.7). In this regard, the correlating representation of variability (STD) is equally significant and underlines the existence of greater variability in the burying communities.

7.3 Population size and its spatiotemporal dynamics

The temporal probability distributions of the residential area data (see Chapter 5.1) represent a dimensionless proxy with potentially significant relevance to the fundamental demographic parameter – population size (e.g. Petersen 1975; Schacht 1980; Chamberlain 2006; 2009; Drennan, Berrey, Peterson 2015). Inevitably, the assumption of such correlation is biased by several issues, and it is naturally problematic to straightforwardly associate the structuring qualities and quantities drawn from archaeological data with dynamic and complex past realities. However, from the available information basis on the subject within the MARCOMANNIA dataset, it is, foremost, the residential areas subset, which, from the theoretical perspective, contains the most information on this subject. It represents the context primarily bound with the residential function and long-term presence of the population (differing through the established temporal identification, i.e. dating). Further demographic proxies contain vital information, such as the funerary areas and their contexts, habitation units (pit houses), or conspicuous and distinctive find categories (e.g. brooches or tools). Still, their explanatory potential is constrained through circumstantiality (portable archaeological material) or spatial and quantitative representation (e.g. funerary areas or pit houses). Eventually, to approximate the temporal development of the population size, the secondary proxy based on probabilistic simulation modelling with yearly resolution will be utilised (see Chapter 5.1.2).

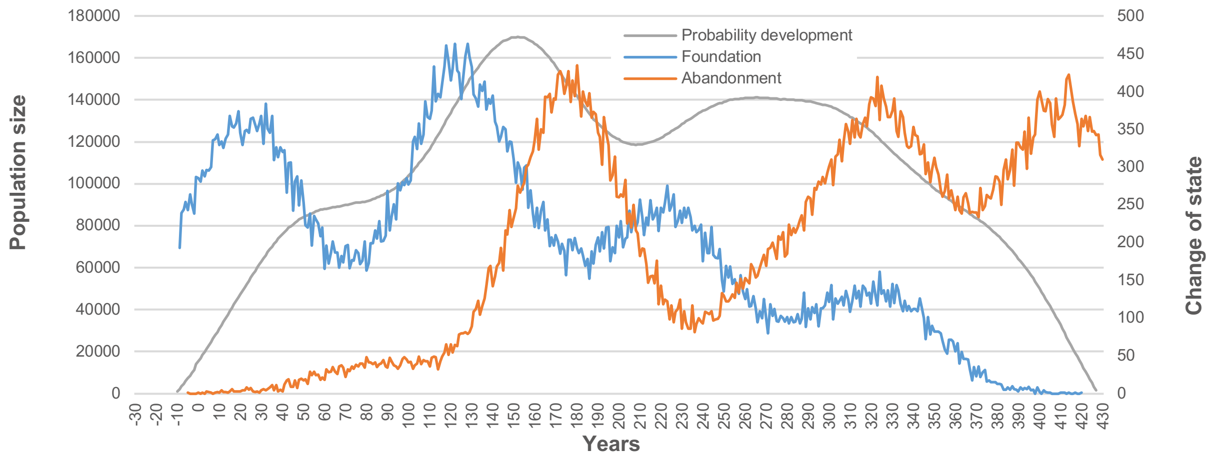
As the reference for the absolute estimated counts in individual time blocks, the results of the previously conducted analyses of the quantitative and spatial aspects of the demographic context of the Middle Danubian Germanic populations through the ABM modelling (see Vlach 2018b). In the model, the acting entities – agents – have been conceptualised as individual communities (i.e. settlements/residential areas), including internal and external processes regarding the demographic context based on the predicted quality of spatially differentiated conditions for suitability of the subsistence requirements. For the terminal stage of the digital model simulation (time frame from 150 to 175 AD), the total population size of the 'Marcomannic' settlement zone was estimated to be between 150,000 and 190,000 individuals (Vlach 2018b, 70). Therefore, it is simple to recalculate derived temporal probability in yearly resolution to the estimated absolute population size within the 'Marcomannic' settlement zone. An average of the 2σ estimates was used, resulting in the estimated population size of 170,000 (Vlach 2018b, Tab. 4), for calibration at the peaking reconstructed population size proxy during the 150–200 AD time block, which assigns proportionate values to the whole curve (Graph 5.5). Despite the results being represented through a yearly temporal resolution, it can reflect rather long-term trends over two generations (i.e. more than twice the life expectance at birth around 25 years; cf. Coale, Demeny, Vaughan 2013; Knapp 1998), which correspond to a time block temporal resolution framework. Therefore, it cannot provide details on the potential short-term consequential changes, positive or negative, which were embedded components of demographic development (e.g. various types of demographic crisis, migrations, epidemics, warfare, etc.), and this representation reflects moving-window averaged values.

The resulting quantitative projection of the population size of the 'Marcomannic' settlement region was additionally supplemented with the frequencies of underlying drivers of development – simulated *Foundation* and *Abandonment* of the residential area data (Graph 5.2). Furthermore, *net population growth* was also derived (Graph 7.8) from the yearly change of the estimated population size projection. This reconstruction reflects the resultant rate of change throughout the studied period, showing presumed percentages of the population's annual increase or decrease. It holds significant potential for the interpretation of structural tendencies and reflection on the magnitudes regarding the potential of differentiating the internal (e.g. intrinsic growth) or external factors (migration processes).

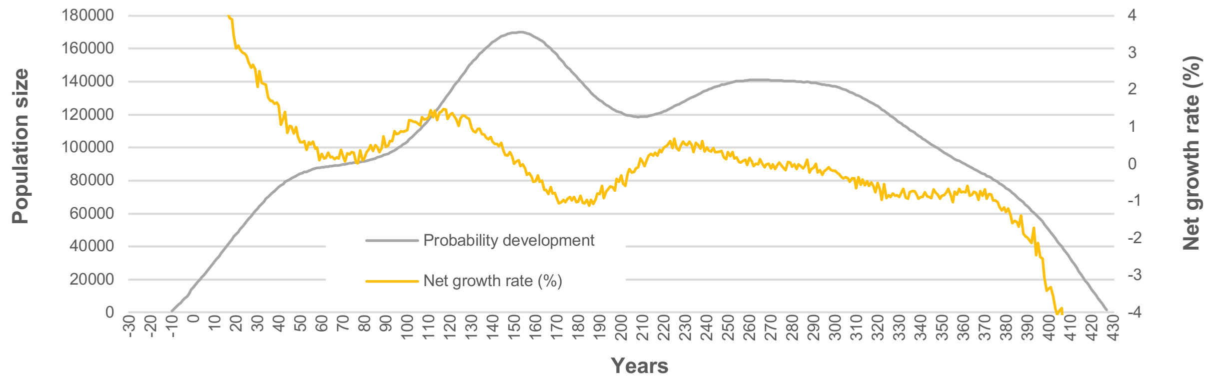
The starting population size at the beginning of the studied period and its growth rate are challenging to determine. The underlying theoretical assumption substantiates that Germanic populations were absent at the beginning of the studied period. Based on the empirical archaeological data, there is no contextualised data on the presence of Germanic material culture during phase A (e.g. Tejral 1977; 2009), i.e. from BC 30 to BC 10 within the first time block -30–0 BC/AD. This time block also contains a small fraction of phase B1 (i.e. B1a) within the adopted relative chronological system and its absolute dating (cf. Chapter 3.3). Therefore, the population absence was set for the initial relative-chronological stage A, and the initial numbers were provided from the beginning of stage B1. However, from the quantitative point of view, unlike the historical one, the expected amounts and estimated figures are around 20,000 for the settlement region at the turn of Eras, resulting in the local population densities below one person per km^2. Therefore, the arbitrarily established settings for inceptions of the study period assume only negligible amounts of the Germanic population, which would have propagated into the archaeological record in quantity below the level of recognisability. Notably, the reconstructed net growth rate during this period significantly exceeds 4% per year, suggesting the consequential role of migration processes in the incoming Germanic populations to the studied region of the Middle Danube (e.g. Tejral 1977; Salač, Bemmann Hrsg. 2009). Conversely, the intrinsic growth (even if at the rate of 2%) has expectedly lesser input to the resulting population size on the newly settled territories of the Middle Danube region.

The reconstructed growth continued during the following time block 0–50 AD and slowed down during the 60s of the 1st century AD. At this point, it theoretically could have reached approximately 90,000. The consecutive population growth with the same magnitude as the previous one (an increase of approximately another 80,000) conversely results from a relatively limited net growth rate of 1.3% of maximum annual growth. By this period, the expected and reconstructed population size reached the level where relatively low net growth rates (below 1%) result in quantitatively significant demographic output. This rapid population growth lasted until the mid-2nd century AD when it reached its peak when the curve bent at the total population size of the referential estimate of 170,000 (Vlach 2018b). At this point, for the first time during the one and half centuries, an estimated drop in the reconstructed annual net growth rate reach negative values. During the last third of the 2nd century AD, the mean yearly negative net growth rate could be estimated to surpass 1%. However, the occurrence of the extensive conflict of the Marcomannic Wars (Komoróczy, Vlach 2020), which impacted Germanic populations in the short-term perspective (foremost during the time frame of 172–180 AD), is expectable in the case of such a significant violent event (e.g. Otto, Thrane, Vandkilde eds. 2006). However, it is methodologically complicated to differentiate such an impact from the archaeological record of residential areas, foremost due to the temporal resolution of the archaeological material and the dating of the key contexts. In established estimated population projection, it propagates as a more gradual decrease, which could have been temporarily more constrained to the conflict period. Nevertheless, for the decades following the Marcomannic Wars, the projection suggests a decrease in the population size to roughly 120,000, which means a drop of 30%, i.e. 50,000.

In general, oscillating and gradually decreasing tendencies characterise the following development through the Late Roman Period. An intriguing insight provides the respectively derived growth rate (Graph 7.9), regardless of the nature of such growth (population influx from other regions, intrinsic population growth). For a short period, between roughly 210 and 260, there was a moderate increase when the net growth rate reached up to 0.7%. As a result, the population size could have recovered and increased again to around 140,000. Further development of the projection shows stagnation till the end of the 3rd century AD. However, during the first decades of the 4th century AD, the net growth rate reached -1%



Graph. 7.8. The projected population size (grey) based on the probabilistic modelling yearly resolution (see Chapter 5.1.2) and respective probability distributions of the Foundation and Abandonment rates.



Graph. 7.9. The projected population size development (grey) based on the probabilistic modelling yearly resolution (see Chapter 5.5) and net growth rate (%). Visualisation of the net growth rate was limited to the range of ±4.

and marked a further decrease in population size. At this point, the reconstructed population size reached back the counts of the drop after the Marcomannic Wars (i.e. 120,000). Significantly exceeding negative net growth rates could be assumed for the last quarter of the 4th century AD, during the phase C3/D1 at the beginning of the 5th century AD reaching the rates (below -4%) associable with a large-scale emigration, which is also attested in narrative sources for 406 AD, when substantial parts of the Germanic populations of the 'Marcomannic' settlement zone and other neighbouring regions have withdrawn to the west (e.g. Hummer 1998).

7.3.1 Regionality of the population size reconstructions

Using the methodological framework of segmentation to the hexagonal grid spatial structure (see Chapter 6.2), the reconstructed population size of the study region could be projected through this framework to outline the general characteristics and temporal patterns in demography properties of the Germanic population of the studied region. The same approach was used as in the previous chapter to recalculate the residential areas' baseline proxy temporal probabilities in hexagonal structure to actual spatially differentiated population size from the 150–200 AD time block (mean estimated population size 170,000; cf. Vlach 2018b).

The results of the spatial differentiation of the reconstructed population could provide the basis for assumptions about the local population density distribution throughout the studied region. The systematically higher values are naturally calculated for the regions adjoined to the main regional rivers. From a general perspective, the overall 'spatiotemporal' average population density is 5 persons per km^2, which could be considered a global population density, characterising the general baseline value. Nevertheless, the significantly differentiated pattern, reflecting rather 'local' population densities, is evident from the individual hexagons. Their reconstructed population densities for the whole study period oscillate within the relatively wide margins between 1 and 20 persons per km². A relatively large proportion of hexagons (44, i.e. 62%) with estimated densities below the baseline value (5 persons per km²) represent the peripheral regions with less favourable conditions for long-term habitation (higher elevations with more pronounced geomorphology, less fertile soils, cf. Vlach 2018b). Much more spatiotemporally vivid patterns are contained in hexagons above the baseline value. They are spatially consistent with the prominent core parts of the studied region, which provide substantial conditions for settlement activities and subsistence. For example, the reconstructed densities for the broader region of the Dyje–Jihlava–Svratka confluence (hexagon K-11; e.g. Komoróczy, Vlach 2022) exceed even 30 and 40 persons per km² during the 2nd and the 3rd centuries AD. It also applies to the regions of the middle reaches of the River Morava below Spytihněv Gate (hexagon O-11) and two within the Upper Moravian ravine, representing the clusters of the broader extent of Kostelec na Hané sub-region (hexagon N-8; cf. Zeman 1961; Vachůtová, Vlach 2011) and Přerov district (Kolbinger 2013). As a result, these regionally conceived estimates are consistent with the previous estimates based on the simulation model approach and other existing estimates from the comparable contexts (cf. Zimmermann, Hilpert, Wendt 2009; Vlach 2018b; Schmidt et al. 2020).

On the contrary, the underlying temporal and spatial variability patterns can be assumed through the standard deviations (Fig. 7.1). Generally, they do not diverge significantly from the averages (Fig. 7.2) but provide insight into the magnitude of changes in the baseline proxies from the demographically most relevant segment of archaeological data: residential areas (cf. Chapter 5.1). The highest variability between 15 and 18 STD during the study period exhibits two prominent regions (hexagons K-11 and N-8), but also most of the others above the baseline population density (5 persons per km²). However, also the regions with lower averages, such as the

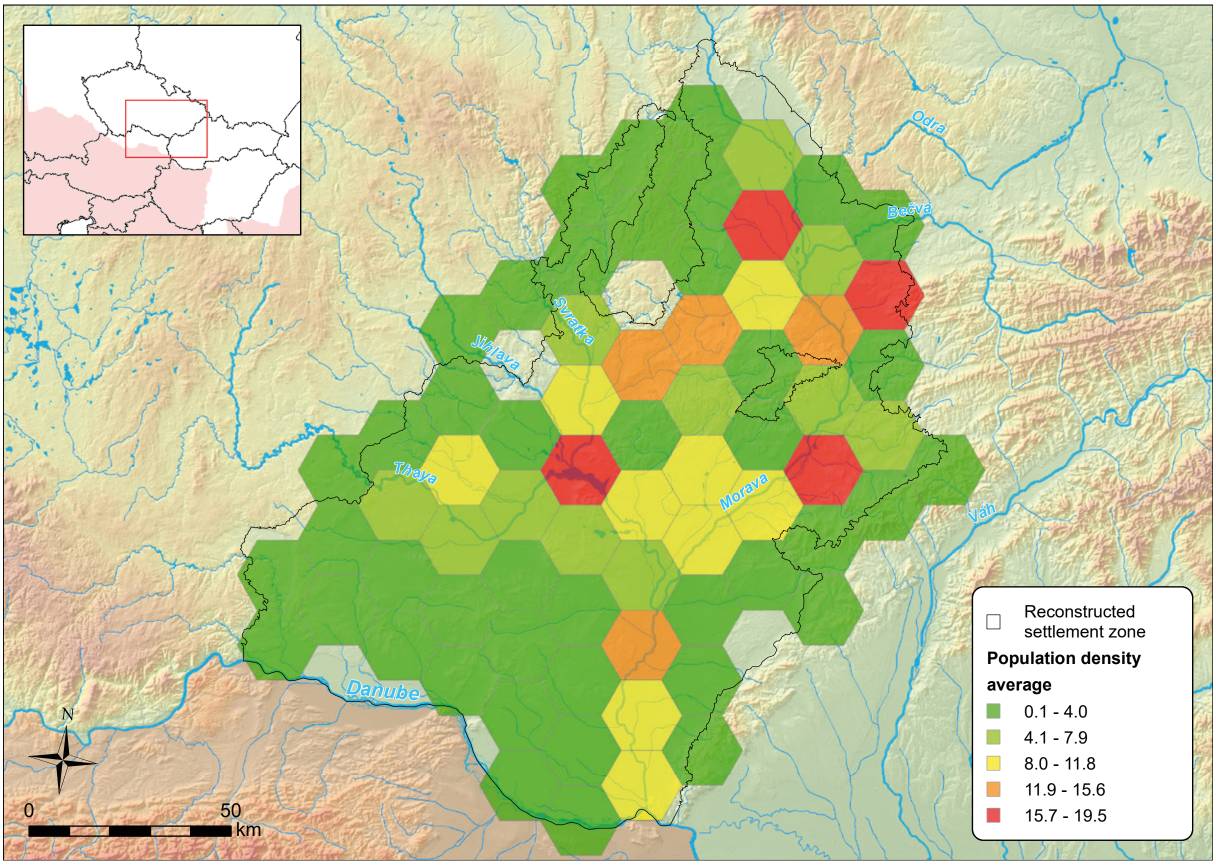


Fig. 7.1. Population size. Spatial distribution of STD of the reconstructed population density in a hexagon structure.

Boskovice Furrow and the conspicuous concentration of Germanic activities in the Jevíčko region (e.g. Droberjar 2014; 2020), whose variability underlines the substantial reconstructed increase between the 1st and the 2nd half of the 2nd century AD from 5 to 17 persons per km^2. Comparably high increases are also evidenced in the hexagons P-9 and M-9 in the Upper Moravian ravine during the 100–150 AD time block.

Similarly, a temporally differentiated perspective on the variability in reconstructed population densities brings further perspective on the spatial variability of population distribution patterns (Graph 7.10). The consistently low variability during the 1st century AD suggests spatially extensive settlement activities with a relatively uniform structure. On the contrary, the following 2nd century is represented by the most significant variation in the spatial distribution of the reconstructed Germanic population quantities. Despite the decrease in variability during the 3rd century AD, it is still relatively high compared to the 1st century AD. However, several outliers (hexagons) could also be seen during the 4th century AD, indicating more spatially differentiated population density patterns.

7.3.2 Implications to survival/recovery rate in archaeological data and estimates of original quantitative aspects

One of the traditional conundrums of archaeological science is the various approaches and assumptions on the actual proportion of information and archaeological material surviving to the present research, either with or without the organic materials. The individual proxies reflect all presently available knowledge on a material basis from the studied region, and the derived estimates also apply to the whole spatiotemporal context of interest. As the demographic proxies have provided substantiation for the derivation of quantitatively represented development patterns, the 'survival rate' or 'archaeologisation' proportion could be assumed through the most

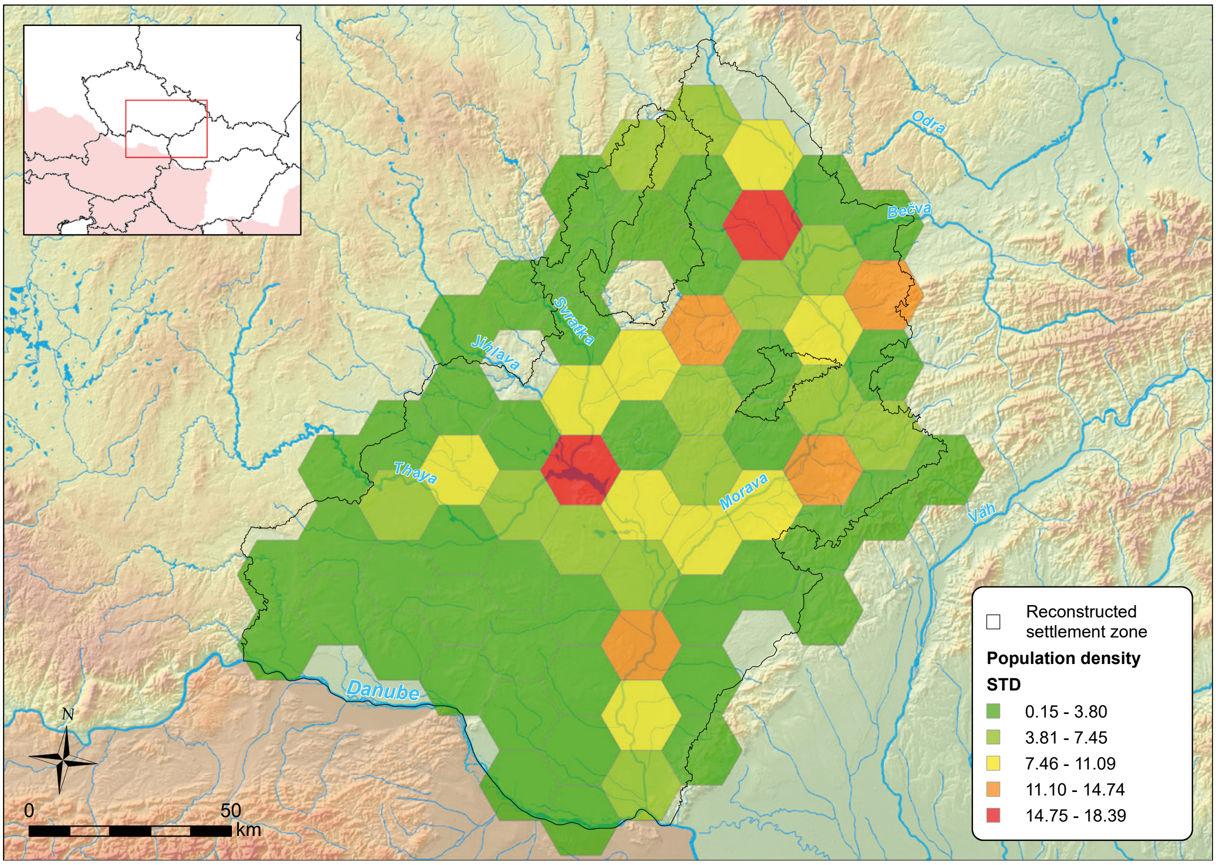
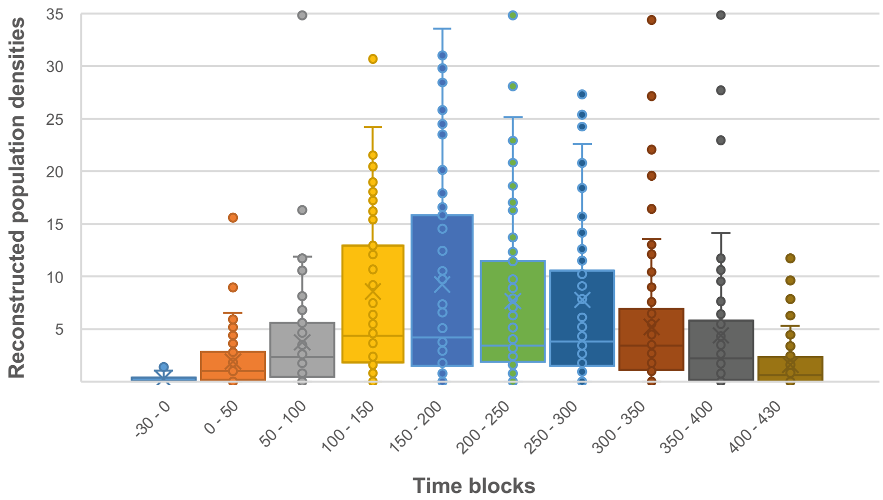


Fig. 7.2. Spatial distribution of the reconstructed population density average in a hexagon structure.



Graph 7.10. Population. Distributions (Whiskers-box plot) of the reconstructed population densities in individual hexagons in time blocks.

represented find category – brooches[55] (regardless of origin or typological distinctions) – which have tangible demographic connotations, as argued in Chapter 5.3.1. The theoretical assumption about their positive correlation with the population size is well substantiated through other 'demographic' proxies, foremost the residential areas (Chapter 5.1), but also the funerary areas (Chapter 5.2) or find categories, such as tools (Chapter 5.3.5). To avoid potential overrepresentation and exaggeration of the estimates, 'minimal' parameter settings were used in the calculations. The empirical data from the MARCOMANNIA dataset indicated the two main contexts of origin differentiate the underlying drivers and motivations. The most significant part (82%) of the whole brooch subset could be potentially associated with loss, either within the residential context (70%) or outside (i.e. 'off-site' context of individual finds not reflecting the local habitation, 11%) or were intentionally deposited as grave goods within the funerary record (19%). In the known burials with information on the composition of the grave goods from the studied region, brooches are present in 31% of cases. Subsequently, the proportions from the empirical data could provide the basis for approximating the quantities of brooches aggregated in *thanatocenosis* over the temporal extent of the study. Correspondingly, the estimates have been made using the contextual categories of funerary areas and settlement/off-site context.

Firstly, the potential aggregation of the brooches within the funerary context has been established through the estimated number of deaths/burials (for simplification preset as 4% per year[56] uniformly through all the time blocks; e.g. Coale, Demeny, Vaughan 2013; Neustupný 1983, 17, 33; Livi Bacci 2000; Vlach 2018b, 50–53), which would result in cumulative total deaths over the studied period would reach 1.95 million. Inevitably, factors such as age, legal status, social position, etc., would determine and constrain the estimated number of burials. Considering theoretically about two-thirds (i.e. 66%) of this number of deceased to be actually buried (i.e. those making it to the age or other stature allowed to become a full member of a community with the right to a proper burial), there could be an estimated number of 1.2 million burials/grave context emerging during the studied spatiotemporal context, which has potentially originated within the studied spatiotemporal context. Therefore, the presently known total burials (regardless of the quality of available information) of 1,414 provide the hypothetical 'recovery rate' of 0.0012%, which is also consistent with previous estimates from other parts of *Barbaricum* (cf. Steuer 1982, 68–70, Tabelle 1).

Regarding the brooches, the reconstructed cumulative number of potentially emerging burials could be subsequently constrained by the evidenced frequency of brooches occurrence in burials (31%), which results in 370,000 brooches for the studied period. Yet, this staggering number represents only around 19% of brooches distribution, as suggested by empirical data, and the most significant part belongs to the 'profane' context in general. Maintaining the

55 Presently, the total of 4,007 records in the MARCOMANNIA dataset.
56 I.e. from the demographical perspective an average of 40 deaths per 1,000 individuals for a year.

empirical ratio, assuming that around half of the population wore brooches daily (and it would be reasonable to expect the more significant part to do so), from which the loss would result in the most often, with a 'loss rate' of 10 years (i.e. an average of a loss in 10 years, which could also be even shorter in reality), the resulting total reaches a little over three million over the study's temporal extent. Providing the proportions from empirical data are kept in this calculation, the different settings (loss rate or proportion of brooches worn) could be chosen to achieve the exact representation and reconstructed totals. Simultaneously, it could be anticipated that the results of accidental loss are not a part of the 'material pool', which would be subject to recycling, as was the case for many metal objects. As a result, it could be estimated that 3.2 million cumulatively aggregated brooches ended up within the *thanatocenosis* of the 'Marcomannic' settlement zone. Applying this estimate to the empirical data eventually provides a 0.0011% 'recovery rate' of the past material culture volume and the present archaeological knowledge base. Indeed, the rediscovery and reuse of the already lost and discarded brooches could decrease the figure, but certainly not significantly.

Further assumptions can be drawn from the contextual archaeological data, particularly the burials and pit houses (432 records of individual known archaeological features), which could be justifiably considered in close connection with the quantitative demographic properties of the studied region. To derive an approximation of the cumulative total during the studied temporal extent, the estimated population size in time blocks was divided by the average size of a standard household (i.e. five members; cf. Chapter 7.1). For the clarity of the quantitative approach, the mean life expectancy of a pit house was set to 50 years to be in alignment with the time block temporal framework, which is also in accordance with the existing estimates on their life-span and endurance (cf. Vlach 2018b, 55). The resulting figure of 209,000 pit houses is more understandable in the spatial dimension, resulting in the density of 12.6 pit houses per km^2 accumulated over the four centuries. The density of the simultaneously existing pit houses would certainly be significantly lower based on the expected period of the activity of the primary function (i.e. its life expectancy). Eventually, the reconstructed 'recovery rate' of this contextual category results in 0.002%, again consistent with the calculations above. Nevertheless, the existing estimates expect the life expectancy to be around 25 years (Coale, Demeny, Vaughan 2013; Neustupný 1983), leading to more than double the estimated aggregated figure, i.e. 0.001%.

Indeed, the survival rates of past material cultures and the magnitude and probability of their recovery through archaeological methods or under other conditions are complex issues. They are conditioned by the type of material (with a significantly lower expectation of survival of organic materials), the life cycle and use of artefacts, and the respective formation processes of individual types of archaeological contexts (e.g. Schiffer 1987). In general, it is assumed that survival rates are well below 20%, mostly around 5 or 10% (e.g. Shennan 2000; Eerkens, Lipo 2007; Harrison 2011). Nevertheless, as demonstrated through the estimates above, it is apparent that the actual 'recovery rate' of archaeological material, at least for some categories of archaeological data, could be far below these assumptions. The results show surprisingly consistent ranges between 0.001 and 0.002% of the empirically ascertained representation of the percentage of the material base, which is transformed into the archaeological data. However, such assumptions are possible for the material categories or contexts with distinctive theoretical backgrounds (i.e. life span in brooches and pit houses or formation processes and their constraints in the burials).

Conversely, the derived 'recovery rate', in theory, could also be applied to the case of Roman coinage, which spatiotemporal distribution, however, was shaped by several specific factors (foremost the role within the Germanic economic system and their volumes in circulation) and the quantities differ through the time and space distinctively (e.g. Chapter 5.5, 6.3). Supposing the 'recovery rate' of around 0.0015% and the number of presently available records in the MARCOMANNIA dataset, the theoretically aggregated amount of the Roman coinage circulating and eventually deposited within the 'Marcomannic' settlement zone would be around 2.24 million. Such a number is, at first glance, staggering, but it is significantly lower than the respective calculations for the brooches. Still, it represents the average of 4,870 Roman coins per year transferred to *thanatocenosis*, which is certainly not that many for the estimated population size and the spatial extent of the 'Marcomannic' settlement zone with 16.2 thousand km^2 (see Chapter 6.1). Although many coins from various periods have been in circulation within the Germanic context simultaneously, based on the evidenced context of origin, they were in dominant proportion the subject of loss, as is convincingly attested by their presence almost exclusively within the topsoil and rarely contained within the archaeologically excavated settlement or other features.

On the contrary, the present knowledge of the size and scale of the settlement structure, based on the conducted spatially explicit simulation modelling (Vlach 2018b), suggests the peaking size of the settlement structure during the 2nd century AD (i.e. time block 150–200 AD), the estimate of nearly 5,000 residential areas (Vlach 2018b, 69–70, Tab. 4). Within the MARCOMANNIA dataset, 540 records of residential areas are currently present with presumed activity during this time block. That would imply a substantially higher proportion (11%) of residential areas transformed into the archaeological knowledge base, which is a natural consequence of the structure and formation processes of archaeological contexts and sites (cf. Neustupný 1983; 2009; Schiffer 1987). Nevertheless, the overall conditions for the preservation and survival of the burial contexts are, as also indicated by the outlined estimates, significantly lower due to the post-deposition processes and respective archaeological transformations in the Middle Danube region (cf. Vachůtová, Vlach 2011). Although additional potential areas exist to further assess 'survival' and 'recovery rates' across various contexts or categories, the currently available sources of information do not permit more representative assumptions, and they will potentially emerge with the future increase of archaeological data in the MARCOMANNIA dataset.

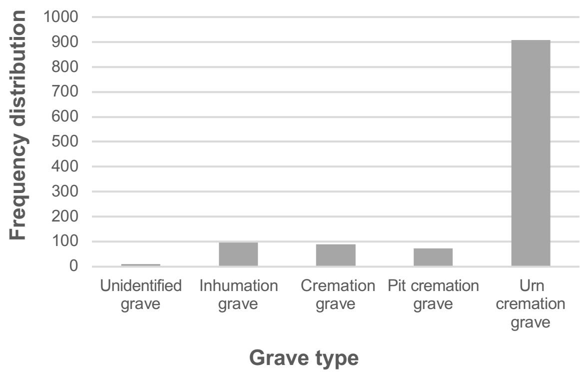
Chapter 8

Germanic society and its structure through the burial context

Burial grounds, a cornerstone of many archaeological theoretical models, play a crucial role in understanding the living context of past populations (e.g. Tainter 1978; Pearson 1999). They offer unique insights into the archaeologised manifestations of ritual and religious beliefs, as well as fundamental aspects of past societies. The Germanic society of the Roman Period, particularly within the Middle Danube area, was a dynamic, complex system with principles of social organisation at the chiefdom level. Its relationship to eschatology and burial practices reflected the ideological world of living culture, the current state of the social structure and its symbolic manifestations in the context of the terminal transition ritual. The formalised analyses aim to explore the possibility of social interpretation of the detected structures in archaeological data. The depth of social dimensions depends on many factors, and its materialised traces are not necessarily contained in the available archaeological record. In this sense, the inconsistency of the material reflection of social identities in the funerary and residential components of Germanic societies of the Middle Danube is striking. Although their structure and character stem from fundamentally different processes, Germanic burial grounds express a more complex picture of social identities through their symbols.

8.1 Theoretical basis of the funerary context and its interpretation possibilities towards the societal structure

From the establishment of archaeology as an independent scientific field, the remains of the materialised representation of burial practices have been an essential means for understanding material culture and advances in archaeological knowledge (Graph 8.1). Within the discourse of the cultural-historical paradigm, attention was paid mainly to chronological and typological issues and, last but not least, also to their cultural or ethnic affiliation (Chapman 2004, 2). In social interpretations, attempts were made, especially in the case of higher social strata, based on grave furnishings above standard (e.g. Peška, Tejral 2002). Today, however, even this archaeological interpretation should not remain at the level of general statements, and it also aims to reflect the current state of research in the two dominant theoretical areas of the field, German and Anglophone archaeology (e.g. Burmeister, Gebühr 2022; Steuer 1982). The foundations of social interpretation underwent significant changes during the development of archaeological paradigms of the 20th century, especially the theoretical research approaches of the both research milieu (e.g. Härke 2000, 369;



Graph 8.1. Burials. Representation of the evidenced forms of burial practices.

Chapman 2003, 310; Pearson 1999). These changes have greatly influenced the field, leading to a more nuanced understanding of social structures in the past. German research tradition, and under its influence, Czech, Polish, and Slovak research were generally oriented on issues of a typological-chronological nature. At the same time, theoretical constructions from social archaeology (Renfrew 1984; Renfrew, Bahn 2016) and sociocultural anthropology coupled with various computational techniques and methods have been applied here (e.g. Egger, Veit Hrsg. 1998; Burmeister 2000; Burmeister, Müller-Scheessel Hrsg. 2011). The grave component is viewed not only as a composition of grave goods and furnishings but also as a complex structured entity, which reflects, among other things, the structural elements of the social identities of the burying population (cf. Binford 1971; Saxe 1970).

The relationship between the resulting object of study – a burial – and the projection of relevant social identities in the context of grave goods depends on the 'materiality' of various aspects of the social world (e.g. Fahlander, Oestigaard 2008). In this direction, it is essential to distinguish the degree of symbolic content of different types of artefacts. The main observable dimensions of human burials include age, sex, social status and kinship within a given social formation, cause of death, and its place (e.g. Binford 1971).

Each death within a community represented a change in social conditions and, in principle, resulted in varying degrees of change in the current social order of the community. Funeral rituals, therefore, played an essential role regarding the respective family and the community as a whole. Their social relations, plans and strategies, and the resulting interactions may have been reflected in the final form of the burial complex in specific ways. Therefore, there are opinions that social differentiation in society could take a different form than its materialised form (Leach 1979). Each burial results from the joint work of a group of individuals who had a particular relationship with the deceased, especially a kinship relationship. The archaeological record of the grave context is also considered a reflection of the religion and its rituals rather than a direct reflection of the living culture of the time (Neustupný 2010, 257).

The Germanic territories of the Middle Danube and other regions characterise almost exclusive dominance of the cremation rite, which, from a qualitative and quantitative point of view, represents a fundamental transformation process (cf. Cerezo-Román, Wessman, Williams eds. 2017). Cremated remains, among other things, create only minimal requirements for the deposition, directly affecting the character of the spatial structuring of burials and the entire burial grounds. These are also fundamentally different characteristics of destructive changes not only on anthropological material. Artefacts forming the composition of the grave goods of the buried person show marked fire damage, which limits the spectrum of preserveable artefacts to varying degrees. However, the variability of quantity and quality of the grave goods testify to their survival based on other factors of the burial rituals where all the objects placed along with a body on the cremation pyre would be affected indiscriminately. Therefore, some of the intended grave goods did not come in contact with fire during the process. The selected parts of the burnt skeletal remains and the grave goods were then stored shallowly below the surface in a ceramic container – urn – or a simple pit, probably in organic packaging. Therefore, the Germanic cremation graves of the Roman Period contain information about these dimensions in proportion to the degree of archaeological transformations.

The numerous exceptions in the form of inhumation suggest an exalted and top position within the social structure, as with discovering the so-called princely grave from Mušov (Peška, Tejral 2002). Nevertheless, the variability in the formal and quantitative representation of archaeological material throughout the funerary context of the Germanic societies (e.g. Ravn 2003), in general, provides a valid substantiation of the assumption that the magnitude of grave furnishing is in correlation with the position of an individual on the social scale. This assumption has also gradually been corroborated through the expanding archaeogenetic research. Multiple chiefdom-type societies on various levels of complexity and development show the relation between the burial furnishing and the 'wealth' of the burying family (e.g. Binford 1971; Tainter 1978; Pearson 1999; Chapman 2003). Therefore, a significant methodological advance corroborates the validity of the primary assumption about the correlation mentioned above. It also implies that social status and wealth were inherited traits and highlights the presence of social hierarchies and the importance of family connections in maintaining social status. Spatiotemporally and culturally, the closest evidence comes from the Viking Age in Scandinavia (Margaryan et al. 2020).

The intention to decode the social structure of Germanic society based on the funerary context and the compositions and characteristics of available burials is long present within the archaeological research of the Roman Period. The applied vertical hierarchisation by the field tends to be accepted, but without a significant effort for social and sociocultural anthropological reflection (e.g. Krekovič 1993; 2007; 2014). Rich, royal or princely graves, retinue members and elite warriors are all terms commonly used in evaluating graves since the beginning of the field constitution. They mainly concern the graves of the actual or constructed elites. We often encounter a somewhat problematic percentage expression of the proportion of 'rich' or 'poor' graves in individual necropolises, as well as a comparison in terms of presumed position within the social structure across the contemporary necropolises (cf. Droberjar 1999, 169; Salač ed. 2008, 97). Often, there is an assumption about the impoverishment of the Germanic society of the Late Roman Period and its grave goods (e.g. Salač ed. 2008). It seems, however, that a purely economic or political explanation of this phenomenon may not be sufficient, and other factors will have to be sought behind the chronologically differentiated change in the composition of the grave furnishing.

An example can be some child burials, the equipment of which points to the fact that it is not possible to straightforwardly formulate a relationship between the social roles, profession performed or personal property during life and after death based on the grave goods. The specifics of symbolic representations of social identity are also evidenced by numerous burials with 'warrior' equipment where a female was buried (e.g. Simniškytė 2007). On the contrary, weapons in some graves, especially those generally attributed to elites of the Late Roman Period, contain weapons whose direct use in combat is problematic (silver weapons from inhumation graves of the Late Roman Period; e.g. Gommern; Becker 2010).

Due to the methodological aspects of contextually structured data, the Germanic funerary areas are suitable for applying various statistical methods and approaches to investigate formal structures in archaeological data (cf. Neustupný 1997). The basic assumption is that each grave complex of the transformed archaeological culture of the studied Germanic society represents a unique record that, through the filters of archaeological transformations, contains a certain amount of information about social stratification. The grave context should be perceived as a composition of symbolic means, which may express the individuality of the buried as well as the burying individual, the perception of the act of transition ritual by the burying community. To broaden our understanding of the basic structures in society, it is essential to exploit the information potential of all available data and test and validate the assumptions on a large scale based on a representative dataset.

8.2 Social dimension through wealth distribution

Within the multiple methods and approaches to address the potential inputs and insights for assumptions on the societal vertical alignment or stratification of the Germanic populations of the Middle Danube region, there has also been explored the interpretative potential of the theoretical and methodological concept of the so-called 'social index'. It was established and used foremost within the past societies represented by inhumation, which, in contrast with cremation and under certain conditions (e.g. absence of large-scale grave robbing), provide substantial grounds for establishing assumptions about the potential position of the buried individuals in the complex societal fabric of various past societies (e.g. Arnold 1980; Sprenger 1999; Rebay-Salisbury 2006; Wahl 2007; Bösel 2008; Kozubová 2013). Once coupled with the anthropological data, such approximations could also be differentiated based on sex and age. However, the predominant funerary rite and its implications (destructive transformations, selectivity by unknown factors, etc.) in Germanic societies of the Roman Period constrains the width of the contained qualitative and quantitative markers. However, the approach is, in essence, based on a reflection of the materiality of a burial, and other indicators with implications to the societal position are obscure or missing (the reflection of the deceased by the burying community and parts of funerary rites not propagating into the resulting archaeological record). However, the denomination of the index as 'social' straightforwardly implies its aspiration to contaion the neccessary informaiton. Therefore, for use in this study, the concept of 'wealth index' is used as the proxy to provide foremost insight into the material/wealth substance of a burial. The calculated *wealth index* was exclusively on quantitative aspects of the grave goods data (representation of various categories or their sums), not on the particular find or find categories (e.g. weapons, personal garments), as there would be missing supportive evidence of their 'evaluation' for the analysis. Nevertheless, the present state of relevant knowledge implies correlations between the composition of the grave goods and the presumed position of the individual in social classes (e.g. Krekovič 2014).

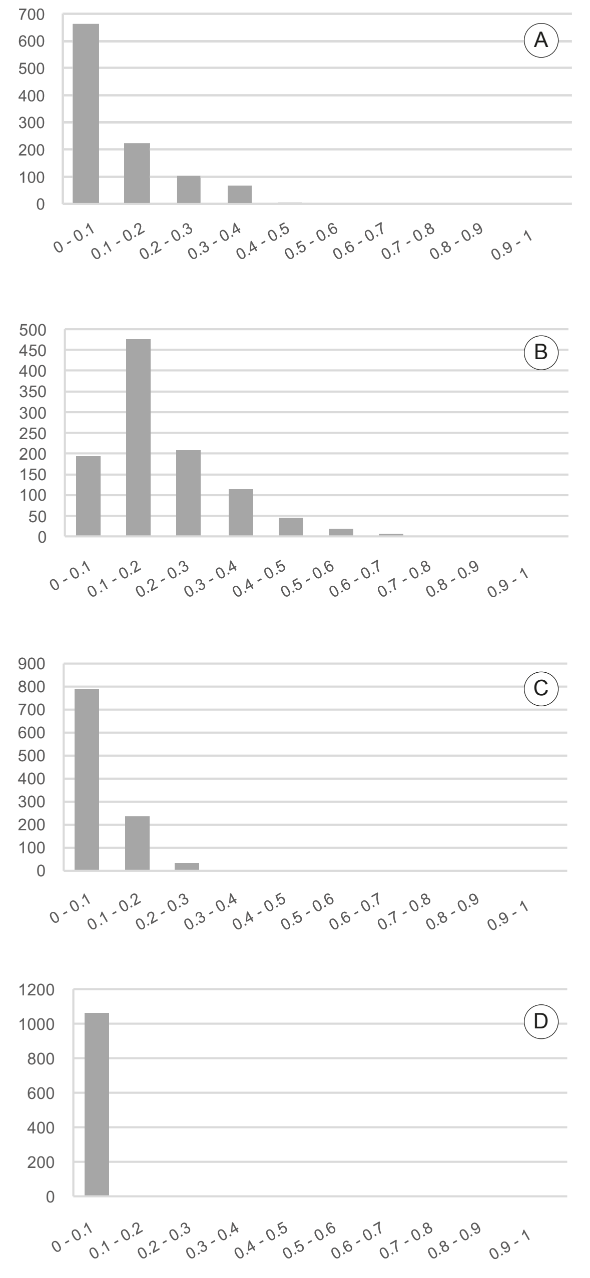
8.2.1 'Wealth index' and social stratification scaling

The primary assumption of the use of the approach is that the data presently aggregated and available from the 'Marcomannic' settlement zone funerary record within the MARCOMANNIA dataset allows for the derivation of several variables (components of the *wealth index*), which will provide the data for calculating the *wealth index*. From the total number of 1,414 graves in the dataset, a subset of 1,071 graves, with information on the composition of the grave goods, has been established to analyse the societal dimension. Despite being biased to various extents by the quality of the available information and the past transformation processes, the study is based on 4,461 movable find records representing the items of grave goods, which constitute quantitative substantiation of the approach. The implemented variables (components) were established through the following principles and assumptions:

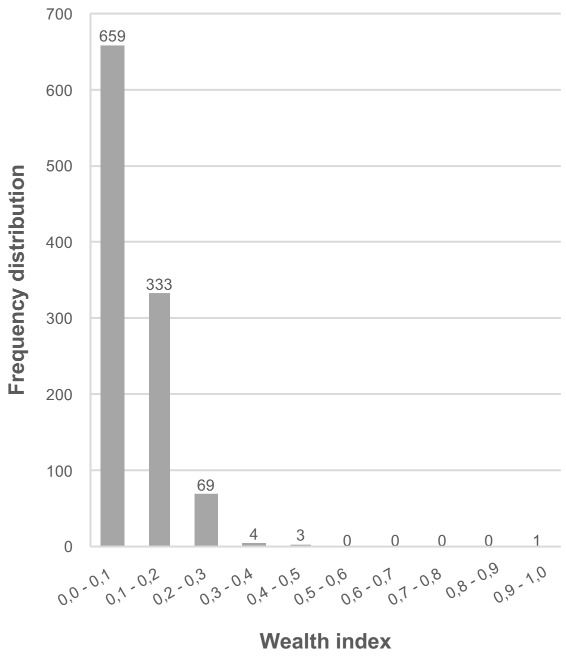
- **Materials** – the sum of all recorded types of materials in grave goods (either primary or secondary)
- **Find categories** – the sum of all recorded find categories in grave goods
- **Find number** – the sum of all recorded finds in grave goods
- **Find types** – the sum of all recorded find types in grave goods

Despite a certain proportion of mutual dependency among the components, their value distribution points out the differentiated explanatory potential on the societal dimension (Graph 8.2). The resulting *wealth index* has been established through an even weighted sum of all the input components.

The frequency distribution of the resulting *wealth index* evaluation suggests, in general, that the societal scale is relatively highly disproportionate (Graph 8.3), with a dominance of burials in the lowermost ¼ of the scale. Therefore, the extent of disbalance of the whole scale was significant, however, with large parts of the societal scale aggregated at its lower spectrum, indicating the potential for further differentiation within these margins. From Table 8.1, representation weight points are also apparent, where the first two classes (0.1–0.2) contain 82% of all evidenced 'wealth', distributed through 92% of all objects of the input burial subset. This observation suggests a relatively evenly fashioned distribution of wealth and a stratified society with a lower wealth/income distribution disproportionality. Conversely, on the other end of the X-axis is inevitably located the splendidly furnished princely grave from Mušov (maximum value 1), which illustrates the scale of the wealth/social distance from the other higher-positioned individuals.



Graph 8.2. *Wealth index*. Frequency distribution of the normalised values (0–1) of the individual components constituting the index. A – Number of identified materials; B – number of identified find categories; C – find sums; D – Number of identified find types. In all the components, only one object of analysis achieved a maximum value of 1 – the princely grave from Mušov.



Graph 8.3. *Wealth index.* The frequency distribution aggregated into ten groups (by 0.1).

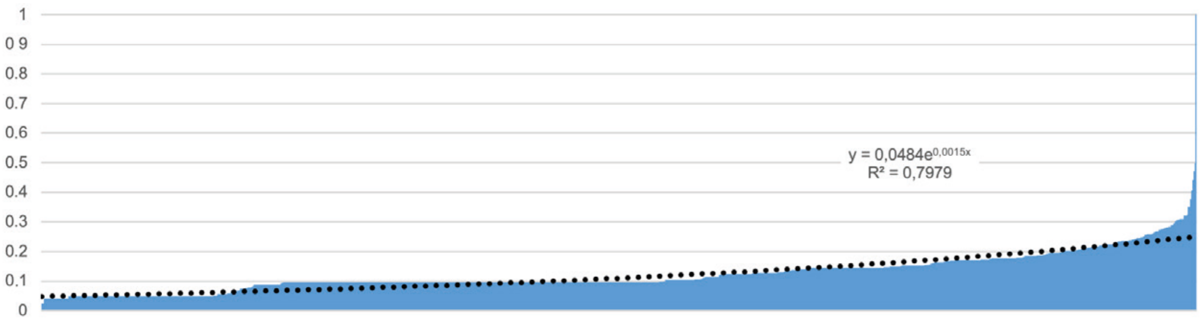
Wealth index class	No. of burials	Burial proportion (%)	Wealth distribution (%)
0.1	657	61.3	41.3
0.2	328	30.6	41.2
0.3	74	6.9	13.9
0.4	8	0.7	2.0
0.5	3	0.3	0.9
0.6	0	0.0	0.0
0.7	0	0.0	0.0
0.8	0	0.0	0.0
0.9	0	0.0	0.0
1	1	0.1	0.6

Tab. 8.1. *Wealth index.* Quantitative outline of burial 'wealth' classes and their representation and wealth distribution within the whole burial subset.

To provide another form of scaling of the reconstructed wealth distribution, the dimension to outline its distribution could be simply achieved by sorting all the values (analysis objects, i.e. burials) on the X-axis in increasing order (Graph 8.4). The right end of the plot underlines the exponential character (R^2 = 0.9) of the wealth distribution, with only an insignificant amount of them over the value of 0.3.

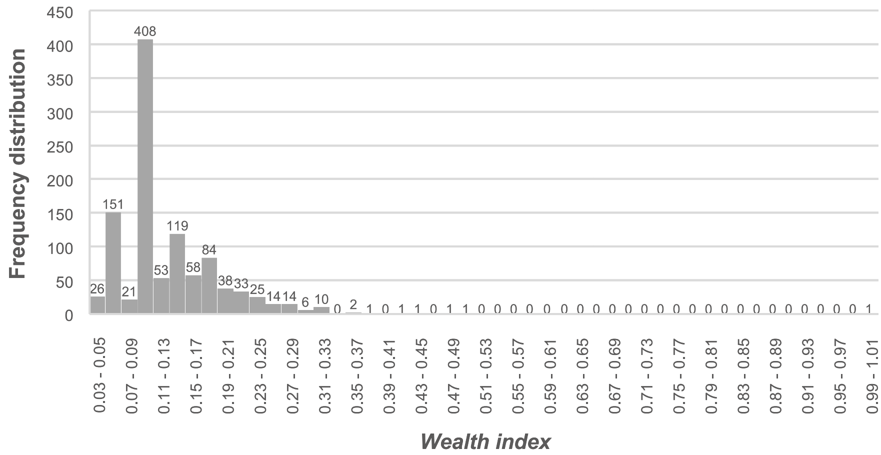
However, despite the whole *wealth index* range, the data's detailed frequency distribution within the left side of the histogram (Graph 8.5) points out a somewhat structured and heterogeneous distribution of the social proxy. Several pronounced peaks suggest a reflection of nonaccidental structures in a *wealth index* frequency distribution, potentially identifying the weight points of the burial compositions. The most significant peak for the reconstructed values between 0.09 and 0.11 suggests an abnormal uniformity of the input data (408 burials, i.e. 38 % of the total input sample). It is represented by the burials with the value 2 in each 'unnormalised' component of the *wealth index*,[57] which consists of cremation and urn without other grave goods and pit burials with cremation and only one item of the grave goods. In this category, the destructive effects of ploughing and other activities are also often evidenced by missing upper parts of the burial. Therefore, they could also have contained other components of grave goods, which were later spatially dissociated from the burial context. Hence, the complete knowledge may provide a more differentiated frequency distribution around this reconstructed value.

Nevertheless, it would be difficult to expect that such structure in data distribution would result foremost through this effect. The number of the affected grave goods may not differ significantly from the empirical data, and the shape of the general



Graph 8.4. *Wealth index.* Sorted values from the minimum (left) to the maximum (right).

57 Therefore, containing two types of material (ceramic, anthropological material), number of documented finds, find categories and identified find identification (i.e. urn, cremation).



Graph 8.5. *Wealth index.* The frequency distribution aggregated by 0.02, excluding the princely grave from Mušov (i.e. the maximum value on the X-axis is 0.499). [58]

distribution would not change significantly. It could be flatter but still represent a quantitatively significant structure nonetheless. Eventually, such a structure could be potentially associated with a particular stratum of the societal vertical stratification, mostly connected with the uniformitarian character of the burials during the Late Roman Empire, known foremost from the extensive burial ground in Kostelec na Hané 'Zadní Pololány' (Zeman 1961) or the respective parts from other funerary areas, e.g. Šitbořice 'Padělky od Moutnic' (Droberjar, Kazdová 1993) or Velatice 'Zadní půllány' (Jílek, Kuča, Sojková 2011).

Another conspicuous peak rises in interval 0.05–0.07, representing 151 burials (14% of the total sample), which consist foremost of the pit burials with no evidenced urn. Regarding furnishing and wealth, it would be tempting to associate this 'minimalistic' burial conception with the societal entity, which would be expected in this segment (i.e. from 0.03 to 0.09 in general) of the frequency distribution scale (X-axis) – generally 'low-income' society members, theoretically the enslaved people or freedmen. Generally, it is assumed that this societal segment is mostly 'invisible' in the archaeological record of the Prehistory and Protohistory, and therefore, difficult or even nearly impossible to detect (Gronenborn 2001). However, their presence in Germanic societies, in general, is tentatively corroborated by narrative sources[59] and is depicted as distributed through economically independent units of households. Naturally, in a stratified society, the variability on the social scale would provide differentiated conditions for the slave population distribution, but within the limits of the 'household' type of slave distribution (e.g. Hrnčíř, Květina 2016, 433–434). However, it is unjustified to anticipate for each household on average to include an enslaved person, which would result in occurrence between 17% and 25%. The parallels from the documented cases through the social anthropological research testify to the significant variability of representation of this societal segment ranging from 5% to 30%, in general (e.g. Earle 1987), depending mostly on the intensity of warfare, tribute system and economic specialisation.

For instance, in the case of the Roman Empire, where the slave population could be rightfully expected to be in higher proportions, the maximum is assumed for the city of Rome to be 30%, for Italy 25%, and 22% on average for the rest of the Empire (Scheidel 1997, 156; 2012; Goldhill 2006;). However, the different conceptions and practices of slavery in Germanic societies, at least for the 1st century AD, are also suggested by Tacitus's scant remarks. Furthermore, the estimate is consistent with patterns observed in early medieval societies where the documentation is more robust (cf. Biermann, Jankowiak eds. 2021). Nevertheless, despite it would be tentative to associate at least part of the *wealth index* – based distribution to this specific societal segment, the lack of corroboration from the archaeological evidence from the studied societal context suggests either its relatively small proportion in the society or limited forms of propagation into the archaeological record.

Conversely, further to the right on the X-axis of the frequency distribution (Graph 8.5), two minor peaks could be observed between the values 0.13–0.15 (122 burials, 11%) and 0.17–0.19

58 This point is represented by the richly furnished grave No. 40 from the burial ground in Sekule 'Za humnami' (Iván, Ölvecky, Rajtár 2019).

59 Tac. *Germ.* 25, 26.

(84 burials, 8%). Both represent dominantly urn burial contexts furnished with differentiated assemblages of grave goods. In almost all cases, items of personal garments (brooch) are documented, with varying frequencies and quantities accompanied by tools, in lesser amounts *militaria*, bronze vessels, glass (beads) and others. Therefore, these two peaks could be associated with the wealthier social environment of the Germanic society, where a certain proportion (naturally about 50% of the male population) of it could be potentially associable with the retinue members of differentiated positions (including warriors), as reflected through the composition of the grave goods. The composition diversity within these two relatively marginal peaks shows that the 'schemes' of grave goods composition were relatively loose (apart from some specific material categories, such as *militaria* convincingly associable with retinue members). Eventually, it validates the approach despite the present biases in the archaeological data.

Apart from the simple projection of the *wealth index* through frequency distributions and actual values (cf. Graph 8.4, 8.5), the application of the primary exploratory multivariate approach – cluster analysis – may provide further opportunities (Graph 8.6). The input variables consisted of the four components of the *wealth index* (cf. Chapter 8.3.1), and the resulting dendrogram is supposed to outline the respective similarities. Inevitably, in this analysis, the most significant dissimilarity could also be observed at 2.1 of the linkage distance, where the princely grave is bound to the rest of the burial subset, constituting only two clusters. Further down in the structure, more complex clustering is observable.

A standard next step of the analysis – identifying the relevant groups/clusters in the results – is constrained by several methodological issues. There is an unknown number or size of the actual social hierarchical entities in the Germanic societies of the Middle Danube, apart from those vaguely described in the narrative sources. Therefore, it is inevitably a challenge to identify the linkage distance on which the potential societal entities could be generated. The narrative sources suggest that there are less than five such vertical social stratification segments, consisting mainly of the large body of free people with an adjoined slave class of limited size. Above, a more prominent level of retinue members (*comitatus*) can be found, followed by the nobility (*principes*).

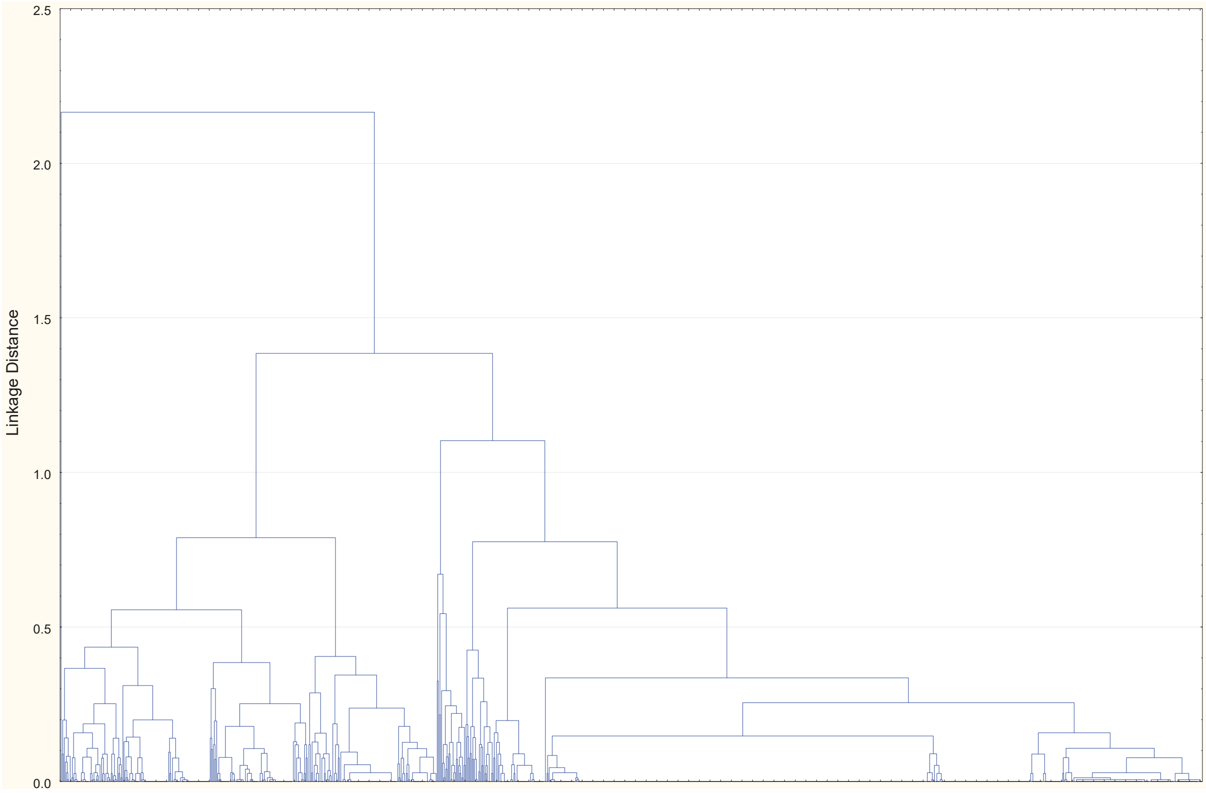
Further up, the highest societal segments were represented by the positions of *rex* and *dux*. However, this simplified structure must have been significantly fluid in terms of the potential of their representation in the funerary record. Therefore, the quantitatively based classification is significantly biased through all the respective methodological and theoretical aspects. There is no intention here to specifically assign the societal strata, as described by the narrative sources, nor to establish structures that would represent such societal entities firmly. The resulting groups from a linkage distance of 0.5 and representation of the reconstructed wealth (Graph 8.6) may underline the distribution of these values through the space based on multivariate analysis (Graph 8.7).

About half of the burials used for deriving the *wealth index* also contain information on temporal probabilistic distribution (478 burials). Therefore, a quantitatively representative subsample could be used for its chronological distribution. The temporal dimension provides an insight into the development of the *wealth index* in time through the calculated MEAN and STD values in individual time blocks (Graph 8.8). The temporal probability distribution of burial contexts (cf. Chapter 3.2.3) multiplied by the derived *wealth index* provided a basis for developing the resulting temporal outline. There has been an apparent growth since the end of the 1st century AD, with a lesser decrease during the 1st half of the 2nd century AD. This structure could suggest a shift in a relatively short-term fashion, which could not have been observed in the empirical data until now. Most baseline proxies exhibit an increasing tendency between 50–100 and 100–150 AD time blocks. It also seems that the trend to a gradual decrease in burial furnishing reaches the second peak and could have started at this point and was only afterwards significantly marked by the turbulent epoch of the Marcomannic Wars within the time block 150–200 AD, as a significant increase and peak value is evident. In this case, the peak value is not significantly influenced by the princely grave from Mušov (Peška, Tejral 2002).[60] The averages reflect a general tendency within the data, particularly for the time block 150–200 AD, where the increased number of more richly furnished burials (often with weaponry[61]) are documented in increased frequency.[62] The following development during the Late Roman Period represents values that

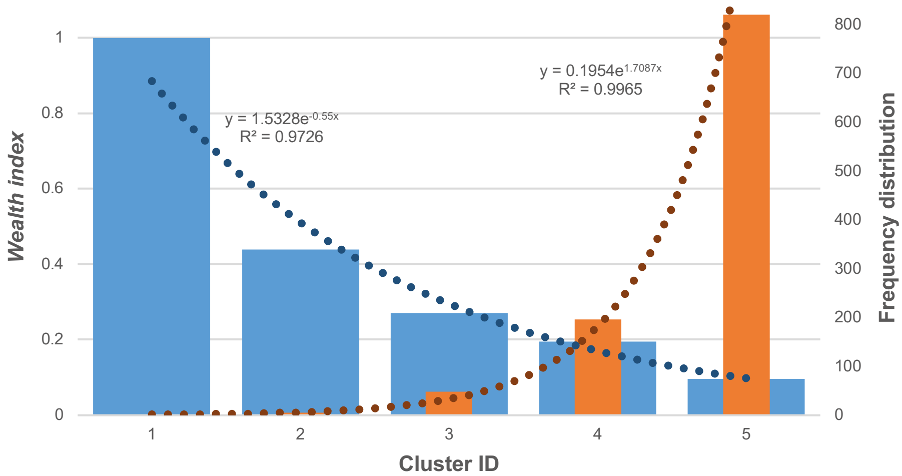
60 It represents the actual difference by 0.1 of *wealth index* in the time block 150–200 AD.

61 E.g. the graves 6, 19, and 20 from Šitbořice or the grave from Blížkovice (Droberjar, Peška 1994, 276–282).

62 They are often represented by burials including *militaria* and traditionally ascribed to the 'warrior' communities, the armed and fighting members of retinues.



Graph 8.6. *Wealth index.* Euclidean distance-based dendrogram of the CLU analysis of the input subset of burials.



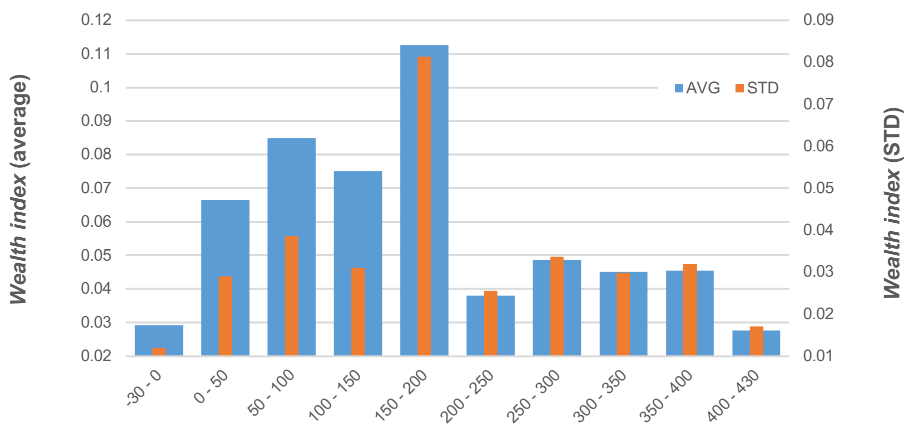
Graph 8.7. *Wealth index.* The outline of the quantitative representation and average *wealth index* (blue bars) and number of represented graves (orange bars) of the CLU (at the linkage distance of 0.5).

are generally half below the average during the Early Roman Period. It suggests the relative stability and lower variance within the *wealth index* value distribution. Nevertheless, the relatively low variability in temporal distribution shows that the STD values could be observed with a singular peak in the time block 150–200 AD.

8.2.2 Gini index and inequality

The further step in exploring the potential of the funerary record towards the Germanic societal scaling leads through the derivation of the so-called Gini index (Gini 1912).[63] It is a widely used concept for representing inequity within present or past societies. Apart from sociology and economy, this idea of general quantification of foremost economic inequality

63 Also see Chapter 7.7.1.



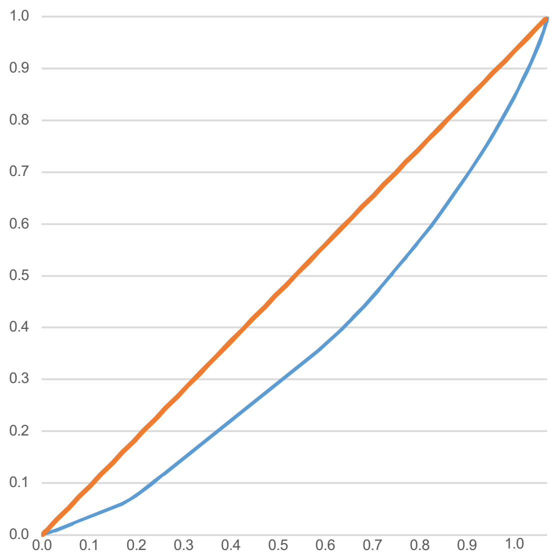
Graph 8.8. *Wealth index.* Temporal distribution of average and STD values.

has been commonly used in archaeological and social anthropological research (Kohler, Smith eds. 2018; Fochesato, Bogaard, Bowles 2019). The baseline assumption for its application holds that wealth differentiation tends to increase with society's growth in size and a socio-political scale (Flannery, Marcus 2012; Kohler et al. 2017). Various estimators have been developed for its calculation, but input data is often drawn from the burial (usually grave characteristics and grave goods value, e.g. Nørtoft 2024) or residential context (floor area or other relevant data of habitation units, e.g. Basri, Lawrence 2020). However, they sometimes provide different Gini coefficients in the same societal context, reflecting the biases in archaeological data in various segments, advocating for employing a broader range of inputs on the studied context to provide the basis for Gini coefficient establishment. The calculation of the index is based on the assumption that the input data contain at least partially represented traces of past societal stratification through the 'wealth' inequity. For the studied context, only the funerary context provides quantitatively representative substantiation of the Gini index use.

In principle, the index defines, on a scale between 0 and 1, the distance of the evaluated entity from the 'egalitarian' forms of wealth distribution within the society (0) and utmost disproportionate to the distribution (1). The method is oriented to grasp the general tendencies within the whole input data, and various types of wealth distribution may lead to the same index value (Peterson, Drennan 2018, Fig. 2.2). During the long-term use of the computational concept, several enhancements and debates over various methodological aspects of the Gini index have occurred (e.g. Peterson, Drennan 2018). However, in a nutshell, it survived, and the width and universality of use speak for its validity. Therefore, the concept provides a valid tool for approximating the wealth distribution and inequality coefficient within the studied Germanic society of the 'Marcomannic' settlement zone and putting them into a broader context of the Iron Age and other comparable societies.

The abovementioned input subset from the funerary burial context provided the resulting Gini coefficient of 0.27.[64] It is vital to keep in mind that the application within the studied context and the resulting Gini index is based exclusively on quantitative aspects of the burial context. In contrast, a large variety of others – foremost those from the symbolic value sphere or meaning within the grave goods compositions – could not be identified and reflected through present-day knowledge. The resulting value is also inevitably skewed by the occurrence rate of the highest societal classes on the level of the princely grave from Mušov or somehow below (i.e. within the *wealth index* range of 0.6–0.9, which is absent of any evidence), which were primarily located in solitary locations, making their acquisition less probable and frequent. This absence is also evident from the comparison with other parts of *Barbaricum*, foremost central and northern Germany as well as southern Scandinavia (cf. Steuer 1999, 380–384, Abb. 3). Therefore, it would be reasonable to expect a slightly higher value of around 0.3. Notably, the shape of the Lorenzo curve (cf. Graph 8.9) is regularly shaped with no pronounced balance shift to either end of the x-axis. Only in the lowermost part of the graph (coordinates 0.18 and 0.17) is the apparent bend, suggesting the weight point of the

64 For instance, the comparable values are recorded for some of the present-day states of the western Europe (e.g. Netherlands, Finland, Norway, Iceland, Czechia) but also other countries with lower GDP (e.g. Azerbaijan, Tonga, Algeria), as the actual cumulative value is not considered, but rather its distribution through the population (World Bank 2024).



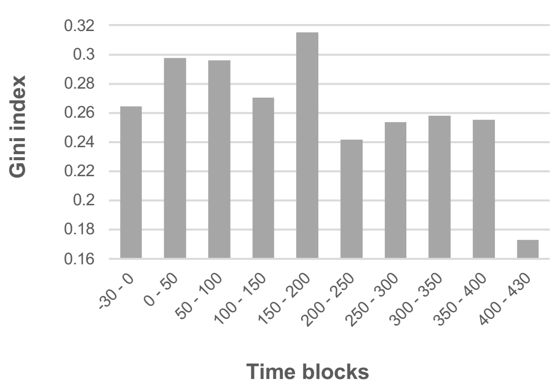
Graph 8.9. Gini index. The representation of the cumulative estimated wealth distribution in empirical data (Lorenzo curve, blue) and linear 'egalitarian' distribution (linear function, orange).

wealth distribution at the generally lower margins and more pronounced changes in wealth distribution at this stage of the cumulative function.

Nevertheless, the comparable numbers are usually associated with lower margins of stratified societies in general and, in this case, could be related to a relatively lesser degree of stratification. This result is also expected based on the frequency distribution of the *wealth index* (Graph 8.4, 8.5). For example, pastoral societies documented a mean Gini index of 0.42 with an STD of 0.05 (Borgerhoff Mulder et al. 2010, 38). The comparable value was obtained for several studied preindustrial societies with intensified agriculture (Shenk et al. 2010). An extensive comparison (Fochesato, Bogaard, Bowles 2019) evaluated the Gini index in the case of 150 prehistoric societies from the Neolithic to the High Medieval Period (the New World civilisations were taken into account), revealing considerable variability ranging from 0.1 to 0.8. Large variability throughout the comparable time scale (10,000–500 BC) also shows the study from the Near East (Basri, Lawrence 2020), which considers the significant parts of the temporal scope with mean values between 0.2 and 0.3. Almost the same mean values (0.27) provide other studies with extensive uses of the Gini index in various socio-economic and cultural contexts (cf. Gurven et al. 2010, Tab. 3; Kohler, Higgins 2016;). Through extensive cross-cultural diachronic research by T. Kohler et al. (2017), margins have also been developed for the general types of political organisations and subsistence orientation. It has been observed that the societies, in the anthropological context referred to as horticultural (with less advanced forms of agricultural practice), have a similar mean value of 0.26 (Kohler et al. 2017, Fig. 2).

From those spatiotemporally and more broadly relevant contexts, the Gini indices of 0.27 and 0.37 for Early Iron Age hillfort Heuneburg for phases IVa1 and IVb2, respectively, could be mentioned (Kohler et al. 2017). For instance, Herculaneum and Pompeii provided the values of 0.52 and 0.54, respectively. Culturally and ethnically related Viking societies of Scandinavia exhibit a Gini coefficient between 0.35 and 0.55 (Vésteinsson et al. 2019). However, for the time being, there are no comparative estimates of the inequality measure for other closely related and comparable contexts of the Germanic societies of the Roman Period or Iron Age in general, as well as for the inequality development during the following periods of early barbarian states. Nevertheless, the result enables the positioning of the Germanic chiefdom society of the 'Marcomannic' settlement zone within the well-established inequality metrics.

Considering the variability of the funerary record of the studied context, additional insight may allow for the temporal distribution and calculation of individual Gini indices based on the time block resolution (Graph 8.10). In general, the overall distribution implies relative stability in wealth distribution. Surprisingly, compared with the *wealth index* and the large part of the baseline proxies, the Gini index during the 3rd and 4th centuries AD values are similar to those during the prior development. Therefore, the most significant shift in the temporal Gini index distribution is evident between



Graph 8.10. Gini index. The temporal distribution of the inequity coefficient calculated by multiplying the aoristic weights and *wealth index.*

the 2nd half of the 2nd century AD and the 1st half of the 3rd century AD. Such effect could be ascribed to the profound changes in Germanic society, as suggested through several other baseline proxies and indicators of development (e.g. residential and funerary areas, brooches). A conspicuously low inequity coefficient of 0.17 is eventually calculated for the terminal time block 400–430 AD, where general 'impoverishment' of funerary context could be observed in available archaeological data without substantiating the higher societal strata's presence and its vertical differentiation. From this perspective, it correlates with the disappearance of the higher segments of the social space, as the withdrawal of the significant parts of the Germanic populations of the Middle Danube region is also evidenced in narrative sources and corroborated through archaeological records (e.g. Tejral 1982). This structure in the data is also consistent with the baseline proxy based on evidenced variability of artefact types, representing the technological conditions (see Chapter 5.4).

8.2.3 Structures in the composition of the grave goods

The wealth distribution represented through the *wealth index* and the reconstructed Gini coefficient provides a general notion of these properties. However, further exploration of the structures in funerary data could be achieved through the multidimensional statistical analysis of the composition of the represented artefact types and the find categories, which has been conducted in numerous other temporal and spatial contexts (e.g. Saxe 1970; Binford 1971; Neustupný 2009, 121–154). Despite the aggregations and necessary simplifications of the archaeological manifestations of the past realities and taking into account the relevant methodological constraints with strong biases in ritual and religion, the present knowledge base recognises the variability of the conspicuous materialised funerary ritual components (grave goods), which provide quantitatively substantiated basis for statistical testing of the underlying structures within this data, which could bring a valid insight into the funerary dimension of the Germanic societies of the 'Marcomannic' settlement zone of the Middle Danube region.

A wide range of recorded artefact types has been evidenced within the burial context (127). However, such heterogeneity of input information through an excessive number of descriptors would inevitably lead to irrepresentable results. Therefore, an approach has been followed, combining the individual artefact types or the superior level of identification – find categories,[65] if substantially represented. As a result, a more substantiated subset with more varied category manifestation was used for analysis rather than highly varied input data with potentially insignificant structures and correlations. Furthermore, the subset was constrained to burial with temporal identification and temporal probability evaluation (480 context records). This criterion was applied to provide the results for two main reasons. The correlation with the propagation on a temporal scale may provide corrective information regarding the longevity/stability of the generated structures in data or their variation over time. As a result, there were included the substantially represented (positively occurring in more than 7% of all input cases) the find categories of *metal* (14% of cases) and *glass* (7% of cases) *vessels*, *militaria* (10% of cases), and *toilet items* (represented dominantly through various types and forms of combs; 8% of cases). From the artefact type identification were used as descriptors: *urns* (79% of cases), additional pottery (9% of cases), *beads* (13% of cases), *knives* (21% of cases), *scissors* (7% of cases), *spindle whorls* (10% of cases), *belt buckles* (15% of cases), *brooches* (47%). Their quantitative representations (counts) of the find categories in the burial context have been transformed into dichotomic presence/absence information (0 or 1). Therefore, a total of 12 descriptors were used for the statistical analysis. Additionally, the reconstructed variable of wealth

Factor	Eigenvalue	Total (%)	Eigenvector cumulative	Cumulative (%)
1	2.69	20.7	2.69	20.7
2	1.75	13.4	4.43	34.1
3	1.29	10.0	5.73	44.1
4	1.11	8.6	6.84	52.6
5	1.06	8.2	7.90	60.8

Tab. 8.2. Grave goods composition. Eigenvector value and cumulative representation.

65 E.g. the individual types of identification within the find category of metal vessels, are represented within the recorded grave goods up to 1%. However, the find category together occurs in 14%. Simultaneously, symbolic and status meaning of the grave goods, as well as destructive processes during the funerary ritual, provide, in the case of a large scale analysis (not only consideration of the selected burials with exceptionally preserved sets of metal vessels) the most reasonable formalization as a dichotomy resolution. On the other hand, the find category of the personal decorative items or garments in general comprises highly represented find types, such as brooches (47% of cases), beads (13% of cases), or belt buckles (15% of cases), which could be used as individual grave goods descriptor.

	Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Find categories	Metal vessels	**-0.591**	-0.468	0.230	0.196	0.110
	Glass vessels	**-0.537**	-0.056	**0.442**	0.057	-0.162
	Militaria	-0.422	-0.190	**-0.468**	-0.280	0.279
	Toilet items	-0.362	-0.061	0.338	-0.153	**-0.561**
Find types	Urns	0.114	0.343	-0.191	**0.592**	**-0.411**
	Additional pottery	0.030	-0.136	**0.532**	-0.369	0.264
	Beads	-0.075	**0.664**	0.170	0.055	0.313
	Knives	**-0.629**	0.086	-0.343	0.041	0.102
	Scissors	**-0.569**	-0.391	-0.030	0.386	0.148
	Spindle whorls	-0.098	**0.663**	0.359	0.058	0.202
	Belt buckles	-0.303	0.236	-0.246	**-0.566**	**-0.429**
	Brooches	**-0.426**	**0.403**	-0.228	-0.058	0.176
Wealth index		**-0.848**	0.300	0.062	0.028	-0.081
Temporal idenfication	-30 – 0	0.017	-0.082	0.005	-0.070	**0.102**
	0 – 50	-0.092	**-0.162**	**-0.125**	-0.045	0.081
	50 – 100	**-0.116**	**-0.142**	-0.096	-0.051	0.072
	100 – 150	-0.073	**-0.282**	**0.133**	0.016	**0.128**
	150 – 200	**-0.377**	**-0.258**	0.090	0.087	0.074
	200 – 250	0.097	0.043	-0.007	-0.024	-0.022
	250 – 300	**0.311**	0.179	-0.010	-0.011	**-0.169**
	300 – 350	0.330	0.312	0.007	0.056	**-0.131**
	350 – 400	**0.129**	**0.409**	-0.044	0.010	-0.092
	400 – 430	-0.090	0.288	-0.097	-0.118	-0.062

Tab. 8.3. Grave goods composition. Factor loadings for the selected find categories and types accompanied by the supplementary variables of the temporal identification. The colour mapping (green/red) was applied separately for the factor loading of the input descriptors and the supplementary temporal identification.

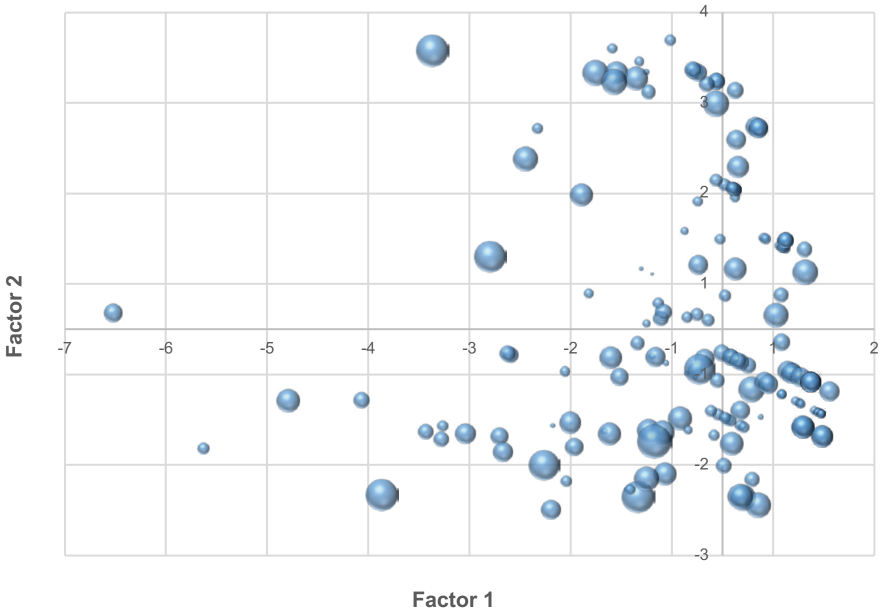
distribution – *wealth index* – was included to provide insight into the potential correlation of the latent dimensions with this phenomenon.

The resulting data matrix provided grounds for conducting PCA, where temporal identification was used as a supplementary variable. According to the resulting Eigenvalues, the first five factors (principal components) above value 1, which contain information on 61% of the variability in the input burial subset, have been considered for statistical structure interpretations (Tab. 8.2). Therefore, it is apparent that the analysed context is highly differentiated with a large proportion of 'singularities' (uncorrelated occurrences of descriptors resulting from individualised aspects of the burial rites and rendering of the deceased within the burying community). Therefore, factor loadings exceeding ±0.4 for find types and categories and ±0.1 for supplementary temporal dimension have been considered (Tab. 8.3).

The **first factor** contains 21% of the variability in the subset. It exhibits several significant negative correlations in non-pottery categories, foremost the co-occurrence of metal and glass vessels, *militaria*, knives, scissors, and brooches. Simultaneously, there is also an exceptional correlation with the wealth distribution through the *wealth index*, as well as the differentiation of the factor strength on the temporal scale (Tab. 8.3). It is negatively correlated foremost with the time blocks 150–200 and, on a lesser proportion, also 50–100 AD. Therefore, it reflects the temporal differentiation of the factor. Conversely, the opposite correlation is apparent for the Late Roman Period. Hence, the factor can be interpreted as a 'poverty/richness of the armed individuals' (potentially the high-ranking members of society, potentially status symbol related reflection of the retinues).[66] On the positive end of the factor score, there are generally the burials with only an urn or additional pottery,[67] underlining the primary wealth distribution of the factor through the multiple co-occurrences of the descriptors. As the individual descriptors have relative variability in co-occurrence, grave goods compositions appear with or without *militaria*. Therefore, there are no marked indices for the gender dimension in this factor. Obviously, such apparent structure and the respective 'rich' burials have been noted and paid attention to

66 Accordingly, the highest negative factor scores of the first factor have been calculated for the exceptional burials such as the Mušov – princely grave, or the graves 6(2010) from Zohor 'Piesky' (e.g. Elschek 2014), 40 from Sekule 'Za humnami' (Iván, Ölvecky, Rajtár 2019, 241–246, obr. 9, 10), 9 from Velatice 'Zadní půllány' (Jílek, Kuča, Sojková 2011, 267–268), or 6 from Šitbořice 'Padělky od Moutnic' (Droberjar, Kazdová 1993, 107–108, Taf. 2).

67 E.g. the graves 73, 135, 250 from Kostelec na Hané 'Prostřední pololány' (Zeman 1961, 41, 61–64, 114, obr. 16A, 26–27, 53–54), 55 from Velké Hostěrádky 'Podlipiny' (Peškař, Ludikovský 1978, 102, 106, obr. 13), 6 from Šitbořice 'Padělky od Moutnic' (Droberjar, Kazdová 1993, 107–108, Taf. 2) or 21 from Sekule 'Za humnami' (Iván, Ölvecky, Rajtár 2019).



Graph 8.11. Grave goods composition. Scatterplot distribution of the first two PCA factors on the X- and Y-axis and the third through the size of circle symbols.

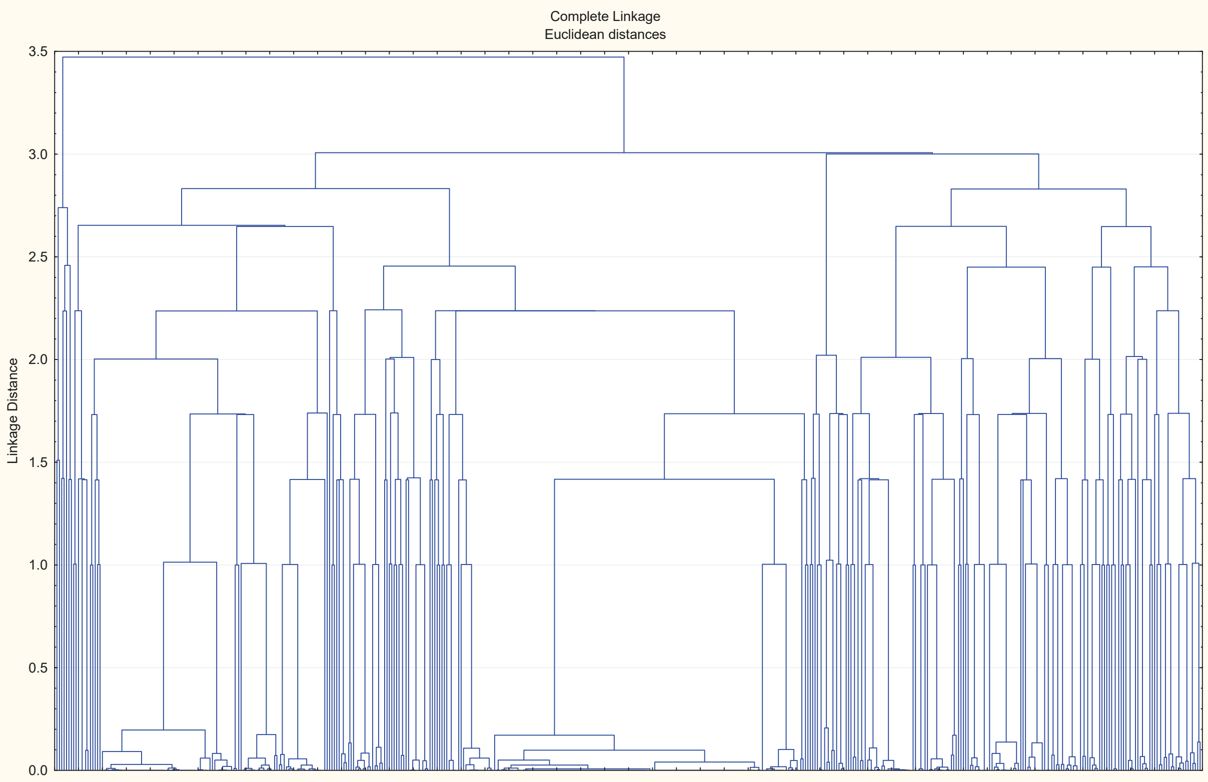
by past archaeological research (e.g. Tejral 1970c; 1971; 1983; 2017), which has brought indispensable grounds for establishing relative chronological relations with various distinctive types of material of either Germanic or Roman origin.

The following **second factor** (13% variability) has a bipolar character, with a negative correlation towards the *metal vessels* and the highest positive correlation of the *beads* and *spindle whorls* (and, to a lesser extent, *brooches* co-occurrence). These grave goods items are often associated with gender differentiation – female burials. However, it also reflects a significant dependence on temporal development, contradicting its intersectionality throughout the study period. It occurs stably negatively during the Early Roman Period and positively during the Late Roman Period. Therefore, the factor contains information on the structural shifts in the composition of grave goods between these main periods.

The **third factor** (10% variability) shows several descriptors (e.g. *glass vessels*, *additional pottery*) to be negatively correlated with the *militaria* find category. This factor is also the first to be almost lacking the 'sensitivity' to the temporal dimension, suggesting more stable and time-resistant propagation (with minor opposite correlations during the time blocks 0–50 and 100–150 AD) of the potentially male burials (implicated by the opposite correlation with the spindle whorls) with a certain proportion of weaponry and tendency for excluding occurrence with *glass vessels* and *additional pottery*. It is also not correlated with the wealth distribution factor. Therefore, this factor could be observed in various wealth distributions and interpreted as a crossectional characteristic of the societal phenomenon connecting limited economic capacities. In increasing direction, it suggests its gender interpretation, as it contradicts the occurrence of *militaria*. On the other end of the scale, it potentially coincides with the presence of the 'warrior' segment, suggesting that the lower-ranking individuals were a broader segment within the military organisation of the Germanic chiefdom society of the Middle Danube region.

The **fourth factor** (9% variability) suggests an opposite correlation for the *urns* and *belt buckles* with an almost absent wealth distribution correlation. From a temporal distribution perspective, it is negatively correlated only with the terminal time blocks 400–430 AD (i.e. phase C3/D), when the burial complexity and furnishing rate are at their lowest levels from the study spatiotemporal context. This factor also contains information on the distinction between the urn and pit graves, which tends relatively often to occur with *belt buckles*.

The **fifth factor** (8% of variability) also tends to be dissociated from the temporal development and wealth distributions. It negatively correlates toilet items, urns, and belt buckles grave goods



Graph 8.12. Grave goods composition. Dendrogram of the cluster analysis of the selected descriptors.

components with indifferent relation to other descriptors.[68] It also suggests relatively weak opposition to the occurrence of *militaria*. In essence, it also distinguishes the urn and pit graves. However, both of the last factors provide only limited factor loadings, and the resulting variability through these factors is relatively high.

The factor score scatterplot distribution of the first three factors (Graph 8.11) suggests relative 'fluidity' of the derived latent dimensions (factor) with limited possibilities to draw apparent boundaries of potential groupings, reflecting more firm and 'standardised' (traditional) societal entities through the funerary record. Therefore, more explicit differentiation of the objects exhibiting similar properties was to be achieved through the CLA and the means to divide structurally similar objects into a certain number of groups – clusters.

There is no straightforward approach to objectively locating the appropriate cutting horizontal line on the Y-axis of the dendrogram to achieve individual clusters of input objects. According to the amalgamation schedule graph, three distinctive steps are observable at the top of the hierarchical structure till the linkage distance of around 2.6 (Graph 8.12), after which the number of separable clusters within the dendrogram increases significantly. Therefore, at the linkage distance of 2.7, seven distinctive groups with variable quantitative representation were created (Tab. 8.4). The sorted count of clusters is well-fitted with the exponential curve ($R2 = 0.948$). This distribution is also well-aligned with the general distribution proxy on wealth distribution (see Graph 8.4).

Within the generated groups, a distinctive structure could be evident in the co-occurrences of the input descriptors (Tab. 8.5). Foremost, the variables for *urns* and *brooches* tend to show limited variability, and minor oscillations occur throughout almost all the differentiated clusters. The only exception is apparent in the absence of urns in the first cluster (skeletal burials) and brooches in cluster three. Therefore, the absence of an urn in data could not be explicitly connected with the 'pit' burials. Nevertheless, they occur only in 8% within the analysed subset.

68 E.g. the 'rich' burial from Čáčov (Pieta 2002), the grave from Chvalkovice na Hané 'Na hamrovém kopci' (Tejral 1971a, 75, Abb. 13:1–6), or the grave 377 from Kostelec na Hané 'Prostřední pololány' (Zeman 1961, 148–150) are positively correlated within this factor.

CA cluster	No. of cases	Percentage	Cumulative (%)	AVG	STD
1	2	0.4	0.4	0.735	0.374
4	5	1.0	1.5	0.365	0.083
2	17	3.5	5.0	0.263	0.066
5	51	10.6	15.7	0.211	0.066
6	96	20.0	35.7	0.184	0.048
7	115	24.0	59.7	0.148	0.045
3	193	40.3	100.0	0.101	0.048

Tab. 8.4. Grave goods composition. Outline the quantitative properties of the clusters generated by CLA and the summarisation of wealth indices (average and standard deviation). The colour mapping (green/red) was applied separately for each column.

CA cluster	Metal vessels	Glass vessels	Militaria	Toilet items	Urns	Additional pottery	Beads	Knives	Scissors	Spindle whorls	Belt buckles	Brooches
1	1.0	1.0	1.0	1.0	0.0	1.0	0.0	1.0	0.5	0.0	1.0	0.5
4	0.6	1.0	0.0	0.8	1.0	0.6	0.2	0.8	0.4	0.6	0.4	0.8
2	1.0	0.3	0.1	0.2	0.7	0.0	0.0	0.6	0.9	0.0	0.0	1.0
5	0.2	0.1	0.6	0.0	0.8	0.1	0.2	0.8	0.2	0.1	0.2	0.6
6	0.0	0.0	0.0	0.2	0.9	0.0	0.3	0.2	0.0	0.3	0.5	0.6
7	0.1	0.0	0.1	0.0	0.7	0.0	0.1	0.2	0.0	0.0	0.1	0.9
3	0.2	0.1	0.0	0.0	0.8	0.2	0.0	0.0	0.0	0.0	0.0	0.1

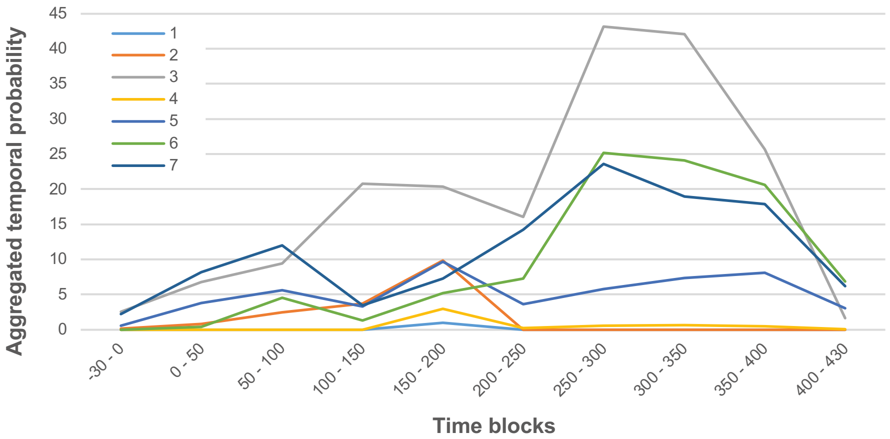
Tab. 8.5. Grave goods composition. Outline of the mean representation of the input descriptors based on binary values.

The first identified **cluster (1)** contains only two objects: Mušov – princely grave (Peška, Tejral 2002) and grave 6(2010) from Zohor 'Piesky' (Elschek 2014). These statistical outliers could be rightfully associated with the most distinctive hierarchical societal entities (despite differing from each other in specific characteristics and parameters, as also suggested by high STD of wealth distribution). Within the advanced forms of the chiefdom societies, they could be rightfully connected with the positions of a 'paramount' chief or a 'petty king', as these terms tend to, in essence, overlap (e.g. Carneiro 1981, 47; Claessen 2017, 109–111). They are characterised through the positive occurrence of most of the grave goods components and, foremost, those presumably reflecting the power and economic capacities of these singularities.

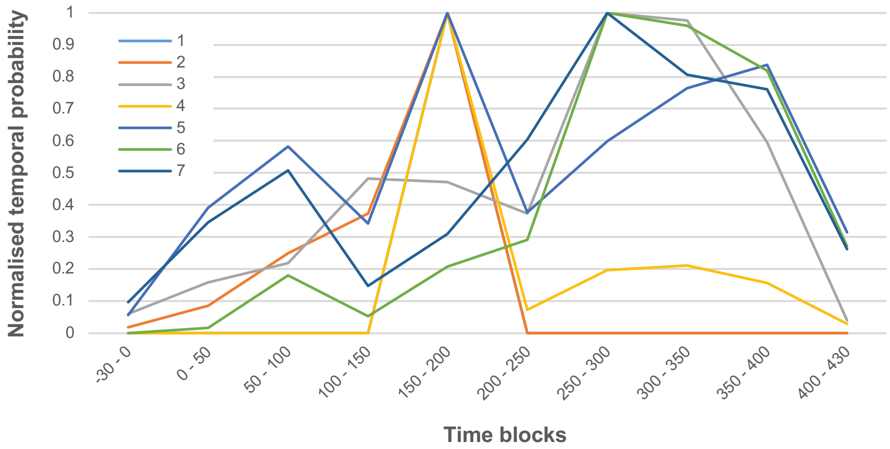
The consecutive **cluster 4**, represented only in 5 objects (1% of cases),[69] shares the most quantitative properties (e.g. glass vessels, toilet items, knives). Still, most distinctively, they lack the representation of *militaria* and contain spindle whorls (60% of the cases). Regarding wealth distribution, an average of 0.365 suggests a higher economic position, potentially according to social status. The absence of *militaria* also exhibits the next **cluster 2** (17 burials), where other grave goods components are almost (e.g. glass vessels – 30%, toilet items – 20%) or completely (e.g. belt buckles, spindle whorls, beads) missing. Conversely, this cluster exhibits an almost persistent occurrence of scissors, brooches, and metal vessels. However, the mean *wealth index* (0.263) indicates lower value aggregations and grave goods representation. Nevertheless, they belong to the higher-positioned individuals, representing only 3.5% of the input subset. The *militaria* find category is again more represented (60%) within **cluster 5** (51 burials, 11% of the cases), which occurs together with knives (80%) and brooches (60%).[70] **Cluster 6** (96 burials, 20% of the cases) embodies an even lower occurrence of the input descriptors, lacking completely *metal* or *glass vessels*. However, the minor representation of the *beads* (30%) and *spindle whorls* (30%), accompanied by the absence of the *militaria* find category, implies the gender dimension of cluster 6 and could be potentially associated with the female burials from the societal environment with lower access to the resources and wealth distribution, as suggested by the mean *wealth index* value of 0.184. This cluster also resembles the correlation from the second factor of PCA (cf. Graph 8.11). Eventually, **clusters 3** (193 burials, 40% of cases) and **7** (115 burials, 24% of cases), representing the most significant part of the input subset (over 64%), have several mutual resemblances through the absence of most of the grave goods components, except for *urns*. The most significant differences between them are in the opposite manifestation of *brooches*.

It is also notable that clusters 1, 2, 4, and 5 have their temporal probability distribution peak during the time block 150–200 AD (Graph 8.13, 8.14), which contains several structurally significant processes and events (foremost the extensive conflict of Marcomannic Wars), simultaneously observable through

69 E.g. the grave 6 from Šitbořice 'Padělky od Moutnic' (Droberjar, Kazdová 1993, 107–108, Taf. 2), graves 21 and 40 from Sekule 'Za humnami' (Iván, Ölvecky, Rajtár 2019, 241–246, obr. 9–10).
70 However, this grave goods component occurs relatively commonly throughout other clusters.



Graph 8.13. Grave goods composition. Temporal probability outline of the individual generated clusters from CLA.



Graph 8.14. Grave goods composition. Temporal probability outline of the individual generated clusters from CLA normalised by value 1.

a number of the baseline and secondary proxies from the archaeological data. Conversely, the development of the rest of the clusters could be followed through the scoped temporal extent with variable representation. The most represented cluster, 3, shows the peak for the 250–300 and 300–350 AD time blocks. However, the composition of the respective grave goods can also be observed during the 2nd century AD time blocks.

8.2.4 Weapons in burials context

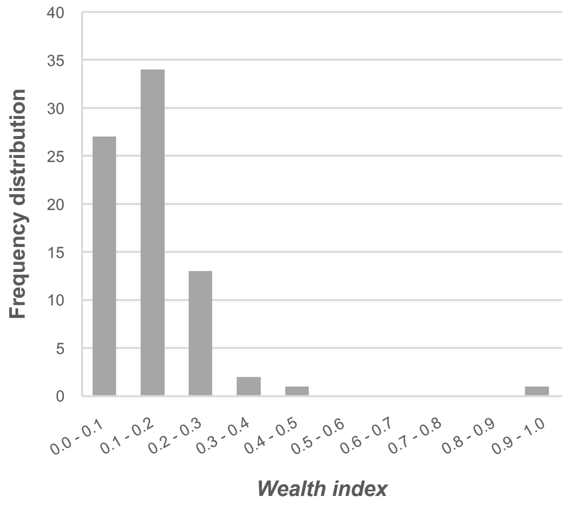
Within the generally conceived approach towards statistical assessment of the grave goods' general compositions and structuring tendencies presented above, the MARCOMANNIA dataset also provides an opportunity to explore the burial subset regarding the presence of the *militaria*. Despite the multifaceted roles and interpretation schemes regarding the *militaria* in the burial context (e.g. Härke 1990; 2000; Hedeager 1992; Carnap-Bornheim 1994), its presence is foremost associated with the presumable members of either retinue or, in a more general sense, 'nobility',[71] and either the actual or symbolic (status) role and use. All chiefdom societies of the past or presence were based on retinues, through which a chief extends his power and exercises his power strategies (Carneiro 1981; 2017; Grinin, Korotayev 2011; 2017; Gavrilets, Anderson, Turchin 2010; Junker 2015).

As outlined in the respective chapter regarding the *militaria* find category (5.3.4), more than half of all the *militaria* records originate in funerary areas, totalling 183 such records. From the subset of the recorded burials, there are 68[72] contexts with at least one evidenced artefact classified as *militarium*. Therefore, from the total number of contexts identified as grave in the MARCOMANNIA dataset, they

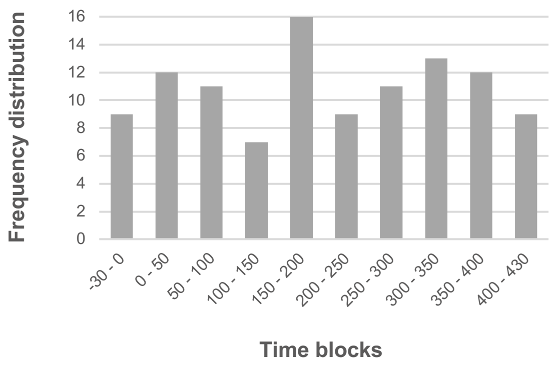
71 Often to be considered as a societal segment accompanied in burial context by weaponry as a result of a social role and status symbol, rather than actual involvement of an individual in the physical violence of any kind.

72 There were included all recorded burials with weapons regardless the temporal information, which would constrain the subset to the number 52. Therefore, reaching the threshold for feasibility of the analysis performance, which is generally assumed to be around 50 analysis objects.

represent 5%.[73] However, a comparable proportion of 7% was observed in quantitatively representative data from Germanic Scandinavia during the Early Roman Iron Age (Hedeager 1992, 115). However, in other parts of *Barbaricum*, a variability on a regional basis could be observed, such as the preset Germany, suggesting the relatively variable range between 5 and 20% of all the documented burials (Steuer 1982, 186–190). The higher figures are also derived for the settlement zone to the east of the Lesser Carpathians, consensually the 'Quadian' one, where the average representation in funerary areas Abrahám, Kostolná, and Sládkovičovo reaches 29% (Krekovič 2007, 92).[74] Therefore, the numbers from the study region of the 'Marcomannic' settlement zone could be considered underrepresented, and the actual proportion of the burials with weapons was higher (Graph 8.15).



Graph 8.15. Weapon graves. Frequency distribution of the secondary proxy *wealth index* in burials with *militaria*.



Graph 8.16. Weapon graves. Temporal distribution of the evidenced burials containing weapons.

Due to multiple destructive transformations during the burial rite, the actual number must be certainly higher, and this proportion should be considered a minimum. There is no intention here to differentiate which find types or their composition qualifies for the 'warrior' grave as the clear distinction could not be ascertained.[75] However, this phenomenon is central to understanding the keystones of the societal fabric of the chiefdom societies, including the ancient Germanic. Therefore, despite the statistically less significant amount of available data, it is also an intention to establish a secondary proxy reflecting its temporal variability.

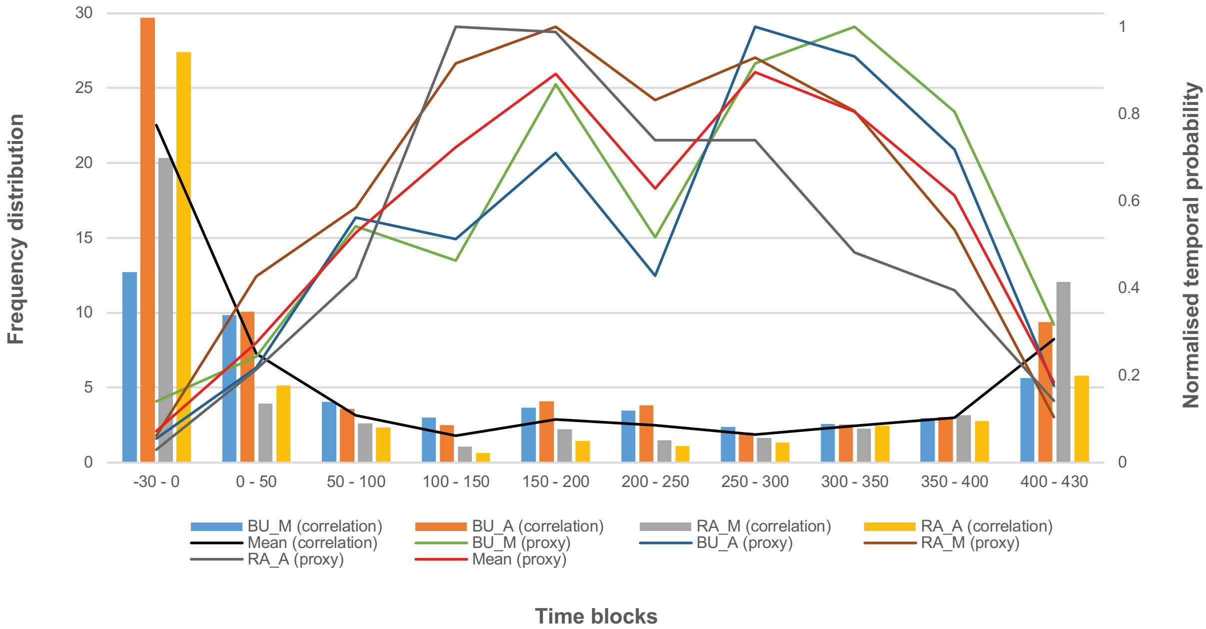
The emerging secondary proxy of the 'warrior grave' frequency temporal distribution implies several conspicuous observations (Graph 8.16). However, it must be noted that the derivation was based on aoristic probability distributions. Therefore, the graves with wider chronological margins of temporal identification could be represented in more time blocks, leading to a certain proportion of overrepresentation. However, the results are biased through this effect only to a limited extent. Foremost, the variation is insignificant during most time blocks, ranging between 7 and 13. The structure shows the 'local' growth/decline developments during the Early and the Late Roman Period divided by a significant isolated peak in the time block 150–200 AD, which could be well anticipated from the *militaria* baseline proxy. Compared to other baseline and secondary proxies, the decreasing tendency from the 2nd half of the 1st to the mid-2nd century AD is a novel feature in temporal probability distributions, comparing most of the baseline and secondary proxies. Following the development of the burial baseline and secondary proxies, there is an apparent gradual increase from the 3rd century AD, peaking during the time block 300–350 AD.

Furthermore, it must be understood in the context of the population size, which was presumably

73 Despite the proportion itself does not seem to be significantly compelling, once put in the quantitative context of the population size reconstructions of the Germanic populations of the 'Marcomannic' settlement zone (cf. Vlach 2018b; Chapter 7.3), it provides a different picture. In the population counting between 160 and 200 thousand, the size of the potential retinue members would be between 8 and 10 thousand.

74 However, the necropolis in Kostolná is, in this regard, rather an outlier as it consists almost exclusively from male burials with high frequency of *militaria* (52%; Krekovič 2007, 92).

75 Nevertheless, usually the burials with any evidenced *militaria* find category are designated as 'warrior graves'.



Graph 8.17. Weapon graves. Calibration of the secondary proxy with baseline and secondary proxies on the demography conditions (RA_A, RA_M, BU_A, BU_M, and their average; black cf. Tab. 5.9) supplemented with the actual temporal distribution normalised to value range 0–1 (with average; red).

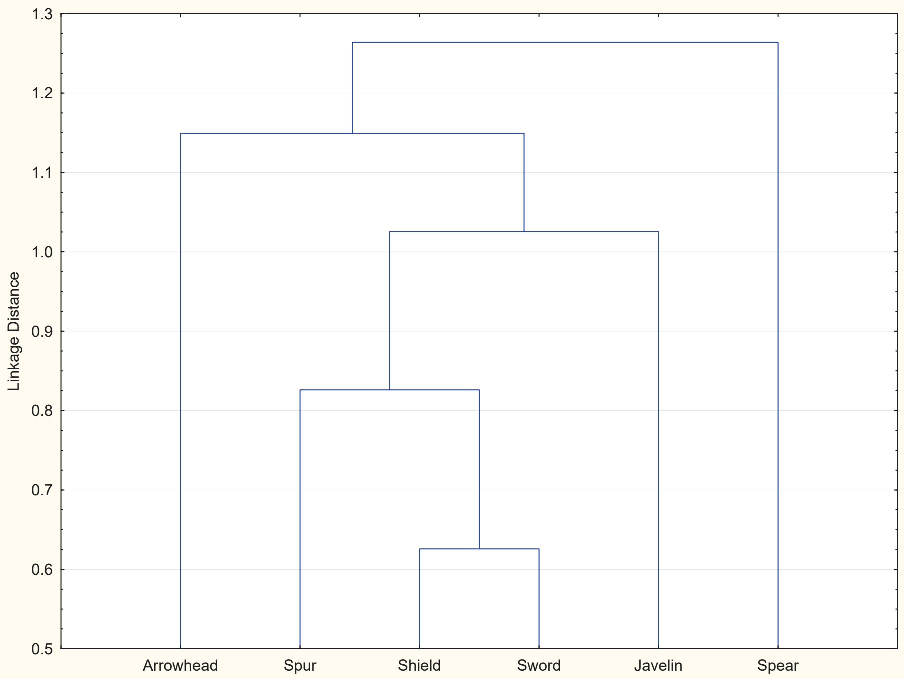
somehow limited during the terminal time blocks of -30–0[76] and 400–430 AD, and the proportion of the burials with weapons towards those without would result in a significant proportion of 'warriors' in the society. The correlation has been established via three distinguished proxies on the demography, respectively the population size – residential areas baseline proxy (RA_A)[77], its simulated addition (RA_M) and the simulated temporal distribution of burials (Graph 8.17). Their representation was calibrated to match the mean proportion of 5%, as ascertained from empirical data from the MARCOMANNIA dataset. Despite the statistical insignificance and biases of the archaeological data for the first time block -30–0 BC/AD, there is an apparent tendency of exponential decrease during the 1st century AD. Following the temporal probabilistic development of the secondary proxies of the *wealth index* and Gini coefficient, the exceptionally high proportions of the armaments within the population incoming to the Middle Danube region west of the Lesser Carpathians during the first phases of the Early Roman Period could be reasonably anticipated based on the data evaluation. According to the calculations above, the representation of 'warrior graves' reached 23% on average (BU_M – 13%; RA_M – 20%, RA_A – 27%). Nevertheless, as it was pointed out in the respective Chapter 5.2, the baseline and derived secondary proxies based on the residential areas are less biased towards the demography implications (population size) than their counterparts from the burial context regarding size and composition differences between the Early and Late Roman Periods.

8.2.4.1 Composition of weapons in 'warrior graves'

With the available data from the MARCOMANNIA dataset, the potential of the analytical approaches towards the composition of the weaponry in the 'warrior graves' could also be explored through the analysis of the *militaria* composition (documented occurrence) in the burial context of the 'Marcomannic' settlement zone (Droberjar, Peška 1994). Such approaches have been applied mainly to the inhumation burials (e.g. Härke 1990; 2000) but have also been conducted in 'cremation-rich' contexts (e.g. Hedeager 1992, 128–137), where the amount of the input data (burial contexts) are also comparable to that from the MARCOMANNIA dataset.

76 As it was pointed out, from the methodological point of view, the frequencies within this time block could be overrepresented, as the relative chronological stage B1a has been used for the temporal probability distribution calculation with the marginal overlap to the first decade before the turn of Eras (i.e. BC 10–0 AD), the binary reclassification transforms even marginal probability rate of occurrence to the value 1. Therefore, most of these evidences have more substantial temporal probability magnitude in the consecutive time block 0–50 AD. Therefore, these values have to be considered cautiously on above-mentioned regards, as well as the low quantitative representativeness and inconclusiveness of the input archaeological data on the respective inception time block.

77 For abbreviations see Chapter 5.5.



Graph 8.18. Weapon compositions. Dendrogram of the cluster analysis of the *militaria* entities.

The spectrum of documented find types represented in a subset of *militaria* from burial context (18 artefact types) has been aggregated into *militaria entities* – spear, javelin, sword, arrowhead, shield and spur. Their numbers in the burial contexts have been transformed into dichotomic presence/absence representation.[78] The resulting frequency distribution throughout points out that 70% contained only one of these types, and within the remaining 30%, the variation ranges from two to all six *militaria entities*. Simultaneously, there is no evident positive correlation between the *wealth index* and the number of evidenced *militaria* entities, which also suggests, up to an extent, their representation in a burial as a status symbol – not necessarily exhibiting the whole range of used weaponry. Nevertheless, from the methodological point of view, such a distribution still provided a valid input subset for multidimensional statistical evaluation.

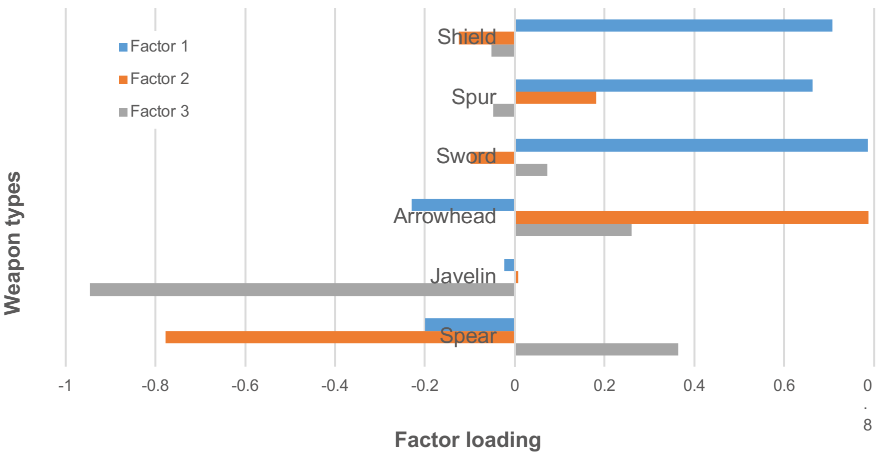
The primary examination of the weapon grave subset through exploratory multidimensional statistics (cluster analysis; complete linkage, 1-Pearson r) provides some preliminary assumptions on the associations and relations between selected *militaria entities* (Graph 8.18). There is an apparent vertical structure of the linkage distance (LD), suggesting the presence of a distinctive group of objects (burials) with an exclusive presence of a spear (LD 1.27). Further on, arrowheads and javelins also constitute relatively non-related groups at LD 1.15 and 1, respectively. However, the more pronounced co-occurrence could be observed in swords and shields (LD 0.6), forming a standard set in other ancient Germanic contexts (e.g. Hedeager 1992, 121, 128, Tab. 3.1; Härke 2000, Tab. 1). Spurs (LD 0.82) are adjoined to these two items, suggesting the manifestation of mounted warriors.

To explore multidimensional structures further, the subset was also analysed using factor analysis.[79] Three factors were established with the Eigenvector above one and combined provide 67% of the variability in the subset (Tab. 8.6). As suggested in the CA, the 'strongest' **first factor** (28% of variability) underlines the tight connection of a sword, shield, and spur

Variable	Factor 1	Factor 2	Factor 3
Spear	-0.200	**-0.777**	0.364
Javelin	-0.024	0.007	**-0.945**
Arrowhead	-0.230	**0.787**	0.260
Sword	**0.785**	-0.098	0.072
Spur	0.662	0.181	-0.049
Shield	**0.707**	-0.124	-0.053

Tab. 8.6. Weapon compositions. The resulting factor loadings of the principal components.

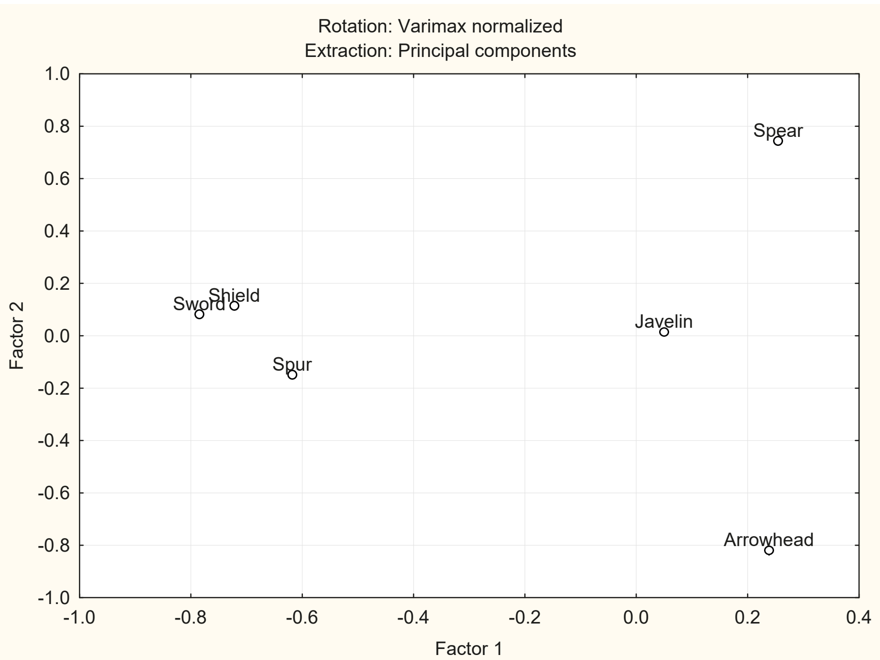
78 The *militaria entities* are represented in the input subset regardless their combinations as follows: spear (44%), javelin (29%), sword (25%), arrowhead (15%), shield (26%) and spur (24%). Consecutively, their combinations are far less represented up to 13%.
79 Using *varimax normalise* factor rotation to enhance possibility of identification within the relative heterogeneous subset.



Graph 8.19. Weapon compositions. The resulting factor loadings of the principal components.

in grave goods and highly correlates with a spur *militaria entity* (Graph 8.19). The strength of the factor reflects the representation of the sword-shield combination in weapon graves at 13%, the highest in all the potential combinations of *militaria entities* occurrence. Furthermore, this composition, including a spur, occurs in 6% of all the input objects/burials. At the same time, the probability of positive occurrence of three *militaria entities* is significantly lower than in two-tier combination occurrence. Simultaneously, the factor is also, in a limited amount, negatively correlated with the other types of evidenced *militaria*, enforcing the notion of the warrior-type distinction, which is also manifested through the burial context of archaeological data.

The **second factor** (22% variability) highlights the negative correlation between the categories of spear and arrowhead, which almost excludes themselves in occurrence (in 37% of the cases), apart from some significant exceptions (e.g. the princely grave from Mušov). The distinction in these weapons is testified for by the warrior designation by weapon type – on-foot infantry by spears or archers by arrowheads, or their combination. Nevertheless, the combinations of a spear with a javelin and shield occur in representation of 9%. Through the significant negative correlation, the last **third factor** (17% variability) almost exclusively refers to the 'warrior graves' equipped almost exclusively with a javelin. Such structure could, therefore, be interpreted as



Graph 8.20. Weapon compositions. Planar representation of the 1st and 2nd factor score.

a differentiation of a form of 'light infantry' – javelin skirmishers. Otherwise, the factor is mostly indifferent regarding most other *militaria entities*. It is only to a limited extent positively correlated with the occurrence of a spear (in 6% of the cases) and arrowhead in that order (Graph 8.20).

As outlined above, the available archaeological data on the composition of weapons in the Germanic burial context of the 'Marcomannic' settlement zone provide the ground for identifying the three observable and statistically distinctive segments of the military structure of the studied Germanic societies. From purelly compositional perspective, there could be assumed categories of swordsmen (with representation of horse-riding attribute), 'heavy' infantry (spearmen) and 'light' infantry (javelin throwers and skirmishers), including archery component. Obviously, any such simplistic statistical differentiation merely approximates a more fluid than the rigid context of the Germanic military and its composition. In a broader context, these observations could be, only up to an extent, put into the context with the models on the structure of the military structures drawn from the outstanding archaeological record of Illerup (Carnap-Bornheim, Illkjær 1996, 483; Jensen, Jørgensen, Lund Hansen 2003, 312–313), which differentiate three distinctive layers of this environment – commanders, officers and warriors (soldiers). The quantitative representation of the identified factors from the 'Marcomannic' settlement zone also testifies for the proportionate scaling in designated military 'classes' based on the composition of the grave goods (see Tab. 8.5). Therefore, the contexts associated with the 'commanders' could be attributed to 0.4% of all documented cases (cluster 1), associable with the 'paramouncy'. The rest of the cases are predominantly contained within cluster 5 (Tab. 8.5; 60% of *militaria*) with variable co-occurrence of knives (80%), brooches (60%), metal vessels (20%), scissors (20%) and belt buckles (20%). These associations could be further observed in factor analysis results (Factors 1, 3; Tab. 8.3) and varying compositions during the time.

Nonetheless, the valid principal components represent only ⅔ of the variability in the relatively limited subset, and multiple aspects distort the perception of past realities through the theoretical models. The occurrence of the *militaria* find category in 'primarily unrelated' contexts, such as the child or female burials (e.g. Krekovič 2007; Simniškyté 2007; Bochnak 2019), burden interpretation possibilities and resulting schemes, based on the statistically significant structures in data on the burial context with *militaria*, into certain proportion. Additionally, these structures were subject to change over time (or rather their representation through archaeologised burial context), as is foremost evident from the differences in the characteristics of the funerary context in the Early and Late Roman Periods.

Chapter 9

Middle Danube Germanic society during the Roman Period from the perspective of social anthropology

Understanding the dynamics and underlying processes within the Germanic populations of the Middle Danube region lies in having sufficient knowledge of its structure, scale, and other properties. Therefore, it is expedient to outline some theoretical perspectives that provide additional insight into interpreting archaeological data (social anthropology, ethnography, e.g. Wenskus 1974; Hodder 1982; Roymans 1990; Ravn 2003; Peregrine 2004). The anthropological perspective on these societies could provide a wide array of means to enrich our understanding, which has yet to be reflected or more sufficiently grasped[80] to exploit its potential. For example, such insights for the conceptualisation of the 'tribal' societies of the regions to the west (Northern *Gallia* and neighbouring territories inhabited by Germanic populations) were highlighted by N. Roymans (1990). However, various perspectives have been drawn within the existing approaches in other parts of Iron Age Europe (e.g. Wenskus 2016; Steuer 1982; Bazelmans 1991; Brather 2005; Hedeager 1992; Ravn 2003). In this chapter, some of the characteristic and structuring aspects of the chiefdom type of social organisation will be dealt with regarding the various sources of evidence (prominently historical and narrative sources) of the Germanic societies of the Roman Period in general, but with the focus of the studied region of the 'Marcomannic' settlement zone. However, it is apparent that such an extensive topic cannot be explored in all its aspects and breadth. Still, the focus is oriented predominantly on the qualitative intersections of the theoretical and empirical perspectives of social anthropology, history, and archaeology about expanding the interpretation frameworks and multilateral margins. The research activities already conducted in that regard have been substantial and addressed a wide array of issues and phenomena (Steuer 1982; Bazelmans 1999). However, at the same time, omitting a conceptualisation of these topics for the sake of the broader perspective and understanding through the multifaceted viewpoints concerning the studied region would provide an incomplete perspective.

9.1 Brief outline of the chiefdom-type social organisation and its structure

There has been a considerable debate on various aspects and approaches (e.g. unilinealism/multilinealism; gradualism/transformism) as well as on the very nature of the concept of chiefdom (e.g. Pauketat 2007) over the last more than seven decades (cf. Carneiro 2017). There are several main perspectives on this concept and multiple differentiated stages or levels of development of these sociopolitical entities (cf. Grinin, Korotayev 2017). For instance, M. Fried (1967, 109–129; Ames 2007) promoted the term 'ranked societies' to distinguish polities between 'tribe' and 'state' *sensu* the evolutionary system by E. Service (1962; 1975). Since the introduction of this concept of political organisation, countless past and present societies worldwide have been associated with this type of societal organisation, chronologically spreading from the first agricultural

80 Whereas there are some exceptions such as Krekovič 2007; 2014.

societies (Carneiro 2017, 21–22) to the present (e.g. Skalník 2004; Chabal, Feinman, Skalník 2017).[81] Regardless of the present or past documented chiefdoms, a large variety of types and variations within this organisation structure have been observed, as is apparent in chiefdom societies of Modern Age Hawaii, the archipelagos of Oceania, or the Americas before the arrival of Europeans and many others.

Over time, several classifications of chiefdoms have emerged, mainly regarding their 'complexity' reflecting their development stage (e.g. Junker 2015). A frequently used differentiation recognises usually simple and complex forms of chiefdoms (e.g. Earle 1991, 3) based on how many vertically aligned organisational levels it incorporates. In this system, the simple ones possess two, and the complex (or paramount; cf. Anderson 1996) ones even have three levels of hierarchical organisation structure. For example, R. L. Carneiro derived a typological classification discerning minimal, typical, and maximal chiefdoms based on the number of villages they incorporate (Carneiro 2017, 47–48). In contrast to the state-type sociopolitical organisation, in chiefdoms, a ruler's administrative system and apparatus (including adjoined bureaucracy) is not fully developed, and decision-making processes are more decentralised, realised both on regional and community levels (Wright 1977, 383). Some classifications are formulated through the absence or presence of distinctive features of socio-political systems and approaches to the economic basis for power strategies (e.g. Claessen, Skalník 1978).

Nevertheless, the pivotal point of the chiefdoms lies in the ruling entities – chiefs. Foremost, successful power control is required from such persons, as well as specific skills and qualities, such as charisma and bravery and the ability to lead and effectively exercise power. Chieftaincy is generally assumed to have been hereditary, however, provided that the successor complied with qualities indispensably required for a chieftain. Otherwise, a more suitable person would be found (Carneiro 2017, 45). Therefore, the level of institutionalisation of the power does not qualify a distinguished lineage to have an undoubted right to continue in governance, as it often applies to the state-type polities (e.g. Ravn 2003, 4–6). Still, succession has been perceived differently through the chiefdoms – from relatively firm hereditary principles to *Big man* 'recruiting' approaches based on individual qualities, not primarily or exclusively the affiliation to aristocracy or in established lineages. Also, the plurality of views testifies to variability and internal differentiation of chiefdom polities, while the first should apply to early chiefdoms (Earle 2017, 246–247).

Also, the principle of redistribution has been central to the concerned type of social organisation since the very beginning of the concept (Sahlins 1958, xi; Service 1962, 143–144), yet it has been pointed out more recently that a chief was more of a concentrator (naturally accumulated wealth to gain prestige and means to exercise and extend his power and to apply his power strategies) than a plain redistributor (Carneiro 2017, 26). Therefore, trade and its control, especially luxury goods, played vital roles in chiefdoms and their potential transformations to state forms of organisation (e.g. Kipp, Schortman 1989). Especially when societies in contact with far more developed entities (e.g. Roman or other empires) have been stimulated to produce surpluses to procure such commodities, they served then as a symbolic embodiment of power wielded by a chief but, more importantly, to extend his power and control through its redistribution to his retinue, other chiefs, and various entities within the chiefly power strategies.

A significant concept of chiefdom coalitions and confederacies resonates through the debate on the fission/fusion processes within chiefdom-type societies (Gibson 2011; 2017). They usually represent alliances formed among multiple chiefdoms to cope with external pressures, coordinate defences, or manage resources (Grinin 2017) while the involved political entities maintain their autonomy. Decision-making often relies on consensus among the allied chiefs. They have been attested for a number of diverse geopolitical contexts and environmental settings. These sociopolitical cooperation and resulting amalgamations are sometimes considered a key prerequisite to the emergence of state polity (Gibson 2017, 189–190).

An important criterion in distinguishing the chiefdom and state types of social organisation is often seen in the ability to mobilise resources through an economic basis (e.g. Kristiansen 1991, 23), generally identified in two forms: *staple finance* and *wealth finance*. The first emphasises the procurement of commodities from subsistence, through which

81 For instance, present-day chiefdoms have many forms. An illustrative example of chiefdom type organisation structure would be Taliban insurgencies in Afghanistan (Carneiro 2017), Hezbollah in Lebanon (cf. Skalník 2004, 76–77) or most of the actual decision-making entities in Africa (Skalník 2017), ISIS/Daes, Mexican drug cartels, and many others.

control redistribution was maintained. It manifests the power over the baseline production, mainly agricultural production (e.g. crops, cattle, and other primary products). This approach is firmly connected to the distribution of suitable land (e.g. Earle 2001, 84). The latter is bound with valuables in the form of 'prestigious goods', and their production and redistribution of exclusive items provide the framework for maintaining hierarchical power control. It is usually the case under the condition of more dispersed and generally accessible sources for *staple finance*, which cannot be monopolised. Therefore, the flow and redistribution of 'prestigious goods' provide a tool for power control (e.g. Hedeager 1992, 86–88). Through these approaches, two forms of chiefdoms are distinguished – collective and individualising and associated with *staple* and *wealth finance*, respectively (cf. Renfrew 1974). Nevertheless, in various proportions, both forms are usually present in most complex pre-state polities. It is obvious that in the studied context, a large part of items considered 'prestigious goods' are of Roman origin. It could be argued that the quality and, foremost, the available quantity of Roman production outweighed the local production. Apart from the importance of an influx of the material for further reuse, they provided significantly higher diversity in material culture and symbols for social presentation. Thus, it could be considered a vital driver of social changes and an increase in inequity (cf. Gini index; Chapter 8.2.2).

For many documented chiefdom-type societies, monumental constructions are documented and typically interpreted as a result of a specific form of collective communal work organised by a chief or for a chief (e.g. Junker 2015, 378–379, Fig. 1). However, throughout the extensive spatiotemporal extent of the chiefdom organisation structure appearance through the Metallic periods, its presence is not conditional or uniform, based on empirical data. It is present in some 'Prehistoric' chiefdoms (e.g. Late Neolithic, Bronze Age, Hallstatt Period). In contrast, for the later periods, this type of communal energy expenditure is somewhat limited (e.g. the Germanic Iron Age societies). Therefore, in this particular chiefdom 'identification markers', there is also variance in its manifestations (e.g. Grinin, Korotayev 2017, 97).

9.2 Germanic society through the narrative sources

The available narrative sources have provided the basis for deriving the theoretical models of the Iron Age society during the Roman Period in the past. By far, most of the societal entities, their characteristics, and relationships have been drawn foremost from Tacitus' *Germania* (e.g. Beare 1964; Steuer 1982; 2006; Bazelmans 1991; Lund 2007; Ravn 2003; Pagán 2012; Lightfoot 2020; Steinacher 2022) and others, but more fragmentary remarks (e.g. Caesar, Pliny the Elder). In the generally conceived hierarchical model, which could be drawn from these sources (Fig. 9.1), the Germanic society consisted of a large body of 'free' people (*Gemeinfrei*) with a minor group of 'slaves' (*servi* or *thralls*) and 'freedmen'. Nevertheless, the extent of the freedom within the Germanic societies, represented almost exclusively by small agricultural communities, should not be considered through the prism of some past theoretical models, endorsing the concept of 'warrior democracies' (e.g. Modzelewski 2017, 163–165). Such an ideal depiction could also stem from the narrative agenda underlining the 'ideal' structure of the Germanic society despite the fact that reality was probably more differentiated and complex. Indeed, there was an extent of degree in personal freedom. However, the existing internal binding obligations to the community (a complex network of patron-client relations) and its representative (tribute, military service of levies) limited its actual extent (e.g. Steinhübel 2012, 12–17). For the later social segment – the slaves – the surviving narratives by Tacitus[82] describe their conditions in relative contrast to the slavery in the Roman Empire, which is inevitably a result of the narrator's agenda, portraying particular aspects of the Germanic society through the *ethos* of virtues, lacking in the Roman culture. However, there is no reason to disprove the described position of slaves in economic structure, allowing them to constitute a household[83] with a tribute obligation to the master. Nevertheless, the less idyllic and more prone to the actual state of slaves' rights and legal position comes out from the remark on the immunity of the master in the case of the murder of his slave (cf. Modzelewski 2017, 137–139).[84] Therefore, the institute of slavery could have been a more heterogeneous phenomenon in Germanic societies (not exclusively the form of a 'domestic' or 'household'

82 Tac. *Germ*. 25.
83 Which could be considered a parallel to the *colones* in the Roman milieu.
84 Tac. *Germ*. 25.

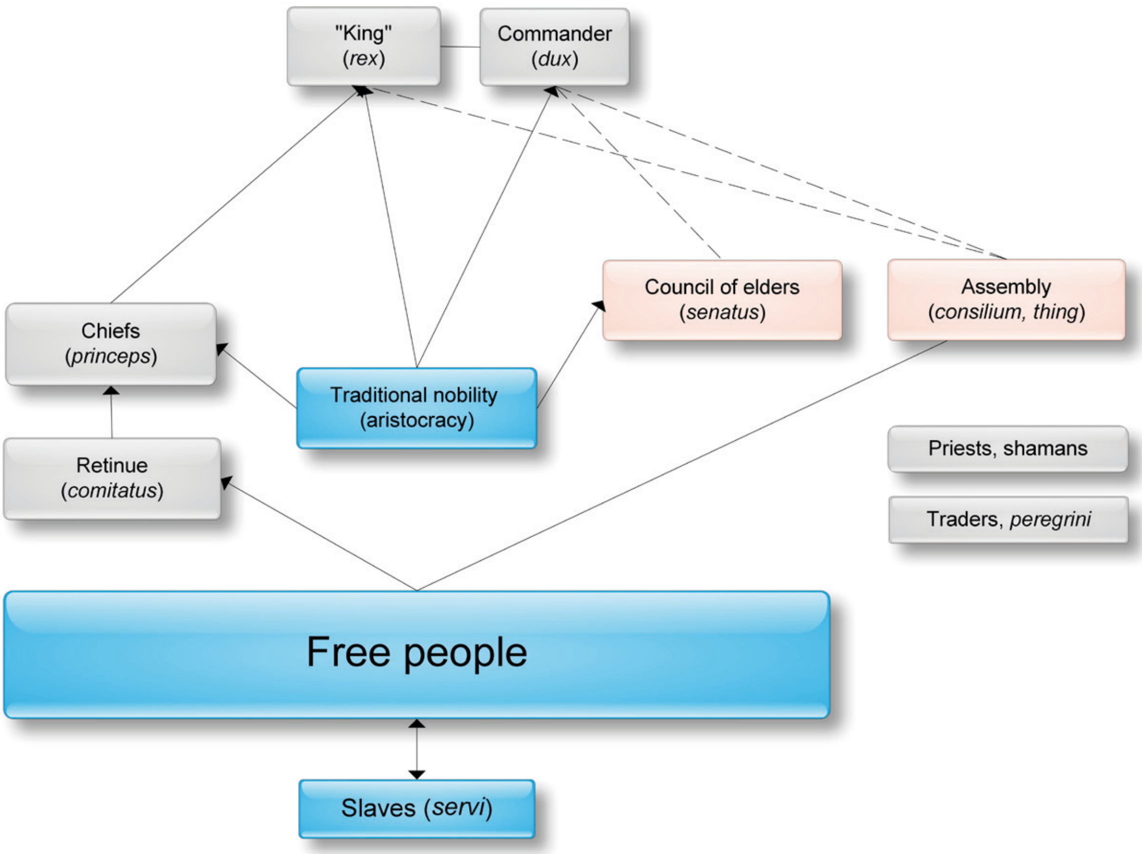


Fig. 9.1. A general outline of the Germanic social structure and presumed interconnection among individual acting entities of the Germanic society, primarily based on the description provided foremost by Tacitus's *Germania*.

slavery; e.g. Thompson 1957), and due to the differentiated economic position, it could have proportionately propagated in the archaeological record, foremost the burial context (cf. Chapter 5.2, 8).

These main building blocks of the societal space were interconnected and operated through several key institutions and positions.[85] However, it is not the aim to elaborate on these entities in detail here through the prism of the narrative sources, which are significantly biased (e.g. Bazelmans 1991). Nevertheless, in the following chapters, some of them will be considered in terms of their meaning within the chiefdom type of social organisation of the studied Germanic societal context. The crucial role in power organisation is occupied by the chiefs (*principes*), accompanied by a retinue (warband) reflecting their powers and abilities. This entity held key importance in the Germanic chiefdom power structure, which formed the military and social backbone, serving as personal armies that enabled enforcement and coercion, which was maintained by prestige and loyalty through gift-giving, feasts, and ritual bonds. These structures align with models of redistribution economies and honour-based systems (e.g. Bazelmans 1991). At the top of the organisational structure were located the most prominent figures, with roles described in surviving narrative sources as *rex* (king) and *dux* (military commander or war leader). The decision-making process regarding essential matters (e.g. wars, political alliances) was presumably, up to an extent, conditioned by the assemblies (*consilium* or *thing*; Iversen 2013) consisting of the 'free' individuals and the council of elders (*senatus*). With less explicitly formulated links to the above-mentioned social entities, the classes of priests/shamans and the conspicuous and unclear class of 'foreigners' (*peregrini*) or traders are also present.

However, this information does not provide a substantial basis for the actual vertical structuring of the 'power domain', differentiating

85 E.g. Tac. *Germ*. 7, 11, 13, 19, 25.

individual vertical positions of organisation entities – chiefs – according to their abilities, power basis (control of the critical sources and mobilisation of income and revenue), and capabilities to enforce their power strategies and personal objectives. Such a formal representation of the chiefdom type of structured society could be found in social anthropology (e.g. Anderson 1996; Peeples, Kus 1977), where the respective system classification is based foremost on the number of identified levels of the active power entities (Fig. 9.2). The previous research of the Celtic and the Germanic populations in the northwest (the Netherlands) also enabled the association of the hierarchical levels with the spatial and political entities known from the narrative sources (Roymans 1990, 17–27, Fig. 3.1), discerning the local groups, *pagus* and *civitas*, where the relatively high level of autonomy on the superior or central organisation entity (*rex*/*dux*) could be observed. Obviously, these diverse contexts differ significantly in many aspects, however, the underlying features of the vertical (hierarchy) and horizontal (spatial) alignment of the internal administration structures. Potentially, these hierarchically aligned spatial entities, drawn from the narrative sources, could be associated with the levels of decision-making of a paramount chiefdom organisation structure (e.g. Anderson 1996, Fig. 10.1). It has also been acknowledged long ago that geopolitical entities (tribes), referred to in works such as those by Tacitus, represent tribal confederacies rather than individual 'tribes' (Todd 2004). In this regard, it was pointed out earlier that societies in the Bronze and Iron Ages should not be designated as 'tribes' but as chiefdoms (Kristiansen 1980; Hedeager 1992, 2). Regardless of terminology and typological classification of social anthropology, there was inevitably a much more vivid fabric of various influential and acting entities within the rigid representation of a 'tribe' in surviving narrative sources (e.g. Todd 2005, 440–441).

9.3 Comparative contexts and parallels

The territory inhabited by the populations with Germanic cultural assignment during the first four centuries after the change of Era was enormous (about 1.5 million km^2 only for the 'continental part' outside Scandinavia), and this aspect also manifested itself in the variability of cultural and social

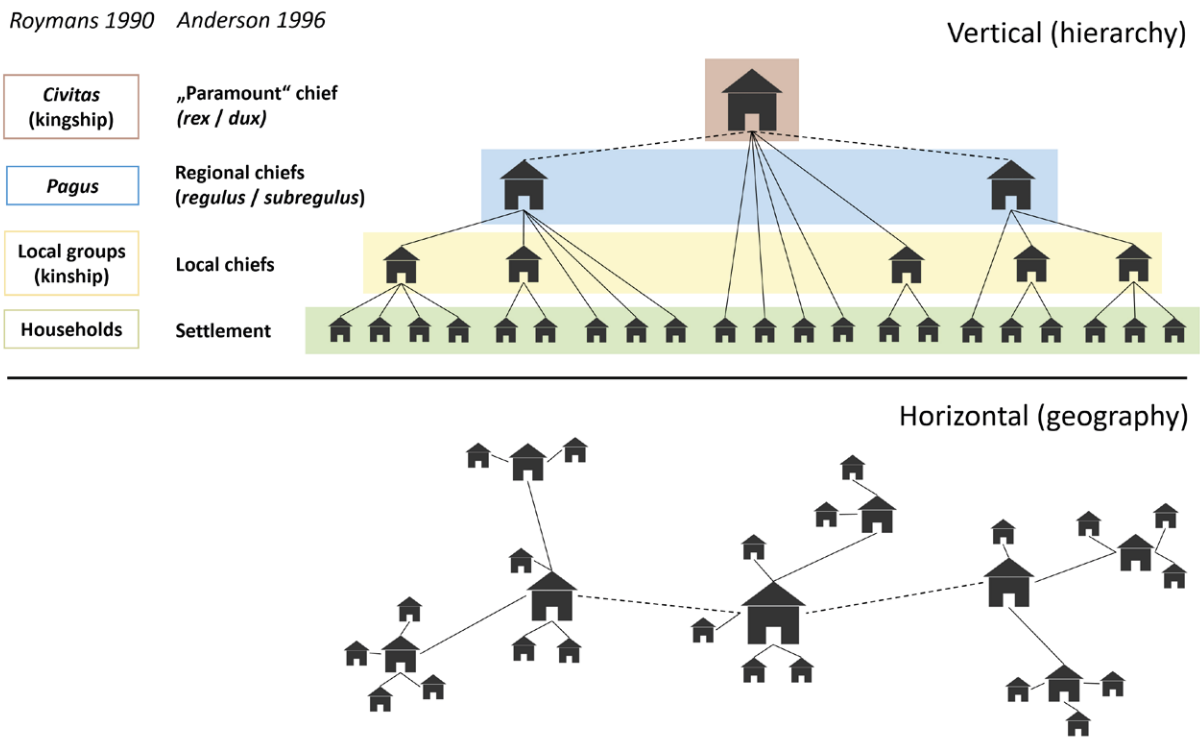


Fig. 9.2. Model of a 'paramount' chiefdom organisation structure (Anderson 1996; Roymans 1990) in vertical (hierarchy) and horizontal (geography) dimensions.

relations in various parts of the so-called *Germania Magna*, inherited from the Roman geography, should in various considerations serve only as a 'auxiliary' construct reflecting distinctively diverse context as the respective populations have never referred to themselves as *Germani* (cf. Todd 2004, 8–9; Steinacher 2023). However, the Roman-Germanic interactions and direct presence (foremost through the service in the Roman army) presumably mediated the Roman 'perspective' (Clay 2008). Nevertheless, the variety and specifics within each region inhabited by the Germanic populations (either the so-called *Germania Magna*; cf. Künzl 2019, 43, or later political entities within the former Western Roman Empire) or 'tribal' political entities still have the most fundamental aspects in common and comparable (cf. Götz, Liceras-Garrido 2019). However, despite many differences and development changes, the temporal scope of the Germanic societies stretching from the pre-Roman Period to the Middle Ages, the Germanic World represents a heterogeneous socio-political context, where, however, some features are common and have lasting traditions (cf. Peregrine 2004). It has been pointed out that comparing various Germanic societies could be possible in such a diachronic perspective (e.g. Roymans 1990, 17). The northern European milieu (Scandinavia, Denmark, and northern Germany) before Christianization can provide essential parallels through well-documented characteristics of various aspects of the societal structural features (e.g. Gilman 1995; Steinsland et al. eds. 2011; Modzelewski 2017).

Scattered narrative sources of information are further occurring throughout the Migration Period (i.e. the 5th and 6th centuries AD). In this period, these sources also appear within the Germanic environment (e.g. Bible translations or legal codes). The period represented a vital transition stage of some pre-state Germanic polities into early 'barbarian' states within the environmental context of the declining Roman Empire (e.g. Pohl 2001; 2021). Similarities could also be found in features of the properties described fragmentarily by Tacitus as well as within those from the Early Medieval northern Germanic societies before Christianisation (Modzelewski 2017). It is foremost the power organisation, centred around chiefs in various mutual relations, accompanied by retinues with the strongly established institution of 'gift-giving' and feasting (e.g. Bazelmans 1991). For example, vital institutions such as an assembly of 'free men' (*thing*), constraining up to a limit, power of chiefs (elections, council) served from ancient to early medieval times (Todd 2004, 29; Iversen 2013). The parallels could also be seen in the sacral and legal aspects of the kingship (e.g. Sundqvist 2021), as well as the patterns in the transcendental sphere of beliefs, also connected with human and animal sacrifice (e.g. Russel 1994). More extensive narrative sources for the later period provide the opportunity for a more detailed examination of the dynamics of social interactions and the development of social structures. Such features also testify to a certain amount of conservatism and continuity within profound aspects of the social organisation. There is also a conviction that the clans of the Scottish Highlands represent the last surviving example of a chiefdom organisation in the form documented in Tacitus's *Germania* (Gilman 1995, 239).

Remarkable continuity within the unifying (amalgamation and fusion) social practices can be recognised in bog deposits, some of which were active for several centuries, despite not continuously and in varying frequencies (e.g. Vimose, Jensen 2007; 2022; Christensen 2005; Jensen, Abbeg-Wigg, Rau 2008). Despite the objection to non-critical placement of parallels among such cultural entities, a more thorough analysis of cross-cultural (or rather, in this case, cross-temporal parallels). Notably, these parallels between the descriptions from the Medieval Period narratives and Tacitus's *Germania*, which was not available to the medieval authors to draw from (e.g. Modzelewski 2017, 18–22).

In referencing the Germanic social alignment, a prominent place is also held by the poem Beowulf (e.g. Bjork, Niles 1997), whose origins are sought between 500 and 1000 AD and was written in the 11th century AD (Ravn 2003, 9). The description of the featured social entities (warlords, retinue members), their internal binding principles (e.g. gift giving, feasting) or rituals (cremation of the fallen hero) bear multiple intersections with those from the narratives by Tacitus and others (Bazelmans 1999). Therefore, through the various distortions and 'filters', the underlying clues on the vital aspects of the Germanic milieu could be observed in this unique narrative.

9.4 Organisation of power – Reges, Duces, and Principes

The understanding of the power of the leading persons inevitably differed in the Germanic and Roman environments. It is only natural that the terminology of the Roman sphere only approximated the circumstantially observed and described reality through the familiar terms closest to the key hierarchical segments of the Germanic societies – chiefs (associable with the term *principes* in surviving narratives, e.g. Price 1968; Schlesinger 1968; Wells 1995; Todd 2005; Steuer 1999; 2006; Brather 2005; Wenskus 2016), which were in more frequent contact with the Roman milieu. The necessity of conceptualising a vivid and complex environment in narratives inevitably simplifies and distorts the complex past reality. Nevertheless, for differentiation of the positions termed as *dux* and *rex*, substantiation exists almost exclusively from the narrative sources.[86] The terminology which we inherited from the Roman sources and are referred to, often without consideration of the implications within the broader context of the organisational structures of past societies, has to be perceived as a product of the contemporary conditions and settings of the complex reality of the Germanic world and the necessity to apply the terminology already known to Romans (Todd 2005).

The topic of *kingship* in the Germanic Iron Age world has been debated for an extended period (e.g. Wallace-Hadrill 1971, 15; Pitts 1989; Thurston 2010). However, for the Roman Period Germanic societies, the term *rex* has to be perceived in the context of the circumstantiality of its origin and differently from those polities of the Mediterranean milieu of more advanced state-level societies with institutionalised power organisation (cf. Earle 2001; 2011; Claessen 2017; Chacon et al. 2015). In connection with kingship, as well there has also been a significant role of the 'sacral' kingship in Iron Age societies in general, not excluding the ancient Germanic societies. This element was embedded in these high functions in several instances. The selection of a king was often conducted or confirmed by a general assembly (*consilium* or *thing*), which had a sacral nature in essence. The kings (or paramount chiefs through the prism of social anthropology) also often originated from highly positioned individuals from nobility (*principes*), which usually derived its descent and ancestry (royal genealogy) to a mythical past in order to connect with the divine realm (e.g. Laidoner 2020). The mentioned association of the *kings* with their descent and ancestral origins suggest their hereditary position. However, for most representatively documented cases,[87] this accession principle was often complemented with election-based king appointments (Grierson 1941; Sutherland 2001).

In this regard, the contextually relevant and frequently stated narrative by Tacitus suggests the existence of distinguished lineages of Marobuduus and Tudrus of *Marcomani* and *Quadi*, as well as the gradually increasing dependence of the power of the Germanic 'kings' on the Roman administration, comparing to the condition around the turn of Eras.[88] For the mid-second century AD, the growing dependence of the prominent Germanic power entities is besides the above-stated narrative corroborated by the coin emission, issued between 140 and 144 AD during the reign of Antoninus Pius, interpreted as a reflection of direct appointment of the Germanic paramount chiefs or *kings* – *REX QUADIS DATUS* (Swoboda 1957). As an essential fact in mutual relations, the equality of both sides is suggested based on the height of the depicted figures. Likewise, the appointment of Furtius during the reign of Marcus Aurelius is another testimony of the well-established principle of Rome's approval of the supreme leadership in the neighbouring Germanic environment (Pitts 1989, 49) and proportionally significant reaction in the case of his removal and establishment of Ariogaisos in his place.

The weak institutionalisation of kingship is apparent from the significantly short-lived tradition as the first indication of such an esteemed class in the archaeological record on ancient Germanic societies appears in Scandinavia no sooner than during the 1st century BC (e.g. Thompson 1965, 32–38; Wallace-Hadrill 1971, 7–8, 17). Simultaneously, in the brief outline of individual 'tribes' by Tacitus, the institution of kingship is explicitly mentioned in the case of *Lugii* and *Gotones*,[89] from which could be assumed that kingship was not a widespread practice in Germanic society on a regular basis by the time and that the standard organisation and political entity were chiefs/*duces*. Nevertheless, such a state of variation through the dynamic development of power structuring is embedded in the chiefdoms (Carneiro 2017, 50).

Nevertheless, there was inevitably another correlation between the success in performance (foremost positive outcomes in raiding, warfare, crop yields, etc.) and the maintenance of power of a particular chief, which Ammianus Marcellinus

86 Tac. *Germ*. 7.
87 Tac. *Germ*. 12.
88 Tac. *Germ*. 42.
89 Tac. *Germ*. 44.

perhaps best attested in the case of Burgundians.[90] The practice was to depose the king, also the war leader here, in case of military or crop failure (Wallace-Hadrill 1971, 15). There was no contradiction of the debated functions in societal leadership. Therefore, a *rex* could have become a *dux* and vice-versa. Notably, such practice is well-attested for the Early Medieval Scandinavian kingship (Sundqvist 2021, 279–280). The archaeological manifestations of these topmost social strata – generally labelled as aristocracy, nobility, or elites, are almost exclusively based on richly furnished burials, known from various parts of the Germanic world. Both stated principles somehow merged in surviving narrative sources mentioning the Quadian representative Gaibomarus, who was accused by his countrymen at Romans of his misconduct, and they demanded he be deposed.[91] Furthermore, the expulsion of Vannius by the opposition, including his relatives (Vangio and Sido), due to power accumulation and tyranny over his subjects, has imprinted into written sources.[92]

It is a well-known fact that the Roman administration intervened significantly in the political affairs of the neighbouring populations. These interferences have been evident since the first narrative sources on the Roman-Germanic political and diplomatic interactions of the Middle Danube region, as well as other parts of the Germanic world (e.g. Timpe 2006; Wendt 2012). The supreme entities/paramount chiefs often depended on the neighbouring superpower – the Roman Empire – and their power could have been maintained with long-term support. Nevertheless, the chiefdom power organisation is generally sensitive to the significant shifts in the balance of a system towards a more centralised one with an outlook of securing power continuity under formalised and institutionalised conditions, which are the keystones of any early or further state entities. At the beginning of the temporal extent in question, the emergence of distinctive policies, such as the 'Marobuduus empire' or Arminius's power ambitions, which both had eventually not a long existence (Wallace-Hadril 1971, 5–6). Narrative sources suggest that Marobuduus has become unpopular due to the title 'king', which the Roman administration assigned him (Sutherland 2001).[93]

No matter how exactly they should have been best named, these top-level social and power entities are generally recognised in archaeological sources foremost through the exceptionally rich burial complexes, such as the rich princely grave from Mušov (Peška, Tejral 2002; Komoróczy, Vlach 2022), or others counting among the burials of Lübsov (e.g. Lichardus 1984; Schuster 2010) or Leuna-Hassleben-Zakrzów (e.g. Werner 1973) horizons, which by far exceed most of the burial contexts in many qualitative and quantitative aspects. Perhaps the most striking properties of this phenomenon are the narrow and consistent chronological margins (generally the second half of the 3rd century AD) and the spatial distribution (two significant concentrations: Saale-Elbe region and Denmark). However, the period of their appearance, which covers roughly one and a half generations, does not represent a continuation of the local development. Conversely, these burials also do not show grave goods compositions reflecting the presence of chronologically heterogeneous material suggesting propagation of long-term aggregation of 'prestige goods', the phenomenon apparent in the princely grave from Mušov (Peška, Tejral 2002). The more pronounced vertical hierarchy of several stages/levels within the chiefly organisation structure of the Marcomanni is also reflected through the remarks by Cassius Dio, which is for the time of the beginning of the Commodus's reign, suggesting that the Marcomannic Wars-caused depopulation propagated also into the reduction of number of power entities for to be sending only two chiefs and further two inferiors as envoys for peace negotiations (cf. Birley 2000, 148, 169).[94]

Another implication for the more profound differentiation of the Germanic social structure during the Late Roman Period could be seen as a new name for a power and social position denomination called a *regulus* or *subregulus* (translated and associable with the terms of 'petty' or 'inferior' kings within the organisational structure) in the sense of subordinate political figures (e.g. Price 1968; Pitts 1989; Fanning 2011). The situation is documented for Quadian king Viduarius, who was presumably in a superior position over a number of subordinate 'inferior' or 'petty' kings (one of them named Agilimundus) and other entities of power organisation around

90 *Res Gestae div. Aug.* XXVIII. V. 14.
91 Cass. Dio LXXVII.20.3.
92 Tac. *Ann.* XII.29.
93 Tac. *Ann.* 3 II.26, 62; Vell. Pat. II.108.
94 Cass. Dio LXXII.2.

the mid-4th century AD, named as *optimates* (presumably *principes* in power, i.e. chiefs) and *iudices* (i.e. judges).[95] This formulation further corroborates the chiefdom type of social organisation, where the judicial power is often embedded in the chief's portfolio. Therefore, the narrative sources point out the gradual development and growth of the power hierarchy. This territory was divided into the western and eastern parts at an unspecified time but no later than at the beginning of the Late Roman Period. Such fissioning could be considered a process opposite to a 'standard' path to the evolution of the *early state* or *analogous* forms of organisation (Grinin 2017; Grinin, Korotayev 2017). Distinctively differentiated forms and hierarchy within the rex extended categories can be seen in Ammianus Marcelinus's mentioning the battle against the *Alamani* in Strasbourg in 359 AD, where apart from *rex* distinctions such as *regales* or *regulos* also appear (e.g. Geuenich 2005).[96] As was pointed out before, this development could be explained by an internal political differentiation, which eventually lacked supreme authority which would be able to contain such a process under a supreme power organisation entity. Therefore, similar development tendencies could also be anticipated for the 'Marcomannic' settlement zone, which reached the peaking values in some properties and development tendencies even on the eve of the Marcomannic Wars (above all population size proxies).

Simultaneously, it was no sooner than by the 3rd century AD when more stable power organisation units in terms of continuity emerged, such as in the case of, e.g. Langobards, Goths or Franks (Grierson 1941), where the hereditary kings arose from the presumably well-established houses (lineages) or 'royal' families (*stirps regia*), recruited from the highest nobility strata (e.g. Amals, Balthas or Merovingians respectively). Particularly within the archaeological record from the Mušov region, the available traces reflect the local presence of elites (e.g. Komoróczy, Vlach 2022). The large-scale rescue excavations connected with the reservoir Nové Mlýny (Stuchlík ed. 2002) uncovered foremost an outstanding princely grave from Mušov (Peška, Tejral 2002; Komoróczy, Vlach 2022), which could suggest such a social niveau. Despite the number of ambiguities in interpretation possibilities and the limits of archaeological contexts, the region can be straightforwardly associated with the presence of the highest class of Germanic society within the 'Marcomannic' settlement zone. Several indices testify to a long-term enduring 'house' or lineage of the local or presumably regional or supra-regional elites. This resemblance of grave goods includes not only the sets of the most exclusive items for the contemporaneous elites but also the heirlooms of the past generations (e.g. the folding table from the 1st half of the 1st century AD; Peška, Tejral 2002).

Furthermore, in the immediate proximity of Mušov-Burgstall, a Germanic settlement with exceptional archaeological context and finds was documented in Pasohlávky 'U vodárny' (Komoróczy, Vlach 2022), containing, amongst others, specialised crafts – iron smelting, blacksmithing and copper alloy processing (Tejral 2006). Among the documented archaeological contexts and material categories, which outmatch the standard representation of the settlement archaeological record of the studied region (cf. Droberjar 1997). The long-distance trade contacts are also distinctively emphasised by one of the recent finds of raw amber (Komoróczy, Vlach 2022, 351, Fig. 21:18), representing a high-valued material for jewellery production (e.g. Quast, Erdrich 2013). Such evidence could also corroborate the expectation of the 'secondary' branch of the Amber route along the lower reaches of the River Thaya (e.g. Madejski 2013, 48). The evidence of long-distance exchange and controlled specialised production is generally associated with the presence of political leaders of chiefdom social organisations (Claessen 2011, 10–11). All of these exceptional features are underlined by the immediate closeness of the rich princely burial (Peška, Tejral 2002), where the apparent spatial, temporal and formal (archaeological record) intersection suggests the mutual relevance (Komoróczy, Vlach 2020).

From the documented forms of indigenous architecture, there were documented 13 pit houses and a significant amount of post-hole above-ground granaries. Nonetheless, a considerable concentration of above-ground granaries implies more substantial amounts of stored food, supposedly for redistribution or other expenditure (Komoróczy, Vlach 2011; 2020, Fig. 20). In theory, the situation could be considered to be a result of, e.g. regionally based tribute shipment or even partial provisioning for the Roman

95 Amm. Marc. XVII.12.21.
96 Amm. Marc. XVIII.2.13.

army during the presence in the region (cf. Komoróczy et al. 2020; Komoróczy, Vlach 2022).[97] Furthermore, from the interpreted ground plans, the extensive rectangular three-ailed building with dimensions 21 × 7 (147 m^2) surpasses nine times the average roofed area of pit houses. The ongoing debate considers the connection of such structures within the Middle Danube region with higher social strata with reservations (e.g. Schuster 2024). Nevertheless, their general scarcity in this region, hardly explainable solely through the excavation techniques, underlines use in particular contexts. Conversely, their abundance in the northwestern environment points to a dominating form of housing, reducing pit houses to 'utility' structures. Nevertheless, the fundamental expectations stemming from constraints given by the climatic condition would expectedly reflect the observed differences between the 'roofed areas' of the respective housing structures. This type of building is also often associated with the residential function of leaders (chiefs), as well as hosting their associates and the retinue's members (e.g. Donat 2002; Todd 2004; 2005; Kristiansen 2010). Therefore, under the given extraordinary conditions, the structure in question could be cautiously associated with the attested presence of the organisation entities of supraregional outreach of power exercise. Otherwise, the association of chiefs of clearly paramount stature within the context of the living would have to be south elsewhere for which the clues in the archaeological record are presently missing.

Scaling-up and from the general perspective, within the *wealth economy* settings, the 'prestige goods' are considered indispensable means in maintaining social relations (e.g. Ekholm 1977, 117; Earle 1997; 2011). In theory, the apparent indications of some form of legal implications of the social stratification towards the land holding for primary subsistence (e.g. fields, pastures, various types of wood formation for multiple purposes) are also crucial for any modelling conceptions of the structure of a 'standard' community (settlement) and its economic/subsistence hinterland. Indeed, one of the natural laws of the least cost and affordance has been one of the primary drivers of such land partitioning.

Similarly, the environment of the top social class of the Germanic society of the Middle Danube, as in other comparable societies at the level of chiefdom social organisation, was highly competitive and, in this sense, also prone to more turbulent and dynamic development. Narrative sources testify to the stable presence of violent internal political struggles at the organisational structures. For instance, in the case of Arminius, even members of the ruling clan or family were involved. According to written sources (inevitably biased through the narrative agenda) and interpretations based on historical and archaeological data (e.g. Dobiáš 1964, 89–148; Salač, Bemmann eds. 2009), Marobuduus[98] was a significant political figure of the Germanic world in all aspects and, for a particular period, was a leader of a considerable 'tribal' alliance, coalition, or confederacy (cf. Gibson 2011), the actual extent of which and forms of the power exercise of its entities is the subject of debates (e.g. Salač 2006; 2021; Vlach 2018b). However, his position was not strong enough to withstand the gradually growing opposition from his unwillingness to join the broader anti-Roman coalition. Due to the weakening of Marobuduus's position, Catualda overthrew him eventually, but he was soon to experience a similar fate. Notably, the emergence of the documented Germanic burial activities within the archaeological record of the Early Roman Period southwest Slovakia (e.g. Abrahám, Sládkovičovo; Kolník 1980) is to be potentially associable with the results of a movement of the part of the population/retinue from Central Bohemia to the Middle Danube region, forming the so-called Vannius's kingdom (*Regnum Vannium*) between 19/20 and 50 AD. In this regard, the overthrow of Vannius by his opponents, represented by Vibilius, Vangio, and Sido, after resorting to more oppressive forms of rule,[99] is not surprising. Tacitus also stressed the emerging resistance of Germanic societies to power aggregation and kingship claims and the risk of violent deposition.[100]

At the beginning of the conflict, the assembly led by Ballomarios requested the allocation of land for settlement activities. The causes of this pressure are seen in several factors, but the movements of so-called *barbares superiori* are most often mentioned, associable with the ethnical entity of the Baltic

97 However, other possible explanations are also at hand in this complex situation. The amassed stored grain may have partially provided the Roman occupation forces stationed at Mušov-Burgstall and its vicinity (Komoróczy, Vlach 2022).

98 Within the given context, such an exalted individual would meet the requirements of the category of 'paramount' chieftain, if we were to contextualise through the theoretical framework of social anthropology (cf. Anderson 1996).

99 Tac. *Ann*. XII.29.

100 Tac. *Ann*. II.44, 48.

Goths, presumably *Gotones* (Heather 1996; Kokowski 1999; Todd 2004), the movements of which have also been corroborated genetically (Stolarek et al. 2019). Therefore, from the social anthropological perspective, it could be assumed that the institution of kingship in Germanic tribes reflects transitional stages between kinship-based chiefdoms and early state formations, presumably *early state analogues* (Grinin 2017; Grinin, Korotayev 2017). While Tacitus and Caesar highlight early Germanic kings' egalitarian and military aspects, social anthropological studies emphasise economic redistribution, symbolic leadership, and religious legitimisation as driving forces. The concepts based on the narrative sources are consistent with redistributive chiefdoms, and controlling this flow was an essential source of chiefs' power. Nevertheless, these aspects have inevitably undergone changes as a result of the gradual involvement of the Germanic populations in various spheres of the Roman world. One of the primary environments of direct interactions represented the military service, in which the Germanic warriors and leaders were involved. Such phenomena were accompanied by later involvement in administration and other domains (e.g. Wolfram 1997; Heather 1997; Pohl 2006).

9.5 Coalitions and confederacies

Throughout the Germanic world of the Roman Period, various examples of profound changes in the structure of geopolitical alignment were observed long ago through the available narrative sources and patterns in archaeological data (e.g. Todd 2005). The emergence of various alliances and coalitions in Germanic societies is one of the symptomatic features of the Germanic environment. Their features show a comparable pattern, consistent with this socio-anthropological research phenomenon (e.g. Grinin 2017), and observed in chiefdom polities worldwide. Simultaneously, they are considered a vital prerequisite to the emergence of state-level governance (cf. Gibson 2011). In this regard, the influence and various forms of interactions with the Roman administration significantly affected the geopolitical fissioning and fusioning process, as Tacitus corroborated.[101] He explicitly identifies Roman pressure as the driver of temporary coalitions and alliances between otherwise opposing Germanic sociopolitical 'tribal' entities.[102] Nevertheless, also the internal development processes within the Germanic societies, in general, had presumably significant importance in the emergence of the more 'advanced' and centralised political entities formed by several 'tribal' polities or relatively marginal chiefdoms, which were apparent foremost during the Late Roman Period (Hummer 1998).

From the short-term perspective, due to the highly 'personalised' role of the chiefs in diplomacy and bi- or multi-lateral treaties, the Germanic world was under the ever-changing current of such emergence and dissolution of coalitions and confederacies, and since such entities are nearly impossible to discern within the archaeological record, at least few have been reflected within the surviving narratives. Perhaps one of the largest, best known, but only short-lived, was initiated by 'paramount' chieftain Marobuduus at the turn of Eras (e.g. Dobiáš 1964, 98–101; Droberjar 2008; Salač 2006; 2021; Salač, Bemmeann eds. 2009; Vlach 2018a). The emerging polity should have encompassed multiple geopolitical entities (the 'tribes' of the *Lugii*, *Zumi*, *Butoni*, *Sibinii*, *Semnones*, *Langobards*, *Gothons* and partially also the *Hermunduri* and *Quadi*; Preidel 1972; Droberjar 2008; Steuer 2006, 231) stretching throughout the enormous geographic extent comparable with the size of present-day France (i.e. around 644,000 km^2). Such a coalition must have been maintained only through exceptional personal abilities, which Marobuduus presumably was not lacking. According to some of the narrative sources,[103] the formation was formidable enough to require Roman military intervention on a considerable scale (two expedition forces from *Carnuntum* and *Mogontiacum* should have met after their advance somewhere on the borderland of the Marobuduus's territory), which is itself still a subject of debate, and the stage of its realisation is uncertain (Vlach 2018a; Kehne 2006; 2009; Salač 2006; 2021). The binding of such an exceptional polity to an individual and his authority also illustrates its low resilience to destabilisation and consecutive dissolution in the case of the weakening of an integrating power.[104]

101 E.g. Tac. *Germ*. 29, 33.
102 Tac. *Ann*. II.45.
103 Vell. Pat. II.108.2.
104 Nevertheless, the 'extremity' of the length of the both advances and geostatistical reflection of the landscape parameters suggests various options of the actual paths of advance (cf. Vlach 2018a), encompassing the already suggested courses and their evaluation regarding the least-cost parameters.

Further example of an 'chiefdom confederacy' emerging for a specific objective can be seen in the aggregation of 'tribes' centred around *Cherusci* led by Arminius, which resulted in defeat of three legions with considerable civil accompaniment in the Teutoburg Forest in 9 AD (e.g. Rost, Wilber-Rost 2014) and, in general, put on hold the long-term Roman ambitions for further annexation of Germanic territories into the provincial structure. Regardless of the debates on its true nature oscillating between the large-scale indigenous Germanic uprising against the Roman occupation and a simple mutinous attempt by one of the ambitious Germanic leaders (Timpe 2008), the cooperation of the multiple political entities within a coalition is hardly disputable. Oddly, no other comparable entities are mentioned for another 150 years until the outbreak of the extensive Roman-barbarian conflict – the Marcomannic Wars (Friesinger, Tejral, Stuppner Hrsg. 1994; Erdrich et al. 2020).[105] At the initial phase of barbarian intrusions, there is a mention of a coalition of 11 tribes led by a *rex* (i.e. highly positioned representative of a tribal coalition or alliance; e.g. Gibson 2011) Ballomarios,[106] possibly grouping most of the political entities of the Middle Danube region. Notably, from the spatial perspective, it represents a higher number of polities ('tribes') than could be assumed from the narrative sources.

The more profound and lasting changes in Germanic societies and shifts in power organisation have been recognised mainly through the emergence of the new political entities ('tribes') and the disappearance of some others in narrative sources (e.g. Todd 2005), suggesting large-scale socio-political amalgamation from the 2nd to the 3rd centuries AD (Hummer 1998). These phenomena are considered to be an outcome of internal socio-political processes and competitive-expansionistic tendencies, where often 'lesser' polities were absorbed by the larger and more powerful ones in the process. Nevertheless, in the overall outcome, there is an apparent tendency to aggregation of political structures, which eventually led to the emergence of larger coalitions of several Germanic polities, mainly induced based on the etymology of their names (e.g. Alamans, Franks, or Goths). Such coalitions can be formally classified as chiefdom confederacies (Gibson 2011, 220).

9.6 Retinue (Warband)

From the perspective of maintaining, extending and monopolising chieftains' power position, the retinue represented an essential element, representing an exclusive part of the society (*Gefolgshaft*, retinue, warband or sometimes a 'warrior club'; e.g. Price 1968; Wenskus 1974; Steuer 1982, 48; 2021; Enright 1988; Carnap-Bornheim 1992; Bazelmans 1991). Its basis is usually seen in a patron–client relationship (Sahlins 1961; 1963), where the loyalty of the retinue members to a chief is conditioned by providing benefits and satisfying the needs in exchange for the required services, thus generating economic dependence (Roymans 1990, 18). It also has a prominent role in social anthropology research of the chiefdom-type societies in general (e.g. Earle 1997), where the retinue is indispensable in the system's functioning and maintenance of power structure. It also plays a central role in the narratives by Tacitus, where it is generally associable with the later construct of the *comitatus*[107] and where a positive correlation between the ranking of chieftains and the size and quality ('splendidness') of retinue could be assumed. Inevitably, such a relationship required a proportionally robust redistribution system (subsistence and economic base) through which the flow from the chiefs' sources of common (e.g. foodstuff and daily necessities) or specific products (luxury items). The tightness of the relationship between a chief and his retinue was conditioned by sufficient provisioning of all the items within the 'prestige' goods economy (e.g. Earle 1991).[108] As corroborated by the surviving narratives, the latter was generally gained through raiding and warfare, as the internal production capacities were mostly insufficient to meet such requirements. Accordingly, from an anthropological perspective, warfare plays a more or less prominent role in multiple theoretical concepts (Carneiro 1981, 64; 2017, 33–37; Earle 1997), not only as the violent medium of enlargement of the territorial extent and gaining control over other political entities. Therefore, the loyalty of the retinue members was tightly bound to the actual success and achievements of the respective chief and provided the grounds for high fluidity (change in leadership, growth and reduction of the retinue size) within these societal segments. However, the degree of such provisioning, necessary to be mobilised at once in

105 However, this correlates well with the scanter occurrence of military conflicts and violent hostilities during this long period.
106 Cass. Dio LXXI.3.
107 Tac. *Germ.* 13.
108 Tac. *Germ.* 14.

the immediate risk, could also significantly deplete the available chief's resources (e.g. Roymans 1980, 136–144).

The degree of relationship between a leader (chief) and his followers (retinue members) was further explored by H. Steuer (1982, 55), who outlined three levels. The first category is based on a bond maintained by the prestige and charisma of a patron/chief. The retinue members are recruited foremost from the same geopolitical entity ('tribe'), preferably kin-based, to decrease the possibility of violent overthrow. The second category is thought to be induced by external threats, and the retinue member could also originate from other geopolitical units, as higher demand draws the attention of potential retinue members from elsewhere. This inevitably increases the probability of hostilities towards the local population and its chiefs. The increased pressure on the redistribution system to maintain loyalty ('prestige goods' and gift-giving institutions) would also increase the frequency of raids and armed conflicts, either between the Germanic geopolitical entities or the Roman Empire. However, this category fits more within the 'decentralised stratified societies' (Kristiansen 1991). The third category is more advanced, where a sizable retinue is maintained by regularly distributed subsistence and wealth. The resulting requirements put significant pressure on the gradual expansion of the territories, procurement of new sources of income and monopolisation and specialisation of production). However, this form is expected for the polities on the level of transitional or early states (e.g. Claessen, Skalník eds. 1978).

The retinues were primarily oriented to extend the chief's power strategies and consisted of 'warriors'. However, theoretical models consider non-combatants to be a vital component of the chief's retinue, serving administrative (management of land, livestock, and resources), economic (traders, artisans and craftsmen), ritual roles (priests), and cultural (musicians and poets) roles, and which reinforced political stability and military/economic efficiency (e.g. Service 1975; Earle 1997). These specialised members supported the redistributive economy and ceremonial legitimacy and potentially played a part in the early state-building processes. The respective heterogeneity could be anticipated for the Germanic societies (e.g. Enright 1988; Carnap-Bornheim 1992; Bazelmans 1991; Steuer 2021). Nevertheless, presumably, the largest part of the retinue consisted of armed persons, which in the archaeological record are primarily associated with the 'weapon' or 'warrior' graves. Important implications for the structure of retinue and social stratification were drawn from military equipment from Illerup (Carnap-Bornheim, Illkjær 1996, 483; Jensen, Jørgensen, Lund Hansen 2003, 312–313). The model identifies the commanders, officers and warriors (soldiers) who could be associated with corresponding entities in narrative sources.[109] Up to an extent, comparable structures could be observed in the funerary record from the 'Marcomannic' settlement zone (see Chapter 8.2.4).

9.7 Vertical (social) and horizontal (spatial) organisation structure

Various aspects of the hierarchical entities of the Celtic and Germanic social organisations have been explored previously by N. Roymans (1990, 17–47), establishing the model of the structure comprising the hierarchical sequence: local groups – *pagus* – *civitas*, which is based on multiple narrative sources and corroborated in the archaeological record. These hierarchical entities were established above all through the narrative sources, i.e. Caesar,[110] Tacitus,[111] or Pliny the Elder.[112] Inevitably, structuring the Germanic social space requires a reflection on its geographic counterpart and political and territorial segmentation. Such differentiation would also correspond with identifying the studied Germanic society as a complex or paramount chiefdom. Nevertheless, for such assessment, archaeological sources provide information only circumstantially and on a limited scale.

The local groups were presumably internally organised through kinship relations and formed fundamental entities of the social fabric (Roymans 1990, 18–19), and presumably, chiefs of local importance, and political power governed them. The exact status of these groups is unknown, but they presumably varied in size, wealth, degree of nobility, and political influence. Therefore, an additional hierarchical structure probably existed within this level of social organisation. In contrast, the surviving narrative by Tacitus reflects the existence of the spatial and

109 Tac. *Germ.* 6.1. 13–14; *Res Gestae div. Aug.* XVI. XII. 23–26.
110 E.g. Caes. *BGall.* I.12.4–7, IV.22.37–38, V.31.1, VI.11.2, VI.19.3.
111 E.g. Tac. *Germ.* 6, 20, 21.
112 E.g. Plin. *NH* IV.101, IV.106.

organisational entity conventionally translated as a 'canton', which was regarded especially concerning the levy-raising capacities (infantry and cavalry) of a uniform number of a hundred (*centeni*).[113] Nevertheless, such explicit information potentially reflects more complicated and variable partitioning of the 'administrative' entities and has to be considered cautiously. This narrative also includes the development of the term, which presumably lost its original meaning over time due to the development of quantitative properties of the Germanic political organisations (population size and territory extent) to align with the actual needs of military power strategies and conceptions. Such capabilities depend mainly on these geopolitical entities' demographic and economic conditions. Providing this number could be roughly 20% (the proportion of those fit for warfare) of the total population, such entities would be around 2,000 in size.[114] Nevertheless, considerable variability existed there, and this number oscillated significantly (cf. Vlach 2018b; Chapter 7.3).

Further to the top, a somewhat more explicit organisation entity, called *pagus*, has been drawn from narrative sources (Dobesch 1980, 379; Roymans 1990, 19–21). The *pagi* presumably experienced a relatively considerable amount of autonomy, and on some occasions, they acted as independent political entities. They represent sort of a 'subtribal' entity (potentially a distinguishable clan) and are expected to have the same political institutions as *civitas*, which is the overreaching level of social organisation.[115] Their integration within the superior *civitas* level was presumably not unchangeable, as reflected through the narrative sources, where on several occasions, *pagi* (or their assumed representation) are mentioned to split from their *civitas* and move elsewhere, eventually establishing a *civitas* on their own (Roymans 1990, 22). The top level in this model – *civitas* – is then regarded as a sizeable sociopolitical formation, bearing their 'tribal' names, conducting the wars, concluding peace and other treaties, and having their own political institutions (Roymans 1990, 21). Generally, it is supposed to be an agglomeration or confederacy of several *pagi*. Their spatial dimensions could be assumed from the Augustan transformations of the *civitates* in *Gallia* around 27 BC into provincial administrative units (Roymans 1990, 22). Although the conception reflects the Gaul environment foremost, the assumptions could also be drawn for the Germanic societies in terms of underlying properties.

The actual quantification of the population size and occupied territory of the chiefdom-level societies also has some traditions and has been debated in several instances (e.g. Steuer 2006; Grinin 2017, Tab. 1). However, the variability of many properties defining a chiefdom and the number of existing parallels of either modern or past polities provide significantly wide margins for estimating these parameters. For example, it has been estimated earlier for the comparative context of complex or paramount chiefdom that the basic territorial units of between 2,800 and 7,800 km^2 (ideally defined as a circle with a radius between 30 and 50 km) could include an average population of 10,000 (Steuer 2006, 229). In this context, it is also notable that the territory controlled by political entities from Heuneburg (e.g. Parzinger 1991; Härke 1982), represented through exceptional funerary context, was roughly up to 50 km (Krause et al. 2019). The level of excellence of the most prominent burials justifiably complies with the 'paramountcy'. As already assumed above, about 20% of the population could be fit to fight. Estimates of the size of the military from one territory, roughly between 1,500 and 2,000 fighters, are correlated, for example, with estimates based on the quantity of the shield finds from Illerup (Steuer 2006, 229).

Nevertheless, the territory size of the studied 'Marcomannic' settlement region covering 16.5 thousand km^2 would produce a population density between 1.3 and 3.6 per km^2, which is well below the expectations (cf. Vlach 2018b; Chapter 7.3.1). However, such discrepancies have been seen previously in past chiefdom societies, and not only in quantitative but also qualitative categories. Therefore, A. Korotayev and L. Grinin have introduced the concept of the *early state analogues* (Grinin 2017; Grinin, Korotayev 2017), which deals with the chiefdom-type polities, which in some of their properties (their population size in particular), match or even exceed the thresholds assumed already for the of the early states. Specifically, the Iron Age societies of the European context (i.e. the Celtic and Germanic societies) are particularly named as examples of such 'analogues' (Grinin 2017,

113 Tac. *Germ.* 6.

114 With such reconstructed population size and modelled local population density within the 'Marcomannic' settlement region (cp. Vlach 2018b).

115 Caes. *BGall.* V.31.1.

201–203). The mid-4th-century record from the German invasions to the province of Raetia informs about the combined Germanic army with a total of 35,000 fighters led by a total of 17 tribal leaders,[116] again indirectly suggesting high variability in the average military size of a 'tribal' territory between 2,000 and 3,000 warriors (Steuer 2006, 231). Yet, the notorious bias in explicit figures within the surviving narratives has to be considered, and the numbers could be a product of agenda endorsement or vagueness of the contemporaneously available information. Nevertheless, the geopolitical development within the Germanic societies and the emergence of more substantial chiefdom confederacies of the Late Roman Period.

One of the rare surviving indications of the complexity of the internal power division and structure of the Middle Danube region comes from the turbulent epoch of the Marcomannic Wars, when the assembly led by Germanic chief *Ballomarios*, perhaps of even paramount status and other 11 'tribal' representatives were involved in the negotiation of a peace treaty in 166 AD shortly after the initial failures of the invaders.[117] It seems evident that such a number could not correspond to the known 'tribal' political entities of the region, where only three significant ones can be observed (*Marcomanni*, *Quadi*, and *Iazyges*). In addition, there is one more obscure and probably relatively marginal entity of *Naristi*. Additionally, the potential presence of the newly coming entities of Langobardi and Obii could be accounted for, as they perpetrated the first and unsuccessful attack at the beginning of the Marcomannic Wars. However, no more than six such representatives would potentially be necessary for the assembly considering the required one representative from one polity ('tribe'), identified from the Roman perspective. Almost twice the large number from the surviving narratives seems to suggest other potential clues. It may also reflect the presence of other prominent power figures (distinctive chiefs) directly below the paramountcy from the featuring 'tribal' entities to be included in the deputation.

9.8 Demesnes, subsistence and economic aspects

Concerning the development and dynamics of the economic aspects and wealth distribution within Germanic society, it is necessary to tackle the issue of the potential ways in which individual demesnes/farmsteads (*Lendbesitz*) are passed from generation to generation. As pointed out earlier (Price 1968, 436) and is well attested for the Celtic environment (Roymans 1990, 20), if the gavelkind succession[118] were employed within the 'free' population, it would lead to a continuous division of the basic economic unit of subsistence.[119] Logically, such submersion would result in the incapability of the respective units to sustain their population due to a lack of necessary land or other means. For the studied region, this assumption merits foremost for the first two centuries AD, when an almost exponential increase in population size is reconstructed from archaeological data (Chapter 7.3). Nevertheless, this problem was conveniently solved by the firstborn male's inheritance of a subsistence unit. At the same time, the younger sons were predestined – among other possibilities[120] – to become retinue members. Naturally, high natality and mortality rates played a significant role in this process. However, such a solution was only possible to prevent consecutive division of formally and spatially elemental demesnes, which were not part of direct chieftain holdings and were distributed within the 'free' Germanic population. Nevertheless, based on narrative sources, the gavelkind succession type was also used in Germanic populations, as it was relatively wellattested in the case of *Chauci* (Price 1968, 443), which seems to be absent of stable retinues. Conversely, they presumably could have summoned a sizable army[121] in case of need. However, most of these ties and connections, which underline the vital bonds and constituted margins of traditional or 'legal' settings, are nearly untraceable in the archaeological record, but assumptions on their existence and principles could significantly enrich our understanding of the studied societies.

116 Amm. Marc. XVIII.2.13.
117 Cass. Dio LXXII.3.1a.
118 The form of inheritance where only the first-born male is considered. Other male successors must find their income and subsistence elsewhere or within the heirloom but in a probably inferior position (Gibson 2008).
119 Even if, during the first stage, it was intended for all the heirs to inherit the demesne together and to remain undivided (Price 1968, 443), the tendency to the particularism type of development is embedded here.
120 Expectedly, some of them may have proven unfit for the service in chief's retinue, therefore remaining at a homestead of origin and take up a rather inferior position.
121 Tac. *Germ*. 35.

Only two remarks on the principles of primary subsistence source distribution on a community level are available in narrative sources. The first comes from Caesar, stating that the agriculturally viable land was distributed through the principle of non-permanent holding, in which chiefs annually assigned the land. This system allegedly prevented the risk of the emergence of bonds to land and further aspirations of enlargement of demesnes.[122] Such an approach should also maintain the idea of social equality, minimise sources of inequity and quarrels, and encourage military readiness of the population (e.g. Price 1968; Wells 2001; Young 2015). However, Caesar's statements need to be considered in the context of the narrative agenda, which portrayed the Germanic polities as rather 'primitive' and warlike to endorse their danger for either Celtic societies or Rome. Nevertheless, it is in partial alignment with the only surviving account by Tacitus on this topic, which is potentially more relevant for the studied region in terms of time and space, pointing out that control over the distribution of these critical primary resources within the community is the competence of a respective chief. Both narratives reflect the practice of a periodical basis on which the redistribution of the primary means of subsistence was allocated through the Germanic communities. However, there is a difference in the admission of the partially hereditary forms of landholding and its assignment through hierarchical principle in the later narrative by Tacitus, despite also having Caesars' reflections on the subject to draw upon, suggesting a shift in these fundamental rights throughout the time (roughly one and half centuries). Explanation of this shift could be sought through the process of spatial stabilisation of the geopolitical and habitation structures of the Germanic populations, which gradually led to an increase in rights for personal landholding, which the very principle of the land rotation and assignment should have prevented (Young 2015).

In any case, the described rights held by organisation entities – chiefs – to decide on the land allocation, if anywhere near the back-then realities or at least existing partially, must have been within the most significant and influential ones in the chief's portfolio. However, from the perspective of social anthropological models, such forms of collective landholding are documented in segmentary societies (both agrarian and pastoral), where it is distributed periodically through kinship hierarchies and also complies with 'redistributive economies' within chiefdom-type societies (e.g. Earle 1991). As documented in both surviving narratives, such principles were oriented to reduce inequity and economic stratification (e.g. Sahlins 1972). The main difference represents the strikingly 'egalitarian' approach of the practice in the earlier description by Caesar. Nevertheless, these forms of subsistence are documented for the less complex chiefdom societies, and their presumed existence in Germanic societies during the Roman Period would represent a rudimentary factor. It is notable that the result of social inequity evaluation through the Gini index, based on the funerary context (see Chapter 8.2.2), accordingly suggests generally lower numbers (average 0.27 during the studied period) of this key variable, that it is often documented in complex chiefdoms (e.g. Kohler et al. 2017). Even more pronounced 'equality' suggests the same approach in the case of documented pit houses, where the 'living floor area' was used as an input variable (Gini index of 0.19; see Chapter 7.1.1). Such principles would also be in alignment with the spatial possibilities and limits reflected through the knowledge of the structure and scale of the Germanic community areas of the studied region, i.e. settlements (e.g. Droberjar 1997; Droberjar, Komoróczy, Vachůtová eds. 2008; Vlach 2018b), suggesting domination of relatively small community areas with generally favourable conditions and good accessibility of the adjacent economic hinterlands.

If we consider the context of the 'Marcomannic' settlement zone in terms of the economic resource of the chief power strategies from the social anthropological perspective, several distinctive aspects emerge. Regarding the level of societal complexity, subsistence strategies, and available sources, it would be prone to comply with the category of *staple finance* and commodity flow-based power maintenance, which no doubt was an underlying part of the practice. Nevertheless, the exceptionally anomalous role had the coexistence with the Roman Empire and the role of the imports, which quality and accessibility could be attributed on the various scales as a part of the so-called 'prestige goods'. As a result, a significant part of the *wealth finance* resources originated outside its consumption environment. Their significance within the 'prestige economy' (e.g. Earle 2011) and redistribution system for power

122 Caes. *BGall*. IV.1, VI.22.

maintenance was considerable either in the perspective of its mediation as well as its restriction (prohibition of unauthorised access to 'prestige goods'). Therefore, the Roman-origin items represented an extraordinary opportunity for chiefs to maintain their monopolised position in its mediation, and simultaneously, they served as a significant catalyst for social changes on the *Barbaricum*-wide level. Such expectations are corroborated through the archaeological data from the studied region, where the exceptional aggregations of various find categories of 'imports' within the 'Marcomannic' settlement region (cf. Chapter 6.3) points out the structuring of the actual and 'power' space consistent with prestate social organisation models (Spencer 2010). These results suggest the relatively stable presence of power structure entities in archaeological data. The magnitude of its significance in Germanic society and the economic interaction with the Roman Empire is sometimes rendered as a key factor resulting in the emergence of the Late Antiquity 'barbarian' states (e.g. Pohl 2001; Todd 2005).

Some proxies of economic change could be seen in the level of complexity and organisation of particular production activities. Hand-made pottery represents the most common archaeological material, which reflects the traditional form of local production on the scale of individual communities (cf. Droberjar 1997). In contrast, during the Late Roman Period (generally from phase C2 onwards), a large part of the Germanic world witnessed the emergence of specialised production centres for wheel-thrown pottery (designated within the studied region as the fine grey 'Jiříkovice-type' ware, e.g. Pernička 1985; Peškař 1988, 111–113), but known from multiple parts of the Germanic environment,[123] clearly using advanced Roman technologies, requiring the existence of distribution patterns, which could have been organised by a power-yielding authority – a chief. Such enterprises required more developed organisation capacities and capabilities to successfully run this specialised production, which was unknown in the Germanic environment during the Early Roman Period. The benefits from the control and distribution of the production could have provided additional sources of revenue for expenses (retinue members) and exercise power strategies. Such initiatives are also attributed to the compensation for the decrease in Roman pottery influx (e.g. Mayer et al. 2016). Nevertheless, the state of knowledge on this specific category of archaeological material from the studied region doesn't allow this assumption to be corroborated at present.

One of the critical factors in the chiefdom type of societies and control of the sources of income is a bottleneck strategy. Such effects could emerge from geographical (environmental) fragmentation and other communication constraints and are essential in procuring means for materialising chief power strategies. Within the 'Marcomannic' settlement zone, the 'axiality' of the region is naturally prone to the channelling (or 'bottleneck') effect, especially along the axial rivers. Beyond any doubt, the ancient Amber Route (cf. Quast, Erdrich Hrsg. 2013; Hilgner, Greiff, Quast (Eds.) 2017) ran along the River Morava (e.g. Pollak 2006) with an expected associated network of regional and secondary 'subroutes' from which one of the courses presumably led along River Thaya in the direction of Bohemia, cf. Madejski 2013, 48). It represented a vital commodity flow direction (e.g. Čižmářová, Měchurová 1997). Nevertheless, the recorded occurrence and use of amber in the Roman Empire peaked during the 1st century AD and later decreased. The notorious comment on the journey of the Roman knight to the Baltics procuring an astonishing amount of amber[124] also provides some additional insight into the organisation of the trade (cf. Quast 2017). The theoretical models by C. Renfrew (1972, 465–471) seem to best explain the chain and its organisation. The scant evidence from various periods (the Le Téne and Hallstatt Periods) shows that long-distance transport has been conducted through several points ('middlemen' resulting in archaeological contexts interpreted as depots) along the route (Quast 2017, 65).

In this context, not only the amber but also a variety of other commodities flowing both ways through these routes could have provided an extraordinary source of chiefly income through taxation. Therefore, it is unsurprising that such exploitation is also corroborated in narrative sources, as the *vectigalia* is mentioned for *Regnum Vanium*, whose power could have extended to the lower reaches of the River Morava (Pitts 1989, 48; Zeman 2017b) by the time the amber trade was significant (e.g. Quast, Erdrich Hrsg. 2013). The presence of the Roman traders is also indirectly corroborated by the mortuary inscription, which was found as a *spolia* in the church in Boldog (Kolník 1978).

123 Bohemia (e.g. Rybová 1976), Slovakia (Pastor 1961; Luštíková, Rákoš 2018), or other parts of Germanic milieu (Mayer et al. 2016).
124 Plin. *NH* XXXVII, 45.

Nevertheless, such trade route bottlenecks could be anticipated along all the substantial river courses and some passes (e.g. Vyškov Gate, Spytihněv Gate, and the corridor between Ždánice Forest and Chřiby), placing significant advantages on the chief who controlled the respective sections of these courses.

9.9 Conflict and warfare

In the early historical societies of the first millennium AD, war was conducted almost every year (Steuer 2006, 229), as well as in many other periods of Prehistory, and according to some theories, it was a significant component of a chiefdom and a driver of its changes (e.g. Carneiro 1991; 2017). It is also assumed that the names of the 'tribes' seem to be based on the names of the military entities – retinues, demonstrating the dynamics of the transformation over time (e.g. the emergence and collapse of military coalitions and tribal unions). Archaeology, through its sources of information, reflects the foremost 'peaceful' activities of the studied societies. On the other hand, evidence of combat engagements is naturally quite rare (Vencl 1984b), and the quantitative and qualitative characteristics of their frequency and distribution are subject to the same rules as other archaeological sources. The dynamics of these processes can be secondary to the archaeological record (e.g. 'destruction' horizons, presence of weapons or anthropological material with characteristic traumas, etc.). However, the predominant nature of these events does not create conditions suitable for their propagation in the archaeological record, evident through the optics of archaeological field methods. An exception, for example, is the well-known battlefield in Kalkriese (e.g. Rost, Wilber-Rost 2014) or, most recently, in Hartzhorn (Pöppelmann, Deppmeyer, Steinmetz 2013).

As the monopolisation and exclusivity of organised violence (warfare) are expected at the state level of social organisation (Armit 2011, 499), the chiefdoms exhibit forms of violence (e.g. revenge/vengeance for individual- or group-based crimes) which are not under explicit, but more fluid and negotiable rules (Armit 2011, 501). On the contrary, the need for capable, unambivalent warriors and generally 'battle-ready' levies in such societies inevitably increased the general violence level and standardised its practice (Ember, Ember 1994, 620). As a consequence, the pre-industrial societies, in general, were in a permanent state, where conflict of various forms could occur and was the permanent reality – a 'State of Warre' (Hobbes 1642; Corbey 2006), foremost due to the absence of an institution that could prevent such a state (Claessen 2017, 118–119). Such omnipresence of conflict was also attested in multiple documented chiefdom societies. The actual extent and distribution of the right to perform violence within the community could be very well illustrated through the institution of *wergeld*, the ancient and somewhat 'universal' right of individuals or family members whose individual has been harmed in a codified form to perform vendetta or accept compensation in form of the preset value in various currencies or means (Modzelewski 2017). However, in these later contexts, it is already explicitly specified in monetary means. It is a well-documented phenomenon for the succeeding Migration Period or the later stages of development of the Germanic societies (e.g. Machajevsky 2006). Therefore, such principles were inevitably present also in Germanic societies during the Roman Period. The right to organise and perform violence was not exclusively held in the power organisation entities, and its access was limited to the ruling entity, such as the established state organisation structure.

The internal warfare within has played an essential role in chiefdom. It is also well attested in ethnographical context, narrative, and other sources for Germanic society. In its ritualised form, the violent struggle and warfare, occupy an essential position in these societies, but with exceptions, not as a means of mutual destruction. For example, the numerous inter-war battles between the tribal groups in today's New Guinea did not contain the dimension of the promotion of political or power interests (Malinowski 1961, 538). There was never mass destruction of the population or enslavement, and all members of a 'tribe', including women and children, were participants in combat missions. According to existing theories (cf. Otto, Thrane, Vindkilde eds. 2006), the ritualised institution of war and the warfare of pre-industrial societies have significantly shaped social structures. One of the explanations of conflicts generally comes from psychology (Murdock 1960), where violence and aggression are grounded in compensating for frustration due to behavioural regulation through established social standards and can be a mechanism for regulating internal tensions. These behavioural tendencies may, however, reflect individual identification with society and the pursuit of delimitation towards an external/foreign milieu. The author of one of the dominant theories of the evolution of the social organisation – R. L. Carneiro

(1970) – sees a significant element of social transformation towards the emergence of the state in the concept according to the evolutionary scheme by E. Service (1962) in the conflict at the level of individual chiefdoms. In principle, social pressure increases as a result of the internal growth of the population. The victorious party will create power elites that control others through force from the ensuing conflict.[125]

Raiding the neighbouring political entity has always played a vital role in most documented chiefdom-type social organisations, and in surviving narratives on the Germanic societies, it was considered a regular form of interaction.[126] The raiding between the neighbouring concurrent or competing political entities is the cornerstone of the chiefdom performance and represents a vital part of the ritualised and institutionalised violence (Ember, Ember 1994). The success or failure in these activities have been the main criteria for the prestige of individual chiefs and simultaneously constrained the influx of the spoils of war, loot and booty, which was indispensable for the maintenance of retinue. Inevitably, a long-term failure would lead to the reduction of retinue size and proportionately further chances of success. Simultaneously, it would provide the ground to pretenders for power to the questioning of the chief's authority and his deposition. In essence, it is anticipated that they have not been unrestricted destructive activities, presumably leading to only limited casualties, which have not profoundly impacted the overall structure. Instead, they have been a part of socially accepted and culturally embedded violence perforation under specific conditions and rules.

125 Tac. *Germ*. 14.
126 Tac. *Germ*. 29, 30.

Chapter 10

Discussion and conclusions

The present state of research and knowledge on the Germanic communities of the 'Marcomannic' settlement zone represents momentum in the long-term continuous gathering of archaeological material and expanding the knowledge base. The extensive heuristics, conducted examinations, and analyses have been undertaken within the research project supported by the Czech Science Foundation (No. GA20-11070S *Protohistoric Communities of the 'Marcomannic' Settlement Zone in the Middle Danube Region – Structure and Dynamics based on Digital Modelling*; see Acknowledgements in Chapter 1). The core part of the project activities and respective methodological outcomes and approaches were designed to formalise and aggregate the sufficiently representative available data on the Germanic population of the 'Marcomannic' settlement zone of the Middle Danube. The extensive heuristics and the resulting MARCOMANNIA dataset subsequently provided the basis for the generated series of proxies on diverse and heterogeneous phenomena (demography, economy, social structure), represented as probabilistic temporal representations, considered through the inseparable spatial dimension (Chapter 5).

Apart from data-driven analytical approaches (Chapters 5–8), the broadening of the interpretation framework of the 'Marcomannic' settlement region has also been attempted through the contextualisation of archaeological and narrative sources within the theoretical construct of chiefdom in social anthropological research (Chapter 9). Due to the wide array of new results, the evaluation focuses predominantly on the studied regions, where the methodological framework used in this book provided mutually comparable proxies. However, the neighbouring regions presently lack such data and aggregated quantitatively substantiated perspectives on individual segments of archaeological data. Nevertheless, it poses further challenges and opportunities resulting from extending the spatial scope of the already compiled dataset by the directly neighbouring Germanic settlement zones to the west (Bohemia) and east (southwestern Slovakia).

From an extensive array of data inputs from the archaeological record used in this book, it is apparent that it is beyond the scope to fully explore all multifaceted aspects of archaeological data contained in the MARCOMANNIA dataset (Chapter 4). Instead, it aims to consider the derived baseline and secondary proxies as additional, more quantitatively substantiated perspectives on the development of the studied Germanic societies from a general standpoint. The approach does not question the present or past theoretical frameworks but instead, it provides quantitative substantiation on some of the processes and supplies additional differentiated perspectives, which have not been available so far for the scoped spatiotemporal anthropic context. Furthermore, there is no intention here to put forth a coherent and exhaustive outline of the chronological development of the studied region during the Roman Period; instead, it is to investigate the development patterns in archaeological data. In this summarisation, the pivotal point lies in the extensive conflict of the Marcomannic Wars and the evaluation of the development patterns in various proxies regarding pre- and post-war characteristics of the development of the 'Marcomannic' settlement zone from a general perspective. Nevertheless, the conspicuous trends in other parts of the Roman Period will be considered.

The endorsement of the principle of quantitative representativeness (cf. Neustupný 2009, 54–67) resonates throughout this book's approaches and underlines the objectives of exploring this unexploited dimension of archaeological data so far. Nevertheless, large quantities do not necessarily equal significance or correlate with interpretation 'strength'. Leaving aside the dominant segment of archaeological material consisting of the pottery of the local origin, whose interpretation 'strength' somewhat negatively correlates with its quantity, it was the foremost objective to employ into consideration and analysis the find categories, which possess at least minimal typochronological and dating features. Nevertheless, there are significant gaps in the present knowledge base constructed on the assumptions of the 'recovery rate' of archaeological material and information. Simultaneously, as demonstrated in the case of the data quality and representativeness assumptions of residential areas (see Chapter 4), even a relatively small subset contains the data providing the same trends as the whole dataset. Respectively, this principle applies to other find categories, such as brooches or Roman coins. However, the detailed qualitative perspective on various find categories will be the subject of dedicated studies in future, and they are significantly beyond the scope of this book. Therefore, some of the perspectives may suffer from this deficiency.

From the perspective of the primary agency of past activities, which could secondarily propagate into the archaeological record through a series of archaeological transformations and biases (cf. Neustupný 2009), the population size is a key factor in understanding the quantitative aspects of archaeological data and the changes in time. Therefore, the derived proxy indicators, which have a justifiable relevance and presumed connotations with underlying demographic properties (i.e. foremost the settlement and burial data; see Chapters 5.1, 5.2), have been explored to provide the basis for reconstruction and estimates on the population size and its development within the studied region (Chapter 7.3), as well as on spatially differentiated scale (see Chapter 7.3.1) or through various segments of habitation-related subsets of data from the MARCOMANNIA dataset (e.g. floor-area size, average community size; Chapter 7.2). Therefore, it was possible to put other proxies on individual find categories that could have been put into perspective of their relative 'amount' or rather proportion regarding the available contexts.

The demographic reconstructions show a differentiated but rather steep increase in population size throughout the first two centuries AD. Nevertheless, the derived net growth rate of over 4% per year during the initial phases suggests external sources of the population increase (immigration) to reach the reconstructed population size at the end of this century AD (estimated 80,000; see Chapter 7.3.1). The reconstructions of this temporal segment, coupled with the network analysis results (Chapter 6.4), suggest initially high rates of decentralisation and low integration of settlement structures with the residential areas scattered in low numbers throughout a considerable extent of the studied region. The following increase during the 2nd century AD, despite quantitatively equal to the previous increase, could result from the intrinsic growth, oscillating between 0 and 1%. Therefore, different underlying demographic processes could be distinguished in available 'demographic' proxies. The reconstructed population growth reached its climax in the mid-2nd century AD (estimated 170,000). Nevertheless, the comparable pattern of increase is documented in other parts of *Barbaricum*, such as the spatial domains of the Przeworks and Wielbark cultures (Domański 1994, 64) or the north-western borderland (Erdrich 2001).

This development in the 'Marcomannic' settlement zone was followed by the first significant decrease in the reconstructed population size between the 150–200 and 200–250 AD time blocks. Such a decrease could be well associated with the extensive warfare period of the Marcomannic Wars. Apart from war-caused attrocities, the potential role of epidemics (Antonina plague) could have potential effect on the reconstructed decrease in population size (Vlach 2020). However, despite the high recorded *abandonments*, relative stability could still be observed through the recorded *continuity* of residential areas, complemented by high rates of the recorded *foundations* of the new settlements in the time block 200–250 AD. Considerably different properties of the spatial pattern of residential areas also underline the network analysis (Chapter 6.4.). There are apparent disintegrating trends and clustering of the previously more interconnected continuum of the settlement zone.

Furthermore, these clusters are more densely distributed and have a high reconstructed connectedness. The following time block, 250–300 AD, suggests a marginal increase in population size, followed by consecutive decreases and high rates of recorded *abandonments* in residential area data until the terminal time block, 400–430 AD when large parts of the Middle Danube Germanic populations are expected to move from the region to the west (e.g. Dobiáš 1964, 303–304; Hummer 1998). Notably, the corresponding gradual decrease in population size is expected for the settlement regions of Wielbark and Przeworsk cultures (Domański 1994, 64). Nevertheless, the unified and aggregated demographic trend is underlined by the distinctive regional variability apparent through the hexagon-based outlines (see Chapter 7.3.1). There could be distinguished regions with low reconstructed population densities during the whole studied period, as well as significant fluctuations in prominent low-laying regions along the axial river courses of the 'Marcomannic' settlement zone. Therefore, a profoundly vivid mosaic of spatio-temporal development emerges from empirical data.

One of the most significant phenomena of the 'Marcomannic' settlement zone, significantly affecting Germanic societies, was their vicinity to the Roman Empire. The large amount of archaeological data on Roman provincial products ('imports') within the Germanic context, coupled with available narrative sources, provide unique information for these studies. Yet, theoretical models usually do not deal with the quantitative substantiation of the aspect of the phenomena they describe on a larger scale. Thus, despite the extensive typological variability of the featuring find categories of Roman origin, only those with the highest quantitative representation were included in the evaluation to reveal underlying trends (Chapter 5) or spatial patterns (Chapter 6.3). Notably, the development patterns in the proxies of the material categories and respective materials *per se* (foremost copper alloys and iron; Chapter 5.4.2.2, 5.4.2.3) have to be put into perspective and contextualised regarding the differentiated ways in which materials were transferred to the Germanic environment. From the limited availability of the primary sources for the production of copper alloys, the influx of Roman-origin material played a significant role in the Germanic economy (cf. Erdrich 2018). Multiple aspects connected with the differentiated use (reparations) and reuse (recycling) and external sources (e.g. *ad hoc* raiding and looting, trade/barter) of various metal objects/materials have significantly influenced the derived temporal patterns. Nevertheless, the differentiation of their frequencies and proportionality in the overall circulation of the materials is challenging to estimate. However, exceptional quantities within this 'flow' could be anticipated within the margins of the phenomena of looting and war booty, which have varying dynamics throughout the studied temporal scope.

The inceptions of the Germanic habitation within the studied region are still the subject of debate, and only inconclusive and often unstratified archaeological evidence and scant narrative sources provide clues on the initial stages of Germanic immigration to the 'Marcomannic' settlement zone (e.g. Tejral 2009; Zeman 2017a). Therefore, the respective digital modelling approaches (foremost the simulation of the population size baseline; Chapter 7.3) are difficult to establish regarding the initial point of the Germanic presence within the studied region. As for the relative chronological stage A, only significantly scant and unstratified evidence is available. The initial point for simulations of the population size was, therefore, set at the beginning of stage B1 (i.e. the beginning of the substage B1a; therefore, BC 10; cf. Chapter 3.3). The actual character of the immigration is nearly impossible to establish. Nevertheless, if the reconstructed net growth rate per year above two could be considered as resulting primarily from this demographic process, the lower values would not be reached before 20 AD. Further development patterns in the dominating part of the derived proxy indicators on various segments of archaeological data show patterns consistent with exponential increases.

Beyond any doubt, according to the present research (cf. Erdrich et al. 2020), the extensive conflict of the Marcomannic Wars (166–180 AD) represented a significant event with substantial and multifaceted impacts on the Roman and German environment. It is not intended to go into greater detail on particular events and periods whose association with the archaeological record is conversely problematic (Komoróczy et al. 2020). From the perspective of the employed arbitrary time block framework of a 50-year duration, the conflict period covers almost one-third (28%) of the respective time block 150–200 AD. As a result, the time block aggregates three distinctive historical phases – pre-war, war, and post-war – and in this temporal framework, it is almost impossible to distinguish them. Therefore, the changes will be considered regarding the preceding and following time blocks and their explanatory potential on the multifaceted causes and consequences of the extensive Roman-Germanic conflict and the wide range of impacts on the Germanic demographic conditions (battle casualties, raiding and pillage of the Roman army, enslavement and hostage-keeping, raising levies then reassigned to other parts of the Empire, effects of the Antonine plague through the Roman military etc.). Nevertheless, the various forms of the impact of the conflict could hardly be quantified and differentiated from the proportions that would be present if such a conflict had never existed.

Yet, this effect is foremost apparent in the baseline proxy of iron (Chapter 5.4.2.3), where the exceptional increase during the time block 150–200 AD suggests an influx significantly surpassing the conditions before and after the respective time block. A notably similar pattern is also apparent in *militaria* (Chapter 5.3.4). Nevertheless, the frequency of the burials with weapons is stable at around 4% of the documented evidence during the 2nd and the 3rd centuries AD (see Chapter 8.2.4). From the 'non-military perspective' of the iron material, a slightly different temporal distribution could be seen in the find category of tools (Chapter 5.3.5), which is also significantly connected with this material type. Despite reaching its peak during this time block, a pattern more consistent with the 'demography' oriented proxies could be seen. Nevertheless, there is also an evident sharp decrease between the time blocks 150–200 and 200–250 AD. Therefore, it is apparent that the surging probabilities in iron material are bound primarily with the *militaria* find category and the warfare period during the 2nd half of the 2nd century AD, but also with the general accessibility of the material, which propagated into the 'civilian' context (tools). Eventually, the significant drop in iron and militaria during the consecutive time block 200–250 AD, documented foremost through the funerary record, suggests the levelling of occurrence to the pre-conflict time block 100–150 AD reconstructed probabilities, comparable to other time blocks. Therefore, the reconstructed probability distributions outside the 'anomalous' time block 150–200 AD could be justifiably associated with this material's baseline volume of Germanic production. In the case of copper alloys (Chapter 5.4.2.2), the peak is reached in the same time block, but it appears to be the terminal part of the gradual increase through the first two centuries AD. However, the probability distribution of both key materials decreases significantly during the subsequent time block 200–250 AD.

The presumable causes of the Marcomannic Wars have been the subject of extensive debate (e.g. Tejral 1983; Friesinger, Tejral, Stuppner Hrsg. 1994; Erdrich et al. 2020), in which one of the primary triggers is seen in the population movement in the northern parts of *Barbaricum* and resulting pressures, coupled with relative weakening of the Roman military capabilities on the Middle Danube borderland (e.g. Böhme 1975, 212; Dobiáš 1964, 194). Within the Middle Danube region, the archaeological record in multiple instances verifies the presence of elements from the environments of the Wielbark and Przeworsk cultures (e.g. Tejral 1970b; Droberjar 2015). Although the movement of the material doesn't necessarily imply population movements (e.g. Gregoricka 2021), the coupled archaeological, documentary (surviving narratives), and new genomics (Stolarek et al. 2019) and paleoclimate research (Drake 2017) corroborate the theory on substantial population movements during the period. However, assuming the increased pressure on the Germanic societies of the 'Marcomannic' settlement zone from presumably substantial immigration (i.e. population from the northern environment, incoming Langobardic army of 6,000 warriors), the question would be entirely appropriate whether it was more advantageous to confront the incoming populations than the Roman Empire. However, apart from external population influxes during the initial decades of the 2nd half of the 2nd century AD, the local population development patterns could also be drawn from 'demographic' proxies (see Chapter 5.5, 7).

The growth observed in reconstructed development patterns (Chapter 7.3) suggests an exponential increase, reaching the maximum already during the mid-2nd century AD. The reconstructed net growth values show that only relatively low rates of up to 1% per year would lead to an increase from the estimated population of 90,000 during the 2nd half of the 1st century to 170,000, assumed for the half of the 2nd century AD. Therefore, no external population influx would be required for such an increase, even if for a relatively short period, once the population reaches the size where even low growth rates can propagate in a significant population increase (cf. Neustupný 1983). Furthermore, the period overlapping with the temporal extent of the time block 100–150 AD is generally characterised by stable and 'peaceful' Roman-Germanic interactions (i.e. both a notable silence in the narrative sources and an absence of relevant evidence in the archaeological data) with the presumably strong influence of Roman administration on Germanic political affairs (e.g. Pitts 1989, 49) including the appointment of the paramount chiefs – 'kings' (the coinage *Rex Quadis datus*; Swoboda 1957; or the confirmation of

Furtius as 'king' of the *Quadi* by the emperor[127]) and favourable climatic conditions (cf. *Roman climate optimum*; e.g. McCormick et al. 2012; Harper 2017; Harper, McCormick 2018). In such conditions, the short-term growth rates between 0.5 and 1% would be reasonable and well within the justifiable margins.

Furthermore, the demographic reconstructions and assumption on the spatially differentiated population densities (see Chapter 7) suggest, along with some theoretical concepts in paleodemographic research, that the estimated population densities were way below the threshold generally called carrying capacity (e.g. Hassan 1981; Turchin 2009; Kempf, Depaermentier, Glaser 2023), which has generally had significantly favourable conditions for the successful performance of primary subsistence strategies on the level of Iron Age societies in general. Therefore, the cause of the actual lack and insufficiency of land for agricultural activities seems to be improbable, even from the perspective of the short-term increase in population size. The written sources explicitly mention the praxis of the relocation of some Germanic communities and groups on Roman land (even in *Italia*) by Emperor Marcus Aurelius as well as many of his predecessors (e.g. Mrozewicz 2013; Steinacher 2019). However, the practice had to be ceased later due to abrupt violence towards the Roman population during the Marcomannic Wars is supported by the surviving narratives.[128] Nevertheless, this practice could be associated with increased pressure on sociopolitical structural maintenance.

Eventually, no matter which demographic processes lead to the documented increase in the size of the settled regions and the population, it would inevitably stimulate an increase in the complexity of the organisational structures. Various factors constrain the capacities and abilities of a chief to control and extend power, foremost the spatial distance and limits of effective 'reach' (cf. Spencer 2010; Turchin, Gavrilets 2009). The increase of controlled territory, therefore, stimulated the emergence of further hierarchically aligned organisation entities. Indirectly, this trend is reinforced by the similarly shaped development of the baseline proxy on precious metals (see Chapter 5.4.2.4), which could be considered one of the circumstantial pieces of evidence on the representation and number of these power entities. Furthermore, its development would inevitably impact one of the essential components of the chiefdom type of society – the retinue. If its proportion within the population of 4% on average (see Chapter 8.2.4) were near the past reality,[129] its size would reach the peaking numbers during the 2nd century AD, between 8,000 and 10,000 (and the actual numbers inevitably fluctuated significantly beyond these estimated margins). Considering the requirements of upkeep of such a body (backed by *staple* or *wealth finance*, or both), regardless of which way distributed within this socio-political context of a presumably increased number of chiefs in different power positions within the system, would inevitably lead to increased requirements of the 'redistribution system'. Therefore, presumed expenses for such upkeep could have pressed the available sources of income. Simultaneously, the lasting, predominantly peaceful relations with the Roman administration during this period (i.e. time block 100–150 AD) provided limited possibilities for additional sources of revenue through raiding and looting on the province's ground. Therefore, the temporal probability distributions of the copper alloy material (Chapter 5.4.2.2) originate from other forms of Roman-Germanic interactions (Erdrich 2018).

However, the causes of these processes can also be found in the development of the internal political and social relations of the Germanic milieu of the 'Marcomannic' settlement zone. It was suggested before that the cause of the conflict can also be seen in the lack of subsidies flowing to the Germanic organisation entities (Ichikawa 1988), who subsequently used them to ensure support for their position within the domestic environment. The latter was supposed to be caused by the initial symptoms of the slowly emerging economic crisis and current expenses due to conflicts in the East (the Parthian campaign under Lucius Verus between 161 and 165 AD; Birley 1987). The emergence of pandemics of considerable proportions (cf. Vlach 2022) further constrained immediately available capacities, foremost in the workforce and available soldiers. These factors, either from the long-term perspective of the development during the 1st half of the 2nd century AD or the decades directly preceding the outbreak of the conflict, this development could have ultimately

127 Cass. Dio LXXII.5.
128 Cass. Dio LXXII.2–3, 10, 15; LXXIII.1–3.
129 However, it is necessary to acknowledge the specific composition of a retinue, which could have been quite variable and which contained not only armed persons (despite probably being most represented) but also some other 'professions' (see Chapter 9.6).

threatened the stability of political structures and social ties in Germanic society. Germanic requests to settle under Roman rule may reflect an effort to compensate for these problems. The emergence of the conflict (in the case of the *Marcomani* and the *Quadi*) could then be partially explained through the gradual escalation of internal tensions after the failure of diplomatic solutions to the crisis of Roman-barbarian relations (Ichikawa 1988).

From the perspective of economic factors and their sociopolitical connotations in this regard, the Roman coinage (Chapter 5.3.2), which, according to their minting period, consisted almost exclusively of *denarii* during the 2nd half of the 1st century AD and their quantities reached the level which is consistent for the three subsequent time blocks (100–150, 150–200 and 200–250 AD). Providing the assumption that they reflect proportionate representation throughout the Germanic organisation structure actors – chiefs in various positions of the power structures, no matter which way they were obtained or transferred into the Germanic environment (e.g. subsidies, bribes, gifts, or results of raiding or trading activities), the relatively marginal increase through this period fails to comply with the trend in 'demographic' (residential areas and others; see Chapter 7) or wealth presence proxies and it even slightly decreases for the time block 150–200 AD. However, this is also a result of a relatively lower representation of the coinage after the Marcomannic Wars (Commodus, Pertinax, Septimius Severus). Nevertheless, the gradual increase of robustness of the chiefdom organisation structure of the 'Marcomannic' settlement zone was not sufficiently balanced with a proportionate rise in disponible 'actives' for various purposes within the chief power strategies portfolio in the form of *denarii*, which could secure maintenance of the system, which settings in this regard are somewhere in the 2nd half of the 1st century when such volume of wealth could 'dissolve' among fewer organisation entities resulting in 'more' for an individual. As the system grew in time, it could be expected that the resources for its upkeep must have been sought elsewhere. And perhaps on a larger scale.

In general, the use of Roman coinage in everyday transactions on a large scale within the studied Germanic context is highly improbable for the studied temporal scope for multiple reasons (e.g. Bursche 2008). Foremost, there was no trade market, and Roman coinage outside its economic milieu could not fulfil all the criteria. The documented forms and organisation of the production would not provide the basis for the emergence of such a phenomenon or the necessity of its adaptation from a neighbouring economic power. Furthermore, the representation of denominations (Chapter 5.3.2.3) with dominating silver *denarii*, with the marginal proportion of copper alloy coins, simply does not comply with such use as the lower values would be required in considerably higher proportions. Such representation, from most of *Barbaricum*, contained in significant proportions from hoards, suggests its use in particular situations, i.e. in the role of the 'special purpose money' (e.g. Wigg-Wolf 2008, 42) or the so-called 'social currency' (Graeber 2012). Due to the significant value stored in this denomination, they could have been used foremost by the power organisation entities – chiefs – for multiple purposes. Various types of 'social payments', such as dowry, gifts, bribes, ransom, tribute, and 'blood money'/*wergeld*, could be expected. However, the Roman coinage would be naturally compatible with the Roman trade market economic interactions to procure Roman-origin commodities from the category of 'prestige goods', vital for power maintenance and cohesion of the social structure of a chiefdom (e.g. Hedeager 1992, Earle 1997).

At the same time, the trend apparent in the probabilistic temporal distribution of the brooches of Roman origin (Chapter 5.3.1) points out an explicitly contradicting development, as they reach the highest representation during the first three time blocks and start to gradually decrease between the time blocks 100–150 and 150–200 AD. Despite their multifaceted social connotations and cultural background (e.g. Hoss 2016), once again, their narrow spectra suggest their procurement rather through organised bulk purchases, which also conditions one of their roles within the 'redistribution system' of the local power structures. Nevertheless, their exceptional spread throughout the Germanic population renders this specific group of Roman 'imports' as an item of a redistribution system with high diffusion, which, due to its relatively lower values (based foremost on the weight of the material), has found its way through 'patron-client' system to all members of the society. Nevertheless, this trend precedes the period of the Marcomannic Wars significantly, and its cause should be sought elsewhere.

However, a conspicuous negative correlation stems from the temporal probabilistic distributions of the Roman coinage and brooches. The outlines of the baseline proxies exhibit a symmetrical shift of the evidenced probability distributions (brooches) and quantities (coins), which might contain evidence of causal interconnection of these two categories in the general preferences of the 'foreign' Roman-origin commodities influx, which was under the control of the chiefly entities to generate the required revenues to extend the power strategies. Notably, the highest deduced proportions of the Roman brooches (see Chapter 5.3.1) are evidenced for the time block 0–50 AD, which also overlaps with the first marked increase of the Roman coinage, suggesting the shift in preference of the form of the accepted subsidies and *donativa*. Bearing in mind all the associated biases, such a structure in the respective baseline proxies converges with the notorious remark by Tacitus about the forms of accepted gifts and donations.[130] Furthermore, this trend continues throughout the studied temporal extent.

Based on the respective baseline proxy, the quantitative temporal distribution of the Samian ware (Chapter 5.3.6) substantially increased from next to nothing during the 1st century AD and the first half of the 2nd century AD to the time block 150–200 AD. Archaeological research on the subject documented a similar pattern within the broader context of the Central European *Barbaricum* (Kuzmová, Roth 1988; Droberjar 1991; Tyszler 1999; Klanicová 2007), with the general shift from the Middle Gaul towards the production originating from the more proximate province of *Germania*. Nevertheless, the qualitatively new influx of Roman production is hard to comprehend in the context of the violent warfare conditions of the conflict period.

Simultaneously, conspicuous trends have been observed through the network analysis of the spatial patterns in settlement structure (Chapter 6.4), suggesting growth in the complexity of the vertical power 'space' as the number of the local and region chiefs would inevitably grow along with the population size. This gradual increase could be underlined by similar patterns in the probabilistic temporal distribution of metal vessels (Chapter 5.3.3) and the occurrence of precious metals (Chapter 5.4.2.4), which is apparent within the development preceding the key time block 150–200 AD. The sharp decrease in baseline proxy indicates a significant shift in this 'prestige goods' influx and changes in the arrangement of the Roman-Germanic relations and interaction. This phenomenon is rendered foremost through the funerary record, where the find category is dominantly represented and where the change in grave goods' patterns is most evident (see Chapter 8.2). Traditionally, this find category is considered more closely aligned with the distinguished entities of the Germanic chiefdom social organisation within the studied region (e.g. Tejral 1967; 1970b; Droberjar 2008; Jílek 2012) as well as elsewhere (e.g. Eggers 1951; Lund Hansen 1987; Erdrich 2001). However, from this perspective, they cannot provide a correlation for the size and complexity of chiefdom organisation entities. Conversely, such a distinctive drop is not apparent in the proxy for precious metals, and the recorded decrease reaches roughly the pre-war level (i.e. time block 100–150 AD).

Furthermore, the peaking probabilities of metal vessels during the time block 150–200 AD are up to an unknown proportion, including the volumes of material relative to the temporal distribution of all contexts originating from the extensive ad hoc warfare-connected events of the Marcomannic Wars. Therefore, the magnitude of the following drop in metal vessels could be considered from a differentiated perspective of copper alloy material temporal probability distribution (Chapter 5.4.2.2). There is an apparent shift in proportions in identified provenance, where Germanic production from this material reaches the highest point during the consecutive 200–250 AD time block. The volume of copper alloy material required for such an increase would inevitably include recycling Roman-origin objects aggregated during the conflict period.

Nevertheless, in terms of the post-war reaction of various subsystems of the studied Germanic society in the short-term perspective during the consecutive decades, the resolution of the analytical approach in this book does not allow for further distinguishing nuanced features, which are usually the results of exceptional events with far-reaching impact on the demographic, social and economic segments, such as epidemics or social uprising. The systemic consequences and propagation of the Marcomannic Wars into the Germanic societies of the 'Marcomannic' settlement zone (cf. Friesinger, Tejral, Stuppner Hrsg. 1994; Erdrich et al. 2020), potentially assumable from the archaeological record, could be observed in general perspective, foremost through the difference of various proxies between the time blocks 150–200 and 200–250 AD. Germanic chiefs and their retinues were the primary driving force of the warfare and other organised violent

130 Tac. *Germ*. 15.

actions. As such, these segments of society must have suffered significant casualties through the long conflict period. Therefore, the existing ties and bonds among these entities underwent substantial modifications as, presumably, some chiefs have been replaced for various reasons during this period. It could be well expected that the authority of involved chiefs, presumably significantly increased after the series of successes during the first 'offensive' part of the conflict, which provided considerable material influx, has proportionately suffered during the consecutive 'defensive' phase between 172 and 180, where the military operations have moved to the Germanic territories (Komoróczy et al. 2020). It could justifiably be presumed that their power was eroded (e.g. Earle 1987).

As the narrative sources indicate, multiple Germanic leaders have chosen cooperative and collaborative approaches within these conditions, which could solidify their position. Therefore, further internal political instability would be expected after the Roman withdrawal in 180 AD, leaving the cooperating chiefs without direct support. Another driver of geopolitical change could be assumed in Germanic warriors in Roman services during the Marcomannic Wars, as political instability provided an opportunity for ambitious individuals who could have increased their position through war exploits to seize power. Thus, the political fabric during the following years could have also undergone some changes, and it could be hard to expect that such a significant change in the geopolitical alignment would incite no changes in the sociopolitical domain. Furthermore, under new conditions, the abandoned Roman military installations on the Germanic territories, especially the central military base at Mušov-Burgstall (e.g. Komoróczy 2008; Tejral 2014; Komoróczy et al. 2020; Komoróczy, Vlach 2022), became exceptional sources of Roman objects and various materials (above all the metals but also Roman building materials). Archaeologically documented hostilities during this turbulent post-war period could be attested in archaeological contexts testifying for violence towards the whole community (e.g. Bálek, Šedo 1998; Dočkalová 2005).

During the 3rd century AD, there is a notable change in the balance of copper alloy objects and their provenance during the 3rd century AD (see Chapter 5.4.2). The trend began in the 2nd century AD, and the highest occurrence of Germanic-origin products within the time block 200–250 AD. Reasonably, this peak could be associated with the Roman-origin metal objects transferred to the Germanic environment during the Marcomannic Wars. Despite the significant drop in the probability distribution of documented iron-made objects (cf. Chapter 5.4.3) for this time block, the further values during most of the Late Roman Period suggest generally higher levels compared to the Early Roman Period. Nevertheless, this observation in data could be partially an outcome of higher frequencies of the documented burials, which are one of the significant sources of the iron finds, for this period. Still, it could be anticipated that the considerable influx originating from looting and raiding had influenced amounts of the material within the 'Marcomannic' settlement zone that were available for use and recycling. In this context, it should also be pointed out that the series of Germanic raiding activities to the provincial ground of various extents, based on the available narrative sources during the 2nd half of the 3rd and 4th centuries AD (cf. Dobiáš 1964, 273–283), did not result in material input, which would be discernible from the derived proxy indicators.

Presumably, the warfare period and new geopolitical settings in post-war conditions, as well as changes connected with population movements, also influenced the long-distance communication of the Amber route, which was disrupted during the Marcomannic Wars. The frequency and traffic volume have not been restored in its aftermath. This phenomenon is also potentially associable with a sudden increase in the occurrence of *sestertii* of the foremost western provenance at the terminal region of the route at Baltics (e.g. Bursche 2002a, 3; 200b; 2008, 395–396), interpreted as a shift in weight point from the overland to the North Sea connection. If true, it would mean that the non-negligible part of the metal vessels influx throughout the 2nd century AD was mediated through the Amber route. Such a notion would also corroborate the most distinctive spatial distributions along the River Morava (see Chapter 6.3), concentrated on its lower and middle reaches. Nevertheless, the influx of the metal vessels continued during phase C1a (Tejral 2015, 71–75), foremost through the grooved buckets, but the respective proxy underlined significantly decreased frequencies based on the fragmentary input data. However, these are more represented in the northern regions up to the Baltics (Tejral 2015, Fig. 27), which supports the continuation of this long-distance trade connection.

From the perspective of most of the derived baseline and secondary proxies, the universal pattern of the more or less pronounced decrease could be observed. Apart from the 'demographic' proxies (e.g. residential and funerary areas or pit houses; cf. Chapter 5.5) also, other potentially economy and political-related proxies (e.g. tools, metal vessels, imported brooches) show the same trend. Conversely, a different pattern could be observed in documented Roman coinage in the Germanic environment. Despite an observable short-term drop in the Roman coinage occurrence from 180 AD till the beginning of the Severan Period, from the time block temporal framework, it is notable that the generally aggregated quantities of documented *denarii* maintain their prewar level and suggest the continuation of the Roman administration's practice in subsidiary payments in coinage during the Severan Period. Then, a swift change of denominations reflects the reality of the monetary system of origin and the accelerating debasement.

However, such proportions (ratios) could provide reasonable grounds for assuming this evidence as 'special purpose money' or rather 'social currency' (cf. Graeber 2012) bound to the power entities in various societal positions, which organised bulk purchases of Roman products either from the Roman borderland economic milieu or potentially through activities on the main long-distance trading routes (foremost the Amber route and its side paths). However, the structure of the Roman coinage and representation of individual denominations and materials (silver, copper alloys) in the Germanic context represents the information significantly biased in multiple instances. Regardless of the actual context of origin, the assumable simultaneousness in circulation and presence within the active 'live' societal context. Nevertheless, the outstanding representations of the Roman coinage during the large part of the 3rd century AD also have potential connotations and associations with the internal political development of the Roman Empire, which experienced a long period of leadership instability and decentralisation tendencies with significantly increased frequency of military conflicts into which the Germanic mercenary groups and entities alike had been on a large scale drawn (de Blois 2002; Hekster, Zair 2008; Alföldi 1967; 1989). Nevertheless, the outstanding quantities of the low-value coinage during the part of the 3rd century AD, resulting from the progressing debasements, would be consistent with the theoretical possibility of their use in the internal Germanic exchange and economy system. Still, such significant and systemic adaptation might not be probable to happen during this short period, later followed by another surge in quantities during the rule of the Constantines.

Yet, for the mentioned time blocks, the quantities of the low-value denominations (*antoniniani*) would potentially enable their use in more common transactions and, therefore, more frequent and everyday use in the internal Germanic exchange economy system, which would be, as a result of this property, sort of a hybrid economy. The temporal overlap of this particular phenomenon has potential relevance to another pronounced advance in the local production and economy structure – the emergence of the fine grey ware, locally addressed as the 'Jiříkovice-type' pottery, according to the eponymous production facility (Pernička 1985). Nevertheless, the analogous emergence of production centres and distribution networks is a phenomenon occurring in other parts of *Barbaricum* (e.g. Mayer et al. 2016). Thus, its occurrence within the studied region has no particular prerequisite, and within the studied region, it represents a commodity of extensive outreach, present in a large part of the Late Roman Period sites. The emergence of this phenomenon underlines the systemic changes in Germanic societies, where the transfer and interconnectedness of this environment. Nevertheless, despite the present state of research on this, so-far relatively underscored and insufficiently recognised segment of archaeological data, the increase in economic complexity, represented through the new local commodity, was also stimulated by employing an exchange system with the use of Roman low-value coinage.

Despite the time block temporal framework quantitative aggregation, based on the actual production dating possibilities and their simulation, shows the highest amount of Samian ware in the Germanic context for the time block 150–200 AD, more importantly, the production which could be attributed to the directly post-war influx (Rheinzabern production) is represented within the consecutive time block 200–250 AD are consistent with the continuing demand and undisrupted channels of its influx into the 'secondary' Germanic environment. As pointed out (see Chapter 6.4), the exceptionally narrow spectrum of recorded shapes (dominating bowl Drag. 37; cf. Klanicová 2007) may suggest general culturally-based attitudes. However, various individual needs and preferences would inevitably lead to higher diversity that could be seen in the northwestern Germanic environment (cf. Erdrich 2001). In this context, relative broad spectra are apparent even at greater distances from the Limes. Therefore, these spectra are instead the result of organised procurement as a part of the 'prestige economy'. Nevertheless, the widespread distribution suggests its position in the redistribution patterns, with its distribution to the lower segments of the organisation structure, which includes the local chiefs and individual community leaders. The results of the simulation show that the potential time lag between the production and transfer to the Germanic environment does not provide a distinctively different shape of the quantitative distribution but simultaneously may provide alternative suggestions for the later stages of occurrence, which could have reached more significant quantities even during the time block 250–300 AD.

It is obvious that the significant changes in various aspects of Germanic society could be assumed from the development of various proxies. Furthermore, they could also be considered through the prism of burial components and contexts (see Chapter 8). Apart from the gradual increase in the temporal distribution of the graves, the relative presence of grave goods exhibits a significant drop since the beginning of the third century. In contrast, the number of graves during the Late Roman Period exceeded that of the Early Roman Period. According to T. Kolník (1961, 244; 1975, 356), this phenomenon is caused by rationalising burial rites as the Germanic society presumably moved the significance from materiality to the rite itself, eventually leaving only a limited archaeological record. This would also corroborate the baseline proxy of the copper alloy material, which shows high probabilities for the time block 200–250 AD, where this trend starts. Therefore, there was no scarcity of material, only the selective pattern of what was included in the grave. Despite this effect not being uniformly applied throughout the Late Roman Period, the general proportion of relatively 'less' or 'more' lavishly furnished burials changed. Even though the fundamental feature of burial rites – cremation – remains unchanged, these changes are accompanied by differences in the quantity of documented burials (Chapter 5.2) and the presumable size of the burying population (Chapter 7.2.2). Presumably, the increased intensity of funerary activities of larger populations structured in multiple smaller or larger communities has also led to changes in spatial distribution and densities of documented burial contexts. Such changes certainly raise many questions. Considering that the area of religion represents one of the most conservative domains of any past society, any change could have originated from substantial reason.

However, within this undeniably unprecedented shift in general practice from loosely dispersed fewer burials with relatively more frequent to significantly densely aligned burial spatial patterns represented by significant scarcity of grave goods in general, some of the derived proxies provide perspective on underlying aspects. Firstly, despite the composition of the burials with weapons changes through time within the 'Marcomannic' settlement zone (e.g. Droberjar, Peška 1994), their representation in the overall burial context, around 5% remains at the same level during the large part of the studied period except for initial and terminal periods of the phases C3 and C3/D1 (see Chapter 8.2.4). Therefore, despite the significant changes in grave goods frequencies between the Early and Late Roman Periods, the attested stability in proportion potentially testifies to continuing this practice. The corresponding pattern also corroborates the temporal distribution of the reconstructed *wealth* index (see Chapter 8.2.1). From the perspective of network analysis of the documented archaeological evidence on the settlement structure through the documented residential areas (Chapter 6.4), a trend of ongoing centralisation could be interpreted. Along with the reconstructed decreases in population size between the time blocks 150–200 and 200–250 AD, significant changes in spatial properties of the settlement structure also occurred. During the 3rd century AD, the increase in complexity of the power structure could be assumed from the significant densifying of clustering of the settlement structure with higher heterogeneity and more distinctive positions of some of the network nodes (settlements).

Furthermore, the existing explanation for the emergence of large-scale funerary areas (such as Kostelec na Hané 'Prostřední pololány') as a result of population migration of the regions of the Elbian cultural milieu through the marked similarities in grave goods compositions (e.g. Tejral 1975; 1993, 490–492) is partially corroborated by the reconstructed increase in population size during the time block 250–300 AD. Nevertheless, such an increase, which does not surpass the net population growth of 0.5% per year, could result well from the intrinsic demography processes before the onset of more significant deteriorations of the climatic conditions. Further stagnation of most of the 'demography-relevant' proxies could also be attributed to the generally attested large-scale gradual deterioration of climatic conditions (e.g. McCormack et al. 2012; Harper 2017; Torbenson et al. 2024), potentially constraining the capacities of the Germanic subsistence sources. Apart from population size reconstructions, the significant qualitative and quantitative properties of the so-called 'Zlechov-type' development phase of the end of the 4th and the beginning of the 5th centuries AD (cf. Tejral 1975; 1982; 1989).

The Germanic 'tribal' populations of the 'Marcomannic' settlement zone, as well as many other 'tribal' societies of the Roman Period or predeceasing Celtic societies during the La Téne Period could be from multiple perspectives of differentiated information sources, acknowledged as a chiefdom type of sociopolitical organisation, based on social anthropological research (see Chapter 9; e.g. Roymans 1990; Carneiro, Grinin, Korotayev eds. 2017). Apparent intersections are present in many aspects, from a number of underlying structural properties, foremost the characteristics of power and control division and distribution, as well as the degree of institutionalisation of the power positions. In Germanic societies and the documented chiefdoms, the power is centred around the chiefs of various positions within the power hierarchy space, where the continuity and stability are constrained by multiple factors, such as personal abilities to lead, organise and mobilise available resources for the fulfilment of the power strategies. Therefore, the respect for a chief came more from the actual person than the significance of the chieftaincy institution. The associated institution of the retinue primarily supported and enforced a chieftain's power position and provided his protection. The main underlying principle of maintenance of social cohesion is the redistributive system through which the proportionate size of the retinue and effective power through *staple* or *wealth finance* (or usually both).

Nevertheless, the retinue upkeep generally exceeded (or at least at some point of its enlargement) the resources available to a chief. Therefore, the raiding and conflict towards neighbouring polities provided the necessary surplus and is often seen as one of the key factors in the emergence of early states (Carneiro 1970; 1981; 2017). A significant parallel could be observed in contextualising the concept of chiefdom alliances or confederacies (Gibson 2017) and the pattern based on surviving identifications of the Germanic polities (i.e. 'tribes'). The significant interconnectedness of the topmost strata of the organisation structure – in terms of the social anthropology associable with paramount chiefs – is underlined by exceptional connections among the princely tombs from Mušov, Czarnowka, and Kariv (e.g. Tejral 2004; Schuster 2021). Such connectedness corroborates the prerequisite for the emergence of extensive 'tribal' confederacies and coalitions.

As was also pointed out earlier, in principle, the labelling of the polities of the Iron Age Germanic world as 'tribal' rather reflects direct acceptance of the contemporaneous Roman terminology, which could have hardly differentiated complex aspects of the Germanic social fabric and forms of power structure, where only brief and biased narratives are available on the subject (e.g. Kristiansen 1980; Roymans 1990; Hedeager 1992, 2), almost exclusively limited to the persuasive narrative of Tacitus's *Germania*. Nevertheless, in most distinctive diagnostic features and properties, the description fits the general properties of the social anthropological concept of a chiefdom (cf. Flannery 1972; Service 1975; Grinin, Korotayev 2017). However, the term implies a significantly different type of social organisation where the institutionalisation of power positions is much less pronounced as it is based almost entirely on the personal qualities of 'Big Men' and his kin ties (e.g. Service 1962; Sahlins 1963), where the decision-making process is placed foremost through consensus. In contrast, the chief's authority extends beyond kin groups and encompasses multiple communities and regions. In economic aspects, the 'wealth' is mostly communally distributed, and subsistence is oriented toward reciprocity and egalitarian redistribution (Fried 1967; Earle 1997). Accordingly, the principle of the 'redistribution' of the top-down client-patron system could be well attested for Germanic societies. Apart from supporting narratives in *Germania*, the existing stratification of the society is well apparent through the various reconstructions based on the funerary data from the 'Marcomannic' settlement zone (Chapter 8). Despite the temporal fluctuations, the derived Gini index of 0.28 (Chapter 8.2.2) and the distribution of the *wealth index* suggest the existence of more advanced forms of the sociopolitical organisational structure (e.g. Kohler, Smith eds. 2018).

However, it would be possible through institutionalised rather than ad hoc authority to establish significant alliances and confederacies (Gibson 2017), such as the so-called 'Marobuduus' empire' or coalition led by Arminius. Also, the emergence of the new 'tribal' entities during the Late Roman Period suggests integration processes amalgamating significant population sizes, reaching early-state or even state territorial extents (cf. Turchin, Gavrilets 2009). The general limits in the control of any territory represent accessibility and affordance. Naturally, extensive territories and their populations could not be organised without the vertical distribution power hierarchy, with spatial connotation to particular administrative units, structuring the space (cf. Spencer 2010). Furthermore, conflict resolution in tribal societies is based on kinship ties and settlement negotiation, and in chiefdoms, there is already some form of judicial authority, often connected with a chief, that resolves disputes. There is also a formalised system of punishments for individual crimes (i.e. sort of *wergeld* of Late Antiquity), as could be observed in the Germanic societies under consideration. The distinctions could also be seen in the representation of religion, which is decentralised in tribal polities and practised distinctive individuals (shamans), but in the chiefdoms, along with the monopolisation of various aspects of the social world (judicial powers), the chiefs also claim divine heritage to legitimise their authority (e.g. Earle 1991). Such property in Germanic societies is well attested through the concept of a 'sacral king' (e.g. Wallace-Hadril 1971, 8–10; Sundqvist 2021), who also maintains the divine connection between the community and deities.

From the perspective of the spatial extent of the 'Marcomannic' settlement zone, defined through consistent and continuous spatial representation, if considered as defining an explicit political entity of a 'tribe' in Roman terminology (i.e. chiefdom or their confederacy), the estimated population size, particularly during the 2nd century AD (reaching probably 170,000 with respective margins of probability, cf. Vlach 2018b), would have surpassed the numbers reasonably expected for even more advanced chiefdom polities (i.e. paramount chiefdoms). Therefore, the above-stated points suggest the classification of the Germanic societies of the 'Marcomannic' settlement zone within the category of the so-called early state analogues (cf. Grinin, Korotayev 2017). Nevertheless, despite the underlying form of power organisation of the Germanic societies of the 'Marcomannic' settlement zone generally staying the same during the study period (i.e. below the early-state level), its structure, complexity and scale were logically constrained by general population properties (represented by the reconstructed population size, see Chapter 7.3), which fluctuated considerably throughout the time. Simply put, fewer people usually have proportionately fewer leaders and *vice versa*. Expectedly, the significant changes in population size and its spatial distributions constrain the magnitude of complexity of social organisation regarding the number or intermediate levels of power distribution.

Eventually, regardless of the number of methodological pitfalls and objections of the applied statistically oriented approach, certain differentiated and structuring entities within the funerary context appear through the variable composition of the observed and documented grave goods within available burial contexts (see Chapter 8). Indeed, many of them have been pointed out earlier (e.g. Krekovič 1993; 2007; Kolník 1961; Tejral 1970c; 1971; 1975). Nevertheless, the respective comprehensive archaeological data on the Germanic funerary context of the 'Marcomannic' settlement zone to the west of the Lesser Carpathians, which have reached in terms of statistical methods requirements the proportions sufficient have not been exploited in terms for a broadly conceived statistical evaluation on a regional scale until now. The applied multidimensional statistical methods revealed the magnitude of structuring elements and features and strung out the proportion of heterogeneity in the grave goods components surviving in the archaeological record. The grave goods composition data provide the basis for formal and temporal distribution of statistically significant occurrence of grave goods compositions. Despite the limitations in input data quality (e.g. frequently observed disturbances of upper parts of burial context due to dominating shallow deposition) and other biases (the presumed discrepancies between the funerary rite and characteristics of the resulting burial context), several distinctive groups could be observed (see Chapter 8.2.3).

The processes mentioned above (significant increase in the population size and scale, proportionately increasing requirement for social cohesion, especially regarding the upkeep of the retinues) have also been substantially imprinted into the funerary record through the occurrence of the grave contexts interpretable based on the presence of the find category of *militaria* as 'warrior graves', which as far more significantly represented during the first half of the scoped period. Hence, such an environment of high competitiveness and adaptation was created during the swift demographic, social, and economic development in the context of Roman-Germanic interactions and, more importantly, political and diplomatic activities. Generally, the non-military intrusions into the internal political affairs of the Germanic populations followed the Roman objectives of cross-border development. In the currently available archaeological sources (primarily residential areas/settlements) and their quantitative interpretative possibilities, the hints for such pressure during the 2nd half of the scoped temporal extent are absent.

Conversely, the relatively lower values of the Gini index (based on the wealth distribution within the documented burial context (Chapter 8) and complementary floor-area sizes (Chapter 7.1) would suggest a relatively lower inequity and potentially also the complexity of organisation structure and a less stratified society. Despite the recently emerging clues on more pronounced hierarchy within the settlement structures (cf. Komoróczy et al. 2019a; 2021; Komoróczy 2022), predominant uniformity is also consistent with this assumption. Furthermore, if the only surviving narratives by Caesar and Tacitus on the principles of the assignment of the fundamental subsistence resources within the Germanic communities (see Chapter 9.9), their effect on the distribution of wealth through the society would also be consistent with the relatively lower Gini indexes.

The complexity of the power hierarchy and propagation of an 'intermediate level' (i.e. regional chiefs potentially associable with the spatial entity of pagi) of the organisation entities within the studied Germanic societies of the 'Marcomannic' settlement zone could also be substantiated through the spatial distributions of quantitatively representative Roman origin find categories (brooches, coins, metal vessels and Samian ware; see Chapter 6.3). Apart from the spatial patterns, which could be potentially assumed to reflect the presence of organisation 'power' structures of regional distinction (i.e. 1st order clusters), also the conspicuous aggregations may suggest the hierarchically subsequent organisation entities on local level (see Fig. 9.2). Each of these find categories has specific aspects, properties and possibilities/constraints of interpretation margins and their position and use within the Germanic society were different. Their individual qualitative (and cost or exclusivity) properties naturally differentiate their significance, accessibility, and value in the 'prestige economy'. However, as they were not directly available within the Germanic environment, they could be considered 'prestige goods', whose value changed along with the milieu of existence. Nevertheless, four distinctive density aggregations with consistent spatial alignment (one-day walking distance to the borderlines of the reconstructed territorial extents) within the studied region emerged from the analysis, suggesting reflection of the locations or rather subregions, which played an essential role in the channelling of the Roman production, controlled by the distinctive chiefs, who could have profited from the specific position within the 'redistribution system'. Therefore, the unique spatial pattern could be interpreted as a sort of 'redistribution centre', already identified in the archaeological record of Roman Period Scandinavia (Lund Hansen 1987).

Eventually, the available archaeological data on the Germanic societies of the 'Marcomannic' settlement zone provided an opportunity to explore general trends and patterns. This book's distinctively rigorous and quantitatively oriented approach may seem to reduce the complexity and diversity of the past context. However, reconstructing and identifying underlying trends in various factors (e.g. population size and density, the influx of Roman production, social structure complexity or inequity) place the general margins for understanding and explaining the past development trajectories. From the overall perspective, the Roman-Germanic interactions played the vital role of catalyst within underlying aspects, and foremost, the influx of the Roman-origin material provided an indispensable driver of change to economic, social, and political processes within the 'Marcomannic' settlement region, as well as other parts of *Barbaricum*. Its significant impact on the *wealth finance* and redistribution system in the form of 'prestige goods' also had a proportionate effect on the complexity of social structure, which reached its highest levels during the 2nd century AD until the extensive conflict of the Marcomannic Wars. From a long-term perspective, this event resulted in structural changes in Germanic society.

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