THE BALTIC IN THE BRONZE AGE

Regional patterns, interactions and boundaries

edited by
Daniela Hofmann, Frank Nikulka
& Robert Schumann

THE BALTIC IN THE BRONZE AGE

sidestonepress

THE BALTIC IN THE BRONZE AGE

Regional patterns, interactions and boundaries

edited by

Daniela Hofmann, Frank Nikulka & Robert Schumann

A publication of the Institute for Pre- and Protohistoric Archaeology (Institut für Vor- und Frühgeschichtliche Archäologie) of the University of Hamburg.

Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

Published by Sidestone Press, Leiden
www.sidestone.com

Imprint: Sidestone Press Academics
This book has been peer-reviewed. For more information see www.sidestone.com

Lay-out & cover design: Sidestone Press

Photographs cover:
Front: weststrand on the Fischland-Darß peninsula (Ariana Rama | stock.adobe.com);
Drawings: Nordic full-hilted sword from Asnæs Åstofte and octagonal-hilted sword from Niløse Kongsted (Aner, E. and Kersten, K. 1976. *Die Funde der älteren Bronzezeit des nordischen Kreises in Dänemark, Schleswig-Holstein und Niedersachsen*. Neumünster: Wachholtz, plates 29&20).
Back: mixed pine and deciduous forest, Lithuania (MNStudio | stock.adobe.com).

ISBN 978-94-6427-018-1 (softcover)
ISBN 978-94-6427-019-8 (hardcover)
ISBN 978-94-6427-020-4 (PDF e-book)

Contents

Preface and Acknowledgements

This volume is the result of a 2017 workshop and a 2018 conference on the theme of circum-Baltic interactions, held at the University of Hamburg and kindly funded by the Behörde für Wissenschaft, Forschung und Gleichstellung (Ministry of Science, Research and Equality) of the Free and Hanseatic City of Hamburg. The majority of the papers collected here were first presented at these events, with a few contributions invited subsequently to fill thematic or regional gaps. At this point, we would like to thank all participants in the workshop and conference for sharing their ideas, the engaging discussions and the enthusiasm they have brought to the project. Thanks are also due to Hamburg University for the administrative support and to the many students who helped with the practical running of both events. All authors are thanked for their patience while this volume slowly neared fruition.

At Hamburg University, we would also like to express our gratitude to Paulina Kiel, who proved an invaluable help in all matters bibliographical, as well as Jeffrey König for his assistance with the figures. Finally, we are enormously indebted to the many colleagues who generously donated their time to provide peer reviews: Marja Ahola, Johann Arntzen, Richard Bradley, Dirk Brandherm, Alexandra Gavan, Svend Hansen, Anthony Harding, Christian Horn, Janne Ikaheimo, Mateusz Jaeger, Christoph Jahn, Aivaras Kareiva, Matt Knight, Chris Knüsel, Lene Melheim, Stuart Needham, Kamil Niedziółka, Courtney Nimura, Heide Wrobel Nørgaard, Grzegorz Osipowicz, Tomas Rimkus, Oula Seitsonen, Helle Vandkilde, Andrejs Vasks and Danuta Żurkiewicz. Thank you!

At Sidestone, we would like to thank Monica Huisman, Eric van den Bandt and Karsten Wentink.

Daniela Hofmann, Frank Nikulka, Robert Schumann

List of contributors

Teija Alenius
Department of Archaeology,
Turku Institute for Advanced Studies (TIAS)
University of Turku
20014 Turku
Finland
teija.alenius@utu.fi

Ines Beilke-Voigt
Archäologie Manufaktur GmbH
Friedrich-Rumpf-Straße 15
14641 Wustermark
Germany
ibvoigt@julio.de

Jan-Heinrich Bunnefeld
State Office for Heritage Management and Archaeology
Saxony-Anhalt
- State Museum of Prehistory -
Richard Wagner-Straße 9
06114 Halle (Saale)
Germany
jbunnefeld@lda.stk.sachsen-anhalt.de

Agnė Čivilytė
Department of Archaeology
Tilto g. 17
01101 Vilnius
Lithuania
civilytea@gmail.com

Ingo Feeser
Institut für Ur- und Frühgeschichte
Christian-Albrechts-Universität zu Kiel
Johanna-Mestorf-Str. 2-6
24118 Kiel
Germany
ifeeser@ufg.uni-kiel.de

Lars Forsberg
Department of Archaeology, History, Cultural Studies and Religion (AHKR)
Bergen University
Øysteinsgate 3, Postboks 7805
5020 Bergen
Norway
lars.forsberg@uib.no

Hella Harten-Buga
Institut für Vor- und Frühgeschichtliche Archäologie
Universität Hamburg
Edmund-Siemers-Allee 1 (West)
20146 Hamburg
Germany
palaeomechanik@uni-hamburg.de

Daniela Hofmann
Department of Archaeology, History, Cultural Studies and Religion (AHKR)
Bergen University
Øysteinsgate 3, Postboks 7805
5020 Bergen
Norway
daniela.hofmann@uib.no

Nicola Ialongo
Seminar für Ur- und Frühgeschichte
Georg-August-Universität Göttingen
Nikolausberger Weg 15
37073 Göttingen
Germany
nicola.ialongo@uni-goettingen.de

Detlef Jantzen
Landesamt für Kultur und Denkmalpflege
Mecklenburg-Vorpommern
Landesarchäologie
Domhof 4/5
19055 Schwerin
Germany
d.jantzen@lakd-mv.de

Jutta Kneisel
Institut für Ur- und Frühgeschichte
Christian-Albrechts-Universität zu Kiel
Leibnizstr. 3
24118 Kiel
Germany
jutta.kneisel@ufg.uni-kiel.de

Kristian Kristiansen
Department of Historical Studies
University of Gothenburg
Box 200
40530 Gothenburg
Sweden
kristian.kristiansen@archaeology.gu.se

Valter Lang
Institute of History and Archaeology
University of Tartu
Jakobi 2
51005 Tartu
Estonia
valter.lang@ut.ee

Mika Lavento
Department of Cultures
University of Helsinki
Unioninkatu 38
00014 Helsinki
Finland
mika.lavento@helsinki.fi

Gundula Lidke
Schloßstr. 50
14059 Berlin
Germany
tollensetal-projekt@web.de

Heidi Luik
Archaeological research collection
Tallinn University
10 Rüütli St.
10130 Tallinn
Estonia
heidi.luik@tlu.ee

Marcin Maciejewski
Institute of Archaeology
Maria Curie-Skłodowska University
Plac Marii Curie-Skłodowskiej 5
20-031 Lublin
Poland
maciejewski.archaeologist@gmail.com

Birte Meller
Institut für Vor- und Frühgeschichtliche Archäologie
Universität Hamburg
Edmund-Siemers-Allee 1 (West)
20146 Hamburg
Germany
birte.meller@uni-hamburg.de

Algimantas Merkevičius
Department of Archaeology
Vilnius University
Universiteto str. 7
01513 Vilnius
Lithuana
algimantas.merkevicius@if.vu.lt

Chiara Molinari
Department of Physical Geography and Ecosystem Science
Lund University
Sölvegatan 12
22362 Lund
Sweden
chiara.molinari@nateko.lu.se

Oliver Nakoinz
Institut für Ur- und Frühgeschichte
Christian-Albrechts-Universität zu Kiel
Leibnizstr. 3
24118 Kiel
Germany
oliver.nakoinz@ufg.uni-kiel.de

Frank Nikulka
Institut für Vor- und Frühgeschichtliche Archäologie
Universität Hamburg
Edmund-Siemers-Allee 1 (West)
20146 Hamburg
Germany
frank.nikulka@uni-hamburg.de

Kerkko Nordqvist
Department of Cultures
University of Helsinki
Unioninkatu 38
00014 Helsinki
Finland
kerkko.nordqvist@helsinki.fi

Kamil Nowak
Institute of Archaeology
Nicolaus Copernicus University in Toruń
Szosa Bydgoska 44/48
87-100 Toruń
Poland
kamil.nowak@umk.pl

Jörg Orschiedt
Institut für Prähistorische Archäologie
Freie Universität Berlin
Fabeckstr. 23-25
14195 Berlin
Germany
jorschiedt@zedat.fu-berlin.de

Vytenis Podėnas
Lithuanian Institute of History, Department of Archaeology
Tilto g. 17
01101 Vilnius
Lithuania
vytenispodenas@gmail.com

Lorenz Rahmstorf
Seminar für Ur- und Frühgeschichte
Georg-August-Universität Göttingen
Nikolausberger Weg 15
37073 Göttingen
Germany
lorenz.rahmstorf@uni-goettingen.de

Daniel Sahlén
Stockholms läns museum/Stockholm County Museum
Box 38 204
100 64 Stockholm
Sweden
sahlen.d@gmail.com

Stefanie Schaefer-Di Maida
Institut für Ur- und Frühgeschichte
Christian-Albrechts-Universität zu Kiel
Olshausenstr. 80a
24118 Kiel
Germany
sschaefer@ufg.uni-kiel.de

Robert Schumann
Universität Heidelberg
Institut für Ur- und Frühgeschichte und Vorderasiatische Archäologie
Sandgasse 7
69117 Heidelberg
Germany
robert.schumann@zaw.uni-heidelberg.de

Katarzyna Ślusarska
Archaeology section, Institute of History
University of Szczecin
Krakowska 71-79
71017 Szczecin
Poland
katarzyna.slusarska@usz.edu.pl

Uwe Sperling
Heinrich Schliemann-Institute of Ancient Studies
University of Rostock
Neuer Markt 3
18051 Rostock
Germany
uwe.sperling@uni-rostock.de

Thomas Terberger
Seminar für Ur- und Frühgeschichte
Georg-August-Universität Göttingen
Nikolausberger Weg 15
37073 Göttingen
Germany
thomas.terberger@phil.uni-goettingen.de

Vanda Visocka
Department of History and Archaeology
University of Latvia
Kalpaka bulvāris 4
1050 Rīga
Latvia
vanda.visocka@gmail.com

Joakim Wehlin
Department of Archaeology and Ancient History
Uppsala University
Box 626
75126 Uppsala
Sweden
joakim.wehlin@arkeologi.uu.se

Introduction

The Baltic in the Bronze Age world

Daniela Hofmann, Frank Nikulka,
Robert Schumann

The Bronze Age is a period defined by long-distance interactions between areas with very different socio-political organisations, resource bases and worldviews, both globally and within Europe (see e.g. Harding 2000). The maintenance of a secure metal supply has often been seen as the main driving force behind the restructuring of settlement systems, the emergence of hereditary elites and the development of new hoarding practices and pictorial conventions, to name but a few. Yet the way in which these interactions have been conceived has also seen its fair share of criticism (see below), in particular because some regions have been accorded a more central role, while others are interpreted as peripheries. This is also the case for the Baltic Sea area, a fact that motivated the workshop and conference on which the papers in this volume are based.

In this brief introduction, we set the scene for the chapters that follow by drawing out some of the main strands of the theoretical debate surrounding the nature of Bronze Age interactions, focusing mainly on the applicability of core-periphery models. In the case of the Baltic Sea region, the resulting interpretative trends have certainly also been influenced by the divergent research histories that played out in the shadow of the Iron Curtain. The contributions to this volume, which we introduce towards the end of this paper, are an attempt to bridge some of these divides and provide new data and outlooks on the question of circum-Baltic interactions in various phases of the Bronze Age, bringing to bear a broad spectrum of theoretical and methodological approaches on a combination of artefact, settlement, environmental and mortuary data.

Circum-Baltic interactions

The Baltic has been a crossroads for communication and trade in many different periods. Beginning with well-known phenomena like the Hanse (e.g. Gaimster 1999), one can also cite the written and archaeological sources for Early Medieval trade routes and emporia (Bogucki 2010; Kempke 2011; Mägi 2011) and the role of the Baltic Sea as a corridor for Scandinavian expeditions and expansion well into the Russian mainland (e.g. Androschuk 2013). As a prehistoric example, one could list the spread of pottery technology westwards along the Baltic shores during the Mesolithic (Piezonka 2015), or the coastal and expansive settlement structure of the Pitted Ware culture southwards into areas settled by Neolithic communities (Svizzero 2015). Yet it is perhaps the Bronze Age that sees some of the most startling evidence for circum-Baltic interactions, given that European societies at this time are argued to have been drawn into a true world system for the first time.

Many examples of such emerging long-distance networks can be mentioned, such as disc needles of Nordic type which ended up as far away as Saarema island (Sperling and Sahlén in this volume), or the two hoard finds from Staldzene (Vasks and Vijups 2004) and Tehumardi (Sperling 2013) in the eastern Baltic, which contain typically Gotlandic finds. Even the realm of practices and ideas is affected. For instance, while boat-shaped graves have their main area of distribution in Sweden and on Gotland, a small and intriguing

In D. Hofmann, F. Nikulka and R. Schumann (eds) 2022. *The Baltic in the Bronze Age. Regional patterns, interactions and boundaries*, Leiden: Sidestone Press, pp. 13-30.

Figure 1. The boat-shaped grave from Bīlavas, Latvia (photo: D. Hofmann).

cluster has been documented in Latvia (see among others Pfeifer-Frohnert 1997; Wehlin 2013; Wehlin this volume; Figure 1). Finally, a lost Early Bronze Age bronze figure from Šernai, Lithuania, of which only one foot has been preserved (Stöckmann *et al.* 2021, 86-87), most likely originated in Syria. From there, it might have travelled to Scandinavia, and eventually onwards to what is now Lithuania (Civilyte *et al.* 2015, 105-06), or it could have been traded more directly in exchange for Baltic amber, which becomes widely distributed at this time. In either case, the figurine poses the exciting possibility that not just materials and objects might have moved, but also associated ideas, whether these be about divinities and the shape of the cosmos, or the best way to illustrate the human form.

For the Late Bronze Age, one of the most intriguing examples are no doubt the so-called KAM (or Kel'ty Akozinsko-Melarskie) axes. These socketed axes with ridge decoration (Figure 2) have an exceptionally wide distribution from western Norway to the Urals, taking in the Baltic in the process (e.g. Melheim 2015). However, their distribution there is distinctly patchy compared to the two main clusters in the Volga-Kama region and the Uppland area of central Sweden (where these objects are known as "Mälar" or "Mälardal" axes). Few representatives of the type are found in the eastern Baltic (but see e.g. Paavel *et al.* 2019, fig. 5), yet the majority of the casting moulds for such axes have been recovered in the south-eastern Baltic area (Podėnas and Čivilytė 2019, fig. 10 and appendix), in spite of the lack of large ore deposits. Indeed, the Swedish and Norwegian KAM examples that have so far been studied appear to have been made from metal sourced in the Mediterranean (Ling *et al.* 2014, tab. 1; Melheim 2015, 199), while those in the Volga-Kama region have a composition consistent with Russian ore deposits (Melheim 2015), suggesting multiple production networks. In general, the distribution of KAM axes of particular subtypes and their respective moulds is not necessarily contiguous, suggesting

Figure 2. Mälardalen axe from Trysil in Hedmark (© Kulturhistorisk museum, Universitetet i Oslo, published under CC BY-SA 4.0).

complex patterns of exchange and innovation that transgressed regional boundaries, and in which production and consumption areas were not equivalent (Melheim 2015, 200-01; Podėnas and Čivilytė 2019, 186). Accordingly, it has been suggested that in the eastern Baltic, such axes were either made specifically for export (Civilytė 2009, 115; Sperling 2016, 109) or were produced by itinerant craftspeople from Scandinavia, who used these items in a broader network of exchange relations in the course of which for example brushed pottery styles could in turn have reached the western Baltic (Podėnas and Čivilytė 2019, 180-84). In the latter case, it is unclear why so few finished items ever made it into the regional archaeological record, given that general ideas concerning accepted locations for depositing metalwork (e.g. in wetlands, near boulders and so on) seem broadly comparable to those in Scandinavia (e.g. Paavel 2016).

These examples clearly illustrate that in the Bronze Age, materials, ideas and people were constantly on the move, also throughout the Baltic, even if the precise mechanisms are still debated. How was all this organised? Who took the decision to travel and what direction to take? Why was it important to obtain new things in the first place, and what else was moving with the archaeologically visible goods? How can we explain both the evident desire to be part of larger networks, and the local and regional distinctions in practice? One popular view, discussed in the next section, has been to treat the Bronze Age in the Old World as an integrated totality, driven mainly by large-scale processes rooted in economic transactions. Yet the case studies presented in this volume also make a strong case that this perspective needs to be complemented with regional and local studies in order to gain a fuller picture. Interactions across the Baltic are a particularly promising case study to illustrate the value of such an approach.

A bird's eye view of the Bronze Age

Looked at from afar, at large spatial and temporal scales, the Bronze Age is indeed above all a period characterised by multiple long-distance connections, along which an unprecedented volume of goods flowed. Although exotic items, sometimes in impressive quantities, were already circulating widely in the Neolithic (see e.g. Pétrequin *et al.* 2012; Windler 2018), the restricted availability of tin for bronze production, coupled with the increasing reliance on this new material for weapons, tools, ornaments and containers, led to much more extensive supply chains that needed to operate more predictably. This, amongst others, required a greater effort to produce goods for exchange, resulting – so it is argued – in regional specialisations in, for example, the production of salt, amber or textiles, alongside many less archaeologically visible commodities, such as horses or slaves. In addition, there was increased focus on the (violent) control of trade routes and the goods that passed along them (e.g. Kristiansen 2015; Vandkilde 2016).

The roots of all this lie in the fundamental transformations that took place in many European societies at the end of the Neolithic, with the emergence of the Corded Ware and Bell Beaker phenomena. Since it has been established that their archaeological visibility coincides with a new genetic signature (Haack *et al.* 2015), there has been a tendency to reconstruct a watershed moment, which saw the introduction of Indo-European languages, a warrior ethic, a new gender ideology, increased hierarchy and a new form of family structure in the course of an at least partly violent wave of migration from the steppes (e.g. Kristiansen *et al.* 2017). While many core aspects of this narrative, notably the timing and duration of changes and the nature of social interactions, have been repeatedly critiqued (e.g. Furholt 2019; 2021; Vander Linden 2016), this has provided a convenient origin point for Bronze Age social structure. This new constellation could then be seen as fundamentally different from earlier phases of the Neolithic (e.g. Kristiansen 2015) and as instead providing long-term continuity to later and better-known periods, for instance the Viking Age (Ling *et al.* 2018).

In addition, given a new unprecedented interconnectivity, it is now difficult to appreciate local developments purely on their own terms, although there is considerable debate about how these relations should be conceptualised. One popular model starts from the perspective of core-periphery relations, whereby the emergence of state societies in the Near East and adjacent areas profoundly influenced events in central Europe by driving demand for luxuries as well as technological and social innovations, increasingly binding other societies in networks of dependency and causing irrevocable changes there, too (amongst many examples, see e.g. Kristiansen and Larsson 2005; Kristiansen and Suchowska-Ducke 2015). It is suggested that central and northern European males served as mercenaries in Near Eastern armies and brought back a new warrior professionalism, alongside new sorts of prestige goods like weapons or thrones and a new Bronze Age world view and religion to help bolster their claims for dominance. Within the European periphery, certain regions then formed secondary power centres, with their own peripheries attached, and saw the concentration of (metal) wealth in their area. In key regional studies, for example at Thy in Denmark, it could be traced how the competition for status and the display of wealth centred on chiefly residences which could eventually manoeuvre to the head of "super chiefdoms" (Kristiansen *et al.* 2020, 275; Ling *et al.* 2018), while others prefer the terminology of early states headed by princes ruling over lesser regional lords (e.g. Meller 2019a).

However, these core-periphery models and the world systems approach on which they are ultimately based have been criticised for often hovering rather far above the details of the evidence. In a paper summarising the shortcomings of world systems theory in its application to the Bronze Age, Anthony Harding (2013) for instance lists the tendency to find "confirmation" for a world system based on very few indicators (such as the simple existence of contact) which can often have alternative explanations, the problems in using a theory originally developed for the rise of modern capitalism to explain a prehistoric situation, and the strictly top-down nature of the approach. Instead, he argues, there could have been many shifting and overlapping zones of influence with fuzzy and permeable boundaries, leading to much greater potential for divergent trajectories. It is here that we should begin, as "to understand the nature of interactions in the Bronze Age, one needs first to contextualize them, which means understanding the nature of the local societies in which they operated" (Harding 2013, 394; see also Kienlin 2017).

Others have also pointed out that these kinds of narratives are variously bolstered by imaginative connections between suggestive pieces of evidence (as in the case of Meller 2019b), or by extending the reach of one particular kind of model and one particular kind of society to cover all of the Bronze Age, without necessarily taking in all the details. Thus, while Kristian Kristiansen and Thomas Larsson (2005, 1-10) originally set themselves a more open agenda of charting how hierarchies are dynamically challenged, how people in "peripheries" can remain rather independent of the centre, and how many different forms of organisation are covered by terms like "chiefdom", a few years later (Earle and

Kristiansen 2010, 17-19, 222-38) all of Europe is seen as being steered by warrior chiefs dependent on the control of long-range connections, and assisted by ritual chiefs with a more local and circumscribed power base. The model had fossilised.

In her more flexible model of Bronzization, Helle Vandkilde addresses many of these points and argues that the Bronze Age globalised system is much less dependent on a specific core, but is rather driven by the multiple interactions between overlapping interaction zones. While some objects and ideas circulate widely as transcultural objects, these are always locally contextualised. This in turn causes not just increasing connectivity, but also its flip-side, increasing friction fuelled by inequalities and challenges to existing value systems (Vandkilde 2016). The result is an overall very dynamic constellation, in which periods of greater stability are always interleaved with periods of fragmentation and challenge (Vandkilde 2016; for an alternative, long-term approach see also Jeunesse 2017). While Bronze Age exchange systems thus spanned a much wider area than before, we still need to look at multiple scales to understand how all these transcultural objects and ideas were transformed locally and acted back on the wider world (e.g. Harding 2021; Vandkilde 2019).

While these reflections considerably nuance the picture, it is inevitably still the case that some few, very well researched areas and sites are often used to stand in for the remainder of the continent, even if evidence is much more patchy both chronologically and regionally. The result is a kind of pastiche or pick-n-mix approach to “the” European Bronze Age that has been heavily criticised by those researchers working at more regional and local levels. Thus, Tobias Kienlin (2019) has argued that the tell societies of the Carpathian Basin owe more to their local, Neolithic roots than to any perceived motivation to emulate faraway states. He traces how items like prestige goods and new practices, even if adopted, will always need to be recontextualised to fit local expectations, so that the “peripheries” in our world systems are not passive (see also Kardulias 2015; Frieman and Lewis 2021). Structural inequalities and systemic dependencies need to be proven in each case, rather than assumed, and this is rarely achieved (Harding 2013; Kienlin 2019). In addition, large-scale systems approaches can come to rely on a very restricted view of power as (aggressive, physical) “power over” – over resources, over other people, over territory – assumed to be active at all levels, from interpersonal relations to the regional “chiefdoms” or dominant lineages, up to the (inter)continental scale. This makes it difficult to appreciate the moral and reciprocal dimension, and the mutual dependencies and obligations, which also structure exchange (e.g. Bloch and Parry 1989; Mauss 1954) and which will often limit the capacity of actors – be they chiefs or other kinds of leaders and specialists – to flaunt their wealth (e.g. Brück and Fontijn 2013; Rosenberg and Rocek 2019).

Most pertinently for the topic of this volume, such systems provide a rather restricted narrative role for the societies on the periphery, which are not seen as interesting players in their own right – this is also the case for the eastern part of the Baltic. The Nordic Bronze Age, and Scandinavian researchers, have been key driving forces behind the establishment and rise to dominance of world systems and core-periphery models built on hierarchical warrior societies. In this process, they have painstakingly traced the relationships of their region to central Europe and the Mediterranean. Tellingly, however, many distribution maps of kinds of artefacts (swords, ornaments, kinds of burial rite etc.) and of trade connections leave a gaping hole around the regions of the eastern and/or northern Baltic, positioned on the other side of the line delimiting the Bronze Age world system (see e.g. the maps in Kristiansen and Larsson 2005; Vandkilde 2016). This also necessitated some lively discussion during our original conference, where it was suggested that the Baltic indeed had very little to offer the wider European Bronze Age, except perhaps some forest products and of course amber, or that the area may largely have been raided for slaves (see also Ling *et al.* 2018, 502). At best, its role is that of the “periphery of the periphery” (as also criticised in Čivilytė 2012, 15; this volume), to which knowledge and products were brought from the outside.

Yet such ideas do not explain distribution patterns like those of the KAM axes mentioned above – these rather suggest active agents engaged in aspects of these wider Bronze Age connections, but combining them in slightly different ways in each region, potentially involving different actors and different outcomes. How to deal with this difference is an important challenge for circum-Baltic research, and it works at two different levels. On the one hand, the narratives sketched so far have been largely produced by researchers active in western parts of the Baltic, and therefore reflect one particular, historically rooted view of looking at the evidence that could benefit from being expanded. In contrast, research on the eastern Baltic regularly discussed the role that the eastern Baltic could have taken in the European Bronze Age and thus integrated this region into the large-scale narratives (see among others e.g. Čivilytė 2012; Sperling 2016; Vasks 2010). In addition, recent aDNA studies on the third millennium suggest migrations from the eastern Baltic as far as the Bohemian heartland at the beginning of the Bronze Age and could thus also speak for a more active role of the Baltic and its residents in emerging Bronze Age networks (Papac *et al.* 2021, 8). In what follows, we first briefly outline the main chronological frameworks used by Bronze Age archaeologists working in the Baltic. In addition, taking the criticism of world systems approaches seriously requires the construction and careful comparison of regional trajectories. The Baltic offers a particularly fruitful case study for this, as we briefly outline near the end of this introduction, and as is attested by the papers in this volume.

East is east and west is west?

The Bronze Age in the circum-Baltic region is extremely diverse in its character, onset and duration. Regional cultural characteristics can be distinguished from each other, processes of sedentarisation, the importance of agriculture versus hunting, fishing and gathering, and the extent of metallurgical production are regionally different and follow different temporal sequences. Social differentiation and organisation thus also vary from region to region, as therefore do individual and collective ways of life.

The relative chronological system in use across the Baltic area is still based on the period division according to Montelius (1885), developed in the first half of the nineteenth century for Scandinavia and also used for northern Germany. Nevertheless, it is not easy to determine the beginning of the Bronze Age in absolute chronological terms, especially since key social developments may have begun earlier (see e.g. Iversen 2017). While the dagger hoard from Melz in south-eastern Mecklenburg-Western Pomerania has been ^{14}C-dated to about 2200 cal BC (Schwenzer 2002), this find rather represents the north-western periphery of the Aunjetitz/Únětice culture. The beginning of the Nordic Circle of the Bronze Age will generally have to be set somewhat later.

Based on the typochronological dating of hoards and relying on the early date from Melz, Knut Rassmann (2004, 46) has suggested that Periods IA/IB/IIA cover the time span 2100/2000-1600/1500 BC. Yet in many later phases, particularly those where cremations predominate, it remains difficult to link typochronological developments with accurate absolute dates (but see Olsen *et al.* 2011). This also applies to the end of the Bronze Age, for which different estimates exist even just between the Oder and Ems in northern Germany, depending on whether a very early Iron Age in Period VIb (starting at c. 750 BC) is recognised or not (see e.g. Heynowski 2014; Schneider 2006). An earlier date appears to be preferred by Polish colleagues (e.g. Jażdżewski 1984, 206).

Moving eastwards from the Nordic Circle, the Únětice culture with its lavish graves and hoards is bordered to the east by the Trzciniec culture, which extends into modern-day Ukraine and Belarus, and borders the eastern Baltic states in southern Lithuania (Makarowicz 2015, 214). Via the Trzciniec culture, features such as images of two-wheeled chariot teams with four-spoke wheels, partly with a standing charioteer, known from equestrian nomadic groups further south-east (Penner 1998) could have reached the Baltic region. As an alternative route to the often postulated south-north exchange of metal, amber, artefacts, decorative or religious symbols and ideas (Hänsel 1997; Kaul 2014; Price 2015, 196-250), these eastern contacts are worth pursuing. Chronologically following the Únětice culture, the Lusatian culture extends from the northern edge of the Carpathians to the Baltic Sea and in the north-east to the West Baltic Barrow culture in Lithuania. The Lusatian culture could be considered the inspiration for the fortifications (hillforts) that appeared in the south-eastern and eastern Baltic from the end of the second millennium onwards (Vasks 2007, 34-36). In this context, the Daugava river forms an important east-west transit axis, but many of the fortifications along its banks have not yet been dated. Nevertheless, contacts to the Black Sea and Caspian Sea were possible via the Daugava and the Dnieper (Lang 2007, 14; Messal 2001).

In spite of these connections, the Bronze Age in the eastern Baltic follows a fundamentally different dynamic to the regions discussed so far. To begin with, in the Early Bronze Age (dated to 1700-1100 BC by Podėnas and Čivilytė 2019, 171) there are very few metal finds, and no indigenous evidence for metal production, in spite of the closeness to the Trzciniec culture (Makarowicz 2009). The Early Bronze Age find of a spear tip typologically attributed to the Seima-Turbino culture in the Urals shows that contacts did exist, but their extent remains questionable and is in need of further investigation (Lang 2007, 44). A larger number of metal artefacts only appear at the beginning of the Late Bronze Age, which is also when the KAM axes discussed above are attested. The amounts of metal finds in Latvia and Lithuania increase markedly at this point (e.g. Sidrys and Luchtanas 1999). In Estonia, there are fewer metal objects and important production sites like those of the Asva group do not begin until late in Period V, thus in the ninth century (Sperling 2014). While the transition to the Iron Age is then placed around 500 BC, this again sees a marked drop in the region's supply with metal artefacts (Lang 2007, 15; Podėnas and Čivilytė 2019, 182; Sperling 2014, 21), so that one could characterise the adoption of metalworking in the eastern Baltic area in a sense as intermittent.

This raises the question of how impactful the new material was in terms of a more general reorientation of social relations. Intriguingly, agriculture as an important subsistence base also only became established in the region between c. 1400-1200 BC (Minkevičius *et al.* 2020), thus providing a horizon in which several important changes intersected which would have changed both people's daily lives, their connections to the landscape and the way they interacted with outsiders. Much more research is needed into the overlapping outcomes of these novelties. For example, metal and especially metal production was largely limited to coastal and riverine areas and concentrated at new sites like hillforts (Podėnas and Čivilytė 2019, 179). Similarly, the extent of agricultural subsistence needs to be further defined. In how far society as a whole was fundamentally transformed is an open question.

It is also interesting to reflect on what did not travel. For example, around 1000 BC, stylistic and symbolic elements that originate in south-eastern Europe are incorporated into the design of bronze artefacts of the Nordic Circle (Hänsel 1997; Kaul 2014). At first horse symbolism dominates, later there is a rise in bird symbolism alongside other animals, such as the snake, and spoked wheel representations. These symbolic images are understood not only as ornamental elements, but as religious symbols, thus as an expression of an intellectual reorientation. This change, which unmistakably emerged in the context of pan-European contacts, seems to have no impact at all in the eastern Baltic.

The result of all this diversity is a colourful mosaic of the Bronze Age economy and way of life and at the same time a reflection of the differentiation of the Bronze Age in the entire Baltic region. But the Baltic in the Bronze Age is not only defined by diverse lifeways in the past, but also by a large diversity in archaeological approaches and divergent research histories. These, directly and indirectly, influence the perceptions of contacts across the Baltic in (pre)historic times and therefore are crucial for understanding dynamics and interactions in archaeology. Baltic interactions in the Bronze Age had already been discussed by Eduard Šturms (1935) and Birger Nerman (1933) in the 1930s. The respective interpretation of corresponding large-scale interactions is always shaped by the state of research and the prevailing views in a generation of researchers. Thus, the role of Scandinavia was initially the focus and Scandinavian groups and individuals were assigned the leading, active part (Nerman 1954; see Sperling 2016).

The political situation in the twentieth century in particular had an enormous impact on the study and interpretation of circum-Baltic contacts in the Bronze Age (see e.g. Sperling 2016), due to its influence also on archaeology. Ēvalds Mugurēvičs has particularly emphasised the varied history of archaeology in the Baltic states (Mugurēvičs 1993). Initially, archaeology was conducted mostly by experts from other countries, before the discipline was established in the independent states and then integrated into Soviet archaeology, only to become devolved to individual nation states again after the fall of the Iron Curtain. Valter Lang has also pointed out the changes in archaeology in Estonia during the twentieth century, specifically with regard to the Bronze and Iron Ages, and the effects the different organisational set-ups, paradigms and agendas had on our knowledge of these periods (Lang 2006). Specifically for cross-cultural contacts, Andrejs Vasks has drawn attention to the contrast between Soviet archaeology's regional perception of the Bronze Age in the Baltic states on the one hand, and contemporary Western research traditions on the other, which focus on large-scale interactions (Vasks 2010, 153). Also outside the eastern Baltic, the mid-twentieth century saw huge changes in archaeological thinking and practice based on political developments. For example, in Germany different research traditions developed between East and West Germany as scientific exchange was curtailed by an increasingly hard border (see e.g. Coblenz 2000; Sommer 2000). In the case of the eastern Baltic, language barriers initially also continued to affect research into large-scale interaction and contacts across modern borders, even after the end of the Soviet era (but see e.g. Loit and Selirand 1985).

On the edge: the Baltic as a Bronze Age interaction zone

Part of the rationale for the conference on which this volume is based was to contribute to an emerging dialogue between these different research traditions. This is all the more important since the connections between eastern and western, northern and southern shores of the Baltic in the past offer an excellent opportunity to investigate how interactions flow across a boundary between very different ways of doing things and organising society, from hunter-gatherers to farmers and metal-poor to metal-rich areas. This also ties in with a string of scholars who have argued that we need to better characterise the diversity in the relationships between putative "cores" and "peripheries" (e.g. Anfinset and Wrigglesworth 2012; Harding 2013; Kienlin 2017). For example, looking at another periphery, western Norway, there are interesting regional differences in the extent and speed with which innovations were taken up. Rogaland and Vest Agder in the southern parts of the west coast have good access to maritime trade routes and show an early peak in metal items. In contrast, in Inner Sogn there are many metal objects, but very few grave monuments, so that a less hierarchical structure may have been in operation, quite in contrast to, for example, Jæren (Anfinset 2012; Austvoll 2018, 224). Also, while copper ores are exploited in eastern Norway, it is far from clear whether the impetus for this came from the southern Scandinavian or central European "centres", or was rather related to older, eastern connections to northern Scandinavia and Russia (Melheim 2012, 100; Engedal 2012, 116). There is also a temporal dimension, in that early metal in Rogaland seems to be deposited mainly in hoards, with a shift to graves only in a second phase; the argument is that initial imports had to fit into more co-operative or community-based strategies of wealth display (Anfinset 2012). Over time, the restricted availability of agricultural land limits further growth in some areas, while others prosper, and the details of the geography also ensure that some areas would be easier to control by a centralised authority than others (Austvoll 2018, 224). Similarly, as Karin Ojala and Carl-Gösta Ojala (2020) have traced in the case of Sweden, historical power relationships between regions can have a profound effect on how past patterns of interaction are interpreted, in this case opposing southern and/or coastal "cores" to northern and/or inland "peripheries" without adequate critical scrutiny.

This kind of patchwork situation is also applicable to the Baltic (see also e.g. contributions to Martinsson-Wallin 2010). Thus, Peter Skoglund (2009) could trace how ship settings and ship symbolism have been differently employed in different areas of Sweden. In southern Bohuslän, depictions mostly occur on small, personal bronze items, mainly razors deposited in mortuary contexts, indicating restricted access and individual control over mythological knowledge. In contrast, on Gotland monumental stone ship settings are frequent and highly visible, and a wide cross-section of the population appears to have been buried in them, so that the way in which the widely shared symbol "ship" worked in these different settings would not have been the same (see also Bradley *et al.* 2020). This is one indication that the extent to which warlike "maritime chiefdoms" (Ling *et al.* 2018) can be reconstructed in these areas, and what the status of boat owners and boat crews may have been, varies widely and will depend on how such new endeavours are successful in transforming daily routines (see also Armstrong Oma 2012, 75-83; Skoglund 2009).

Our volume first and foremost aims to extend the possibilities for such circum-Baltic dialogue and comparisons by providing regional case studies and inter-regional reflections, specifically envisaged as a counter-balance to world systems approaches. Around the Baltic, we are dealing with a large, diverse cultural landscape. How its constituent parts were interconnected, where there was cooperation and where antagonism, which region is to be understood as an isolated periphery and which, on the other hand, is more characterised by far-reaching intensive networking, albeit perhaps in unexpected directions, is all highly varied and could have changed repeatedly over the 1500 or so years of the Bronze Age.

Given the nature of the sea as both dividing and connecting, we certainly do not want to deny the crucial role of movement and mobility of goods and people, and the fact that these did have far-reaching consequences for many societies, as has been amply demonstrated (e.g. summaries in Frei *et al.* 2019; Frieman *et al.* 2019; Harding 2021, 91-121; Nørgård *et al.* 2021; Vandkilde *et al.* 2015, to name but a very few examples). Nor do we wish to resurrect the dichotomy between large-scale and regional analyses, when clearly both have important insights to contribute. Yet we feel that societies in the "peripheries" are still often treated as poorer versions of the centres, held back by their lack of agricultural potential or lack of exchangeable wealth. Yet they actually pose a real challenge to our interpretations. Partly because the success of the Bronze Age world system has been so closely linked to a unified worldview and religious conversion (as traced in Kienlin 2019, 23), the very different constellations and models of social interactions that we meet beyond the "centre" provide a glimpse of alternative, divergent trajectories, not just economically, but in ways of seeing the world and the place of human societies in it. Alleged peripheries resist the narratives of inevitable progress and ideological unification, remaining resolutely "other". This begs the question of whether a "periphery" should even be called that if the people there were not all that impressed with the offers of the "centre" to begin with and if, as Michael Rowlands and Dorian Fuller (2018) have demonstrated for Africa, long-distance networks could easily exist without being dominated by any putative "centre".

The Baltic is an interesting case study in this context because it cannot be neatly characterised by a straightforward duality of those inside and outside the Bronze Age world system. In the west, Denmark and adjacent areas of northern Germany and Sweden can be said to be fully integrated into the world system as characterised above; indeed, they are some of the prime case studies for it. Further east and north are hunting and gathering societies, or those only just in the process of adopting an agricultural lifestyle, and which provide crucial links eastwards to the steppe and forest zones. In between are a myriad gradations between these extremes in a broad kind of "frontier" sensu Bradley Parker (2006), that is to say an interaction zone in which various kinds of boundaries (geographical, cultural and demographic, economic and political) can be situated and intercut. These boundaries need not coincide spatially, and each one can fall anywhere on a broad gradient between rather static and closed, somewhat more porous, or even fluid and open. A further interesting path to follow is which items of material culture could have functioned as boundary objects (Wenger 1998, 107), i.e. as things whose specific qualities made them apt to cross cultural boundaries and form networks of interaction along which other ideas also travelled, even though the objects themselves need not have "meant" the same at each point they were used. Bronze artefacts like the KAM axes are cases in point, but could be complemented by other examples perhaps working at smaller scales, such as for instance pottery (e.g. Ojala and Ojala 2020, 162; Forsberg this volume). Tracing these intercutting connections will likely provide a fuller picture than just focusing on putative elite material culture.

The careful mapping of different practices, objects, monuments, and people can therefore help to characterise frontier areas in a multidimensional way, and decrease our reliance on just single aspects of particularly mobile elite culture. Instead, we can also include themes like the organisation of daily life and domestic production, ritual expression beyond the deposition of metal, variation in dress and costume elements, or small-scale adaptations to particular environmental conditions, to name a but a few examples.

The volume

The papers in this volume cannot address all of these aspects, but go some way in drawing out patterns of interaction in the Baltic at different scales. As a collection they make a powerful case for the Baltic as a frontier zone combining diverse kinds of interaction, which are not static over time. Kristian Kristiansen's contribution is the one most closely connected with the macro-scale, linking the region of Thy in Denmark to the much better documented centres of the Near East to suggest a context of elite-driven trade, protected by semi-professional warriors, at least for the western shores of the Baltic Sea. The paper thus draws on familiar themes of aggression, long-distance networks and a hierarchical society, aspects of which recur in other contributions.

For instance, organised violence involving hundreds of participants is demonstrated by the exceptional finds in the Tollense valley. In their contribution, Hella Harten-Buga and colleagues, using a micro-wear approach, can clearly document that the projectile points recovered from the site were fired, and could even identify possible traces of blood. Tellingly, however, it is stone rather than bronze arrowheads which are most prominent here, which does not quite fit the warrior aesthetic of shining metal occasionally postulated for this period (Felding *et al.* 2020). This could be because the metal weapons were subsequently looted, but in their paper, Detlef Jantzen and Gundula Lidke also propose an alternative explanation of a violent clash between local forces and a trade caravan, rather than between the semi-professional armies suggested in world systems approaches. Such perhaps more temporary or situational groupings would have been just as effective at keeping the Bronze Age world interconnected. As Joakim Wehlin reminds us, such travelling communities must also have existed in the guise of ships' crews, and stone ship settings across the Baltic may stand as monuments to the ritual and organisational needs of just such special-purpose collectivities, keeping them at least partly independent of elite strategies concentrated at land-based nodes.

The two papers by Jutta Kneisel and colleagues also neatly draw out this duality at a more regional scale, the western Baltic and adjacent areas. Settlement patterns across the area oscillate between periods with more visible occupation sites, when there is also more innovation in object design, and periods when the landscape was still used, but rather for graves and hoard deposition. The mechanism driving these cycles will be interesting to disentangle further. The complementary paper on fortifications also eloquently documents that the widespread occurrence of hilltop enclosures and land divisions is a feature particularly of the later parts of the Bronze Age sequence. In view of the key role often accorded to raiders and warriors, this also now requires further study, as it would imply that either the scale and frequency of violence were not always equally large, or that the techniques and practices of combat changed (for example from pitched battles to sieges). In many other regions, it is still much more difficult to accurately characterise the development and context of hillfort emergence. Thus, Algimantas Merkevičius sees the Lithuanian data as broadly supporting a link between hillforts and hierarchical social relations, and charts how these new kinds of site emerged from within a local settlement tradition. However, current dating evidence is not yet fine-grained enough to answer whether elites instigated the building of hillforts, or whether the need to manage communal defence instead caused the emergence of an elite. Many other aspects, such as the visibility of these putative high-status individuals in burial contexts, will also need closer attention.

Fortified settlements also exist in Estonia, but if we follow Valter Lang's argument, here they do so in a context in which both western Baltic influence and more easterly cultural trends, manifested for example in linguistic changes and in burial customs, constantly interact. Estonia thus stands at a crossroads between different interaction spheres, and is a key test case for how these interrelate. A very similar situation is also reconstructed for Finland by Mika Lavento, who uses artefact typologies and distributions to trace in-migration from both the west and the east, particularly into coastal areas. Again, such zones would have been fertile breeding grounds for creolisation and hybridisation. Regionally specific adaptations would also be called for because the traditional economic regimes of, for example, a western Baltic migrant would simply not have been viable here. Indeed, Kerkko Nordqvist and colleagues use pollen data to reconstruct a landscape with at best small-scale clearings, where a largely hunter-gatherer-fisher lifestyle continued to dominate. In how far would limited influx of novelties in coastal areas even impact these societies, certainly independent from and not governable by any faraway centre? Taking to heart Lars Forsberg's in-depth discussion of networks in hunter-gatherer societies mainly in northern Sweden, it becomes clear that the introduction of novelties involved social interactions and exchanges at different scales, and that this is crucial for understanding which materials and technological knowledge systems could have been more or less restrictively controlled. This stresses the active role of hunting and gathering societies, who certainly were more than just passive consumers of southern novelties.

Of course, variation in economic strategies did also exist within more agro-pastorally oriented communities further south. For her case study of the lower Oder and the Oder lagoon, Katarzyna Ślusarska has managed to reconstruct a varied, and thereby rather resilient, economic system, which was unlikely to be majorly impacted by climatic changes. This would mean that at least one of the major factors which is often identified as causing synchronous, large-scale changes (e.g. papers in Meller *et al.* 2015) may not have been particularly relevant near the edges of the Bronze Age world system.

Moving to the importance of bronze and bronze objects, the volume also provides different viewpoints. At a large-scale level, the balance weights which Nicola Ialongo and Lorenz Rahmstorf identify in their contribution did not, on current evidence, spread further east than Gotland. Trade in metals – and whatever flowed as return commodities – must hence have been organised along different practices for establishing equivalent values, or at least have used different measurement systems, requiring negotiation and translation. This apparently also applies to the currency of different kinds of items, for example swords, as Jan-Heinrich Bunnefeld demonstrates. Given the radically different frequencies of known examples, he concludes that the social importance of these items must have differed between the western and eastern Baltic. If western Baltic traders armed with swords really settled in the eastern Baltic more permanently, as he suggests, then they did not succeed in radically altering the weapon-related depositional practices in this area, with consequences for the warrior-centred worldview which is so often identified for the Bronze Age. Other items may have been more successful transcultural objects. As Uwe Sperling and Daniel Sahlén show, a Nordic type of pin with an oversized disc head, the Härnevi type, circulated as widely as Estonia and was even deposited according to more western customs, indicating (elite) interaction. Still, depositional patterns remained far from unified in detail. Looking at the adjacent areas of Pomerania in Poland and Mecklenburg-Vorpommern in Germany, Marcin Maciejewski and Kamil Nowak compare the importance of metalworking tools in hoards and conclude that there is no universal pattern, with depositional practice differing locally and regionally.

In addition, it is far from clear how far networks predicated on metal exchange penetrated beyond coastal settings, particularly in the eastern Baltic. Heidi Luik makes a case that carefully crafted bone objects could often play an equally important role in display, reducing the dependence on metal (if any), although hillforts may still function as important production sites for these items as well. Vanda Visocka and her co-authors similarly stress that western influences in pottery style are largely found along the coastal areas, and are much more mooted inland. These differences are superimposed on a shared pattern of pottery production technology, indicating a basis of common technological knowledge that also required the interaction of producers in a learning network, albeit one far removed from the elite exchange many models focus on. Finally, Agnė Čivilytė draws together a variety of evidence, mostly centred on technological knowledge and communication regarding new items and practices. Returning again to the issue of KAM axes, she stresses the importance of understanding the social contexts of metalworking and other Bronze Age practices and uses this as a springboard to critically reflect on the concept of "periphery" and the applicability of world systems theory.

Outlook

Together, these papers form a sound basis from which to frame further reflections and explorations concerning the full breadth of mobility and interaction across the whole Baltic Sea region. In particular, it has become evident how much more detailed local and regional work is needed to generate the basis for further interpretation: absolute dates and site sequences for the emergence and transformation of key site types, such as hillforts, chemical characterisation of artefacts, landscape reconstructions, large-scale survey work and targeted excavations are just some of the necessary further steps to understand the variability of ways of life at any one point in time. Particularly in the eastern part of the Baltic, this evidence first needs to be generated before the applicability of more abstract models, like world systems, can be critically evaluated. Otherwise, there is a danger of a self-perpetuating prediction – as more big-data driven models are fed with more of the same information from well-investigated regions, the empty spaces on our maps will by default be declared "peripheries".

Yet this underestimates the creativity of other kinds of societies. To fully exploit the potential of the Baltic Sea area to contribute novel insights also at the macro-level of theoretical debates concerning the nature of "the" Bronze Age, we also need new theoretical approaches which can take this into account. Adapted versions of Parker's (2006) frontier interaction, or other models centring on the situational fluidity of identities, boundaries, the importance of mobility and networks of transmission (e.g. Frieman 2021), need to be explored with Baltic data to provide these new starting points. The papers collected here have begun this task, but we hope this will be widely taken up in future conferences, projects and publications.

Bibliography

Androshchuk, F. 2013. *Vikings in the east. Essays on contacts along the road to Byzantium (800-1100)*. Uppsala: Uppsala Universitet.

Anfinset, N. 2012. Social response or resistance to the introduction of metal? Western Norway at the edge of the "globalized world". In N. Anfinset and M. Wrigglesworth (eds), *Local societies in Bronze Age northern Europe*, 232-50. New York: Routledge.

Anfinset, N. and Wrigglesworth, M. 2012. Introduction: local societies, regions and processes of cultural interaction in the Bronze Age. In N. Anfinset and M. Wrigglesworth (eds), *Local societies in Bronze Age northern Europe*, 1-9. New York: Routledge.

Armstrong Oma, K. 2012. Large-scale “grand narratives” and small-scale local studies in the Bronze Age discourse: the animal perspective. In N. Anfinset and M. Wrigglesworth (eds), *Local societies in Bronze Age northern Europe*, 71-88. New York: Routledge.

Austvoll, K.I. 2018. *Seaways to complexity. A study of sociopolitical organisation along the coast of northwestern Scandinavia in the Late Neolithic and Early Bronze Age.* Oslo: Department of Archaeology, Conservation and History, UiO.

Bloch, M. and Parry, J. 1989. Introduction: money and the morality of exchange. In M. Bloch and J. Perry (eds), *Money and the morality of exchange*, 1-32. Cambridge: Cambridge University Press.

Bogucki, M. 2010. Viking Age emporia around the Baltic Sea – a cul-de-sac of the European urbanization? In A. Buko and M. McCarthy (eds), *Making a Medieval town. Patterns of early Medieval urbanization*, 151-65. Warsaw: Archaeobooks.

Bradley, R., Nimura, C. and Skoglund, P. 2020. Meetings between strangers in the Nordic Bronze Age: the evidence of southern Swedish rock art. *Proceedings of the Prehistoric Society* 86, 261-83.

Brück, J. and Fontijn, D. 2013. The myth of the chief: prestige goods, power and personhood in the European Bronze Age. In H. Fokkens and A. Harding (eds), *The Oxford handbook of the European Bronze Age*, 197-215. Oxford: Oxford University Press.

Čivilytė, A. 2009. Das Neolithikum in der Bronzezeit? Zur wirtschaftlichen Situation im Ostbaltikum. In M. Bartelheim and H. Stäuble (eds), *Die wirtschaftlichen Grundlagen der Bronzezeit Europas*, 105-17. Rahden: Marie Leidorf.

Čivilytė, A. 2012. In search of a theoretical assessment of Bronze Age society in the Baltic countries. *Archaeologia Baltica* 18, 14-27.

Čivilytė, A., Duberow, E. and Pernicka, E. 2015. His left foot: a new investigation of the oriental Bronze Age figurine from Šernai (western Lithuania) and the question of its authenticity. *Germania* 93, 97-120.

Coblenz, W. 2000. Archaeology under communist control: the German Democratic Republic 1945-1990. In H. Härke (ed.), *Archaeology, ideology and society: the German experience*, 304-38. Frankfurt: Peter Lang.

Earle, T. and Kristiansen, K. 2010. *Organizing Bronze Age societies: the Mediterranean, central Europe, and Scandinavia compared.* Cambridge: Cambridge University Press.

Engedal, Ø. 2012. On the bronze trail: short-cuts, byways, transformation and displacement. In N. Anfinset and M. Wrigglesworth (eds), *Local societies in Bronze Age northern Europe*, 108-25. New York: Routledge.

Felding, L., Reiter, S., Frei, K.M. and Vandkilde, H. 2020. Male social roles and mobility in the Early Nordic Bronze Age. A perspective from SE Jutland. *Danish Journal of Archaeology* 9, 1-167.

Frei, K.M., Bergerbrant, S., Sjögren, K.-G., Jørkov, M.L., Lynnerup, N., Harvig, L., Allentoft, M.E., Sikora, M., Price, T.D., Frei, R. and Kristiansen, K. 2019. Mapping human mobility during the third and second millennia BC in present-day Denmark. *PLoS One* 14, e0219850.

Frieman, C. 2021. *An archaeology of innovation. Approaching social and technological change in human society*. Manchester: Manchester University Press.

Frieman, C. and Lewis, J. 2021. Trickle down innovation? Creativity and innovation at the margins. *World Archaeology* 53, 723-40.

Frieman, C., Teather, A. and Morgan, C. 2019. Bodies in motion: narratives and counter-narratives of gendered mobility in European later prehistory. *Norwegian Archaeological Review* 52, 148-69.

Furholt, M. 2019. Re-integrating archaeology: a contribution to aDNA studies and the migration discourse on the 3rd millennium BC in Europe. *Proceedings of the Prehistoric Society* 85, 115-29.

Furholt, M. 2021. Mobility and social change: understanding the European Neolithic period after the archaeogenetic revolution. *Journal of Archaeological Research* 29, 481-535.
Gaimster, D. 1999. The Baltic ceramic market c. 1200-1600: an archaeology of the Hanse. *Fennoscandia Archaeologica* 16, 59-69.
Haak, W. [+ 27 others] and Reich, D. 2015. Massive migration from the steppe was a source for Indo-European languages in Europe. *Nature* 522, 207-11.
Hänsel, B. 1997. Gaben an die Götter – Schätze der Bronzezeit Europas – eine Einführung. In W. Menghin and B. Hänsel (eds), *Gaben an die Götter – Schätze der Bronzezeit Europas*, 11-22. Berlin: Staatliche Museen zu Berlin – Preußischer Kulturbesitz und Freie Universität, Seminar für Ur- und Frühgeschichte.
Harding, A. 2000. *European societies in the Bronze Age*. Cambridge: Cambridge University Press.
Harding, A. 2013. World systems, cores and peripheries in prehistoric Europe. *European Journal of Archaeology* 16, 378-400.
Harding, A. 2021. *Bronze Age lives*. Berlin: DeGruyter.
Heynowski, R. 2014. Der Beginn der Eisenzeit in Norddeutschland – Terminologie und vergleichende Chronologie. In J. Brandt and B. Rauchfuß (eds), *Das Jastorf-Konzept und die vorrömische Eisenzeit im nördlichen Mitteleuropa. Beiträge der Internationalen Tagung zum einhundertjährigen Jubiläum der Veröffentlichung der „Ältesten Urnenfriedhöfe bei Uelzen und Lüneburg“ durch Gustav Schwantes, 18. -22.05.2011 in Bad Bevensen,* 205-21. Hamburg: Archäologisches Museum Hamburg.
Iversen, R. 2017. Big-Men and small chiefs: the creation of Bronze Age societies. *Open Archaeology* 3, 361-75.
Jażdżewski, K. 1984. *Urgeschichte Mitteleuropas*. Wrocław: Archeobooks.
Jeunesse, C. 2017. From Neolithic kings to the Staffordshire hoard. Hoards and aristocratic graves in the European Neolithic: the birth of a “Barbarian” Europe? In P. Bickle, V. Cummings, D. Hofmann and J. Pollard (eds), *The Neolithic of Europe. papers in honour of Alasdair Whittle*, 175-87. Oxford: Oxbow Books.
Kardulias, P.N. 2015. Negotiation and incorporation on the margins of world systems: examples from Cyprus and North America. *Journal of World-Systems Research* 13, 55-82.
Kaul, F. 2014. Bronze Age gold from Denmark. In H. Meller, R. Risch and E. Pernicka (eds), *Metalle der Macht – Frühes Gold und Silber,* 885-902. Halle: Landesmuseum für Vorgeschichte.
Kempke, T. 2001. Skandinavisch-slawische Kontakte an der südlichen Ostseeküste im 7. bis 9. Jahrhundert. In O. Harck and C. Lübke (eds), *Zwischen Reric und Bornhöved. Die Beziehungen zwischen den Dänen und ihren slawischen Nachbarn vom 9. bis ins 13. Jahrhundert*, 9-22. Stuttgart: Franz Steiner.
Kienlin, T. 2017. World systems and the structuring potential of foreign-derived (prestige) goods. On modelling Bronze Age economy and society. In A. Scholz, M. Bartelheim, R. Hardenberg and J. Staecker (eds), *ResourceCultures. Sociocultural dynamics and the use of resources – theories, methods, perspectives*, 143-58. Tübingen: Universitätsbibliothek Tübingen.
Kienlin, T. 2019. On Europe, the Mediterranean and the myth of passive peripheries. In X.-L. Armada, M. Murillo-Barroso and M. Charlton (eds), *Metals, minds and mobility. Integrating scientific data with archaeological theory*, 19-36. Oxford: Oxbow Books.
Kristiansen, K. 2015. The decline of the Neolithic and the rise of Bronze Age society. In C. Fowler, J. Harding and D. Hofmann (eds), *The Oxford handbook of Neolithic Europe*, 1093-117. Oxford: Oxford University Press.
Kristiansen, K. and Larsson, T. 2005. *The rise of Bronze Age society: travels, transmissions and transformations*. Cambridge: Cambridge University Press.
Kristiansen, K. and Suchowska-Ducke, P. 2015. Connected histories: the dynamics of Bronze Age interaction and trade 1500-1100 BC. *Proceedings of the Prehistoric Society* 81, 361-92.

Kristiansen, K. [+ 10 others] and Willerslev, E. 2017. Re-theorising mobility and the formation of culture and language among the Corded Ware culture in Europe. *Antiquity* 91, 334-47.

Kristiansen, K., Melheim, L., Bech, J.-H., Fischer Mortensen, M. and Frei, K.M. 2020. Thy at the crossroads: a local Bronze Age community's role in a macro-economic system. In K.I. Austvoll, M. Hem Eriksen, P.D. Fredriksen, L. Melheim, L. Prøsch-Danielsen and L. Skogstrand (eds), *Contrasts of the Nordic Bronze Age. Essays in honour of Christopher Prescott*, 269-82. Turnhout: Brepols.

Lang, V. 2006. Research into the Bronze and Early Iron Ages. Archaeological Research in Estonia 1865-2005. In V. Lang and M. Laneman (eds), *Archaeological research in Estonia 1865-2005*, 77-104. Tartu: Tartu University Press.

Lang, V. 2007. *The Bronze and Early Iron Ages in Estonia*. Tartu: Tartu University Press.

Ling, J., Stos-Gale, Z., Grandin, L., Billström, K., Hjärthner-Holdar, E. and Persson, P.-O. 2014. Moving metals II: provenancing Scandinavian Bronze Age artefacts by lead isotope and elemental analyses. *Journal of Archaeological Science* 41, 106-32.

Ling, J., Earle, T. and Kristiansen, K. 2018. Maritime mode of production. Raiding and trading in seafaring chiefdoms. *Current Anthropology* 59, 488-524.

Loit, A. and Selirand, J. (eds) 1985. *Die Verbindungen zwischen Skandinavien und Ostbaltikum aufgrund der archäologischen Quellenmaterialien. 1. Symposium der sowjetischen und schwedischen Archäologen, Tallinn 12.-15. Oktober 1982*. Stockholm: Centre for Baltic Studies at the University of Stockholm.

Mägi, M. 2011. Chapter 10: Viking Age and Early Medieval eastern Baltic between the west and the east. In S. Imsen (ed.) *Tax, tribute and tributary countries*, 189-235. Trondheim: Tapir Academic Press.

Makarowicz, P. 2009. Baltic-Pontic interregional routes at the start of the Bronze Age. *Baltic-Pontic Studies* 14, 301-36.

Makarowicz, P. 2015. Barrows, long-distance mobility and peripheral elites between the Baltic and Black Seas during the 2nd millennium BC. In P. Suchowska-Ducke, S. Scott Reiter and H. Vandkilde (eds), *Forging identities. The mobility of culture in Bronze Age Europe. Volume 2*, 213-33. Oxford: British Archaeological Reports.

Matrinsson-Wallin, H. (ed.) 2010 *Baltic prehistoric interactions and transformation: the Neolithic to the Bronze Age.* Visby: Gotland University Press.

Mauss, M. 1954. *The gift: forms and functions of exchange in archaic societies*. London: Cohen & West.

Melheim, L. 2012. Reconsidering a periphery: scenarios of copper production in southern Norway. In N. Anfinset and M. Wrigglesworth (eds), *Local societies in Bronze Age northern Europe*, 89-107. New York: Routledge.

Melheim, L. 2015. Late Bronze Age axe traffic from Volga-Kama to Scandinavia? In A. Hauptmann and D. Modarressi-Tehrani (eds), *Archaeometallurgy in Europe III. Der Anschnitt, Beiheft 26*, 193-202. Bochum: Deutsches Bergbau-Museum.

Meller, H. 2019a. Das Fürstengrab von Leubingen neu betrachtet – zur Konstruktion von herrschaftlicher Legitimität durch Bezugnahme auf die Vorgängerkulturen. In H. Meller and F. Bertemes (eds), *Der Aufbruch zu neuen Horizonten. Neue Sichtweisen zur europäischen Frühbronzezeit. Abschlusstagung der Forschergruppe FOR550 vom 16. bis 29. November 2010 in Halle (Saale),* 245-50. Halle: Landesmuseum für Vorgeschichte.

Meller, H. 2019b. Princes, gold weapons and armies. Reflections on the Dieskau gold find and its possible origin from the Early Bronze Age Bornhöck barrow near Dieskau in the Saalekreis district. *Studia Hercynia* 23, 9-21.

Meller, H., Arz, H.W., Jung, R. and Risch, R. (eds) 2015. *2200 BC – A climatic breakdown as a cause for the collapse of the Old World? 7. Mitteldeutscher Archäologentag vom 23. bis 26. Oktober 2014 in Halle (Saale)*. Halle: Landesmuseum für Vorgeschichte.

Messal, S. 2001. The Daugava waterway as a communication route to the east (9th-12th centuries). *Offa* 58, 71-80.

Minkevičius, K., Podėnas, V., Urbonaitė-Ubė, M., Ubis, E. and Kisielienė, D. 2020. New evidence on Late Bronze Age agrarian intensification in the southeast Baltic and the earliest AMS dates of *Lens culinaris* and *Vicia faba*. *Vegetation History and Archaeobotany* 29, 327-38.
Montelius, O. 1885. *Om tidsbestämning inom bronsålderen med särsskildt afseende på Skandinavien*. Stockholm: Akademiens Förlag.
Mugurēvičs, Ē. 1993. A historical survey and present problems of archaeological science in the Baltic States. *Journal of Baltic Studies* 24, 283-94.
Nerman, B. 1933. Die Verbindungen zwischen Skandinavien und dem Ostbaltikum in der Bronzezeit und der ältesten Eisenzeit. *Acta Archaeologica* IV, 237-52.
Nerman, B. 1954. Yngre bronsåldern – en första svensk vikingtid. *Fornvännen* 49, 275-85.
Nørgaard, H.W., Pernicka, E. and Vandkilde, H. 2021. Shifting networks and mixing metals: changing metal trade routes to Scandinavia correlate with Neolithic and Bronze Age transformations. *PLoS One* 16, e0252376.
Ojala, K. and Ojala, C.-G. 2020. Northern connections: interregional contacts in northern and middle Sweden. *Open Archaeology* 6, 151-71.
Olsen, J., Hornstrup, K.M., Heinemeier, J., Bennike, P. and Trane, H. 2011. Chronology of the Danish Bronze Age based on ^{14}C dating of cremated bone remains. *Radiocarbon* 53, 261-75.
Paavel, K. 2016. Pattern or random? Contextualising Estonian Bronze Age bronze stray finds on the landscape. *Archaeologia Baltica* 24, 26-42.
Paavel, K., Kriiska, A., Lang, V. and Kulkov, A. 2019. Three bronze axes with wooden haft remains from Estonia. *Estonian Journal of Archaeology* 23, 3-19.
Papac, L. [+ 41 others] and Haak, W. 2021. Dynamic changes in genomic and social structures in third millennium BCE central Europe. *Science Advances* 7, eabi6941.
Parker, B.J. 2006. Toward an understanding of borderland processes. *American Antiquity* 71, 77-100.
Penner, S. 1998. *Schliemanns Schachtgräberrund und der europäische Nordosten. Studien zur Herkunft der frühmykenischen Streitwagenausstattung*. Bonn: Rudolf Habelt.
Pétrequin, P., Cassen, S., Gauthier, E., Klassen, L., Pailler, Y. and Sheridan, A. 2012. Typologie, chronologie et répartition des grandes haches alpines en Europe occidentale. In P. Pétrequin, S. Cassen, M. Errera, L. Klassen, A. Sheridan and A.-M. Pétrequin (eds), *JADE – Grandes haches alpines du Néolithique européen. Ve et IVe milléniaires av. J.-C.*, 574-727. Besançon: Presses Univeristaires de Franche-Comté.
Pfeifer-Frohnert, U. 1997. Bronzezeitliche Schiffahrt in der baltischen Koine. In C. Becker, M.L. Dunkelmann, C. Metzner-Nebelsick, H. Peter-Röcher, M. Roeder and B. Terzan (eds), *Chronos. Beiträge zur prähistorischen Archäologie zwischen Nord- und Südosteuropa. Festschrift für Bernhard Hänsel*, 453-68. Espelkamp: Marie Leidorf.
Piezonka, H. 2015. *Jäger, Fischer, Töpfer. Wildbeutergruppen mit früher Keramik in Nordosteuropa im 6. und 5. Jahrtausend v. Chr.* Bonn: Rudolf Habelt.
Podėnas, V. and Čivilytė, A. 2019. Bronze casting and communication in the southeastern Baltic Bronze Age. *Lietuvos Archeologija* 45, 169-99.
Price, T.D. 2015. *Ancient Scandinavia: an archaeological history from the first humans to the Vikings.* Oxford: Oxford University Press.
Rassmann, K. 2004. Chronologie – Die zeitliche Ordnung der Dinge als Schlüssel zur Geschichte der Bronzezeit. In H. Jöns and F. Lüth (eds), *Mythos und Magie. Archäologische Schätze der Bronzezeit aus Mecklenburg-Vorpommern*, 38-49. Lübstorf: Archäologisches Landesmuseum Mecklenburg-Vorpommern.
Rosenberg, M. and Rocek, T. 2019 Socio-political organization in the aceramic Neolithic of southwestern Asia: the complex evolution of socio-political complexity. *Journal of Anthropological Archaeology* 54, 17-30.
Rowlands, M. and Fuller, D.Q. 2018. Deconstructing civilisation. A "Neolithic" alternative. In K. Kristiansen, T. Lindkvist and J. Myrdal (eds), *Trade and civilisation: economic*

networks and cultural ties, from prehistory to the Early Modern era, 172-94. Cambridge: Cambridge University Press.

Schneider, R. 2006. *Der Übergang von der Bronze- zur Eisenzeit. Neue Studien zur Periode VI des Nordischen Kreises in Teilen Dänemarks und Norddeutschlands*. Bonn: Rudolf Habelt.

Schwenzer, S. 2002. Zur Frage der Datierung der Melzer Stabdolche. *Prähistorische Zeitschrift* 77, 76-83.

Sidrys, R.V. and Luchtanas, A. 1999. Shining axes, spiral pins. Early metal consumption in the east Baltic. *Acta Archaeologica* 70, 165-84.

Skoglund, P. 2009. Beyond chiefs and networks. Corporate strategies in Bronze Age Scandinavia. *Journal of Social Archaeology* 9, 200-19.

Sommer, U. 2000. The teaching of archaeology in West Germany. In H. Härke (ed.), *Archaeology, ideology and society: the German experience*, 202-39. Frankfurt: Peter Lang.

Sperling, U. 2013. Der Bronzebruchhort von Tehumardi – Verstecktes Altmetall oder ritueller Weihefund? Ein Deutungsversuch am Erscheinungsbild der Bronzen. In K. Johanson and M. Tõrv (eds), *Man, his time, artefacts, and places. Collection of articles dedicated to Richard Indreko*, 261-316. Tartu: University of Tartu.

Sperling, U. 2014. *Aspekte des Wandels in der Bronzezeit im Ostbaltikum. Die Siedlungen der Asva-Gruppe in Estland. Estonian Journal of Archaeology, Supplementary Volume 18/2S*. Tallin: Estonian Academy Publishers.

Sperling, U. 2016. Visitors to the other side. Some reflections on the Baltic Sea as a frontier and contact zone in late prehistory. In E.A. Kannike and M. Tasa (eds), *The dynamics of cultural borders*. *Approaches to culture theory 6*, 106-32. Tartu: University of Tartu Press.

Stöckmann, K., Heske, I. and Jahn, C. 2021. *Bronzezeitliche Metallfunde aus Ostpreußen. Forschungs- und Überlieferungsgeschichte, Typologie und Chronologie unter besonderer Berücksichtigung der Tüllenbeile*. Berlin: Staatliche Museen zu Berlin.

Šturms, E. 1935. Die Kulturbeziehungen Estlands in der Bronze- und frühen Eisenzeit. *Õpetatud Eesti Seltsi aastaraamat* 1932, 245-77.

Svizzero, S. 2015. Trade, immiserising growth and the long-term Neolithisation process of the Pitted Ware culture. *Journal of Anthropological Archaeology* 40, 332-39.

Vander Linden, M. 2016. Population history in third-millennium-BC Europe: assessing the contribution of genetics. *World Archaeology* 48, 714-28.

Vandkilde, H. 2016. Bronzization: the Bronze Age as pre-modern globalization. *Praehistorische Zeitschrift* 91, 103-23.

Vandkilde, H. 2019. Bronze Age beginnings – a scalar view from the global outskirts. *Proceedings of the Prehistoric Society* 85, 1-17.

Vandkilde, H., Hansen, S., Kotsakis, K., Kristiansen, K., Müller, J., Sofaer, J. and Stig Sørensen, M.L. 2015. Cultural mobility in Bronze Age Europe. In P. Suchowska-Ducke, S. Reiter and H. Vandkilde (eds), *Forging identities. The mobility of culture in Bronze Age Europe. Volume 1*, 5-37. Oxford: British Archaeological Reports.

Vasks, A. 2007. Weapons and warfare during the Bronze Age in the area of present-day Latvia. *Archaeologia Baltica* 8, 32-37.

Vasks, A. 2010. Latvia as part of a sphere of contacts in the Bronze Age. *Archaeologica Baltica* 13, 153-61.

Vasks, A. and Vijups, A. 2004. *Staldzenes bronzas laikmeta depozīts. Staldzene Bronze Age hoard*. Riga: Izd. Fobo Prints.

Wehlin, J. 2013. *Östersjöns skeppssättningar. Monument och mötesplatser under yngre bronsålder*. Göteborg: Göteborgs universitet.

Wenger, E. 1998. *Communities of practice: learning, meaning and identity*. Cambridge: Cambridge University Press.

Windler, A. 2018. *Der Austausch von* Spondylus gaederopus *in Europa zwischen 5500 und 5000 v. Chr.* Rahden: Marie Leidorf.

Shared symbols and values

On Nordic disc pins and deposition practices in the eastern Baltic

Uwe Sperling, Daniel Sahlén

The paper deals with a bronze pin type that is characteristic in the typochronology of Nordic Bronze Age metalwork by Oscar Montelius and Evert Baudou (periods V-VI). Our focus is on the few specimens from the eastern Baltic and their archaeological contexts. The bronze pins have oversized disc heads with a concentric ring motif, and occur in mixed-type hoards or as single-find deposits (rarely in graves). In view of their geographical distribution and occurrence and their expressive symbolism characteristic for Nordic metalwork and rock art, these pins represent a Nordic phenomenon expanding to coastal areas in the east Baltic. Regarding the eastern pins, there are clear signs of selective treatment and deposition practices that point to shared cultural conceptions in how to express symbolic and social value. Yet, these shared values only become visible in Nordic-east Baltic metalwork and deposition customs.

The disc-headed pins of Härnevi type

Since Oscar Montelius and his classic work on the typology and chronology of the Nordic Bronze Age, Härnevi-type pins, large disc-headed pins with concentric circles, have been seen as characteristic types of the Late Bronze Age (Montelius 1917). One of the hoards, that of Härnevi in Uppland, became eponymous for this pin type, also because it contained at least seven specimens of different size (Baudou 1960; Ekholm 1921). Their disc plates are enlarged or supersized and show a concentric ring pattern, with the rim parts of the discs sometimes emphasised. All have the typical bending on the pin's neck. Finds from settlement contexts are rare, as are pins of this type from funerary contexts. The Härnevi-type pins (Baudou's type XXV 2c) have to be distinguished from smaller disc-headed pins with concentric rings and bent neck part (type XXV B 2b; Baudou 1960, 79), which occur frequently in Danish graves of the Montelius period V horizon. The Härnevi pins occur first and foremost in the Mälar valley and on Gotland, with only some contested finds on Zealand, Denmark (Figure 1; Table 1).

Baudou (1960) divides the pins into a Swedish mainland and a Gotlandic type, with the former having a dense and configured ring pattern on the discs and the latter type showing wider relief bands, ring incisions and an emphasised and slightly bent rim part. Looking more closely, the pins all bear their own individual traits in disc size and the arrangement of ring relief (Figure 2), but the supersized disc heads are common to all. The mainland type pins, like the ones from the Härnevi hoard, have a geographically wide distribution west and east of the Baltic Sea, while the Gotlandic pins show a regional occurrence. Both pin types occur in the east Baltic (e.g. Staldzene and Kaali). Positively identified casting moulds for the Baudou XXV 2c type come from Skälby and Bredåker in the Mälar Valley – and from Asva, on Saaremaa island (Estonia).

In the following, we take a closer look at the finds from the east Baltic (Kaali, Asva and Staldzene), particularly at their archaeological contexts (single find, settlement or hoard). The finds complement Evert Baudou's (1960) catalogue of Härnevi pins, and they contribute to the discussion the disc pins' symbolic and social value, especially in light of recurring Late Bronze Age (LBA) deposition phenomena west and east of the Baltic Sea.

In D. Hofmann, F. Nikulka and R. Schumann (eds) 2022. *The Baltic in the Bronze Age. Regional patterns, interactions and boundaries*, Leiden: Sidestone Press, pp. 31-48.

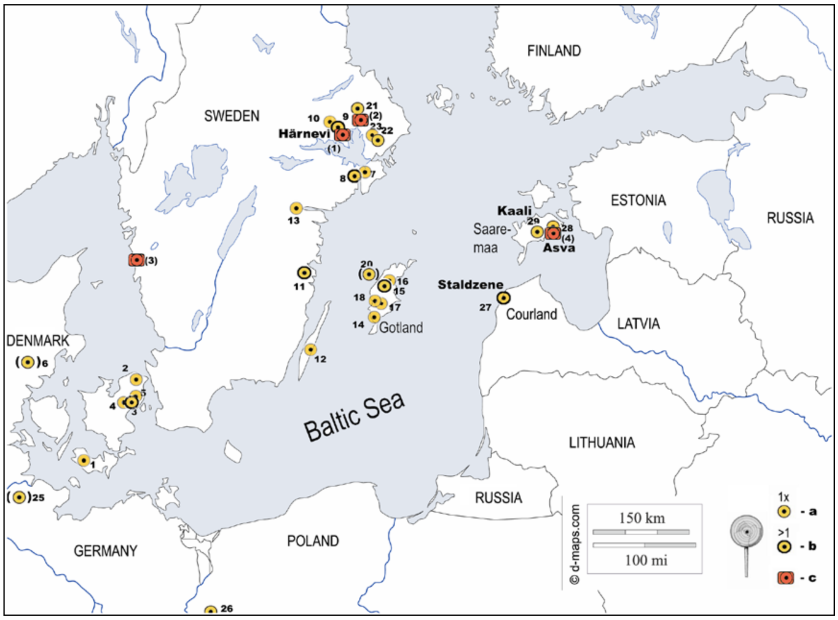


Figure 1. Map of Härnevi-type disc pins (yellow) and associated casting moulds (red). See Table 1 for numbers and references.
a – single or stray find;
b – pins from hoard contexts;
c – finds of casting moulds.

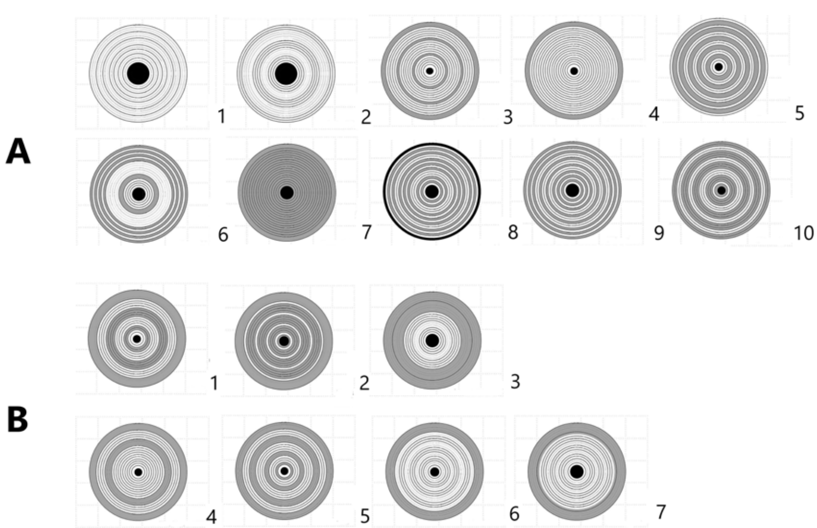


Figure 2. Comparative abstract renderings of selected disc plates of Härnevi-type pins (not to scale).
A – Baudou's Swedish mainlaind type;
1-2: Langbro hoard;
3-5: Staldzene hoard;
6-10: Härnevi hoard.
B – Baudou's Gotlandic type;
1: Kaali, Saaremaa;
2: Roma kloster (hoard);
3: probable single find from Kyrkeby, Gotland;
4: Libbenarve (hoard);
5: single find from "Gotland";
6-7: Nystuga, Gotland.

Figure 3. The disc pin found in Kaali, front and back. Note the repair and the loop on the back (photo: U. Sperling).

Kaali (Estonia) – single find of a disc pin

The disc pin from Kaali has been found in the 1930s and its proper find circumstances remain unknown. The Kaali site in the central part of Saaremaa (Estonia) is one of the most remarkable landscape features of the island, due to a meteorite impact having formed a crater of around 110 m in diameter and with banks up to 14-16 m in height. The impact probably happened during the Early Bronze Age (c. 1500 BC), when Saaremaa was still scarcely populated (Losiak *et al.* 2016). The shallow Kaali lake inside the crater (50-70 m in diameter) has been considered in local folklore as a holy or sacrificial place, while archaeological and geological investigations in the late 1970s could only confirm prehistoric settlement activity on the crater's rim (a house floor or terrace and parts of stone enclosures; Lõugas 1996). The settlement remains include an episodic LBA occupation, identified by pottery, casting moulds and crucibles, as well as by ^{14}C dates (Sperling 2014, 81-94). In spite of the missing information on the find circumstances of the disc pin, the settlement with bronze production is likely part of the pin's archaeological biography (see below).

The bronze pin is in a good state of preservation, being only coated by dark green patina (Figure 3). The disc is 7.7 cm in diameter, the thin sheet of the disc (less than 1 mm thick) shows a finely modelled relief of concentric alternating bands and rings, with a central boss. The disc has an old repair of a casting failure. The 7 cm long shaft of the pin is bent at the transition to the head. On the back of the disc head there is a looped fastener. The complete pin, including shaft and loop, was cast in one procedure (lost-wax casting).

The pin from Kaali is among the Härnevi-type disc-headed pins listed by Baudou (1960). In Estonia, its first mention and photographic reproduction was in a compendium on (Soviet-) Estonian prehistory, but in connection with similar finds made in Asva (Jaanits *et al.* 1982, 141 fig. 105.7).

Asva (Estonia) – the disc pin and casting moulds

In the fortified settlement of Asva on Saaremaa island, another specimen of this disc pin has been found during an archaeological fieldwork campaign in 1965 (led by Vello Lõugas). The north-western and northern parts of the site had been excavated before, in the 1930s and 1940s, but the pin was the first genuine Bronze Age metal object found there. Asva is also one of the first Bronze Age settlements with archaeological evidence of bronze production discovered in the eastern Baltic (Indreko 1939; Lõugas 1966). The settlement site is situated on a moraine, reaching up to 5 m above the surrounding coast and landscape, and was formerly surrounded by sea and brackish water lagoons. Excavations revealed thick cultural layers indicating horizons of habitation and burning mainly during the LBA (900-500 BC). The material comprises large amounts of pottery, antler, bone and stone implements, bronze casting debris (clay moulds) and rich accumulations of animal bones which attest to stock breeding, seal hunting and fishing (Sperling 2014; Visocka *et al.*, this volume).

The bronze pin was discovered towards the inner part of the excavated settlement plateau, at a depth of 40 cm, where the upper part of the cultural layer had been mostly removed due to more recent agricultural activities (in the 1900s). The pin itself was already in a bad condition at the time of its discovery (Figure 4). The object is now housed in the archaeological collection in Tallinn, and no conservation measures have been undertaken so far. Pieces of the patina are flaking off and only parts of the disc head hold together, while the shaft was already broken when discovered. The entire pin has a thick patina, showing grass-like organic impressions on almost every part of the surface. This was apparently due to exposure to an acid environment, and the surface impressions suggest that the object could have actually been covered or coated with horse or cow dung for a time. The straight, c. 15 cm long shaft of the pin was originally about 0.5 cm thick with a round cross section and pointed tip. The shaft is bent on the neck, at the transition to the pin's head. The disc head is c. 7 cm in diameter, the concentric ring decoration remained only partly discernible through the patina cover. Still visible, however, is the modelled boss in the centre of the disc. The long shaft is different from that of the Kaali disc pin, but there are several analogies among the disc pins from the Härnevi hoard (Figure 8). Another bronze find probably belonging to a disc pin was uncovered during the 2012 excavation on the eastern edge of the settlement plateau (trench Asva G). Only the shaft was found, and the head part missing (Sperling *et al.* 2013, fig. 9). Judging from the bent neck and general shape, the pin is comparable to smaller examples from Kaali and Staldzene (see below).

The large disc pin was found in the northern part of trench Asva F (at a depth of 40 cm), 8-9 m away from the actual bronze casting area (Figure 5). The upper cultural layers are either disturbed or not preserved in this part of the settlement plateau, due to later agricultural activities, while in the southern part of the trench the LBA cultural layers remain untouched and more than 100 cm thick. That is why the stratigraphic context of the bronze pin and its association with the neighbouring bronze casting complex remain unresolved. The latter belongs to the cultural horizon of the earlier LBA habitation (Asva I), consisting of a house structure and associated rectangular hearth filled with dark sooty soil and charcoal and partly bordered by limestone slabs. The spatially concentrated accumulation of some hundred pieces of clay casting moulds attest to the connection of the hearth complex with bronze production activity (Figure 5).

Four clay fragments from Asva, found in a 2 m radius around the hearth structure (at a depth of 100 cm), can be identified as stemming from casting moulds of this type of disc-headed pins. These sand-tempered clay mould fragments are only between 0.5 and 1 cm thick, fired at low temperatures and incised with a fine relief of thin concentric rings on one part. Judging from the layout of the incisions and the sizes of the clay pieces, they belong to at least two different casting moulds for disc pins (Sperling 2014, 141-42). From Skälby (Uppland, Sweden) there are at least 19 such clay mould pieces from a cultural layer under a LBA burial mound. They are similar in size and diameter and only slightly different in design of the disc plates, i.e. the layout and size of the concentric rings and bands, but the characteristic rim bands of the discs are present (Jantzen 2008, 72; Oldeberg 1960, 20 Abb. 34.1-12)[1]. Some of the Skälby moulds even allow reconstructing their composition and technical application. The thin and fragile clay discs had a complementary clay pedestal and additional clay cover, c. 1 cm thick, serving as cushion for the actual pin (disc head with shaft), i.e. the original wax model initially coated with clay. Such a cushion or bottom part was recently identified through re-examination of the casting moulds from a former excavation in the northern trench (Asva E, 1948-49; find number AI 3994:174). That additional find comes from another bronze casting area, and thus it appears likely that the disc pins (or at least the moulds) were produced in other parts of the settlements as well, possibly indicating simultaneously working craftspeople in Asva (Sperling 2019).

Staldzene (Latvia) – three disc pins from a mixed hoard

The Staldzene hoard is probably the most remarkable bronze find in the eastern Baltic so far. This is because of the large assemblage comprising a variety of object types, most of them occurring for the first time within the region. The hoard was found in 2001 near Ventspils in Courland, directly on the coast of the Baltic Sea and under a sand dune. It comprised at least 88 items with a weight of c. 5.6 kg (Vasks and Vijups 2004). Hoards or graves containing multiple bronzes are extremely rare in the entire east Baltic (see e.g. Paavel 2017).

There are three disc-headed pins among the bronzes in the hoard, more than 30 freshly cast arm rings or ring-like ingots, 14 spiral rings (including two arm rings), six

1 Another clay casting mould like the ones from Skälby has recently been found in Bredåker (Uppland) (Eriksson 2007; Schütz 2007).

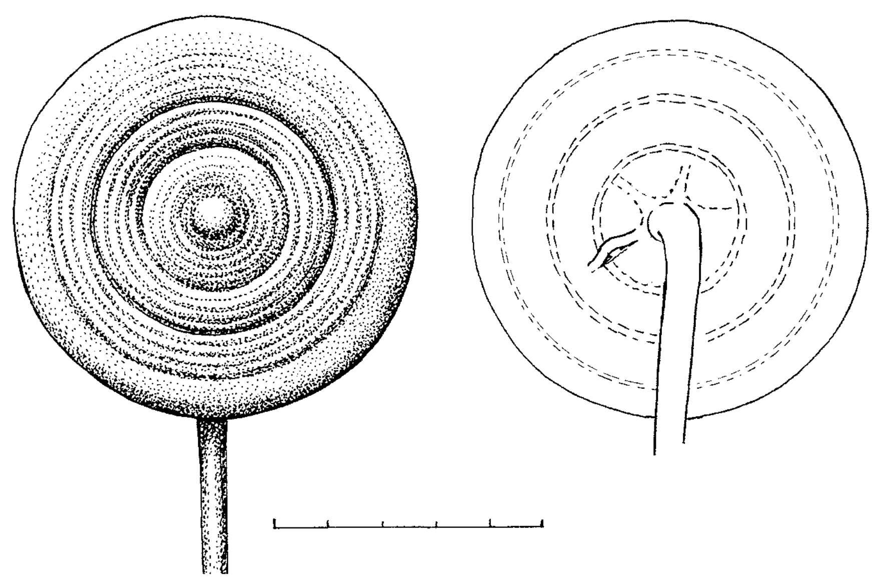


Figure 4. The bronze pin from Asva and its current state of preservation, with idealised reconstruction (photo: M. Konsa; drawing: K. Siitan).

leaf-shaped terminal neck rings, a spectacle fibula and some other items and implements (Figure 6)[2].

The Staldzene disc-headed pins are smaller than their Estonian counterparts from Asva and Kaali. The largest of the three Staldzene pins has a disc c. 6 cm in diameter and a short stem of only 5 cm that barely reaches beyond the disc plate. The medium-sized example has a disc of c. 4 cm in diameter and a slightly longer stem (c. 7 cm). The third

2 In addition to the disc-headed pins of various sizes there is a bronze pin with a horned sheep's head (Vasks and Vijups 2004, fig. XVII, 2), very likely depicting the Gute sheep breed native to the island of Gotland (both rams and ewes are horned). That sheep-headed pin is unique in the Nordic Bronze Age, although there are several zoomorphic depictions on bronzes (horses, birds; Brøndstedt 1958, 224-25).

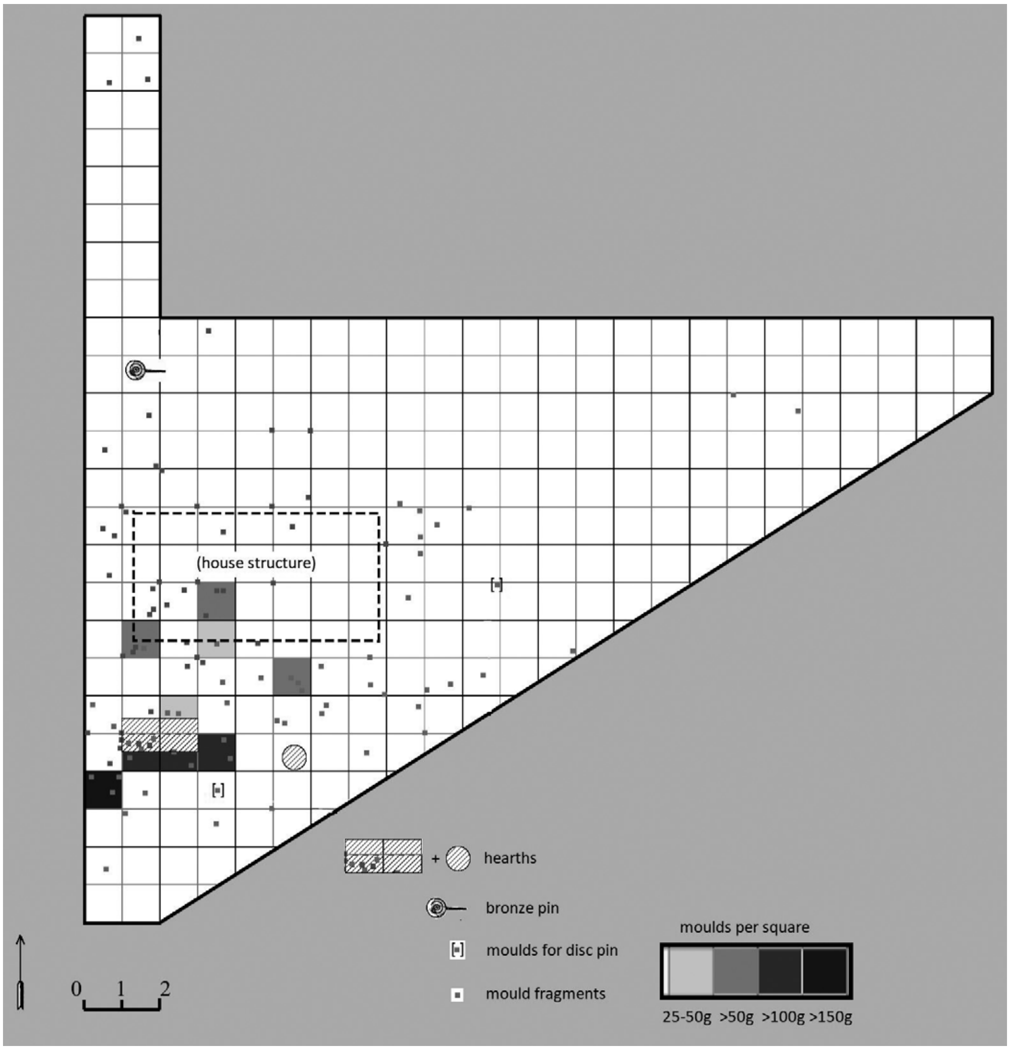


Figure 5. The archaeological find contexts of the bronze pin and casting moulds from Asva (Sperling 2014).

and smallest looks like a miniature disc-headed pin and has a head size of only c. 3 cm paired with a c. 5 cm long stem. Considering their general size and the length of the shafts, their heads appear clearly oversized (Figure 7).

The bigger disc pin has an old repair and shows traces of damage or wear along the rim (Vasks and Vijups 2004, fig. XVII). The same casting-on (running-on) technique was applied as in the case of the Kaali specimen (Figure 3). The disc head shows fine and dense incisions of concentric rings, alternating with concentric plastic ridges. The plate has the characteristic loop fastener on the back. All three Staldzene pins have a boss in the middle of the disc head, giving the appearance of a conjunction of disc and stem. The sizes, design and arrangement of the concentric ring motif of the three pins differ remarkably, and their individuality might imply custom-made production according to socio-cultural criteria and occasions (e.g. age or status related) – or different regional provenance. The Staldzene hoard, as the one from Härnevi, contains mainly bronze types characteristic for the Montelius VI horizon, such as the hanging vessel, the neck rings with leaf terminals and the plate fibula (Heske 2012; Vasks and Vijups 2004). That typochronological setting of the Staldzene bronzes is in agreement with absolute dates from the Asva production site (see below).

Figure 6. The Staldzene hoard (photo: A. Vasks and A. Vijups).

Figure 7. The pins from the Staldzene hoard (photo: A. Vasks and A. Vijups).

The archaeological contexts of the pins

The eastern Baltic disc-headed pins represent a distinct LBA phenomenon of precious bronzes occurring mainly in hoards or as single finds. There are only rare examples from ^{14}C-dated settlement contexts (such as Asva). In the classic typochronological framework by Oscar Montelius (1917) the Härnevi pins are found among the main types of period VI, while Evert Baudou (1960) attributed them to phases V and VI, or the transition. The chronological frames or boundaries of the Montelius periods are still vague, particularly as period V and VI bronzes occur exclusively in mixed hoards. In terms of absolute dating, it is still accepted to date Montelius period V to 950/900-750/700 and period VI to 750-530/520 BC (e.g. Ling *et al.* 2014). While recent dates on Danish cremations indicate a shift back to about 800 cal BC for the beginning of period VI (Olsen *et al.* 2011), the end of period VI can be synchronised with dendro-dated Hallstatt horizons in the circum-Alpine region (Ha D2). In view of the objects typical for period VI in the Staldzene hoard, that means quite a long potential timespan for the use, circulation and eventual deposition of disc-headed pins on the Courlandic coast. The ^{14}C dates from Asva (800-400 cal BC) provide additional support in setting the disc-headed pins within the period VI horizon[3].

3 Three samples taken on charcoal from the cultural layer with bronze casting activity: 2513±27 BP, 2429±28 BP, 2400±28 BP and 2387±27 BP (UBA 27252-55; Sperling *et al.* 2015, 59).

In terms of artefact deposition, the pins either occur in hoards (11) or as single finds (10) (Table 1), and grave contexts are exceptions. Most of the hoards and single finds have been found by chance and not in the course of archaeological survey or excavation, and the majority of disc pins lack contextual information. However, recent studies on deposition patterns of Bronze Age objects show preferences concerning landscape features and the types deposited there (e.g. riverine or wet contexts; Paavel 2017). Spearheads and axes are the predominant single metal finds in the Nordic Bronze Age and this supports selective and deliberate practices behind the deposition patterns (Fontijn 2019; Larsson 1986; Rundkvist 2015). In the case of the disc pins, their association with complex hoards with multiple bronze items points to a similar background of deposition practices. The Härnevi and Staldzene hoards, both containing similar period VI objects in similar compositions and similarly treated, are just prominent examples of collective beliefs behind metal hoarding west and east of the Baltic Sea (see below).

In spite of the lack of data concerning the depositional circumstances and landscape context of most Härnevi-type pins, there are some interesting observations concerning stages of their cultural biographies. The Härnevi hoard (found in 1902), for instance, was placed close to an abandoned settlement (Rundkvist 2015, 42, 61). The Kaali pin has been found in the vicinity of a LBA settlement and bronze production site (a meteorite crater) and the specimen from Asva comes directly from a bronze production site where such pins were actually manufactured (see above). The numerous pins from Gotland occur some distance from the LBA settlement sites known on the island, but that is apparently a research-related phenomenon (Runesson 2014). Only few pins occur as grave goods, but their contexts are unclear and contested, particularly in their association with either male or female burials – or with other accompanying metal finds in these burials (e.g. the tweezer and toggle pin from Salem; Baudou 1960, 79, 268, 321).

Considering the pre-depositional treatment of disc pins

The selective and symbolic aspects of bronze deposition become most visible, however, in the composition and number of objects accumulated in hoards of Montelius periods V and VI. The Härnevi-type pins illustrate this point, because of their regular appearance in complex hoards where particularly ornaments (arm rings, bracelets) occur in paired or multiple sets. For the Staldzene hoard, for instance, that is one of the key observations pointing towards a possible ritual and symbolic background of deposition (Heske 2012). Given the quantity of broken objects, and as many show wear and repair, the assemblage was first attributed to the category of a metalworker's scrap hoard (see Maciejewski and Nowak, this volume), thus emphasising the material value over the social and symbolic value of the deposited items (Vasks and Vijups 2004 suggest the scenario of a retrieved shipwreck cargo). The direct comparison of the Staldzene and Härnevi hoards attests even more to patterns of composition and association: single hanging vessels and spectacle fibulae, as well as arm and neck rings, are further symbolic components, just like the disc pins (and treatments like fragmentation and breakage) (Table 2). These characteristics of LBA hoard composition are clear arguments against any accidental and profane background of such hoards (and transcend the former idea of valued scrap). Furthermore, involving issues of gender, particularly female participants, in discussions of Nordic LBA metalwork and the hoarding phenomenon opens for a different interpretative approach to the processes and actions behind those complex hoards (Heske 2012; Lund and Melheim 2011; Melheim 2015) – and also for the symbolic role of the disc-headed pins. Why did the disc pins occur in hoards or as single finds in the first place? Was it about the material value (bronze) of the items, or was it about their social (prestigious) content? Does the symbolism expressed in the concentric motifs and the oversized disc parts contradict the idea and use of regular clothing accessories?

The supersized disc heads and the large stems of some Härnevi-type pins are surely part of the development that Johannes Brøndstedt (1958, 219) described as general tendencies of overstatement that affected particularly bronze ornaments in the LBA.

No.	Site	Location	Find context	Reference
Pins				
Denmark				
1.	Hellinge	Halsted sn, Lolland, Amt Maribo	Hoard	Baudou 1960
2.	Viksø	Viksø sn, Ølstykke hd, Amt Fredriksborg	Single find	Baudou 1960
3.	Klovetofte	Høje Tåstrup sn, Smørum hd, Amt København	Hoard (2 ex.)	Baudou 1960
4.	Klovetofte	Høje Tåstrup sn, Smørum hd, Amt København	Grave	Baudou 1960
5.	Utterslev Mose	Brønshoj sn, Sokkelund hd, Amt København	Single find	Baudou 1960
6.	"Denmark"	Denmark	Single find	Baudou 1960
Sweden				
7.	Säby	Södermanland, Salem sn	Grave	Baudou 1960
8.	Långbro	Södermanland, Vårdinge sn	Hoard	Baudou 1960
9.	Prästgården	Uppland, Härnevi sn	Hoard	Forsgren 2012
10.	Västervad	Uppland, Simtuna sn	Hoard	Baudou 1960
11.	Fårhult	Småland, Gladhammar sn	Hoard	Baudou 1960
12.	Näsby	Öland, Sandby sn,	Single find	Baudou 1960
13.	Fiskeby	Östergötland, Ö. Eneby sn	Single find	Baudou 1960
14.	Libbenarve	Gotland, Hvadhem sn	Hoard	Hansson 1927
15.	Roma kloster	Gotland, Roma kloster sn	Hoard	Hansson 1927
16.	Kyrkeby	Gotland, Hangvar sn	Single find	Hansson 1927
17.	Nyträsk	Gotland, Hemse sn	Single find	Hansson 1927
18	Nystuga	Gotland, Sanda sn	Hoard	Hansson 1927
19. not mapped	Lerbo	Lagmansö, Södermanland	Single find	unpublished
20.	"Gotland"	Gotland	Single find	Hansson 1927
21.	Skuttunge	Skuttunge sn, Uppland,	Settlement	Grandin and Hjärthner-Holdar 2008
22.	Molnby	Vallentuna sn, Uppland	Hoard?	Appelgren *et al*. 2016
23.	Sigridsholm	Lunda sn, Uppland	Hoard	unpublished
Norway				
24. not mapped	Skerdalen	Vereid sn, Sogn og Fjordane	Hoard	Baudou 1960
Germany				
25.	"Schleswig-Holstein"	Schleswig-Holstein	Single find	Baudou 1960
Poland				
26.	Krzystkowice (formerly Christianstadt)	Woj. Lebus, Żary (Sorau)	Single find	Baudou 1960
Latvia				
27.	Staldzene	Vidzeme, Courland	Hoard	Vasks and Vijups 2004
Estonia				
28.	Asva	Saare county, Saaremaa	Settlement	Sperling 2014
29.	Kaali	Saare county, Saaremaa	Single find	Sperling 2014
Moulds				
Sweden				
1.	Skälby	Vårfrukyrka sn, Uppland	Cairn	Oldeberg 1960
2.	Bredåker	Uppsala sn, Uppland	Settlement	Frölund and Schütz 2007
3.	Hjälm	Kungsbacka, Halland	Settlement	Jonsäter 1979
Estonia				
4.	Asva	Saare county, Saaremaa	Settlement	Sperling 2014

Table 1. Härnevi-type bronze pins (Baudou type XXV 2c) and finds of casting moulds, including their archaeological contexts.

These ostentatious objects are clearly a form of expressing social value and identity, possibly prestige[4]. Here, we particularly seek to understand if that was still the case at the moment of their deposition.

It is noteworthy that the sometimes exaggerated head part with elaborate concentric ornamentation is a distinct typochronological feature, distinguishing the Härnevi-type pins from other varieties with small disc heads frequently occurring in graves on the Danish islands and Jutland (Baudou 1960, type XXV B 2 b). The Härnevi-type pins (Baudou XXV B 2 c) with enlarged disc heads are therefore described by the technically complex making of the extra-thin bronze sheet. This includes the preparation of an extremely thin wax plate and the working of the fine concentric incisions, as well as a suitable clay paste for the casting moulds, given the many risks of cracks or fissures (entrapped air) in the process of firing and casting. That surely demanded experienced and skilful handling of the materials and technical experience by the metalworker. Some pins attest to the risks of failure easily incurred during preparation work (e.g. making moulds) and metal casting. The pin from Kaali shows that such damage occurred, as seen in the small opening on the sheet of the disc plate. That hole had to be repaired and a patch added subsequently. Another pin from Gotland (Roma) has a hole of similar size, also resulting from entrapped air and incomplete diffusion of the bronze in the moulds (see Baudou 1960, plate XVI). The largest of the pins from the Staldzene hoard also shows an old repair, possibly caused by a casting failure (Vasks and Vijups 2004, photo nr. 15), while other rim parts of the sheet are damaged due to wear or decay. The two smaller pins are, however, in excellent condition. Thus, the making of larger bronze disc plates and the prevention of breaks or holes meant serious technical challenges even to skilled and experienced bronze workers. Four of the eight pins from the Härnevi hoard are in fragmentary condition, only the larger ones (with bigger plates) are almost complete (Figure 8). The two specimens from the Långbro hoard (Södermanland) are the most intact, as was the case for the other hoard components, the plate fibulae and neck rings (Ling *et al.* 2014, 108 fig. 4; Rundkvist 2015, 42, 60). The complete lack of fragmentation or breakage remains a remarkable exception in view of the other hoards containing those pins.

Therefore, it is important to pinpoint the nature and cause of the imperfect disc heads when discussing the occasion and circumstances of the hoards' deposition (metal stockpile or metal votive). The repair and altered state or condition of deposited disc pins also points to the discussion regarding the intention behind their deposition as single items or as regular components in multiple hoards in southern Scandinavia and the east Baltic. Again, one can notice those repeatedly occurring repairs also on neck rings or plate fibulae and, in some cases, their sloppy or crude execution. With the ring objects and other fragmentary or worn items in hoards, this seems to support the idea of bronze scrap deposits that have lost their social or symbolic value and became divorced from the former owners' identity. Yet this hypothesis always needs testing based on the condition and causes of the breakage – and the given repair. The latter may result from constraints in material, effort and time right after the laborious process of making objects like the disc pins. Repairing small parts or joints by additionally adding tiny bronze patches was probably accepted by the owners, who likely knew about the effort and risks in attempting to craft a new, flawless bronze object. The repairs may nevertheless indicate that the objects went through the hands of different craftspersons of varying skill and experience, or even changed places or regions. The frequently observed repairs on plate fibulae (occurring mainly in mixed hoards) usually appear at the central joint of the brooch plates. There are plausible explanations for the so-called repairs, for instance re-attachment after use and wear, or recombination of plates from different brooches (see Melheim 2008). Another explanation may relate to the production process, i.e. casting the two plates separately and joining them afterwards

4 M. Stenberger (1977, 220) also referred to the disc pins of Baudou type XXV B 2 c as *Prachtnadeln* (meaning "ostentatious pins" in German).

Table 2. Published or referenced hoards containing Härnevi-type disc pins, listing the other predominant object types in the assemblage.

Hoards with Härnevi-type disc pins (see Table 1)	Predominant object types in hoards
Staldzene	hanging bowl (1), neck ring (18+), arm ring (34), plate fibula (1), others (e.g. axe)
Härnevi	hanging bowl (1), neck or arm ring (10+), arm spiral (4+), plate fibula (1), others (e.g. axe)
Långbro	neck ring (7), neck collar (1), arm ring (1) and spiral (4+), plate fibulae (2), others (e.g. axe)
Fårhult	hanging bowl (1), neck ring (8), neck collar (1), arm ring (6)
Roma	hanging bowl (1), neck ring (3)
Västervad	plate fibula (1) only

Figure 8. The assemblage from the the Härnevi hoard (after Forsgren 2010).

by the on-casting technique (German: Überfangguss; Drescher 1958)[5]. Certainly, the visual-aesthetic qualities of some of the repairs fall short of the generally skilful design of the object (i.e. they look sloppy). Yet assessing the repairs demands a reconsideration of all available information regarding the object's cultural biography – the time and occasion of the repair, the duration of use, the object's ownership or sphere of use, the aesthetic appreciation of the people making, using and repairing such objects. Thus, some of the pins from the Staldzene and Härnevi hoards might appear worn, damaged or fragmented, but probably only at first sight. This "bad" condition does not rule out any symbolically and socially loaded value at the time of their deposition, indeed it could have been a criterion for intentional and selective treatment (Fontijn 2019). The Kaali pin, a single find still in excellent condition, has an on-cast repair on the disc sheet, most likely performed directly after casting and in an accurate, skilled manner by the same craftsperson who made the pin in the first place[6]. Thus, and in spite of the repair, that disc pin was deposited as an intact, possibly prestigious object. If the Kaali pin had been found in a hoard containing a large percentage of fragmentary bronzes, as in the case of Staldzene, this probably would affect our perception of the pin's social and material value, ascribing it a possible ritual and symbolic background.

Gendering the pins

The matter of gendering the Härnevi-type pins is here discussed with reference to their possible function and purpose, and not about stereotypical male-female gendering. The matter is actually twofold, because, on the one hand, it points to the social and personal identification behind a possible dress item or body ornament, i.e. how the LBA community may have perceived the pin's meaning when worn on the body or as part of costume. On the other hand, we must focus on discerning the role the disc pins played as hoard components or as single deposits. Before being finally committed to the hoarding sphere, the pins possibly underwent different stages of social use and value. There probably have been crucial phases in the pins' cultural biography (i.e. ritual event or occasion) that decided about their further trajectory. In the cases of Staldzene and Kaali, that would imply that those pins ended up in the ground somewhere. The Asva case seems different; the pin may have been destined for a crucible at this bronze production place. There also is the hypothetical scenario of temporary use as a trial copy by the metalworker, before the object became a ritual offering. However, the matter and subject of social and personal identification behind the disc pins, particularly the exaggerated design and symbolism, remains hard to grasp given the archaeological filters, i.e. the selective deposition practices (Fontijn 2019; Maraszek 2006). Since these pins occur almost exclusively as single finds or in mixed hoards, there is little information on the circumstances of (and reasons for) their deposition, or on their final use, treatment and significance from the object biography perspective. Gendering the pins as female is tempting because of their association with other body and dress ornaments placed in the same hoard contexts and the fact that the Nordic LBA hoarding sphere is clearly dominated by items or objects that do not belong to the weapon or metalwork category.

Any straightforward association of the Härnevi-type pins with gender identity is also problematic because dress types or costumes do not appear in funerary contexts of the Nordic Late Bronze Age and the east Baltic. The main reason is the cremation ritual and the generally limited numbers and types of bronzes given as grave goods, making LBA society

5 A. Oldeberg (1933, 201) explains the all-in-one casting technique of this fibula type using the Gotlandic example of Stenbro (Silte). Nevertheless, there remains the possibility that some metalworkers preferred to cast the two plates separately, or that breakage occurred already during casting or finishing of the fibula.

6 The results of the XRF analysis by Ragnar Saage at the Laboratory of Archaeology at Tartu University indicate that the same alloy was used for the pin and the repair, as shown by similar Pb values (2-3 %; Saage 2013, 7).

appear almost egalitarian (Sørensen 2013, 231). In those exceptional cases where disc pins occur in cemeteries, it remains difficult to connect them with particular anthropologically determined burials, as in the case of Salem, Södermanland (with tweezer and toggle pin; Baudou 1960, 79)[7]. Thus, the lack of archaeologically attested funerary contexts makes it impossible to connect the disc pins with dress or costume, or with gender. This applies to the northern part of the east Baltic as well, as the stone cist graves in this area only occasionally contain bronzes and depositional practices did not involve adding personal dress items into graves (Lang 2007; Sperling and Lang 2021)[8]. Recent studies on landscape deposition patterns in the east Baltic report increased numbers and types of bronze objects, but body ornaments remain exceptions (Paavel 2017; Paavel *et al.* 2019)[9]. This adds to our current understanding of selective deposition practices in the Bronze Age east Baltic (see Fontijn 2019; Maraszek 2006). Gender identities, however, are not recognisable in the local material culture so far.

This is also the reason why we lack information about the actual use of the disc pins as body ornaments, or how they were worn. For regular Nordic LBA pins and needles, we can assume that they decorated the chest or shoulder areas of both male and female costumes in order to fasten a cloak, and that they were sometimes worn in pairs (Kristiansen 2013, 763-64). The loops on the back of the Härnevi-type pins also support their use as cloth fastener, as they help in fixing the pins onto the cloth with a string or wire. There are several depictions of disc pins on face urns in eastern Pomerania supporting this type of wear. The face urns also provide the first female association of pins with supersized disc heads, but only at quite a geographical distance from the main distribution area of Härnevi-type disc pins: around Gdańsk bay and between it and the mouth of the Vistula (Dzięgielewski 2016; Kneisel 2001). The pins depicted on urns also seem to belong to a related, but different category of disc-headed pins. Chronologically they follow the Härnevi horizon, dating around 500 BC and later (late Ha D/Lt A) and comprising a series of subtypes (e.g. with “swan neck”; Kaczyński 2015). However, the face urn depictions allow us to identify larger discs (with 2-3 concentric rings) as female attributes, as they occur with collars and neck rings. The disc heads of male pins are usually smaller (Kneisel 2001, 292-93 figs 2 and 4). Interestingly, the other female paraphernalia on the face urns, the collars and neck rings, are regarded as attributes of a high social status in the Early Iron Age of the Polish lowlands, while the actual bronze objects occur mainly in hoards (Dzięgielewski 2016, 25 fig. 6.a-d).

As mentioned, with the cremation rite in use from period IV onwards most bronzes disappear from the funerary sphere and with that the chances of archaeologically identifying dress items and body ornaments possibly reflecting personal (female) identity. In addition, the visual culture of the Nordic LBA, such as rock art, lacks female representations, whereas most images and scenes show males or activities with masculine associations (warrior scenes, seafaring, travel: see Kristiansen 2014). Only a few rock carvings with concentric circles are known, but some are depicted on a foot or pedestal (e.g. Hammersholm, Bornholm) and are thus reminiscent of disc-headed pins in an abstract manner (see Kaul 2013, 266 figs 2-3). These concentric stone carvings could express the same iconic pattern or idea as the disc pins, most likely depicting the sun (as e.g. the *Sonnensteine* or “sun stones” in northern Germany; Capelle 2008, 72 fig. 75). The LBA concentric ring motif, when carved in rock, just never appears in clear association with gender, at least not with the female sphere.

---

7 Besides the problem of gender determination of graves and imprecise contextual attribution of objects, those disc-headed pins might also belong to subtype Baudou XXV B 2 b and not to the actual Härnevi-type pins with supersized discs (type XXV B 2 c). See also the similar case of the cemetery in Åsby, Södermanland (Damell 1985, 43-44 fig. 35).

8 In coastal regions of Estonia there are only few cases where personal toiletry equipment occurs (Lang 2007, 159; Sperling and Lang 2021).

9 The 2019 campaign in Asva yielded casting moulds supposedly used for making a plate fibula (Sperling *et al.* 2020).

How then can we relate the bronze disc pins to gender identity? The association with the female sphere is indirect, through the LBA metal hoards. We now know about the association of the disc pins with complex hoards such as Härnevi or Staldzene. We also see the repetitive combination of lavish finely-worked bronzes with rich decorative and symbolic ornamentation representing the dress or ornament category. Hanging bowls, neck rings, bracelets and plate fibulae clearly show an affiliation to rich and opulent Nordic LBA hoards, but are rare or completely missing in contemporary funerary contexts (e.g. hanging bowls; Larsson 1986; Maraszek 2006)[10]. Male-associated items, mostly comprising metalworking tools, appear regularly in these deposits, but play a minor, symbolic part (Lund and Melheim 2011; Maraszek 2006; Melheim 2015). Again, Härnevi and Staldzene are just two prominent examples where the disc pins point to the female sphere.

While Early Nordic BA funerary contexts and bronze figurines allowed us to recognise varied expressions of female identity in how assemblages and ornaments were combined and composed (cloth, clothing, removable dress items; Melheim 2015; Sørensen 1997), in the LBA hoards seem to be the main archaeological source of reference for gender identity. The Staldzene hoard as a typical representative for complex LBA deposition is considered the result of a ritual event carried out by a group of at least six female participants offering their dress fittings to the hoard (i.e. paired neck rings and bracelets; Heske 2012). Some of the opulent hoards of the Nordic LBA realm, dominated by ornaments and dress items, appear to be the legacy of a high status priestly woman (Kristiansen 2014, 348 and references therein). The Härnevi hoard has been seen as being intentionally composed of objects with symbolic meaning (including disc pins), and the entire hoard itself has been read as a mythological manifestation. Magdalena Forsgren proposed a possible background in sun and fertility cults with eastern Baltic traits, with the bronze objects as offerings to a female divinity (goddess of Härn; Forsgren 2010). Following the interesting hypothetical scenario of a Bronze Age Nerthus cult, the disc pins in question might have served as symbolic attributes of a female deity. That, again, leaves us with the matter of the pins' pre-depositional gender identity. We do not know the original purpose of the disc pins at the time and place of their production (e.g. Asva or Skälby), the reasons why they were produced, and whether they were designed to be worn as (female) dress items in the first place or were always items destined for deposition. Given the expressive design and symbolism, the size and the advanced technical requirements in their production, the Härnevi-type pins suggest a socially exclusive status for the people claiming ownership or custody over these precious items.

Concluding remarks

The disc pin finds, particularly those from the Staldzene hoard, put the east Baltic on the map of Nordic LBA deposition customs and practices. Their affiliation to hoard and single find depositions is a common trait in view of selective deposition practice (e.g. Staldzene and Kaali). Only the Asva pin found in a settlement context stands out in view of the archaeological record and the general pattern of find circumstances of the disc pin category. We may assume that the Asva pin's deposition happened accidentally; the pin was either supposed to end up in the recycling process or, at a later stage of its life cycle, as offering (such as in Staldzene or Kaali), entering the spheres of a "sacrificial economy" (Fontijn 2019, 165). The case of the Asva production context (casting moulds), however, sheds new light on the matter of the "Nordic" provenance of objects placed in eastern Baltic landscapes. The casting mould pieces from Asva, possibly of a plate fibula (Sperling *et al.* 2020, 56 fig. 7), provide evidence for the production and circulation of lavish quality bronzes in the east Baltic – objects and types that eventually disappeared from the archaeological record in that area.

10 See Maraszek (2006, 238-42 tab. 69, fig. 116) and her statistics on the affiliation of pins to arm and neck rings in LBA hoards of northern Europe.

That, and the selective patterns in bronze deposition, supports the idea that the few known hoards in the east Baltic are neither necessarily made up of imports nor need they have been deposited as scrap or founders' hoards. The case of Staldzene indicates that a symbolic or social value may exist over and above a material value. It also shows that some LBA communities in the east Baltic were still receptive to Nordic deposition practices, i.e. the ritual events behind them (e.g. Heske 2012).

Yet it remains difficult to determine the disc pins' symbolism, or the contextual meaning of their expressive design, more precisely. The same goes for the gender association (female?) of the bronze pins, which is obscure due to the archaeological filters active with regard to hoarding and funerary customs. We may assume a female association for objects with the functional appearance of dress items, but they could also have served as non-personal dedications or offerings to the numinous sphere.

In view of east Baltic Bronze Age deposition, the disc pins appear as exceptional or exclusive phenomena. That is mainly because the region stands out compared to the hoard landscapes in the Nordic Bronze Age sphere (Maraszek 2006). The east Baltic is characterised by a low density and quantity of bronze finds, with only few hoards known at all. In addition, body ornaments or dress items are generally atypical stray or single finds in the Nordic Bronze Age sphere (Larsson 1986; Paavel 2017).

The hoards with disc pins, such as Staldzene and Härnevi, share a characteristic assemblage composition, as well as fragmentation (ritual killing?), heavy wear and repair (heirloom?) and the presence of metalwork objects possibly referring symbolically-metaphorically to reproduction and transformation (Forsgren 2010; Melheim 2015). The disc pins in question could well be integral parts of ritual and symbolically charged hoarding practices and behaviour. The pins attest to shared symbolic and ritual values in LBA communities in the east Baltic, and to cultural contacts and exchange with regions in the Nordic sphere (e.g. Uppland and Gotland). This also suggests the transmission of metallurgical knowledge (e.g. Skälby and Asva; Table 1).

As visible from their geographical distribution in the east Baltic, the disc pins represent only a coastal, possibly maritime-linked phenomenon (e.g. Saaremaa and Courland). Nordic Bronze Age culture elements are mainly visible in the context of metalwork, while other artefact categories, such as pottery, display only marginal Nordic influences (see Visocka *et al.*, this volume). Particularly noteworthy are the Gotlandic-type ship settings (burials) on Saaremaa island and the Courlandic peninsula (dating to Montelius period V-VI; Wehlin 2013; this volume), another exclusive category of shared symbolism and values in the Nordic-Baltic Bronze Age.

Bibliography

Appelgren, K. (ed.) 2016. *Molnby – spår efter en lång historia. Stockholms län, Uppland, Vallentuna kommun, Vallentuna socken. Arkeologisk förundersökning*. Stockholm: Arkeologerna, Statens historiska museer.

Baudou, E. 1960. *Die regionale und chronologische Einteilung der jüngeren Bronzezeit im Nordischen Kreis.* Stockholm: Almqvist & Wiksell.

Brøndstedt, J. 1958. *Danmarks oldtid. II. Bronzealderen*. Copenhagen: Gyldendal.

Capelle, T. 2008. *Bilderwelten der Bronzezeit. Felsbilder in Norddeutschland und Skandinavien.* Mainz: Philipp von Zabern.

Damell, D. 1985. *Bronsålder i Södermanland. Undersökta gravar och gravfält från Södermanlands bronsålder och tidigaste järnålder. En kortfattad översikt*. Nyköping: Södermanlands Museum.

Drescher, H. 1958. *Der Überfangguss. Ein Beitrag zur vorgeschichtlichen Metalltechnik*. Mainz: Verlag des Römisch-Germanischen Zentralmuseums.

Dzięgielewski, K. 2016. Societies of the younger segment of the Early Iron Age in Poland (500-250 BC). In P. Urbańczyk and A. Rzeszotarska-Nowakiewicz (eds), *The past societies. Polish lands from the first evidence of human presence to the Early*

Middle Ages 4. 500 BC-500 AD, 16-48. Warsaw: Wydawnictwo Instytutu Archeologii i Etnologii Polskiej Akademii Nauk.

Ekholm, G. 1921. *Studier i Upplands bebyggelsehistoria 2, Bronsåldern.* Uppsala: Akademiska bokhandeln.

Eriksson, T. 2007. Specialregistrering av keramik och gjuterifynd. In P. Frölund and B. Schütz (eds), *Bebyggelse och bronsgjutare i Bredåker och Gamla Uppsala*, 157-73. Uppsala: Upplandsmuseet.

Fontijn, D. 2019. *Economies of destruction. How the systematic destruction of valuables created value in Bronze Age Europe, c. 2300-500 BC.* London: Routledge.

Forsgren, M. 2007. *Depåfyndet från Härnevi, del 1. Föremålsförståelse och genusperspektiv med utgångspunkt från ett s.k.skrotfynd från yngre bronsålder i Uppland.* Unpublished BA dissertation, Stockholm University.

Forsgren, M. 2010. The divine appearance of Härn. Determining the identity of a Bronze Age metal hoard. *Current Swedish Archaeology* 18, 105-25.

Forsgren, M. 2012. Om Härnevi och bronsålderskult: kommentar till Leif Karlenby. *Fornvännen* 2012, 277-80.

Frölund, P. and Schütz, B. (eds) 2007. *Bebyggelse och bronsgjutare i Bredåker och Gamla Uppsala*. Uppsala: Upplandsmuseet.

Grandin, L. and Hjärthner-Holdar, E. 2008. *Järn- och metallhantverk vid Skuttunge kyrka: rester från äldre bronsålder och yngre järnålder.* Uppsala: Avdelningen för arkeologiska undersökningar, Riksantikvarieämbetet.

Hansson, H. 1927. *Gotlands bronsålder.* Stockholm: Akademiens förlag.

Heske, I. 2012. Ritual knowledge: the production, distribution and deposition of Late Bronze Age hanging vessels. *Archaeologia Baltica* 18, 43-58.

Indreko, R. 1939. Asva linnus-asula. In H. Moora (ed.), *Muistse Eesti linnused. 1936.-1938. a. uurimiste tulemused*, 17-52. Tartu: Õpetatud Eesti Selts.

Jaanits, L., Laul, S., Lõugas, V. and Tõnisson, E. 1982. *Eesti esiajalugu.* Tallinn: Eesti Raamat.

Jantzen, D. 2008. *Quellen zur Metallverarbeitung im Nordischen Kreis der Bronzezeit.* Stuttgart: Franz Steiner Verlag.

Jonsäter, M. 1979. *Fornlämning 25 och 26, gravfält med underliggande boplats och ensamliggande röse: äldre bronsålder – folkvandringstid, Hjälm 3:1, 4:1, 5:1, Fjärås sn, Halland. Arkeologisk undersökning 1973-74. Uppdragsverksamheten, Rapport 1979: 8*. Stockholm: Riksantikvarieämbetet och statens historiska museer.

Kaczyński, B. 2015. Remarks on disc-headed pins of the Pomeranian culture. *Novensia* 26, 25-42.

Karlenby, L. 2011. *Stenbärarna. Kult och rituell praktik i skandinavisk bronsålder.* Doctoral thesis, Uppsala University. Available at: http://uu.diva-portal.org/smash/record.jsf?pid=diva2%3A438025&dswid=5384

Kaul, F. 2013. Round and round we go – with concentric circles. In S. Bergerbrant and S. Sabatini (eds), *Counterpoint. Essays in archaeology and heritage studies in honour of Professor Kristian Kristiansen*, 265-72. Oxford: Archaeopress.

Kneisel, J. 2001. Zur Verbreitung geschlechtsspezifischer Motive in der Gesichtsurnenkultur. In B. Gediga, A. Mierzwiński and W. Piotrowski (eds), *Die Kunst der Bronzezeit und der frühen Eisenzeit in Mitteleuropa*, 291-306. Wrocław, Biskupin: Polska Akademia Nauk, Muzeum Archeologiczne w Biskupinie.

Kristiansen, K. 2013. Female clothing and jewellery in the Nordic Bronze Age. In S. Bergerbrant and S. Sabatini (eds), *Counterpoint. Essays in archaeology and heritage studies in honour of Professor Kristian Kristiansen*, 755-69. Oxford: Archaeopress.

Kristiansen, K. 2014. The dialectics of gender: ritualizing gender relations in Late Bronze Age southern Scandinavia. In H. Alexandersson, A. Andreeff and A. Bünz (eds), *Med hjärta och hjärna: En vänbok till professor Elisabeth Arwill-Nordbladh*, 339-54. Gothenburg: University of Gothenburg.

Lang, V. 2007. *The Bronze and Early Iron Ages in Estonia*. Tartu: Tartu University Press.

Lang, V. 2018. Fortified settlements in the eastern Baltic: from earlier research to new interpretations. *Archaeologia Lituana* 19, 13-33.
Larsson, T.B. 1986. *The Bronze Age metalwork in southern Sweden. Aspects of social and spatial organization 1800-500 B.C.* Umeå: University of Umeå.
Ling, J., Stos-Gale, Z., Grandin, L., Billström, K., Hjärthner-Holdar, E. and Persson, P.-O. 2014. Moving metals II: provenancing Scandinavian Bronze Age artefacts by lead isotope and elemental analyses. *Journal of Archaeological Science* 41, 106-32.
Losiak, A. [+13 others] and Zanetti, M. 2016. Dating a small impact crater: an age of Kaali crater (Estonia) based on charcoal emplaced within proximal ejecta. *Meteoritics and Planetary Science* 51, 681-95.
Lõugas, V. 1966. Zur Geschichte der bronzezeitlichen Metallindustrie in Estland. In H. Moora and J. Selirand (eds), *Pronksiajast varase feodalismini. Uurimusi Baltimaade ja naaberalade arheoloogiast*, 102-13. Tallinn: Eesti Raamat.
Lõugas, V. 1996. *Kaali kraatriväljal. Phaethonit otsimas*. Tallinn: Eesti Entsüklopeediakirjastus.
Lund, J. and Melheim, L. 2011. Heads and tails – minds and bodies: reconsidering the Late Bronze Age Vestby hoard in light of symbolist and body perspectives. *European Journal of Archaeology* 14, 441-64.
Maraszek, R. 2006. *Spätbronzezeitliche Hortfundlandschaften in atlantischer und nordischer Metalltradition*. Halle: Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt.
Melheim, A.L. 2008. Right and left. Directions in Bronze Age cosmology seen through a pair of spectacle-fibulas. In K. Chilidis, J. Lund and C. Prescott (eds), *Facets of archeology. Essays in honour of Lotte Hedeager on her 60th birthday*, 539-54. Oslo: Unipub.
Melheim, A.L. 2015. Female identities in the making? Aspects of Late Bronze Age hoarding. In P. Suchowska-Ducke, S. Scott Reiter and H. Vandkilde (eds), *Forging identities. The mobility of culture in Bronze Age Europe 1*, 81-91. Oxford: British Archaeological Reports.
Montelius, O. 1917. *Minnen från vår forntid 1. Stenåldern och bronsåldern*. Stockholm: Norstedt.
Oldeberg, A. 1960. *Skälbyfyndet. En boplatslämning från den yngre bronsåldern*. Stockholm: Almqvist & Wiksell.
Olsen, J., Hornstrup, K.M., Heinemeier, J., Bennike, P. and Thrane, H. 2011. Chronology of the Danish Bronze Age based on ^{14}C dating of cremated bone remains. *Radiocarbon* 53, 261-75.
Paavel, K. 2017. Pattern or random? Contextualising Estonian Bronze Age bronze stray finds on the landscape. *Archaeologia Baltica* 24, 26-42.
Paavel, K., Kriiska, A., Lang, V. and Kulkov, A. 2019. Three bronze axes with wooden haft remains from Estonia. *Estonian Journal of Archaeology* 23, 3-19.
Podėnas, V. and Čivilytė, A. 2019. Bronze casting and communication in the southeastern Baltic Bronze Age. *Lietuvos Archeologija* 45, 169-99.
Rundkvist, M. 2015. *In the landscape and between worlds. Bronze Age deposition sites around lakes Mälaren and Hjälmaren in Sweden*. Umeå: Umeå University.
Runesson, G. 2014. *Bronsålderns bosättningsområden och boplatser på Gotland: Många syns inte men finns ändå*. Stockholm: Stockholm Umiversity.
Saage, R. 2013. *Element analysis of Härnevi-type decorative pins from Estonia.* Unpublished report, Laboratory of Archaeology, University of Tartu.
Schütz, B. 2007. Ett bronsgjuteri från yngre bronsålder. In P. Frölund and B. Schütz (eds), *Bebyggelse och bronsgjutare i Bredåker och Gamla Uppsala*, 239-47. Uppsala: Upplandsmuseet.
Sørensen, M.L.S. 1997. Reading dress: the construction of social categories and identities in Bronze Age Europe. *Journal of European Archaeology* 5, 93-114.
Sørensen, M.L.S. 2013. Identity, gender, and dress in the European Bronze Age. In H. Fokkens and A. Harding (eds), *The Oxford handbook of the European Bronze Age*, 216-33. Oxford: Oxford University Press.
Sperling, U. 2013. Der Bronzebruchhort von Tehumardi – Verstecktes Altmetall oder ritueller Weihefund? Ein Deutungsversuch am Erscheinungsbild der Bronzen. In K. Johanson and M. Tõrv (eds), *Man, his time, artefacts, and places. Collection of articles dedicated to Richard Indreko*, 261-316. Tartu: University of Tartu.

Sperling, U. 2014. *Aspekte des Wandels in der Bronzezeit im Ostbaltikum. Die Siedlungen der Asva-Gruppe in Estland*. Tallinn: Estonian Academy Publishers.

Sperling, U. 2019. Zwischen Handwerk und häuslicher Produktion. Bronzegießer von Asva im Kontext der Haushaltsarchäologie. In D. Neumann, G. Woltermann and R. Gleser (eds), *Spezialisierungen in der Bronzezeit. Archäologische Quellen und Modelle. Neolithikum und ältere Metallzeiten*, 161-80. Münster: LIT Verlag.

Sperling, U. and Lang, V. 2021. The Bronze and Iron Age transition in the east Baltic – challenges for research. In E. Kaiser and W. Schier (eds), *Time and materiality: periodization and regional chronologies at the transition from Bronze to Iron Age in Eurasia (1200-600 BCE),* 265-81. Berlin: Topoi.

Sperling, U., Lang, V. and Kimber, A. 2013. Neue Ausgrabungen in der Bronzezeitsiedlung von Asva – Problemfragen und erste Ergebnisse. *Archaeological Fieldwork in Estonia in 2012*, 29-42.

Sperling, U., Lang, V., Paavel, K. and Kimber, A. 2015. Neue Ausgrabungen in der Bronzezeitsiedlung von Asva – vorläufiger Untersuchungsstand und weitere Ergebnisse. *Archaeological Fieldwork in Estonia in 2014*, 51-64.

Sperling, U., Karlsen, H.-J., Lang, V., Lõugas, L., Kimber, A. and Lau, R. 2020. Ausgrabungen in der Bronzezeitsiedlung von Asva im Jahr 2019. *Archaeological Fieldwork in Estonia in 2019*, 51-60.

Stenberger, M. 1977. *Vorgeschichte Schwedens.* Neumünster: Wachholtz.

Vasks, A. and Vijups, A. 2004. *Staldzenes bronzas laikmeta depozīts* = *Staldzene Bronze Age hoard*. Riga: Fobo Prints.

Wehlin, J. 2013. *Östersjöns skeppssättningar: monument och mötesplatser under yngre bronsålder*. Doctoral dissertation, Göteborgs universitet.

Local perspectives on innovation and dispersal of new technologies in northern foraging societies

Lithics, ceramics and early metallurgy in northern Sweden

Lars Forsberg

Introduction

The present article deals with prehistoric local hunter-fisher-gatherer societies in the North, societies that were clearly actively participating in multitudinous social networks of varying scales. Some of these networks connected northern Fennoscandia to the eastern forest cultures of Karelia, the Urals and western Siberia. Other networks connected the northern area with societies further to the south. These connections brought new resources, knowledge and modes of technological practice. The concern of this paper is to understand the scales and forms of some of these social networks. By first reflecting on some central concepts of networks and connectedness and then looking at three central domains of technology – lithics, pottery and metalworking – it is hoped that a further understanding of the changes taking place during the two last millennia BC in northern Sweden can be achieved. The main geographical focus is the northern part of Sweden but also with some further outlooks over northern parts of Norway, Finland and Russia.

Culture-historical archaeology has to a large degree been based on the conceptual linking of culture and people. This is often seen as a relationship between groups living in a continuous area exhibiting a similar culture, and even sharing an ethnic identity. This has produced archaeological cultures represented as plateaus of low variability bordered by zones with rapidly changing material culture. These cultural groups are supposed to exhibit large internal cohesion and contact, whereas contacts with "outsiders" are much less frequent. Culture is seen as normative and shared, based on ideas, bounded in space and time and based on ceramic, lithic or metalwork styles (Childe 1957; Hodder 1982, 1-12; 1991, 1-22).

However, archaeologists have also been interested in society, defined as groups of people involved in frequent interaction. In the 1960s and 1970s much research concentrated on the different levels of social organisation and the transitions between them, creating the problem of how to explain cultural change (Fried 1967; Johnson and Earle 2000; Service 1962). The division of human societies according to economic type has long been a baseline for the interpretation of history and hence also prehistory, most notably the contrast in lifeways between hunter-gatherers and farmers. From the 1980s onwards there has been more focus on local groups of people (e.g. a community) and their immediate surroundings. There is increasing awareness of most prehistoric societies being small-scale and to an extent fluid, with a greater role for individuals and their agency in prehistory (Hodder 1986). Society as a web of relationships was somewhat pushed into the background and instead archaeology was populated with knowledgeable, resourceful actors with individual power strategies, much like contemporary society was viewed during the 1980s and 90s.

In D. Hofmann, F. Nikulka and R. Schumann (eds) 2022. *The Baltic in the Bronze Age. Regional patterns, interactions and boundaries*, Leiden: Sidestone Press, pp. 49-72.

For archaeological interpretations it is important to use constructs: cultures, societies, communities and actors are partly incommensurable and incompatible in that they focus on different aspects and levels of the human life-world and therefore offer different insights.

Networks – a different angle?

A concept that does not focus on coherent groups or territories, but rather on direct relations between people and groups of people, is the network. It emerged in sociology and geography as Social Network Analysis (SNA; Scott 1991). This was first a formal methodology geared towards describing and quantifying patterns of relations in the modern world. From the 1990s, actor network theory widened its scope not only to persons and organisations, but included all possible actants in an empirically studied situation (Latour 2005; Law and Hassard 1999). It was also much less formal than SNA.

These theoretical perspectives enable archaeologists to partly break free from the paradigm of bounded entities such as cultures and societies. While not being inherently incompatible with these concepts, they move the analytical focus. The discussion of the diffusion of cultural traits had earlier been phrased in “aquatic” terms of cultural streams or influences. This de-emphasised the problem of defining by which means the discussed traits have been transferred. It is suggested here that an approach based on network analysis can better specify and pinpoint the processes involved in the transmission of knowledge.

People in prehistory have however always been mobile, travelling shorter or longer distances in order to fulfil individual and/or collective strategies. This would be especially true for hunter-fisher-gatherer (HFG) populations dispersed in the vast northern areas. The movement of different practices/technologies through the taigas of the past must have been founded on certain individuals or groups making risky journeys that were outcomes of specific social strategies.

Mobile people and their knowledge are essential for upholding and constituting networks. It would have been relatively easy to move within the area used by the local group, perhaps mostly connected with subsistence practices. In addition, other, rarer movements might be envisioned, such as movements to fulfil religious and/or social goals.

It is also clear from anthropology that different kinds of frequent contact between individuals from different groups would also have existed in the past, for instance exogamous marriage or various forms of exchange. One should also not rule out hostile relations as one of the factors involved in the fabric of networks (Burch 2005; Burch and Correll 1972). While most people in a local group would probably have had contacts limited to the nearest neighbouring groups, there would have been a fraction of people who made long and/or frequent journeys (see Helms 1988).

The real world was not a “flatland”

Of course, HFGs could not move unhindered in all directions. Rather, they would have followed certain routes that were easier to traverse. These were not only determined by nature (“natural highways” such as rivers or esker ridges), but as much by social considerations. This would have led to a landscape with natural and social restrictions in certain directions and lines of communication that were *facilitative* in another. Hence movements of people and of cultural materials would more easily follow such routes. These preferred routes were also frequently in part dependent upon already established networks – a part of the “interactional history” of the regions.

An additional aspect to be borne in mind is the relative “emptiness” of the prehistoric lifeworld in the areas under consideration. People were scarce and, if from different local groups, probably relatively different from each other due to different histories and traditions. This would make it essential to find “partners” or “relatives” in other groups and areas that could be counted upon. As the archaeological material from the second millennium BC in the north shows, there must have been many contacts between individuals from different groups and areas, some of them relatively long-range. This indicates a strong motivation to create and uphold networks.

Pipelines, nodes and social fences

Several researchers have suggested that HFG societies have a perception of the landscape that is built upon places and the lines (paths, rivers, routes) between these (Ingold 1992; 2000; Tilley 1994). These preferred lines of communication could perhaps be called "pipelines" along which more intense movement of people and thus ideas occurred. These pipelines would probably be perpetuated through larger chunks of time, since their formation and maintenance depended upon investment in social relations between different individuals in the local groups comprising the network.

It is also clear that people were not evenly spread out across the vast boreal forest, but that they were concentrated in certain areas during different seasons. Some areas with denser settlement than other areas seem to emerge during the Younger Stone Age and they continue to be important during the Early Metal Age (e.g. Lavento 2012; Spång 1991). Such places where human and social resources were concentrated might then be called "nodes" in the network. At these nodes innovations and new technologies were assimilated, used actively and transformed. Specific sites or site clusters with an unusual amassment of technologies and materials frequently occur in the archaeological material of hunter-gatherers in northern Fennoscandia and they stand out from the larger mass of sites (Meinander 1979). They seem to have been central in managing the flow of information and human resources. Such nodes might be distinguished archaeologically by looking at clusters of indicators of contact and trying to pinpoint early adoption of new technologies or "styles".

It is thus suggested that some prehistoric HFGs moved long distances, along specific paths (pipelines), targeting specific localities with human and technological resources (nodes). This leads to the archaeological material following linear and weblike patterns with concentrations of new technologies and exotic items clustered in specific locations along these lines. However, as people did not move in all directions equally easily (see above), there could be situations where the transmission of a technology suddenly stops at what looks like a social or cultural border. These patterns could be called social/cultural fences and serve as a corollary to the pipeline/node concepts.

Self-defined local groups and network theory are not incompatible

The introduction to this paper has painted a picture of an either/or situation: on the one hand societies with strict borders and unified culture, on the other hand loose networks of people and culture in a state of continuous change. Yet a network perspective must be founded on an understanding of societies as both dynamic and stable at the same time. The fact that people move in and out of local groups does not mean that stable local societies do not exist. A society actively reproduces its structure and culture and thus can maintain practices and traits for long time spans, even if some of its members shift locus. Still, it is more important to focus on past societies as open-ended systems rather than closed, bounded entities. Instead of fixed, impermeable borders one might talk of membranes separating the different local groups, membranes with differing permeability in different directions and situations.

The spread of technology – a way to uncover past networks?

The emergence of a new technology in a society allows conclusions about social aspects of its users. Technology is both an enabler of new strategies and actions and a frame that restricts action. It can open up new possibilities for resource utilisation, economic and social interaction as well as render power shifts and strategies possible. It can also mean that certain "older" or alternative strategies can be more difficult to implement. In a sense, technology can be a one-way train: once a society has committed itself to it, it is very difficult to retrace the steps (Edquist 1977; Edquist and Edqvist 1980).

This paper will investigate different technologies and their organisation. Were they for example restricted to only a few nodes or more spread out? How was the production sequence organised and how did the social context of the technology, and the technology itself, change through time? This can also say a lot about non-technological questions. Three different case studies can address the questions stated above: the different levels of use of bifacial lithic technology in northern Sweden, the introduction of pottery in the same area and its different context through time, and early metal technology. Together, they shed light on the networks emerging in the second and first millennia BC. The scales of the networks indicated by the different technologies would probably have varied in extent and density. By focusing on the nodal aspect of networks, it might be possible to compare these traits across different technologies and so get an indication of the range and frequency of contacts. It will also be of interest to analyse the fading out of these technologies and to try to say something about the conditions for their demise.

The case of bifacial lithics

In south Scandinavia bifacial lithic technology is central during the Late Neolithic (LN) and Bronze Age (BA). During these periods arrowheads, spearheads, as well as daggers and sickles were produced in this technique (Apel 2001). The northern area has, however, not yet been subjected to a similar study, although there are several studies of smaller regions (cf. Bergman 1995; Forsberg 1985; Holm 1991; Spång 1997).

Studying the production process of bifacial tools from raw material acquisition to the deposition of finished products informs on the social aspects of production, use and deposition, alongside the transmission of technological know-how. The distinction between *connaissance* (knowledge) and *savoir-faire* (know-how) is important in this context. These are different aspects of learning to master a technology; one aspect is to know theoretically which steps that must be taken, another is to be able to perform them. Of essence here is what kind of knowledge is required to master the process and how this is learned and transmitted (Apel 2001, 27).

There are two major types of reduction sequence for bifacial tools. The best studied is the Core Tool System (CTS), where a blank (large pebble or roughout) is continuously thinned and shaped until a finished product is arrived at (e.g. Callahan 1979; Muto 1971). In contrast, the debitage blank system is based on using debitage blanks produced as by-products of the manufacture of other lithic tools; a variant of this technique is known as the Combewa method (Apel 2001, 222; Knutsson 1986).

The main period of manufacture and use of bifacial points in Fennoscandia is the Epineolithic and Early Metal Age. I will focus on the material from parts of northern Sweden, which has been recently studied (Forsberg 2010b). Here, sites occur in large numbers both in the forest plain and the mountain foothills, from Dalecarlia in the south to north Lapland.

The points occur mostly on settlement sites or as stray finds, but there are also caches and points in graves. The most common type is the straight-based point, with a characteristic wide and thinned-down base, probably to be hafted into either an arrow or spear shaft. After considerable debate, an early start date for these points around 2200 BC is now accepted, while they go out of use around 500 BC (e.g. Carpelan 1962, 25; Forsberg 1985, 5; 2003, 135-37; Helskog 1983, 6; Huurre 1986).

In addition to this very frequent point type, there are a few other types of bifacial points with a suggested date in the last two millennia BC. The Sandbukt type is mainly found in north Norway, although a few examples are known from Norrland. They should probably be confined to the second millennium, with an emphasis on the latter half (Hesjedal *et al.* 1996, 168). Another type of bifacial point with short, triangular tang has a somewhat unclear dating, ranging from 900-800 BC (Hood and Olsen 1988, 115) up to 1850-1500 BC (Hesjedal *et al.* 1996, 167-69). In Russia, points with triangular tang occur among others in assemblages of the Sintashta, Abashevo and Seima-Turbino traditions (Koryakova and Epimakhov 2007, 64, 81, 107) and have recently been ^{14}C- dated to 2100-1700 cal BC (Koryakova and Epimakhov 2007, tab. 0.3). In cemeteries with Seima-Turbino materials in the southern part of the boreal forest between western Siberia and north-west Russia, bifacial points are deposited alongside tools for metalworking and warrior paraphernalia, referencing activities other than subsistence (Chernykh and Kuz'minykh 1989), in contrast to northern Fennoscandia.

Procurement of raw materials and modes of production

The acquisition of raw materials was managed in different ways. Organised quarrying of outcrops of especially good raw materials seems to have taken place only at a few key places, mostly in the mountain areas, like the areas of Kårtjejaure, Foskvattnet and Tärna (see below). Remains of eroded cortex on some of the points were found at many of the sites in the forest area, suggesting that large cobbles found on the shorelines of lakes and rivers were used as blanks here. Finally, quartzites from bedrock in the Scandes mountains were transported to the forest area in glacial moraines, while the inland ice also transported larger boulders which were utilised in prehistory.

One conspicuous feature is the uneven distribution of preforms throughout the area (Figure 1). Along the Ume river for example, there is a clear concentration from the Tjålte quarries up in the mountains down to the Laisan lake (Figure 2). Down in the forest plain however, there are few preforms to be found. This pattern repeats itself on most of the rivers studied (Forsberg 2010b, 133-35).

The Tärna area in western Lapland is so far the best example of extensive quarrying of raw materials for the production of bifacial lithic arrowheads in northern Fennoscandia (Holm 1991). The material from two quarries, workshop sites and settlements gives an unusually good possibility to study central aspects of the bifacial lithic technology and its social correlates, such as degree of specialisation.

Looking at the different stages in the production process, obtaining the blank and creating a roughout occurred at the quarries (Holm 1991, 42-46), while sites down by the lake system yielded mostly preforms of stages 2-5. The raw material was transported down to the settlements at the Strimasundet and Vilasundet straits as roughouts or as primary preforms. The preforms at the sites at the outflow of the lake are generally smaller and broken at a later stage in the operational chain, while the number of preforms also decreases the further away they appear from the quarries. Moving down the Ume river, preforms are ever smaller and rarer (Forsberg 2010b, 138) but reach as far as lake Umnässjön, at the westernmost edge of the forest plain.

In the mountain areas, bimodal flake concentrations of a specific shape and size could be "imprints" of huts (Forsberg 1985, 253-59; 2003; 2005, 125-27), and these have also been identified in the Tärna area (Christiansson 1969; Forsberg 2005; Gaustad 1973). This shows which activities have been carried out inside the huts and which in the "yard", or on the perimeter of the site (Forsberg 2005, 147-48; 2010b, 139-41). The results show that the production of points can be located partly within the households and partly in the "yard" between the huts and the shore with few indications of specialisation. It rather seems that each household produced and repaired its own projectile points. This means that the probable locus for the transmission of craft/production skills lay within each household. This could also explain the many preforms broken in the early stages of manufacture, which suggest that people with quite different skill levels, perhaps different age-sets within each household, were involved in production.

In contrast to the mountain area, sites on the forest plain are, with very few exceptions, largely devoid of preforms. There are, however, numerous finished points and broken point fragments, as well as bifacial thinning flakes (Forsberg 2010b, 142). Looking at evidence of point manufacture on forest plain sites from Härjedalen and Jämtland to Lapland, there are significantly fewer bifacial preforms than at mountain sites. Still, there is ample evidence of point production in form of concentrations of bifacial thinning flakes (Bergman 1995, 117-54; Forsberg 1985, 211-20), but these have often been produced according to the debitage blank system. This system, with smaller preforms based upon larger thinning flakes, would be logical on the forest plain, where good raw materials

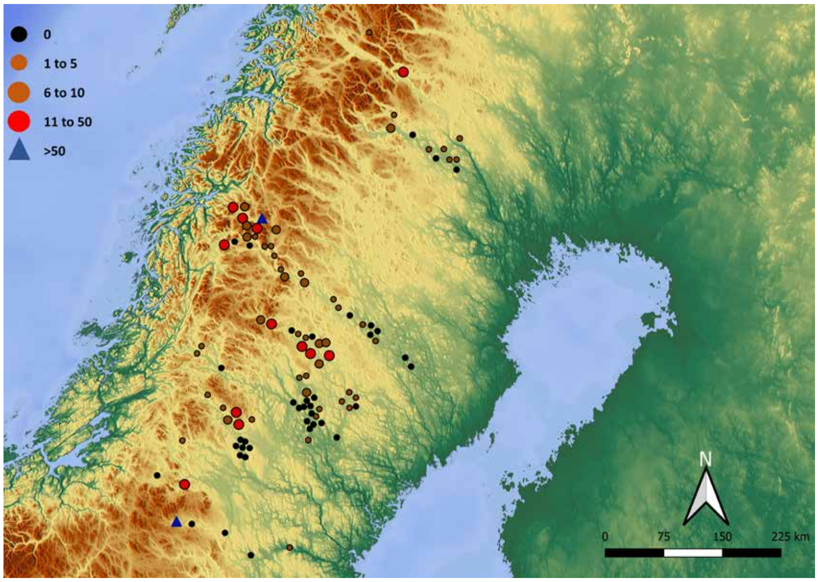


Figure 1. Distribution of bifacial preforms on excavated sites in Norrland based on data from the Early Norrland project. The data from the Skellefte river area are not incuded (but see Bergman 1995); (map: J. König based on maps-for-free.com).

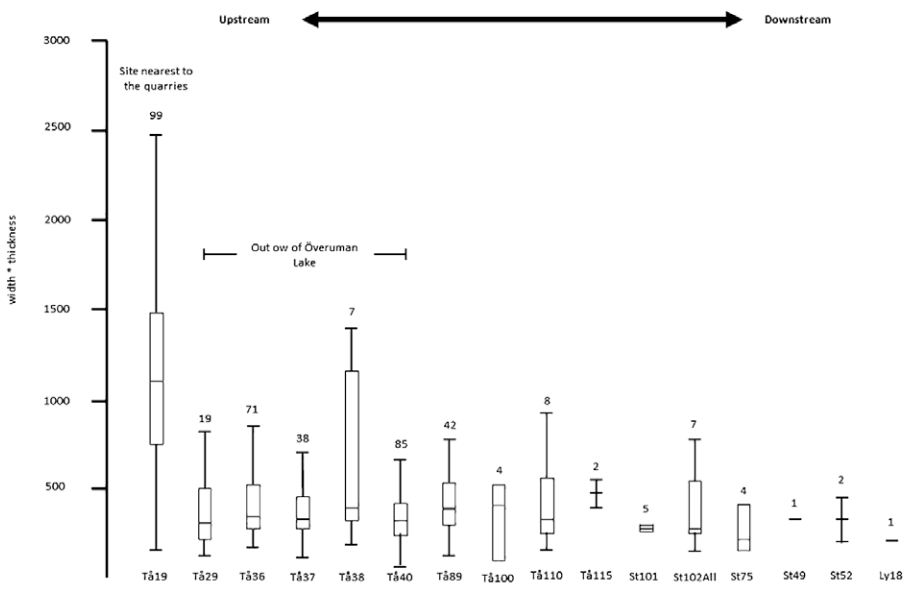


Figure 2. Distribution of preforms along Ume river.

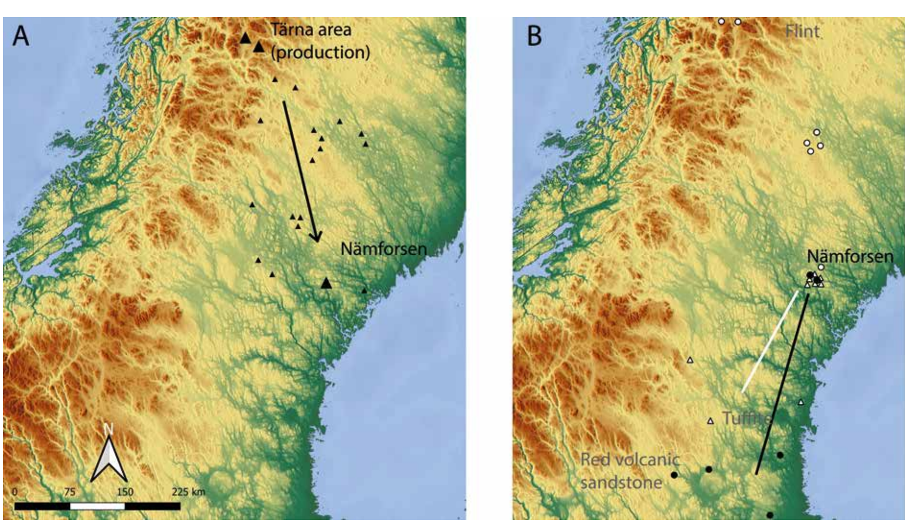


Figure 3. a) Distribution of bifacial points of brecciated quartz; b) bifacial points of "exotic" raw materials found at Nämforsen and their areas of origin (map: J. König based on maps-for-free.com).

were scarcer and often took the form of smaller pebbles or chunks. Overall on forest sites production was much more situational and expedient than at mountain sites. This is also shown by the relative absence of large preforms and large, delicately worked points, as well as the overall lower numbers of points and point fragments.

Deviations from the main localised pattern

This generalised scenario may, however, not tell the whole story. I here follow the approach of John Tukey, who criticised attempts to produce a picture free of contradictions and "noise" (Tukey 1977; Velleman 1988). Instead, he contrasts the "smooth" – the general pattern or main trend – with the "rough" – the understated anomalies and outliers which do not immediately fit the general explanation. Tukey suggests that these cases perhaps are the most valuable, because they can contribute to a more precise understanding.

In our example, there are first of all a very small number of forest sites that deviate from the pattern suggested above, having higher frequency of bifacial preforms (e.g. 1231 Vajkijaure, Varghalsen, Gammboedan, Hälla, Storuman 45). The raw materials of the preforms at these sites coincide with preforms on mountain area sites along the same river. This further supports the settlement pattern suggested by Forsberg (1985), Holm (1991) and Bergman (1995) with seasonal moves up and down the river system.

Second, most preforms are found at settlement sites, and finished points either at other sites or as single stray finds. There are, however, three caches of points and bifacial preforms along the river Ume. One was found c. 300 m from the shore of lake Överuman with points mostly made on brecciated quartz and more rarely dark quartzite (Meschke 1977, 98; Santesson 1935, 7). The Kaskeloukta cache on the large Storuman lake yielded two moulds for copper daggers of eastern type and four preforms of brecciated quartz (Janson and Hvarfner 1960, 26). The third cache near the confluence of the rivers Ume and Vindel contained 35 points and preforms mainly of dark quartzite (Gullbring 1942, 11).

Third, there are a couple of examples of bifacial points and/or preforms being used as grave offerings. In Kumo, on the coast of the Bothnian Sea outside the town of Sundsvall, a bifacial point and two flint flakes were found in one of the cists of a destroyed burial (Baudou 1977, 114). The low stone cairn recently excavated at Umedalen, outside Umeå on the Bothnian coast (Lundberg 2001; 2005), was constructed during the Early Bronze Age on what was then a small island in the bay into which the Ume river discharged. The cairn contained amongst others a bronze spear point of south Scandinavian type, a pointed artefact of south Scandinavian flint, but also bifacial points made of Russian flint, black chert and brecciated quartz, alongside bifacial preforms, scrapers and flakes of brecciated quartz and a brecciated quartz dagger (large biface). This find shows close similarities with other leaf-shaped bifaces found on the Bothnian coast. At Tvillingsta, near Örnsköldsvik, two large bifaces (one of brecciated quartz) were found with a three-sided axe and a simple shaft-hole axe (Baudou 1978, fig. 14). A stray find of a large biface from Byviken, Flärke, Gideå parish (Baudou 1977, fig. 23) was seemingly made of light quartzite and located near the Bothnian Sea between the finds of Tvillingsta and Umedalen. Are these finds to be considered stray finds or are they remnants of graves? The latter is worth considering since except for the Umedalen find, no expert excavations have been performed at these places. Furthermore, the find at Tvillingsta with several different items (axes and points) could also suggest this. Bifaces of diverse provenience thus in some cases seem to have been deposited in other contexts than subsistence-related ones along the coast.

The fourth exception concerns points of brecciated quartz found outside the core area on the upper reaches of the Ume river. Overall, there is a distribution pattern from a gravity centre in the production area up in the mountains at Tärna diagonally through the forest plain of the Ångerman river drainage down to the accumulation of points at Nämforsen near the coast (Figure 3a). Earlier studies have shown that local groups had their home territory along the Ume river (Forsberg 1985; Holm 1991). That there are points but not preforms outside of this territory suggest that the points but not the preforms were transported within a slightly wider kind of network.

The fifth and last exception concerns the site of Ställverket, Nämforsen, with its numerous bifacial points of many different raw materials (Käck 2009, 101). Excessive production of points has been performed here. But there are also many points of different raw materials that are not represented by preforms (Figure 3b). Many other aspects set this site apart from others, such as the large petrographic variation, diverse raw materials from many different regions, its location opposite the largest rock carving site in northern Sweden and many different types of ceramics. All this would suggest that it was an important node in a widespread network.

To sum up, the strategies involved in the production and usage of bifacial points differed considerably between sites in the mountain area to the west and the forest plain in the east. In the mountain area, where fine-grained raw materials were readily available, smaller areas saw extensive production of large points, many according to the core tool system. In the north, the production of bifacial points occurred at different settlement sites during the yearly cycle. In some places, there was a more planned production sequence with acquisition of raw materials, further reduction at workshops and final reduction at settlement sites. The points here were mainly produced according to the core tool system. The basic unit for transmission of knowledge seems to have been the household. The majority of the bifacial points and raw materials were spread mainly via logistic mobility throughout the yearly cycle. In contrast, points in the forest area were primarily made according to the debitage blank system. One can thus envision a more expedient and situational type of point production here.

The case of early pottery in north Sweden

The emergence of ceramic technology in the study area opened new possibilities for resource utilisation, economic and social interaction. It is therefore vital to investigate the scale of impact of pottery technology. Pottery technology was introduced at differing times in different parts of Fennoscandia (Nuñez 1990); I here examine the introduction of early pottery and asbestos-tempered pottery in northern Sweden and Norway during the second and third millennia. A special focus will be on the so-called textile pottery, which is part of a widespread practice of pottery surface treatment stretching over a huge area from the northern parts of Russia to northern Fennoscandia, but in central and southern Finland as well as Russia and Estonia, this pottery differs substantially from the north-west Fennoscandian pottery (Kosmenko 1996; Lavento 2001; Patrushev 1992). By studying this early pottery where many of the wares are tempered with asbestos and have the vessel surface covered with textile-like impressions, an indication of the connections between people and groups of people can be achieved. Textile pottery is roughly contemporaneous with the main phase of usage of the bifacial points.

To investigate the introduction of early pottery, it was paramount to distinguish between different kinds of pottery, which in north Fennoscandia is rather varied (Bolin 1996; Hulthén 1991; Kosmenko 1996). Here I have used surface treatment, temper and sherd thickness, as well as decoration and recent AMS dates to categorise the material (Forsberg in prep.).

The earliest pottery in northern Sweden in the third millennium BC

Over the years, many archaeologists have recognised and commented upon the lack of pottery in northern Sweden during the Neolithic. This lack of pottery was at first supposed to last until asbestos pottery was introduced during the Early Metal Age. Starting in the early 1990s this view has gradually changed. Birgitta Hulthén mentioned a few sherds of pottery of south Scandinavian Neolithic type present in the Ställverket material (Hulthén 1991) and the excavation of the Lillberget site near the Swedish-Finnish border produced typical Comb Ware pottery (Halén 1994). However, only few sites in eastern Norrbotten are connected with the Comb Ware culture in northern Finland, and as of now no further sites of this kind have been found in northernmost Sweden. In contrast, many battle axes of south Scandinavian types have been found in Norrland (Baudou 1989; Malmer 1962). Most researchers suggest that they were exchanged for other items from Norrland. However, the sheer amount of axes of different types in Norrland, especially along the coast, suggests something more than simple occasional exchange of exotic goods (Damm and Forsberg 2014, fig. 39.2).

This picture started to change around the turn of the millennium, when Niclas Björck published an article describing coastal settlements from southern Norrland and northern Uppland which were classified as part of the Pitted Ware culture (Björck 1997; 2011). Later, Lena Holm described the excavations of several sites in Gästrikland and Hälsingland with Neolithic pottery (Holm 2006). Finally, excavations in connection with railway building in the coastal area south of Örnsköldsvik in central Norrland showed sites with indications of agriculture and with Neolithic pottery (Lindholm *et al.* 2007; Lindqvist 2007).

The Neolithic pottery found on the south-western Bothnian coast has later been divided into three phases (Holm 2006, 199; Larsson 2009; Lindholm *et al.* 2007). The sites of the first phase in the early part of the Middle Neolithic (MNa) were characterised by rock-tempered Pitted Ware, the sites of the second phase in the MNb mostly had porous Pitted Ware, which had organic tempering. The site of Hedningahällan in Hälsingland was regarded as a special case with several kinds of pottery, amongst others rock-tempered pottery decorated with pits and cords. A sample from this site gave a Late Neolithic date.

A special case is the rock-tempered pottery with cord and pit decoration found at Hedningahällan and a couple other sites. This was difficult to place within the traditional culture-historical framework, but has now been considered as a mix of Pitted Ware and Corded Ware elements. It has been named “the third group” by some researchers (Larsson 2009, 357-62). Several finds of this type have also been unearthed at coastal sites in Ångermanland (Lindholm *et al.* 2007, 217).

In an analysis of the sherds from the Ställverket site at Nämforsen, I could identify a few sherds of this type, as well as sherds of Porous Ware. Sherds of this latter type were also found at the Rånget site a few kilometres upstream of Nämforsen. Here, they were deposited together with hair-tempered pottery and hair-tempered textile pottery in a c. 5 m^2 area in what has been interpreted as a hut floor (Forsberg 2001, fig. 4; George 2001, 122-23). A sherd of the “third group” type was also found at a site as far inland as Lesjön.

Early pottery in northern Sweden during the second millennium BC

Over the years, many different types of pottery dating to the second millennium have been recognised. In northern Sweden, Hulthén (1991) distinguished an early second millennium asbestos pottery and a later (first millennium) asbestos ware, mainly based on sherd thickness and tempering, in my view a useful but too general division of a large body of material (Forsberg 2001, 130-33). The thicker asbestos pottery can now be dated to the early second millennium BC. However, the earliest occurrence of pottery tempered with asbestos in northern Fennoscandia can be found in Finland, already in the fourth and third millennia BC (Mökkönen and Nordqvist 2017). No pottery of these types has yet been found in Norrland, however. A second type of pottery dating to the first half of the second millennium BC is the earliest with textile-like impressions of alternating lines, which I named Bodum ware. It has been identified along the coast of middle Norrland as well as on the lower reaches of the Ångerman river. It is tempered with organic material, mainly hair, sometimes also mixed with asbestos (Forsberg 2001, 135; 2012; Hulthén 1985, 255-56; 1991, 17).

The best-known pottery of the second millennium in the north is covered with textile or textile-like impressions. It occurs over large areas in the boreal forest zone, from Russia to northern Norway (Lavento 2001; Patrushev 1992) and can be divided into many different regional groups. These coexist with types that have no textile or textile-like impressions.

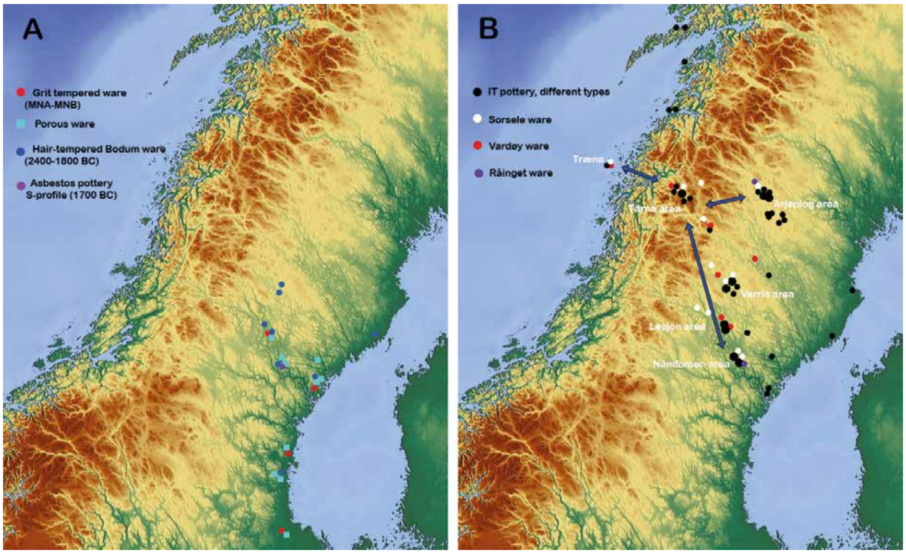


Figure 4. a) Distribution of pottery types of the early and late second millennium BC in Norrland; b) distribution of pottery types of the late second millennium BC in Norrland. Nodes distinguished by many vessels and types of IT pottery and suggested ”pipelines” between them (map: J. König based on maps-for-free.com).

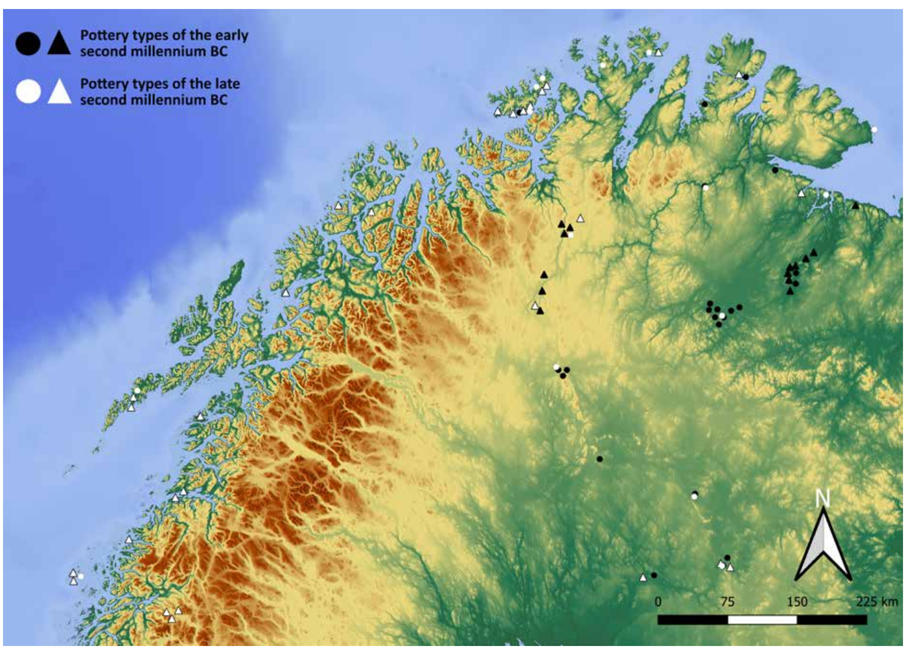


Figure 5. Distribution of pottery types of the early and late second millennium BC in Finnmark (after Carpelan 1990; Jørgensen and Olsen 1988, figs 14-17). Black dots: Pasvik pottery; black triangles: Lovozero pottery; white markings: imitated textile and textile pottery (map: J. König based on maps-for-free.com).

The pottery that is called textile pottery in parts of northern Finland, Sweden and Norway has mostly been tempered with asbestos, something that is very rare with the eastern types. The textile pattern has, however, been applied with different kinds of implements, not with textiles, leading to a designation as imitated textile pottery (IT; Carpelan 2003, 52). Again, there is a variety of types, for example those where rhomboid impressions in a regular pattern were created (Jørgensen and Olsen 1988, 16), or where patterns were applied with the end of a stick cut out to make a small rectangular stamp (Råinget ware; Forsberg 2001, 134) or to produce more irregular impressions (Træna ware; Gjessing 1943). IT pottery was in use during the latter half of the second millennium BC (Carpelan 2003, 52; Forsberg 2001, 138-39). Thus, it is possible to create a rough sequence where asbestos pottery and hair-tempered Bodum ware belong to the early half and IT pottery types to the latter half of the second millennium BC.

By mapping the first appearance of pottery types the networks involved can be investigated. The earliest pottery types seem to be concentrated on the Bothnian Sea coast (porous ware, "third group" ware and hair-tempered pottery) and the outflow and the lower reaches of the river Ångerman (Figure 4a).

During the next phase, the distribution of IT pottery covers large parts of the lower and middle reaches of the Ångerman, continues to the upper reaches of the rivers Ume and Skellefte, and possibly all the way to the Atlantic coast of northern Nordland with the outlying island Træna as the extreme westerly point (Figure 4b). Vardøy ware is spread all over the Nordland, Ume river and Ångerman river area, with an emphasis on the western parts around the national border. Sorsele ware is distributed fairly evenly over the whole area, while Råinget ware occurs at the southern and northern limits of the distribution. Surprisingly no pottery from the third and second millennia has as yet been found along the lower reaches of the rivers Ume and Skellefte and the upper reaches of the Ångerman, despite many known sites (Bergman 1995; Forsberg 1985; Käck 1993; 1995; Spång 1997).

It seems that the introduction of textile pottery happened in middle Norrland at the beginning of the second millennium BC. It then spread north-westwards from the lower reaches of the Ångerman, perhaps all the way to Vestvågøy in the Lofoten islands (Figure 4b). There are almost no finds of IT pottery on the Bothnian coast, suggesting that this area developed in another direction during the later part of the second millennium.

In addition to several sites with only one or two vessels, five local areas with a dense concentration of many vessels and types can be discerned (Figure 4b), the Nämforsen, Lesjön/Bodum, Varris, Tärna and Arjeplog areas. Nämforsen is in a sense unique, both for its rock carvings and because the site of Ställverket has an unusually varied archaeological material (Käck 2009). The other areas have been postulated as central areas for local bands, used throughout the Eneolithic and Early Metal phases (Bergman 1995, 198-99; Forsberg 1985, 271-73; Holm 1991, 44-46; Spång 1997, 234-35). It seems clear that these areas can be designated as important nodes in the network (Figure 4b). The "pipelines" seem to run from the Bothnian coast, following the northern branches of the Ångerman to the upper reaches of the Ume. Here the network seems to divide with a line going north-east over to the Arjeplog area and another one running north-westwards along the Atlantic coast.

A similar distribution analysis can be made for north Norway. Using the data from Jørgensen and Olsen (1988), Lovozero and Pasvik pottery only occur in Finnmark, north Finland and the Kola peninsula (Figure 5). They form a conspicuous pattern with at least two separate paths. One runs between the Enontekiö region in north Finland along the valley of Altavassdraget to Sørøya on the coast of western Finnmark, the other from lake Enare along the Pasvik river to the Varanger fjord and the coast of eastern Finnmark. Thus, there seem to have been two major pipelines in Finnmark during the second millennium.

In north Norway in the later second millennium, a division of the finds into a south-western part, possibly connected with the network in northern Sweden, and a north-eastern part in Finnmark, much in the same areas as the Lovozero/Pasvik pattern, can be seen especially in the Vardøy ware (Figure 5). The other type of textile pottery (Jørgensen and Olsen's group 5) has a more general distribution. An additional observation is that the distribution seems to be more weighted towards the Atlantic coast than the Lovozero/Pasvik one.

Asbestos ware during the first millennium BC in northern Sweden

Asbestos ware, in contrast to asbestos pottery, seems more or less confined to the first millennium BC up to the first centuries AD (Carpelan 2003, 56; Forsberg 2001, 138-39; 2012; Jørgensen and Olsen 1988, 62-65). Two main chronological periods can be defined: undecorated ware and ware with wavy decorations and incised lines were common between 800-400 BC, while the period between 400 BC and AD 400 is characterised by ware with comb impressions (Forsberg 2001, 138-39).

Asbestos ware has traditionally been called Säräisniemi 2 after a locality in north Finland (Ailio 1909) and was later investigated in several typological studies suggesting different subtypes, such as Kjelmøy, Risvik, Sirnihta, Anttila and Luukkonsaari (Carpelan 1979; Jørgensen and Olsen 1988). The geographical spread of asbestos ware from the early part of the first millennium BC shows two major trends (Figure 6). First, no asbestos ware from this period was found on sites along the Bothnian coast. Second, there seems to be a division between a northern area with frequent incised lines on pottery, from the upper reaches of the northern tributary of the Ångerman to the river Lule, and a southern area with undecorated ware and ware with wavy decoration. Interestingly, undecorated ware shows several similarities to the Risvik pottery along the coasts of Trøndelag, Nordland and southern Troms to the west (Andreassen 2002; Figure 6). In Finland, asbestos ware with incised lines seems to have a northern distribution, just like in north Sweden (Carpelan 2003).

The later asbestos ware with comb impressions shows an increase in both the number of vessels and of localities (Figure 7). It seems as though the greatest part of northern Sweden down to the Indal river is dominated by this pottery. There are also frequent finds along the north Bothnian coast. Asbestos ware now seems to occur throughout the seasonal cycle, in all local groups in the region, and is no longer something that is only found at a restricted number of specific nodes. In northern Norway, the so-called Kjelmøy pottery (a problematic category; Jørgensen and Olsen 1988 group 1) seems concentrated in eastern and western Finnmark, with only a few occurrences in Nordland (Figure 8) and none in Troms. Finnmark shows a similar picture as in previous periods, with a western area including sites along the Alta river and the peninsula north and north-east of the Alta fjord; and an eastern area with sites along the Pasvik river and the Varanger fjord.

Discussion

The earliest pottery occurs only on a few main localities on the lower Ångerman and on the coast of the Bothnian Sea. Hence, at first it seems to have been taken up by only a few local communities along the coast and in the hinterland. Localities with several different varieties of textile pottery (defining the ensuing phase) occur in a few select regions in the centre of the forest plain. It seems as though there were certain potters at these sites with knowledge of various ways to produce pots and these must have had contact with other potters at other nodes. They can be characterised as communities of practice (CoP; Lave and Wenger 1991; Wenger 1998; Wenger *et al.* 2002), a concept denoting groups of individuals participating in communal activities of varying kinds, sharing an identity and forming what might be described as a learning network (Hallgren 2008; Handley *et al.* 2006; Minar 2001; Sassaman and Rudolphi 2001).

Through participation, members establish norms and build collaborative relationships, binding the members together as a social entity and creating a shared but frequently renegotiated understanding termed the "domain" of the CoP. As part of its practice, the community produces a shared repertoire, used in the pursuit of the joint enterprise, including both literal and symbolic meanings. One of the main benefits of a CoP is that it acquires social capital, giving value to both the individual and the group as a whole.

The clustering of pottery production at a few nodes during the second millennium BC hints at the presence of CoPs concerned with introducing and developing the technology. These were probably a few individual potters at each node, forming a corporate group crosscutting cognate and familial groups. Thus, the technology seems to be embedded within a different social context than the lithic technology, which was located within the separate households. Where only a few sherds occur outside these nodes, they could have been transported from the manufacturing centres during annual seasonal moves.

While this scenario would account for the emergence of CoPs within communities, it is not enough for explaining the emerging network between nodal communities, represented by textile pottery. Here, CoPs might be usefully extended using the concept of networks of practice (Seely Brown and Duguid 2000). It denotes the overall set of

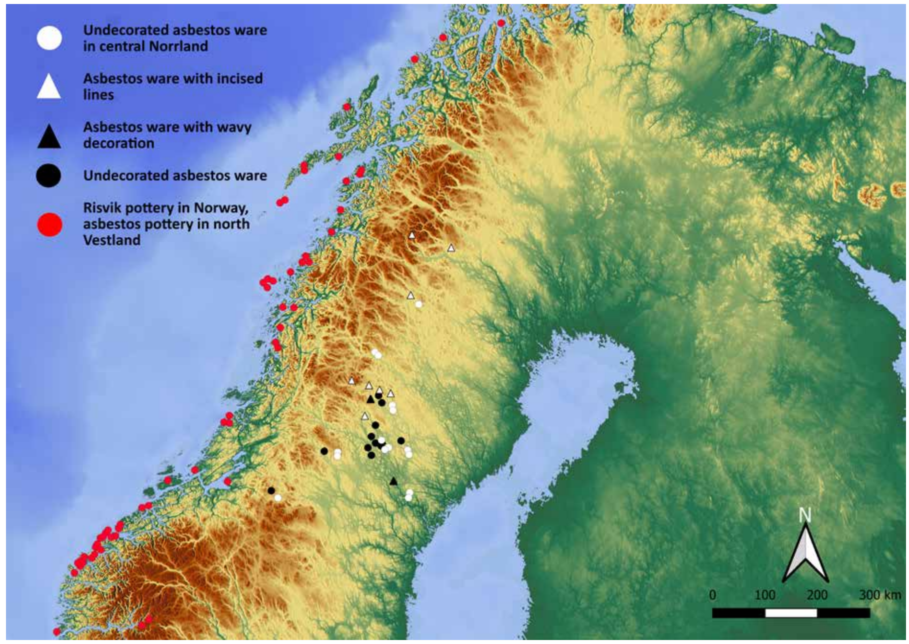


Figure 6. Distribution of asbestos ware of the early first millennium BC in Norrland, Risvik pottery in Norway, asbestos pottery in north Vestland and undecorated asbestos ware in central Norrland (map: J. König based on maps-for-free.com).

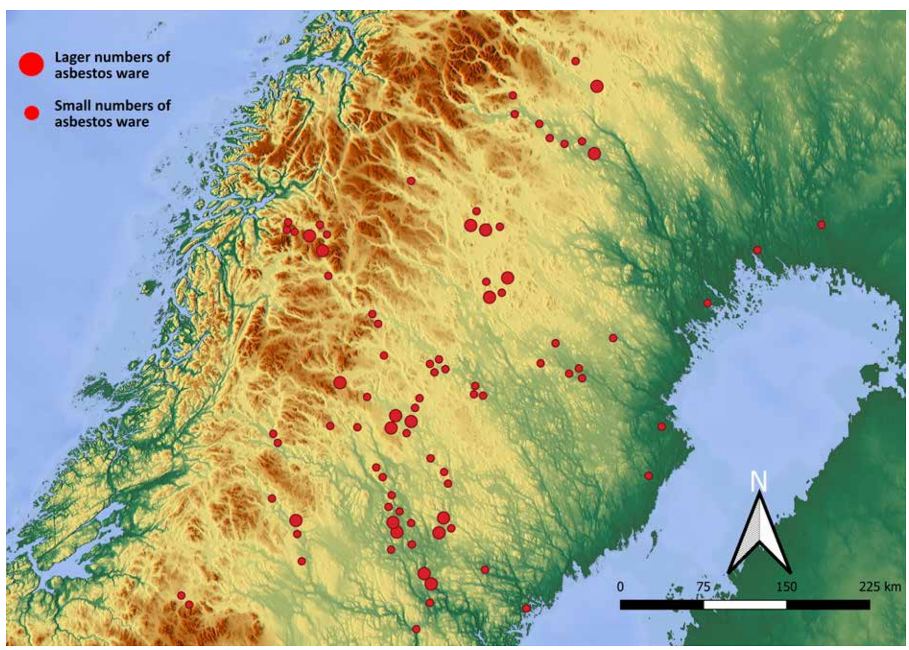


Figure 7. Distribution of asbestos ware with comb impressions in Norrland (map: J. König based on maps-for-free.com).

various informal, emergent social networks facilitating information exchange between individuals with practice-related goals. Hunter-fisher-gatherers are well known for establishing individual contacts with members of other local communities (bands, tribes) as part of their social strategies. Such relationships (e.g. marriage, kinship) must have been in play already when the new technologies first became known. Hence individuals from one community would have transferred knowledge to the next according to pre-existing social networks crosscutting the local units. This could with time emerge as a network of practice. The pattern formed by textile pottery during the second part of the second millennium BC could well be explained in these terms.

This pattern persisted until the first centuries of the first millennium BC, but was superseded by a division into a northern and a southern network during the period

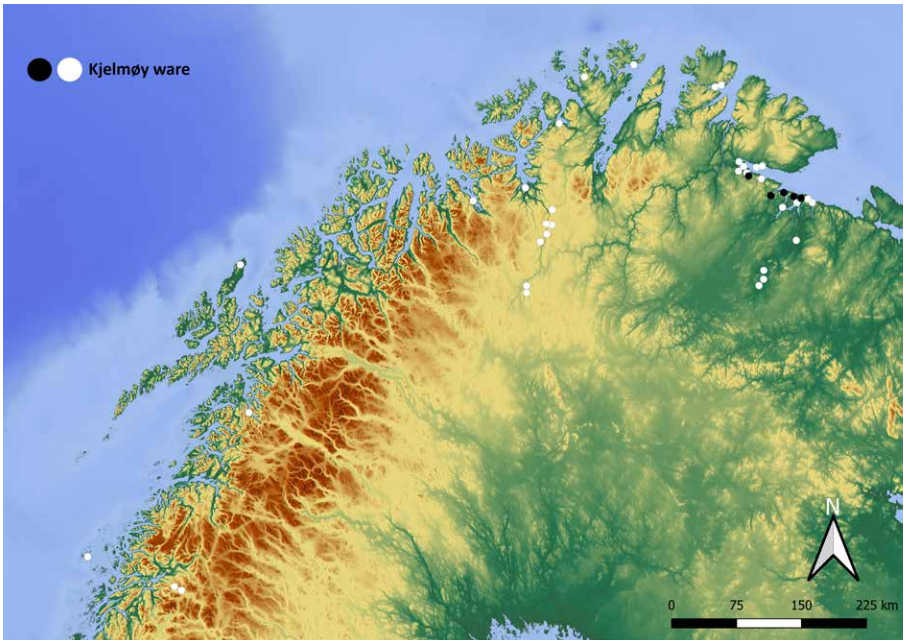


Figure 8. Distribution of Kjelmøy ware in northern Norway (after Jørgensen and Olsen 1988, fig. 12). White dots: Kjelmøy ware; black dots: mica-tempered ware (map: J. König based on maps-for-free.com).

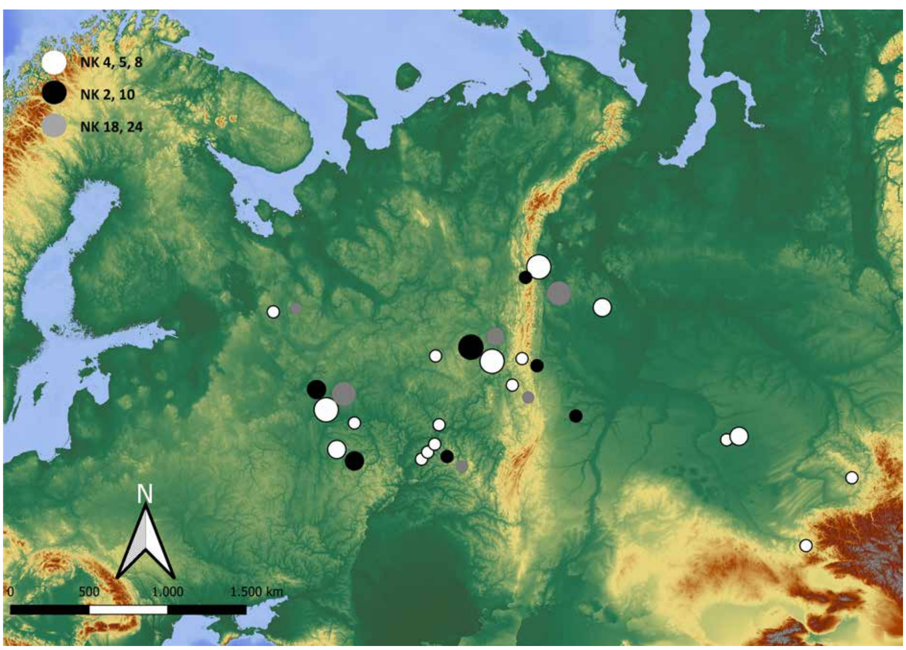


Figure 9. Distribution of bronze daggers of types NK 2, 4, 6, 8, 10, 18, 24 (Chernykh and Kuzminych 1989, fig. 52)
(map: J. König based on maps-for-free.com).

800-400 BC. Some of the central nodes continued, but new ones were established to the north (in the Lule river area) and south (the Indal river area). This could be an example of earlier social fences being broken down and a new structure emerging, reflecting altered social strategies. The distribution pattern of comb-impressed asbestos ware once again differs, as many more settlements have such pottery, and these are also more spread out in the landscape (Figure 8). It would seem that the nodes representing select CoPs disappear and the technology is present throughout all of central and northern Norrland and throughout the whole yearly cycle as represented by base camps, transition camps and short-term activity locales (Forsberg 1985, 263-68). This pattern is very similar to the spread of bifacial lithic technology a millennium earlier.

The case of metalworking

The introduction of metal in northern Fennoscandia slow-started already during the Younger Stone Age, when copper objects occur on Comb Ware sites in north-west Russia, Finland and northern Sweden (Halén 1994; Huggert 1996; Ikäheimo 2019; Lavento 2001, fig. 8.2; Nordqvist and Herva 2013). The first major introduction of metal is connected to a rapid spread of bronze objects in the vast forest area between the Urals and Finland, dubbed the Seima-Turbino phenomenon by Russian scholars (Chernykh 1992; Koryakova and Epimakhov 2007; Yushkova 2012, 131-34) and comprising the so-called Seima bronze axes, mainly found in Finland (Lavento 2001; 2019; Meinander 1954). The spread of this material has been difficult to explain from a traditional culture-historical standpoint, since it does not form local cultures, but appears here and there in a few large cemeteries, in isolated graves or as stray finds. Available radiocarbon dates suggest a beginning of this phenomenon at the start of the second millennium, i.e. coterminous with the early dates of textile pottery (Koryakova and Epimakhov 2007, 110).

This early metal in northern Fennoscandia does not only occur as a few stray axes in Finland, as was earlier assumed, but was also present in northern Sweden and northern Norway (Bakka 1976; Gjessing 1930; Hallström 1929; see especially Carpelan 2003, 48) in the form of daggers, which also occur across northern Russia and in northern Fennoscandia (Figures 9, 10).

Thus, axes mainly occur in southern Finland (with a few in Uppland in central Sweden), whilst the daggers and dagger moulds occur in eastern Finnmark and central Norrland (Figure 9), where they follow a similar distribution as the textile pottery. Finds of this tradition were even made in Kolvika in the Lofoten area, on a site with textile pottery. The only find that somewhat deviates geographically is from Vektarlia, Grong in Nord-Trøndelag (Bakka 1976, pl. 2).

The different distribution of second millennium axes, daggers and moulds could suggest different preferences of the local societies. Since many dagger moulds are found in northern Scandinavia, bronze objects were probably cast here. Furthermore, some of the axes in Finland seem to be of a local variant, the Maaninka axe, suggesting local casting.

Along the Bothnian coast, however, there are also bronze finds of south Scandinavian types (Figure 10). The Early Bronze Age finds have a peculiar distribution, with a northern cluster in coastal Västerbotten and another in south Norrland in Gästrikland and Hälsingland. The finds from the Younger Bronze Age are spread from Ångermanland all the way south to the Gästrikland area. The few inland finds are all from the Younger Bronze Age and all of these (with one exception, still on the Ångerman river) are located in the south. Thus it seems that the networks for south Scandinavian bronzes changed from the Early to the Younger Bronze Age.

During the first millennium BC another horizon of metalwork replaces the Seima-Turbino horizon. This is called the Ananino horizon after the eponymous site in central Russia (Kuz'minych 1983; Yushkova 2012, 135-38). In Fennoscandia, outside of its core area, finds mainly consist of two types of bronze axes: the Ananino and the Akozino/Mälar axe, and casting moulds for these (Baudou 1991; Carpelan 2003, 56; Huurre 1986; Lavento 2019; Ojala 2016; Yushkova 2012). They date between c. 800-300 BC (Koryakova and Epimakhov 2007, 251).

The majority of Ananino finds in northern Fennoscandia are moulds. When comparing the Fennoscandian moulds with finished axes found in the core area of the Ananino culture, it is clear that the Fennoscandian variants are local copies of the ones found at cemeteries in the Volga-Kama area. The casting moulds occur in an arc from the Karelian isthmus and the Russian part of Karelia up through the eastern part of Finland to the northern part of the Bothnian gulf and into the interior of southern Lapland and north-eastern Jämtland (Figure 10). Only four finished axes are found in Fennoscandia: two in southern Lapland, near the sites with moulds, and two further away in south-western Finland and in Uppland in central Sweden. No clear-cut evidence for the casting of Ananino axes has been found there, suggesting the items were imported. Similarly,

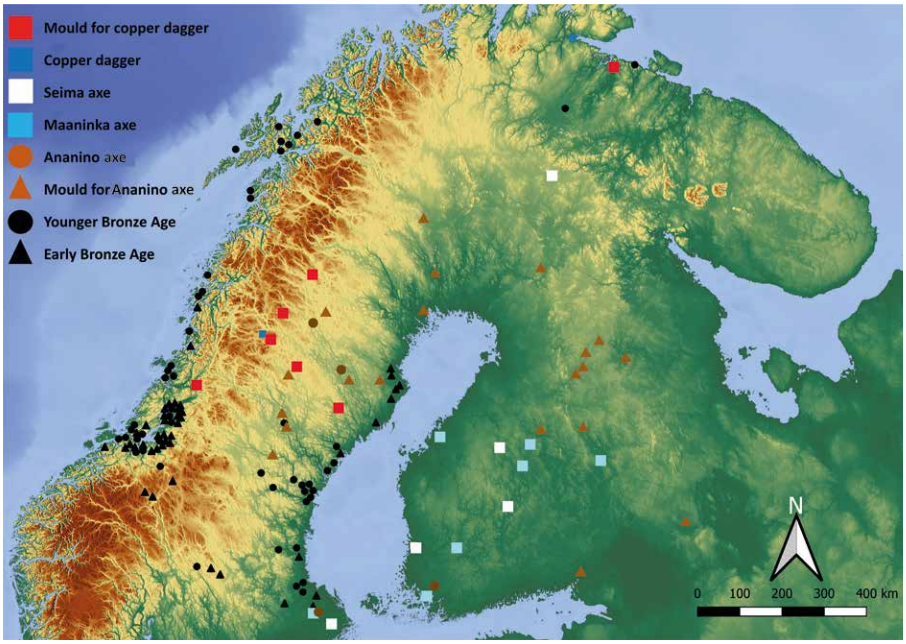


Figure 10. Distribution of Seima-Turbino-related finds in northern Fennoscandia; distribution of Bronze Age bronzes in north Norway and north Sweden (finds in southern Norway are excluded; north Norway based on Engedal 2010, maps 10-17, north Sweden based on Bakka 1976; Baudou 1968; Forsberg 1999; Ramqvist 2007) and finds of Ananino metalwork and related moulds in northern Fennoscandia (map: J. König based on maps-for-free.com).

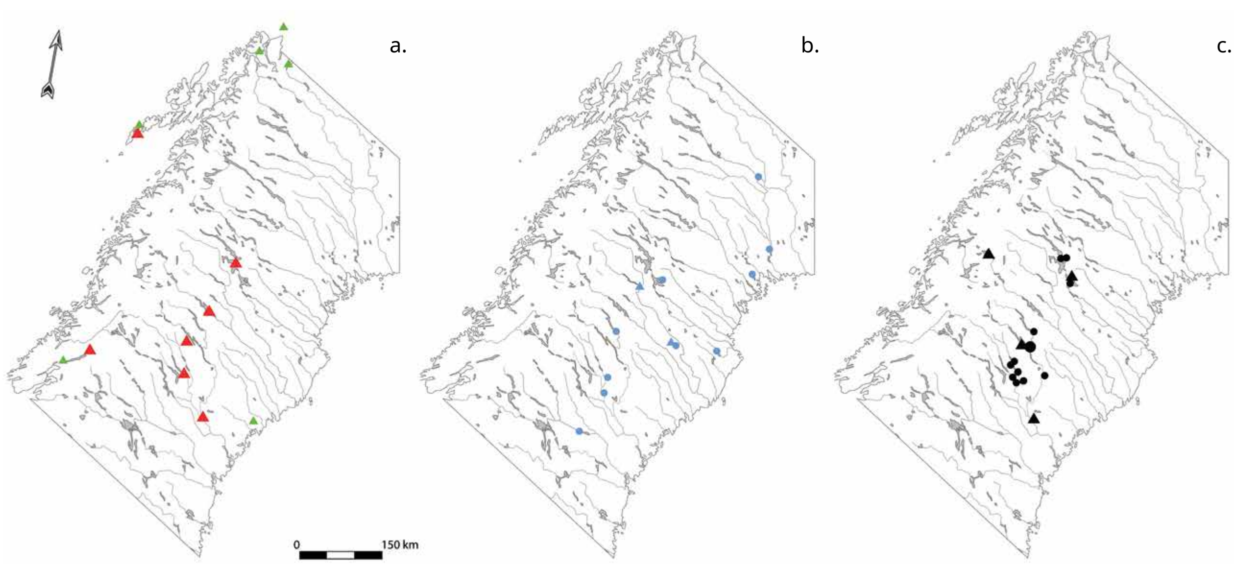


Figure 11. Molds and metalwork in Norrland.
a) second millennium BC;
b) first millennium BC;
c) other indications of metalwork (slag, crucibles, bronze sheets etc.; map: J. König based on maps-for-free.com).

two spearheads of Ananino type were found in south-western Finland and Scania. This pattern of distribution in Fennoscandia thus clearly shows clusters with many moulds in north-eastern Finland (Kainuu, northern Ostrobothnia and Lapland) and north Norrland (Västerbotten and Norrbotten), while southern parts of Finland and Norrland instead have imported bronzes, such as axes of Mälar/Akozino type in southern Finland and south Scandinavian bronzes in both areas (Hjärtner-Holdar 1998; Lavento 2009).

Judging from the distribution of Ananino finds, contacts followed a north-west to south-east axis from the Ladoga-Onega area to Kainuu and the area around Oulujärvi-Oulujoki. This system of waterways has been emphasised as a route of communication from the Mesolithic onwards (Nuñez 2002) and appears to be a central pipeline during the phase discussed here (800-300 BC). One particular concentration on the upper reaches of the Oulujoki river stands out, centring on the large Kiantajärvi lake, where numerous indications of prehistoric metalwork have been found, mostly as stray finds (Huurre

1986; Lavento 2001). It is located about halfway between the Ladoga-Onega area in north-west Russia and the northern part of the Bothnian gulf. In central Norrland, the same areas already central for pottery production and early metalworking in the second millennium BC were still important nodes during the first millennium.

Overall, metalwork during the second millennium in Norrland seems to have a more westerly distribution than the metalwork of the first millennium. There are no clear finds of the Ananino tradition in Trøndelag or Nordland in Norway, in contrast to Seima-Turbino finds. Instead, Ananino finds occur in north-east Norrland, an area still devoid of second millennium metalwork. What is common for both phases is the concentration of metalwork in four to five central regions on the forest plain, the same regions discerned as nodes for second millennium BC pottery.

Other than casting moulds and finished items, there are other indications of metalwork on hunter-gatherer sites in northern Fennoscandia (Hulthén 1991; Ikäheimo 2020; Janzon 1984; Olsen 1991): fragments of copper and bronze sheets, crucible fragments and various finds of slag, as well as casting moulds of soapstone and clay (Figure 11). While dating such items has been difficult, especially on multicomponent sites, several authors have suggested that smelting of metal, as well as casting, smithing and hammering of bronze objects occurred there during the second and first millennia BC (Forsberg 2001; Hulthén 1991; Janzon 1984; Olsen 1991). The origin of the ore itself is a matter of debate. Local ore has been suggested by Janzon (1984), but there is still no clear evidence of this. The work on south Scandinavian bronzes by Ling and colleagues (2013; 2014) shows that the networks involved in transporting the metal can be extensive and that the forms of the bronze items do not necessarily need to reflect the origins of the metal itself. It is of interest, however, that the majority of these indications occur on sites where lithic production and pottery were also represented (Forsberg 2010a).

Discussion

The introduction of metalworking in northern Fennoscandia during the early second millennium BC seems to have followed the same pipelines as early pottery and occurs in the same general area. There are, however, fewer traces of metalworking at the nodes that emerged during the latter part of the second millennium BC. This could be explained with the context of this technology within the local societies. Metalworking in premodern societies tends to have strong ideological and cosmological connotations. The production process is often surrounded by rituals, taboos and definite rules as to who can participate, as well as when and where the different parts of the complicated process can be performed (Barndon 2004; 2005; Haaland 1985; Haaland and Haaland 2007). Often, the blacksmith is seen as an individual somewhat separated from the rest of the local community, whether by a lower or higher status (Haaland 1985, 56-61). In some northern hunter-gatherer societies of Siberia, the blacksmith is seen as possessing secret knowledge, like the shaman (Vitebsky 1995). It is tempting to see this technology as being limited to one or a select few individuals within the local community. Thus, the concept of a local community of practice seems unlikely. Yet blacksmiths in different far-flung communities must have been in contact with each other, given the spread of the technology and the long distances involved. It is difficult to imagine such an esoteric body of knowledge being widely spread by frequent “everyday” contacts between neighbouring communities. Perhaps, then, geographically widespread networks of practice incorporating a limited number of blacksmiths cross-cut the forest areas of northern Fennoscandia and Russia during the second millennium BC.

Networks on different scales

The three technologies of bifacial lithics, pottery production and metalwork clearly show that the hunter-gatherers of the northern forests were embedded in networks on different scales. The exchange and transport of lithic materials mainly show short-range distributions, mostly connected with settlement mobility (Forsberg 2010b). Procurement strategies range from quarry operations in the mountains, probably involving many individuals from the local group, to expedient strategies in the forest area, where pebbles and boulders were exploited. There is no clear indication for specialists, rather production and transmission of knowledge seem to have been connected to the domestic unit. Few nodes or pipelines stand out, rather, production seems distributed locally. The few exceptions, such as the occurrence of points and point production at the Nämforsen locality of Ställverket situated opposite the rock carvings, indicate that points were probably also employed in spheres other than the immediately economic.

The introduction of pottery can be followed as a process of short- to medium-range networking during the third and second millennia BC. The technology first occurred on the coast, initially indicating contacts with societies on the coasts of the Bothnian Sea and later with local societies in Finland. During the middle of the second millennium, four to five nodes emerge as centres for pottery production in the middle of the forest plain in central Norrland. They can be conceived of as early CoPs, situated in communities that strategically adopt pottery making. Connections between these nodes and areas in northern Norway can also be glimpsed. The pottery types made during this phase are variants of IT pottery, which occurs intermittently in several parts of the northern taiga forest, from the Taymyr peninsula in north Siberia to Russian Karelia and the northern parts of the Nordic countries (Carpelan 1979; Khlobystin 2005; Kosmenko 1996). These kind of linear networks change into smaller regions of different types of asbestos ware during most of the first millennium BC, when pottery still is concentrated at a few nodes. A general division between the northern and southern part of Norrland can be discerned, and regional patterns are emerging in the Finnish material. The pattern of pottery production, use and discard at a few nodes in the northern area, present for almost 1500 years, is replaced in the first millennium BC by the pattern of thin-walled asbestos ware used on a majority of sites in all geographical zones throughout northern Fennoscandia.

The evidence of long-range networks is clearest for metal objects. Connections with the forest zones of Finland and Russia are evident from the beginning of the second millennium BC, when the Seima-Turbino metalworking complex connects local societies over a huge area from Siberia to the Norwegian coast. There are no clear nodes, but three pipelines can be discerned: one leading up to eastern Finnmark through north-east Finland, one running from south-east Finland through the Finnish lake district further to central Norrland and the Ångerman river system, and finally one running along the north shore of the Bay of Finland and crossing into the Uppland district in central Sweden.

In the following phase, which comprises most of the first millennium BC, contacts with the Volga-Kama area show that long-range networks were still in play, but there is a clear shift northward in their focus. There seems to be a main pipeline of Ananino metalwork running from southern Karelia north-westward to the north Bothnian area. From this region, the material spreads in two directions, northwards up to eastern Finnmark, and westwards to the forest plain of northern Norrland. Nodes can be discerned in the Suomussalmi area in Kainuu and also in four areas in central and northern Norrland, the same ones that feature in the pottery networks. At the same time, there is metal coming from the south, mainly as finished objects. Thus, there is a difference between a south-north network where finished objects of southern origin are exchanged, and an east-west network where eastern forms are locally produced throughout the forest area.

Finally, during the last centuries BC and the first centuries AD, there is scanty evidence of metalwork, and no clear pipelines or nodes. It seems that large networks of the kind discussed for bronze metalwork cease as iron production takes hold.

Crucially, the picture of egalitarian hunter-gatherers of the kind found in the Mesolithic does not really hold up to scrutiny for the metal-using and metal-producing communities of the last two millennia BC. Only a limited number of the many local societies in the interior appear to have been active in appropriating the new technologies (pottery, metalworking) from the start of the second millennium BC, pointing to differences in the social strategies between local groups from different river systems.

Conclusion

The prehistoric societies of the north were actively participating in social networks of varying scales, connections that brought new resources, knowledge and modes of technological practice. An understanding of these technologies as dependent on communication and information between small local groups is central. As technologies are embedded into pre-existing social networks and practices, the characteristics of their operational sequences at times enable innovations to be easily drawn upon and incorporated into local cultural repertoires, while blocking them at other times. In this way, some new technologies spreading into the north could gradually become part of the fabric of local life, while others were impossible to embed into local lifeways.

The dispersal of the different technologies was dependent upon individuals and small groups, their mobility and social strategies. It was also dependent upon the role of certain local communities emerging as nodes in long-standing interaction routes, or "pipelines", some of which probably extended back into earlier periods of prehistory. The geographical and ecological characteristics peculiar to northern landscapes, as well as the social networks they facilitated or hindered, meant that travel and contacts were not easy in all directions. These deeper interaction histories went on to provide the social conduits for later dispersals of ideas and innovations, often in ways that contradict earlier assumptions about advancing technological frontiers or distinct archaeological cultures.

In some ways, new networks were created around the need for new kinds of raw materials, and localities where they could be combined, all of which must have offered opportunities for local social agents. New raw materials and technologies may have given rise to new specialist roles. Materials, extraction sites, production processes and specialists are all likely to have connected practice and function with ideological and cosmological beliefs. This combination of the practical and the spiritual may have been vital to the introduction of these new technologies.

By tracking the social life and implementation histories of different innovations – and their interlocking *chaînes opératoires* – we can sketch a picture of how these networks operated. The results are not necessarily intuitive, but enable us to understand local social processes through examination of how local communities played strategic roles in wider networks. Network theory provides a basis for following contacts and interaction between people and groups from widely different communities, escaping the limiting paradigm of bounded social groups. Following this, it has been possible to discern certain pipelines and nodes that were instrumental in the spread of early metalwork and pottery during the second millennium BC. This focus on local practices and northern communities helps us to understand how new practices were being negotiated and reproduced over several generations, thereby providing social motors for integration or rejection of new ideas and ways of practice according to pre-existing local traditions.

Bibliography

Ailio, J.E. 1909. *Die steinzeitlichen Wohnplatzfunde in Finland*. Helsingfors: Akademische Buchhandlung.

Andreassen, D.M. 2002. *Risvikkeramikk. En analyse av teknologisk stil på Nordkalotten i sein steinbrukende tid*. Master thesis, University of Tromsø.

Apel, J. 2001. *Daggers, knowledge and power. The social aspects of flint dagger technology in Scandinavia, 2350-1500 cal BC*. Uppsala: Coast to Coast-Books.

Bakka, E. 1976. *Arktisk og nordisk i bronsealderen i Nord-Skandinavien*. Trondheim: Royal Norwegian Society of Sciences and Letters.

Barndon, R. 2004. *An ethnoarchaeological study of iron-smelting practices among the Pangwa and Fipa in Tanzania*. Oxford: Archaeopress.

Barndon, R. 2005. Håndverk, kunst og kunnskap – noen komparative perspektiver på smedens sosiale identitet i jernalderen. In K.A. Bergsvik and A. Engevik jr. (eds), *Fra funn til samfunn. Jernalderstudier tilegnet Bergljot Solberg på 70-årsdagen*, 357-76. Bergen: University of Bergen.

Baudou, E. 1968. Forntida bebyggelse i Ångermanlands kustland. Arkeologiska undersökningar av ångermanländska kuströsen. *Arkiv för norrländsk hembygdsforskning* XVII, 1-209.
Baudou, E. 1977. Den förhistoriska fångstkulturen i Västernorrland. In E. Baudou and K.-G. Selinge (eds), *Västernorrlands förhistoria*, 11-52. Motala: County Council of Västernorrland.
Baudou, E. 1978. Kronologi och kulturutveckling i mellersta Norrland under stenåldern och bronsåldern. In A. Huggert (ed.), *Studier i norrländsk forntid 1*, 8-18. Umeå: Västerbottens Museum.
Baudou, E. 1989. Gränser och center-periferi-förhållanden i Norrlands bronsålder. In J. Poulsen (ed.), *Regionale forhold i Nordisk Bronzealder. 5. Nordiske Symposium for Bronzealdersforskning på Sandbjerg Slot 1987*, 175-84. Aarhus: Jysk Arkæologisk Selskab.
Bergman, I. 1995. *Från Döudden till Varghalsen. En studie av kontinuitet och förändring inom ett fångstsamhälle i övre norrlands inland, 5200 f.Kr.-400 e.Kr*. Umeå: Umeå University.
Björck, N. 1997. New perspectives on the Pitted Ware culture in northern Sweden. *Current Swedish Archaeology* 5, 19-39.
Björck, N. 2011. De bortglömda – berättelsen om östra Sveriges neolitiska jägare och samlare. In P. Bratt and R. Grönwall (eds), *Gropkeramikerna. Rapport från ett seminarium 2011*, 12-28. Stockholm: Stockholms läns museum.
Bolin, H. 1996. Kinship, marriage and traces of social interaction. Aspects of the hunter-gatherer societies in northern Sweden during the Bronze Age and Early Iron Age. *Current Swedish Archaeology* 4, 7-19.
Burch, E.S.Jr. 2005. *Alliance and conflict. The world system of the Iñupiaq Eskimos*. Lincoln, NE: University of Nebraska Press.
Burch, E.S.Jr. and Correll, T.C. 1972. Alliance and conflict: inter-regional relations in north Alaska. In D.L. Guemple (ed.), *Alliance in Eskimo society*, 17-39. Seattle: American Ethnological Society.
Callahan, E. 1979. The basics of biface knapping in the eastern fluted point tradition. A manual for flintknappers and lithic analysts. *Archaeology of Eastern North America* 7, 1-180.
Carpelan, C. 1962. Nellim löytö. *Suomen Museo* 69, 5-25.
Carpelan, C. 1979. Om asbestkeramikens historia i Fennoskandien. *Finskt Museum* 85, 5-25.
Carpelan, C. 2003. Varhaismetallikausi (1900 e.Kr. - 300 j.Kr.). In V.-P. Lehtola (ed.), *Inari/Aanaar. Inarin historia jääkaudesta nykypäivään*, 45-58. Oulu: Painotalo Suomenmaa.
Carpelan, C. 2004. Environment, archaeology and radiocarbon dates. Notes from the Inari region, northern Finnish Lapland. *Iskos* 13, 17-45.
Chalikov, A.C. 1977. *Volgo-Kamye v nashale epokhi rannego zheleza (VIII-VI vv. do n. e.)*. Moscow: Nauka.
Chernykh, E.N. 1992. *Ancient metallurgy in the USSR. The Early Metal Age*. Cambridge: Cambridge University Press.
Chernykh, E.N. and Kuz'minykh, S.V. 1989. *Drevnyaya metallurgiya Severnoi Evraziyi (seiminsko-turbinskij fenomen)*. Moscow: Nauka.
Childe, V.G. 1957. *The dawn of European civilization*. London: Routledge.
Christiansson, H. 1969. "Kungaudden". En hyddlämning i stenåldersmiljö vid kungens sportstuga, Sorsele sn., Lappland. In H. Christiansson and Å. Hyenstrand (eds), *Nordsvensk forntid*, 9-26. Umeå: Kungliga Skytteanska Samfundet.
Damm, C. and Forsberg, L. 2014. Forager-farmer contacts in northern Scandinavia. In V. Cummings, P. Jordan and M. Zvelebil (eds), *The Oxford handbook of the archaeology and anthropology of hunter-gatherers*, 838-56. Oxford: Oxford University Press.
Edquist, C. 1977. *Teknik, samhälle och energi*. Lund: Zenit & Bo Cavefors Bokförlag.
Edquist, C. and Edqvist, O. 1980. *Sociala bärare av teknik. Brygga mellan teknisk förändring och samhällsstruktur*. Lund: Zenit & Bo Cavefors Bokförlag.

Engedal, Ø. 2010. *The Bronze Age of northwestern Scandinavia*. Bergen: University of Bergen Press.
Forsberg, L. 1985. *Site variability and settlement patterns. An analysis of the hunter-gatherer settlement system in the Lule river valley, 1500 BC-BC/AD*. Umeå: Umeå University.
Forsberg, L. 1999. The Bronze Age site at Mårtenfäboda in Nysätra and the settlement context of the cairns on the coast of north Sweden. In M. Huurre (ed.), *Dig it all. Papers dedicated to Ari Siiriäinen*, 251-85. Helsinki: Finnish Antiquarian Society.
Forsberg, L. 2001 Keramiken från Råingetlokalerna. Mångfald i tid och formspråk. In M. Bergvall and O. George (eds), *Tidsspår. Hembygdsbok för Ångermanland och Medelpad*, 129-50. Härnösand: Länsmuseet Västernorrland.
Forsberg, L. 2003. Förhistoriska fångstsamhällen i Indalsälvens avrinningsområde. De arkeologiska undersökningarna vid Foskvattensjöarna i norra Jämtland. In A. Beverfjord (ed.), *Midtnordisk arkeologisymposium 1999. Trondheim 28-30 mai*, 41-70. Trondheim: TAPIR Akademisk Forlag.
Forsberg, L. 2005. Protosamiska och samiska boplatser i Norrland under tidig metalltid – några tolkningsförslag. In K.A. Bergsvik and A. Engevik (eds), *Fra funn til samfunn. Jernaldersstudier tilegnet Bergljot Solberg på 70-årsdagen*, 121-51. Bergen: University of Bergen.
Forsberg, L. 2010a. The spread of new technologies in early Fennoscandia – a view without borders. In W. Østreng (ed.), *Transference. Interdisciplinary communications 2008/2009*. Oslo: Centre for Advanced Study. Available at: https://cas.oslo.no/about-cas/booklets/seminar-booklets/?noredirect=true (last accessed 10.09. 2021)
Forsberg, L. 2010b. A consideration of the role of bifacial lithic technology in northern Scandinavia. In R. Barndon, I. Øye and A. Engevik (eds), *The archaeology of regional technologies. Case studies from the Palaeolithic to the Age of the Vikings*, 127-48. Lewiston: Mellen Press.
Forsberg, L. 2012. Asymmetric twins? Some reflections on coastal and inland societies in the Bothnian area during the Epineolithic and Early Metal Age. In N. Anfinset and M. Wrigglesworth (eds), *Local societies in Bronze Age northern Europe*, 31-55. Sheffield: Equinox.
Forsberg, L. in prep. *Using introduced technologies as proxies for tracing prehistoric social networks – a discussion of the two last millennia BC in northern Fennoscandia.*
Fried, M.H. 1967. *The evolution of political society: an essay in political anthropology*. New York: Random House.
Gaustad, F. 1973. Arkeologiske undersøkelser i Ranafjellene 1960-69. *Vårt Verk* 3, 24-32.
George, O. 2001. Boplatsen vid Rånget. In M. Bergvall and O. George (eds), *Tidsspår. Hembygdsbok för Ångermanland och Medelpad*: 105-28. Härnösand: Länsmuseet Västernorrland.
Gjessing, G. 1930. Et hustuftfunn fra Lebesby. *Universitetets Oldsakssamlings Årbok* 1929, 111-28.
Gjessing, G. 1943. *Traen-funnene*. Oslo: Instituttet for sammenlignende kulturforskning.
Gullbring, M. 1942. Ett fynd av kvartsitpilspetsar från Vännäs socken. *Västerbotten* 1942, 11-18.
Haaland, R. 1985. Iron production, its socio-cultural context and ecological implications. In R. Haaland and P.L. Shinnie (eds), *African iron working. Ancient and traditional*, 50-72. Oslo: Norwegian University Press.
Haaland, G. and Haaland, R. 2007. God of war, worldly ruler, and craft specialists in the Meroitic kingdom of Sudan. Inferring social identity from material remains. *Journal of Social Archaeology* 7, 372-93.
Halén, O. 1994. *Sedentariness during the Stone Age of northern Sweden in the light of the Alträsket site, c. 5000 BC, and the Comb Ware site Lillberget, c. 3900 BC. Source critical problems of representativity in archaeology*. Stockholm: Almqvist & Wiksell.
Hallgren, F. 2008. *Identitet i praktik. Lokala, regionala och överregionala sociala sammanhang inom nordlig trattbägarkultur.* Uppsala: Uppsala University.
Hallström, G. 1929. Kan lapparnas invandringstid fixeras? *Norrlands försvar* 1929, 39-92.

Handley, K., Sturdy, A., Fincham, R. and Clark, T. 2006. Within and beyond communities of practice. Making sense of learning through participation, identity and practice. *Journal of Management Studies* 43, 641-53.
Helms, M.W. 1988. *Ulysses' sail: an ethnographic Odyssey of power, knowledge and geographical distance*. Princeton: Princeton University Press.
Helskog, E.T. 1983. *The Iversfjord locality. A study of behavioral patterning during the Late Stone Age of Finnmark, north Norway*. Tromsø: University of Tromsø, Tromsø Museum.
Hesjedal, A., Damm, C., Olsen, B. and Storli, I. 1996. *Arkeologi på Slettnes. Dokumentasjon av 11.000 års bosetning*. Tromsø: Tromsø Museum.
Hjärthner-Holdar, E. 1998. Samspel mellan olika regioner i Sverige och Ryssland under yngre bronsålder sett utifrån järnteknologins införande. In T. Løken (ed.), *Bronsealder i Norden – Regioner og interaksjon. Foredrag ved det 7. bronsaldersymposium i Rogaland*, 35-44. Stavanger: Arkeologisk Museum i Stavanger.
Hodder, I. 1982. *Symbols in action.* Cambridge: Cambridge University Press.
Hodder, I. 1986. *Reading the past*. Cambridge: Cambridge University Press.
Hodder, I. 1991. Archaeological theory in contemporary European societies: the emergence of competing traditions. In I. Hodder (ed.), *Archaeological theory in Europe. The last three decades*, 1-24. London: Routledge.
Holm, L. 1991. *The use of stone and hunting of reindeer*. Umeå: Umeå University.
Holm, L. 2006. *Stenålderskust i norr: bosättning, försörjning och kontakter i södra Norrland*. Umeå: Umeå University.
Hood, B.C. and Olsen, B. 1988. Virdnejavre 112. A Late Stone Age – Early Metal Period site from interior Finnmark, north Norway. *Acta Archaeologica* 58, 105-25.
Huggert, A. 1996. Early copper finds in northern Fennoscandia. *Current Swedish Archaeology* 4, 69-82.
Hulthén, B. 1985. Hair tempered pottery in Ångermanland. In Umeå University (ed.), *In Honorem Evert Baudou. Archaeology and Environment 4*, 247-58. Umeå: Umeå University.
Hulthén, B. 1991. *On ceramic ware in northern Scandinavia during the Neolithic, Bronze, and Early Iron Age. A ceramic-ecological study.* Umeå: Umeå University.
Huurre, M. 1986. The eastern contacts of northern Fennoscandia in the Bronze Age. *Fennoscandia Archaeologica* III, 51-58.
Ikäheimo, J. 2019. Neolithic native copper finds from Finland and north-west Russia: a multi-method approach. *Fennoscandia archaeologica* XXXVI, 87-107.
Ikäheimo, J. 2020. From obvious to ambiguous: a comparative case study of crucible fragments from a Bronze Age site in northern Finland. *Fennoscandia Archaeologica* XXXVII, 25-44.
Ingold, T. 1992. Culture and the perception of the environment. In E. Croll and D. Parkin (eds), *Bush base, forest farm. Culture, environment and development*, 39-56. London: Routledge.
Ingold, T. 2000. *The perception of the environment. Essays on livelihood, dwelling and skill.* London: Routledge.
Janson, S. and Hvarfner, H. 1960. *Från norrlandsälvar och fjällsjöar. Riksantikvarieämbetets kultuhistoriska undersökningar i samband med kraftverksbyggen och sjöregleringar*. Stockholm: Riksantikvarieambetet.
Janzon, G.O. 1984. *Stenredskap med skafttränna – indikation på tidig metallurgi?* Stockholm: Jernkontoret.
Johnson, A.W. and Earle, T.K. 2000. *The evolution of human societies. From foraging group to agrarian state*. Stanford: Stanford University Press.
Jørgensen, R. and Olsen, B. 1988. *Asbestkeramiske grupper i Nord-Norge, 2100 f.kr. – 100 e.Kr.* Tromsø: University of Tromsø.
Käck, B.-O. 1993. *Boplatser av stenålderskaraktär i området längs Skellefte älv och Malån I. En sammanställning och analys av inventeringsdata*. Umeå: Umeå University.
Käck, B.-O. 1995. *Boplatser av stenålderskaraktär i området längs Skellefte älv och Malån II. En sammanställning och analys av grävningsdata.* Umeå: Umeå University.

Käck, J. 2009. *Samlingsboplatser? En diskussion om människors möten i norr 7000 f. Kr.-Kr. f. med särskild utgångspunkt i data från Ställverksboplatsen vid Nämforsen*. Umeå: Umeå University.

Khlobystin, L.P. 2005. *Taymyr. The archaeology of northernmost Eurasia*. Washington: Arctic Studies Center, National Museum of Natural History, Smithsonian Institution.

Knutsson, K. 1986. Sammanfogning av flintor från de nordsvenska flintfyndplatserna. Belägg för Kombewa-metoden i Kusmark ock Kallbäcken. *Fjölnir* 2, 5-15.

Koryakova, L. and Epimakhov, A. 2007. *The Urals and western Siberia in the Bronze and Iron Ages*. Cambridge: Cambridge University Press.

Kosmenko, M.G. 1996. The culture of Bronze Age Net Ware in Karelia. *Fennoscandia Archaeologica* XIII, 51-67.

Kuz'minykh, S.V. 1983. *Metallurgia Volgo-Kamja. V rannem zheleznom veke*. Moscow: Nauka.

Larsson, Å. M. 2009. *Breaking bodies and pots. Material and ritual practices in Sweden in the third millennium BC*. Uppsala: Uppsala University Press.

Latour, B. 2005. *Reassembling the social. An introduction to actor-network-theory*. Oxford: Oxford University Press.

Lave, J. and Wenger, E. 1991. *Situated learning. Legitimate peripheral participation*. Cambridge: Cambridge University Press.

Lavento, M. 2001. *Textile ceramics in Finland and on the Karelian Isthmus. Nine variations and fugue on a theme of C. F. Meinander.* Helsinki: University of Helsinki.

Lavento, M. 2009. Kan man använda begreppet bronsålder i Finland? In G. Grønnesby and M. Moe Henriksen (eds), *Det 10. nordiske bronsealdersymposium. Trondheim 5.-8. okt. 2006*, 124-35. Trondheim: Tapir.

Lavento, M. 2012. Local centres in the periphery: the Late Neolithic, Bronze Age and Early Metal Age in Finland. In N. Anfinset and M. Wrigglesworth (eds), *Local societies in Bronze Age northern Europe*, 148-68. Sheffield: Equinox.

Lavento, M. 2019. Early Metal Age bronze axes in Finland: an overview. *Transactions of the Institute for the History of Material Culture. St. Petersburg – IHMC RAS* 20, 35-52.

Law, J. and Hassard, J. 1999. *Actor network theory and after*. Oxford: Blackwell.

Lindholm, P., Olsson, E. and Runeson, H. 2007. Grop, snöre och kam. In P. Gustafsson and L.-G. Spång (eds), *Stenålderns stationer. Arkeologi i Botniabanans spar*, 200-35. Stockholm: RAÄ.

Lindqvist, A-K. 2007. I viken vid berget. In P. Gustafsson and L.-G. Spång (eds), *Stenålderns stationer. Arkeologi i Botniabanans spar,* 117-45. Stockholm: RAÄ.

Ling, J., Hjärthner-Holdar, E., Grandin, L., Billström, K., and Persson, P.-O. 2013. Moving metals or indigenous mining? Provenancing Scandinavian Bronze Age artefacts by lead isotopes and trace elements. *Journal of Archaeological Science* 40, 291-304.

Ling, J., Stos-Gale, Z., Grandin, L., Billström, K., Hjärthner-Holdar, E. and Persson, P.-O. 2014. Moving metals II: provenancing Scandinavian Bronze Age artefacts by lead isotope and elemental analyses. *Journal of Archaeological Science* 41, 106-32.

Lundberg, Å. 2001. Värdefulla gravgåvor eller besvärjande offer? *Arkeologi i Västerbotten 2001*, 25-28.

Lundberg, Å. 2005. Gravriter under bronsålder: Ny gravtyp i norr och söder. In R. Engelmark, T.B. Larsson and L. Rathje (eds), *En lång historia. Festskrift till Evert Baudou på 80-årsdagen*, 307-20. Umeå: Umeå University.

Malmer, M.P. 1962. *Jungneolitische Studien. Acta Archaeologica Lundensia*. Lund: Lunds Universitets Historiska Museum.

Meinander, C.F. 1954. Die Bronzezeit in Finnland. *Finska Fornminnesföreningens Tidskrift* 54, 5-242.

Meinander, C.F. 1979. Innovation centres in the Arctic. *Fenno-Ugrica Suecana* 2, 85-94.

Meschke, C. 1977. *Early Norrland sites on the Umeälven. A study of a cultural-historical survey.* Stockholm: Almqvist & Wiksell.

Minar, C.J. 2001. Motor skills and the learning process: the conservation of cordage final twist direction in communities of practice. *Journal of Anthropological Research* 57, 381-405.

Muto, G.R. 1971. *A technological analysis of the early stages in the manufacture of lithic artifacts*. Idaho: Idaho State University.
Mökkönen, T. and Nordqvist, K. 2017. Kierikki ware and the contemporary Neolithic asbestos- and organic-tempered potteries in north-east Europe. *Fennoscandia Archaeologia* XXXIV, 83-116.
Nuñez, M. 1990. On Subneolithic pottery and its adoption in Late Mesolithic Finland. *Fennoscandia Archaeologica* VII, 27-52.
Nuñez, M. 2002. Finland's settling model revisited. *Mankind Quarterly* XLIII, 155-75.
Nordqvist, K. and Herva, V.-P. 2013. Copper use, cultural change and Neolithization in north-eastern Europe (c. 5500-1800 BC). *European Journal of Archaeology* 16, 401-32.
Ojala, K. 2016. *I bronsålderns gränsland. Uppland och frågan om östliga kontakter.* Uppsala: Institutionen för arkeologi och antik historia, Uppsala universitet.
Olsen, B. 1991. Kjelmøyfunnenes "virkningshistorie" og arkeologi. *Viking* 1991, 65-87.
Patrushev, V.S. 1992. Textile-impressed pottery in Russia. *Fennoscandia Archaeologica* IX, 43-56.
Ramqvist, P.H. 2007. Fem Norrland. Om norrländska regioner och deras interaktion. *Arkeologi i Norr* 10, 153-80.
Santesson, O.B. 1935. Märkligt stenåldersfynd i Tärna socken. *Västerbotten* 16, 7-16.
Sassaman, K.E. and Rudolphi, W. 2001. Communities of practice in the early pottery traditions of the American Southeast. *Journal of Anthropological Research* 57, 407-25.
Scott, J. 1991. *Social network analysis – a handbook*. London: Sage.
Seely Brown, J. and Duguid, P. 2000. *The social life of information.* Harvard: Harvard Business Press.
Service, E.R. 1962. *Primitive social organization: an evolutionary perspective*. New York: Random House.
Spång, L-G. 1991. Flyttningsmönster och centrumberoende. Fångstsamhällens sociala och ekonomiska behov av centra i Norrlands inland. In B. Wik (ed), *Sentrum – Periferi. Sentra og sentrumsdannelser gjennom førhistorisk og historisk tid. Den 18. nordiske arkeologkongress, Trondheim 28.8-4.9 1989,* 101-16. Trondheim: NTNU Vitenskapsmuseet.
Spång, L.G. 1997. *Fångstsamhälle i handelssystem. Åsele lappmark neolitikum – bronsålder*. Umeå: Umeå University.
Tilley, C. 1994. *A phenomenology of landscape. Places, paths, and monuments.* Oxford: Berg.
Tukey, J.W. 1977. *Exploratory data analysis*. London: Addison-Wesley.
Velleman, P.F. 1988. *DataDesk version 6.0 statistics guide*. Ithaca, NY: Data Description, Inc.
Vitebsky, P. 1995. *Shamanism*. Norman, OK: University of Oklahoma Press.
Wenger, E. 1998. *Communities of practice: learning, meaning, and identity.* Cambridge: Cambridge University Press.
Wenger, E., McDermott, R. and Snyder, W.M. 2002. *Cultivating communities of practice.* Harvard: Harvard Business School Press.
Yushkova, M.A. 2012. Northwestern Russia at the periphery of the north European and Volga-Uralic Bronze Age. In N. Anfinset and M. Wrigglesworth (eds), *Local societies in Bronze Age northern Europe,* 129-47. Sheffield: Equinox.

Swords and sword-bearers across the Baltic Sea in the Early Bronze Age

Jan-Heinrich Bunnefeld

Introduction

Swords are among the most prominent and eye-catching objects known from the Nordic Bronze Age. The distribution of swords around the Baltic Sea is highly uneven in the Early Bronze Age (as we will see in this paper), but also in the Late Bronze Age. In Montelius' periods I to III most finds are from Denmark, Schleswig-Holstein, Mecklenburg-Vorpommern and Scania, while only few were found in the eastern parts of the Baltic Sea area (Figure 1). Furthermore, it should be noted that in Denmark, Schleswig-Holstein, Mecklenburg-Vorpommern and Scania only metal-hilted swords and daggers are mapped, while in the other regions all swords (with a length of more than 30 cm in case of plate-hilted swords, respectively 35 cm in case of other sword types with parts of the hilt construction included) and daggers mentioned in the literature are included (Bunnefeld 2016a; Čivilytė 2009; Dąbrowski 2004; Edgren 1969; Engedal 2010; Gedl 1980; Kersten 1958; Meinander 1954; Oldeberg 1974; Ottenjann 1969; Salmo 1955; Siiriäinen 1984; Stöckmann 2013). The distribution is therefore even more uneven when all swords and daggers in the western regions are considered.

These maps raise some interesting questions on the reasons for this distribution as well as the functions and meanings of swords in the different regions and societies. Why have swords been buried in large numbers in some societies, while only very few swords have been found in other regions? Did these societies have swords at all?

Swords in the Nordic Bronze Age of southern Scandinavia

In the Nordic Bronze Age – present-day Schleswig-Holstein, Denmark, south-western Norway, southern Sweden and Mecklenburg – more than c. 2500 swords and also more than c. 1500 daggers are known from Montelius' periods I to III (Aner and Kersten 1973-1995; Aner *et al.* 2001-2017; Bunnefeld 2013; 2016a; Engedal 2010; Oldeberg 1974; Sprockhoff 1931; Thrane 2006; Vandkilde 1996; Wüstemann 2004). Many different sword types, for example Nordic full-hilted swords, octagonal-hilted swords from south-central Europe, plate-hilted swords, flange-hilted swords and tang-hilted swords are amongst them (Figure 2).

Surely the Nordic full-hilted swords are the most elaborate and complex of these objects in period II (for the following see Bunnefeld 2016a; 2016b). Their hollow hilts were cast in the lost wax technique with a clay core inside, and the walls of the hilts are very thin. Sometimes there are grooves in the clay core so that the liquid metal could better fill the mould, many hilts have recessed or open-worked walls for ornamental incrustations. The blades end inside the metal hilt in plates, flanges, which are sometimes wedged into the hilt, like in octagonal-hilted swords, and tangs. All these different blade types, combined with various rivet patterns, show an almost unlimited diversity of mounting techniques. The forms are also very different, while most details show a widespread distribution. Ornaments on these swords are even more diverse than the forms, and some have regionally different distributions. However, there are obviously no clear patterns or even combinations of

In D. Hofmann, F. Nikulka and R. Schumann (eds) 2022. *The Baltic in the Bronze Age. Regional patterns, interactions and boundaries*, Leiden: Sidestone Press, pp. 73-90.

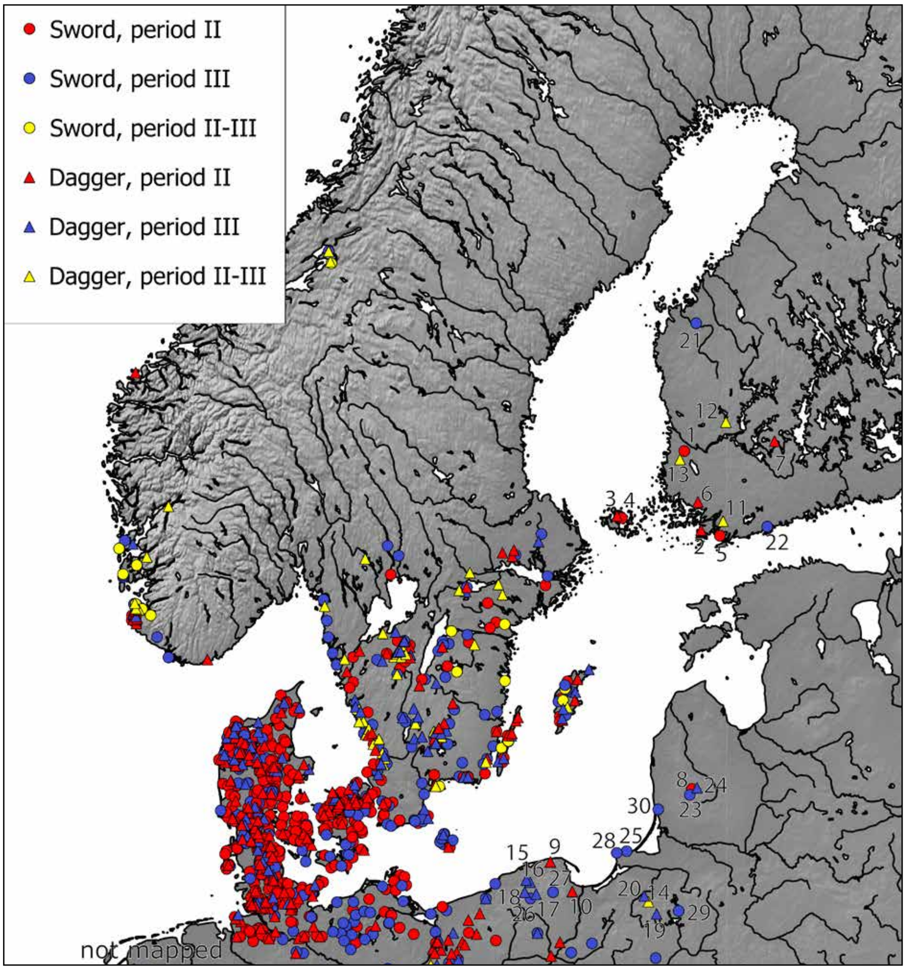


Figure 1. Distribution of dated Early Bronze Age swords and daggers: 1 Panelia; 2 Dragsfjärd; 3-4 Sund; 5 Bromarv Framnäs; 6 Vanhalinna; 7 Luopioinen; 8 "Near Raseiniai oder Telšiai"; 9 Prusiewo; 10 Pruszcz Gdanski; 11 Perniö; 12 Uskela; 13 Lappi parish; 14 Bisztynek; 15-16 Malczkowo; 17 Pomys; 18 Radusz; 19 Pustniki; 20 Krawczyki; 21 Isokyrö; 22 Kirkkonummi; 23-24 "Near Raseiniai or Telšiai"; 25 Zaostrowie (formerly Rantau); 26 Gostkowo; 27 Czaple Nowe; 28 Marjinskoje (formerly Marscheiten); 29 Paprotki. Please note that only metal-hilted swords and daggers are mapped for Denmark, Schleswig-Holstein, Mecklenburg-Vorpommern and Scania (made with Natural Earth).

regionally limited forms, ornaments and techniques. The metal of the Nordic full-hilted swords contains nearly 11 % of tin on average, and there are no clear indications for the use of specific alloys for different parts – for example blade and hilt – on a regular basis.

It is difficult to differentiate the Nordic full-hilted swords chronologically and regionally; the workshop areas postulated by Helmut Ottenjann (1969) cannot be confirmed, most importantly because regular combinations of particular forms, ornaments and techniques are missing. The lack of technical uniformity of swords which, according to Ottenjann, should have been made in the same workshop areas, is an especially strong counter-argument. This shows that it is not appropriate to suggest a few well-defined areas in which all swords should have been produced. However, some forms, ornaments and techniques are distributed unevenly across the Nordic area and when combined show five rather diffuse "zones of influences". Two of these zones overlap with Karl Kersten's (1936) zones I and II and they should probably be explained as specific workshop traditions or social groups of sword-bearers. However, this pattern indicates the existence of a vast network of sword-bearers and craftsmen which was characterised by high mobility and dense communication between both groups. Obviously almost everything, including techniques, was shared in some way even over large distances. Thus, there was probably a large number of small workshops and craftsmen producing swords and daggers of different kinds. Since we know no sword-producing workshop sites in the archaeological record of the Nordic Bronze Age, the only chance to identify the workshops – regardless of whether craftsmen were sedentary or itinerant – lies in the spread of their products, the swords. Of course, it is important to keep in mind a number of distorting aspects, such as factors affecting distribution in the past and

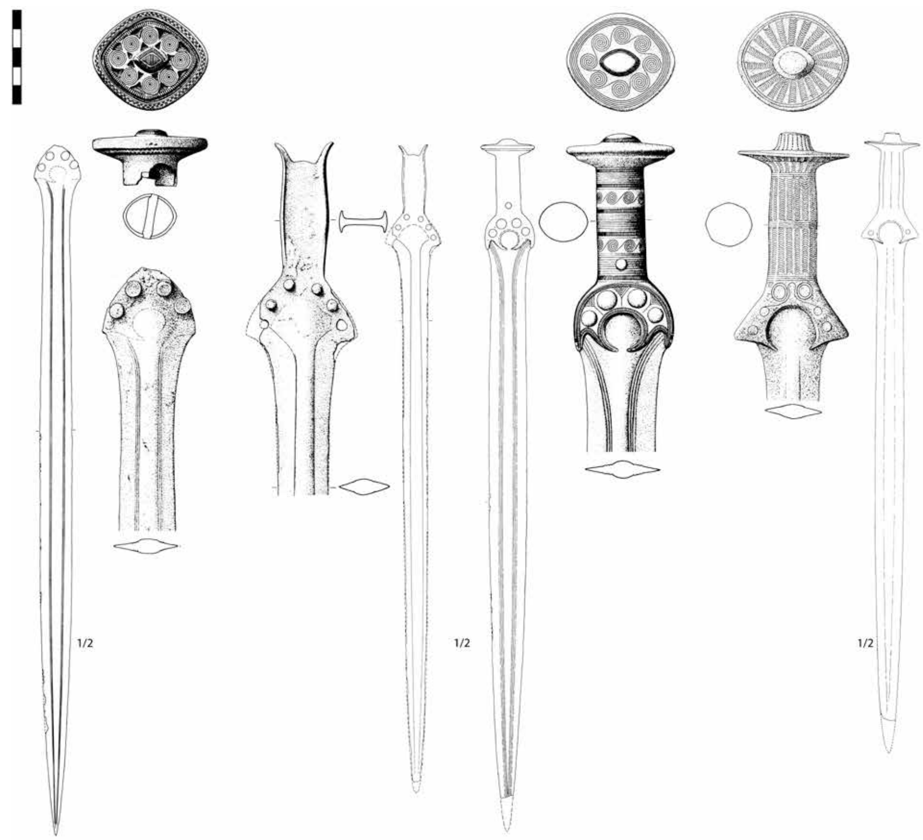


Figure 2. Different sword types in the Nordic Bronze Age (period II): plate-hilted sword, flange-hilted sword, Nordic full-hilted sword, octagonal-hilted sword (Ke 771, Ke 761, Ke 771, Ke 707: Aner and Kersten 1976, plates 20, 27, 29, 30).

deposition rites. The most important factor to identify Nordic full-hilted swords of period II produced in the same tradition or by the same workshop or even craftsman is the similarity in forms, ornaments and techniques or – in ideal circumstances – inconspicuous or normally invisible technical details (cf. Nørgaard 2018). Nordic full-hilted swords of period II are widely dispersed even when they are technologically related and, thus, belong to the same workshop tradition; the sizes of distribution areas for swords which probably came from the same workshop (related by techniques and forms/ornaments) or even craftsman (highly similar in techniques, forms and ornaments) are smaller and more regional. In the case of workshops the distance between the objects is 200 km at most.

In Denmark and Schleswig-Holstein, core areas of the Nordic Bronze Age, 37 % of the swords in period II and almost 20 % in period III have a metal hilt (Aner and Kersten 1973-1995; Aner *et al.* 2001-2017; cf. Bunnefeld 2013). Most of them are Nordic full-hilted swords, but in period II there are also octagonal-hilted swords. Many swords are therefore highly complex and ornamented craft products.

By far the most swords in the Nordic Bronze Age in periods II and III, about 85 % of the swords with known contexts, were found in burial mounds (Figures 3-4). In most cases the swords lay beside the buried person, mainly men according to the well-preserved oak coffin graves and statistical tests of burial assemblages which showed clear gender differences. Otherwise, there were no fixed assemblages so that many different objects could accompany the dead persons and their swords. Burials containing Nordic full-hilted swords were on average more richly equipped than those with other weapons only (Bunnefeld 2016a, 191-93; Thrane 2006, 500-01).

According to the use wear traces on the blades the swords were weapons used in actual combat, but also important status symbols and identity markers. However, concerning the many swords in the Nordic Bronze Age, how many men did bear a sword? And who were these sword-bearers? Did social differences exist between them?

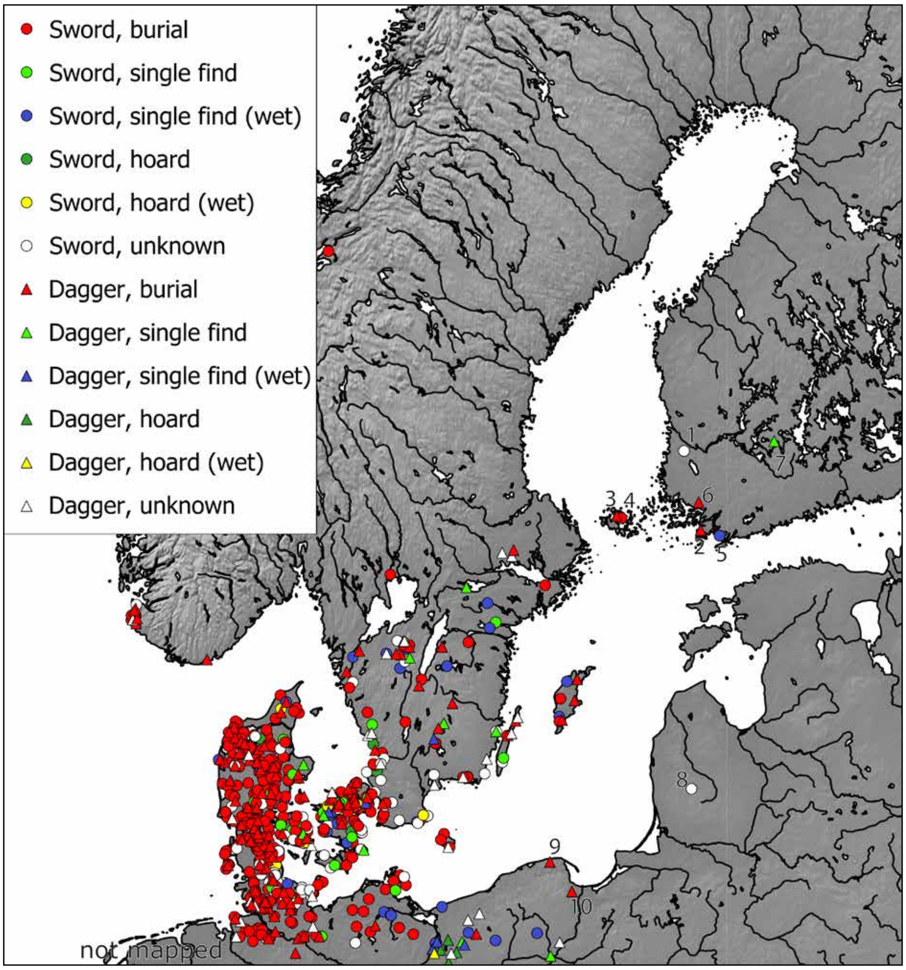


Figure 3. Distribution of swords and daggers of period II with context (for numbers see Figure 1). Please note that only metal-hilted swords and daggers are mapped for Denmark, Schleswig-Holstein, Mecklenburg-Vorpommern and Scania (made with Natural Earth).

My model is based on educated guesses which are deduced from different variables, and can at least provide an overview about realistic possibilities (for the following see Bunnefeld 2013; 2016a, 196-200). From Denmark and Schleswig-Holstein 1057 swords and 491 daggers are known for period II and 1040 swords and 366 daggers for period III. Based on these numbers, it must be considered how many Bronze Age swords were put into the ground and survived until now compared to the number of swords melted down and destroyed by agriculture, grave robbery and so on. The given numbers represent only an absolute minimum because all unpublished swords in museums, many swords with unknown provenance etc. must be added. Since the beginning of archaeological enquiry, according to estimates by Kristian Kristiansen (1985, 116-19, 121-24), objects were found in about 10 % of all known burial mounds. Thus, considering also graves which were destroyed earlier and completely undocumented (Jensen 2002, 145-47; Willroth 1992, 67), we now know at most 1-3 % of all Bronze Age swords in the Nordic area. Of further importance here is the average use life of swords; we can assume c. 20 years or one generation, since the swords in most cases were buried with their probable owners. Calculating these variables in the same way in which living populations are calculated on the basis of cemeteries (Acsádi and Nemeskéri 1970, 65-66), we obtain a likely span of swords and daggers existing simultaneously in the Nordic Bronze Age of Denmark and Schleswig-Holstein during periods II and III.

In the next step we have to consider how many people lived in the region simultaneously, and there are different estimates. Jens Poulsen (1983) calculated the population on the basis of the carrying capacity of all possible natural resources. He suggested 1.9 to 6.4 persons

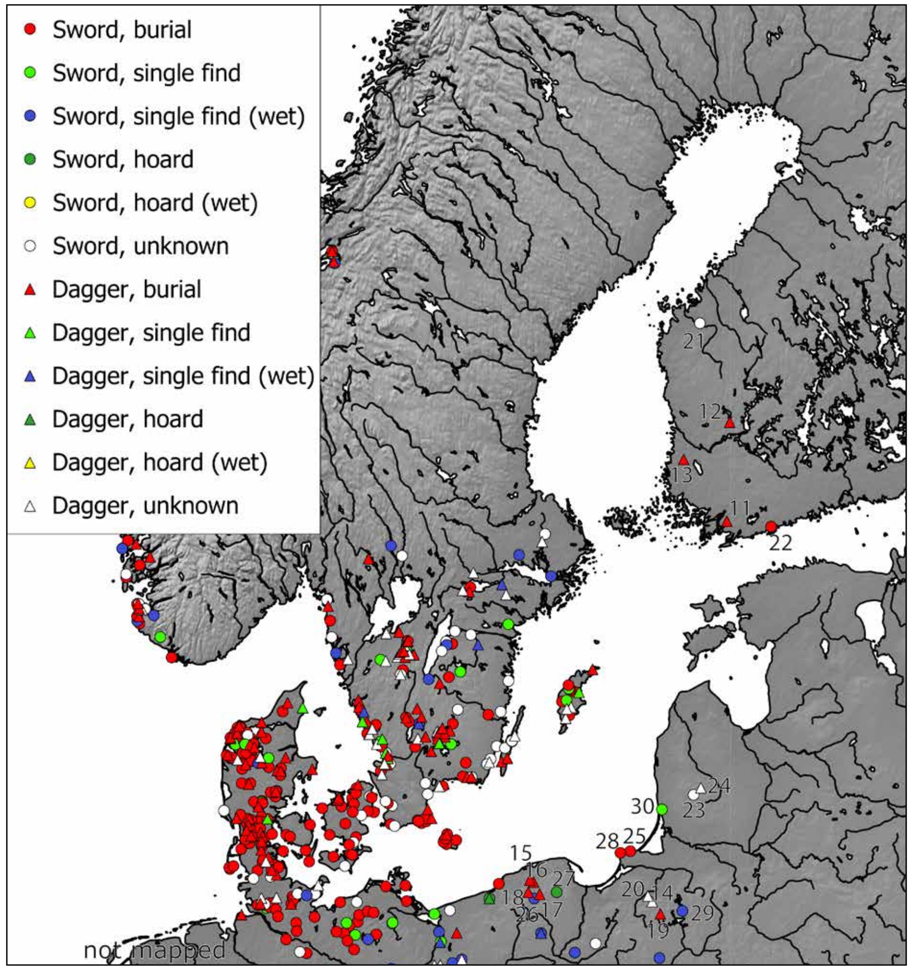


Figure 4. Distribution of swords and daggers of period II-III and III with context (for numbers see Figure 1). Please note that only metal-hilted swords and daggers are mapped for Denmark, Schleswig-Holstein, Mecklenburg-Vorpommern and Scania (made with Natural Earth).

per square kilometre. As a reasonable number of inhabitants for Bronze Age Denmark he proposed 5 persons per square kilometre. Kristiansen (2018a, 109-10) suggests a similar or even somewhat higher population density of 7.5 persons per square kilometre, based mainly on the high settlement density in Thy. However, this seems rather high, since some regions with fertile, but heavy soils like the interiors of Zealand and Funen as well as some parts of eastern Jutland, were not or only sparsely settled, as visible on distribution maps (cf. Kristiansen 2018a, 111, 127). Moreover, the other regions were probably not as densely settled as Thy in period III – of course, we would need more case studies like for Thy in other regions. With 7.5 persons per square kilometre there would have been c. 440,000 inhabitants in Denmark and Schleswig-Holstein, with 5 persons per square kilometre there would have been c. 300,000 inhabitants. However, landscape archaeology studies by a Cologne team led by Andreas Zimmermann show that it is very important to consider regions without settlement, even in areas favourable to settlement activities (Wendt *et al.* 2010). Such regions without settlement might be caused by the security requirements of local and regional communities (cf. Helbling 2006, 553). This difference between a "local" and a "global" population density is crucial. Extensive calculations for the Rhineland in western Germany demonstrate that the population density in the Pre-Roman Iron Age was about 0.9 to 1.8 persons per square kilometre in the Lower Rhine area, which is probably the part of the Rhineland best comparable to the Nordic region. With 2 persons per square kilometre there would have been about 120,000 simultaneous inhabitants in Denmark and Schleswig-Holstein. The question of who had the right to be buried in barrows, and where all the other dead might have been buried, cannot be discussed here (see Kristiansen 2018a, 110). If we suggest a lower population density, the number of people seemingly "missing" would not be that high. Yet probably, not every dead person was buried in a barrow (see e.g. the recently discovered flat graves: Bergerbrant *et al.* 2017).

Concluding our estimates, we suggest that in period II at least every thirtieth man, at most every third man was a sword-bearer. Probably every fifth to tenth man may have had a sword. Interestingly, this is the same proportion as in the barrow group in Flintbek excavated by modern standards. In period III the proportion of sword-bearers is slightly lower.

This means that we have to reconsider the tight relation between swords and so-called chiefs, since it is unlikely that 10-20 % of the adult men could have been chiefs. It seems much more likely that the sword was the weapon of choice and status symbol of free men, which were land-owning farmers and heads of small family groups (Bunnefeld 2016a, 199-200; 2018).

However, social differences surely existed between the sword-bearers, since Nordic full-hilted swords are found in richer graves on average, and there are clear differences in the quality of swords and other objects. The sizes of longhouses (from 100 to 500 square meters) as well as burial mounds are also very diverse. The number of grave goods differs considerably. Most of the 2505 burials in periods II and III have a few grave goods, but no fixed equipment sets (Bunnefeld 2016c, 245-46; Endrigkeit 2014, 44; Holst 2013, 93-97; Steffgen 1997/98, 169-92). The famous division into "ritual chiefs" and "warrior chiefs" cannot be confirmed, since Nordic full-hilted swords were used as weapons to the same degree as octagonal-hilted swords and there are no statistically significant differences in burial assemblages (Bunnefeld 2016a, 191-92).

A proportion of 19 % of the known graves contain gold objects, most of them from Jutland, and these burials are richer than average even without counting the gold. Golden spiral armrings, armrings and bracelets are found mostly in male burials, which are in most cases also equipped with a sword, while bronze armrings had obviously no importance in such burials. The proportion of swords and golden armrings etc. may help us to clarify the social status of the bearers of golden armrings: in period II (only in Schleswig-Holstein and Jutland, golden armrings etc. are missing on the Danish Isles) it is 11 swords to one armring or similar object (in absolute numbers 357 : 32), in period III (in all of Denmark and Schleswig-Holstein) it is 15 : 1 (1040 : 70). If we assume that mostly high-ranking men wore golden armrings, then 7-10 % of the sword-bearers and some other men (and in period III also a few women) hold this social status. Like the man from Toustrup, Denmark, with a golden armring, a flange-hilted sword and a metal vessel in his grave, it can be assumed that every fiftieth to hundredth man was the bearer of a golden armring or a similar piece of jewellery (Bunnefeld 2016c, 250-51).

However, the economic foundations of the Nordic Bronze Age societies and the reasons for their social differences are still under discussion. All metal had to be imported to the north, and came to a large degree from south-central Europe and to some extent from the British Isles (e.g. Bunnefeld 2016a, 164-68; Ling *et al.* 2013; Melheim *et al.* 2018; Nørgaard *et al.* 2021). Nevertheless, we have to reconsider the prevalent focus on long-distance exchange and trade with south-central or south-eastern Europe or even the Mediterranean as basis for the economic and social differences in the north (Bunnefeld 2016c, 254-55; contra e.g. Earle *et al.* 2015; Kristiansen 2018b)[1]. Especially the possible volumes of such interactions are uncertain: in the case of copper – and naturally depending on the estimates

1 The current strontium isotope analyses of sheep wool and the human bone from the female graves at Egtved and Skrydstrup, both in Jutland, as well as the interpretations of their geographic origins in many cases as "not local" may have to be reconsidered in the light of reference data biased by lime fertiliser (Thomsen and Andreasen 2019; but cf. Frei 2019; www.natmus.dk/historisk-viden/forskning/forskningsprojekter/tales-of-bronze-age-women-tales-of-bronze-age-people/nyheder/tre-gode-grunde-egtvedpigen-var-ikke-lokal [8.11.2020]). According to the strontium isotope ratios, the origin of the "Egtved girl" need not be in southern Germany, but could also lie in Sweden (cf. Frei *et al.* 2015, fig. 1). However, the organisation of Early Bronze Age wool textile production indeed seems to have been more complex than simple household production (Bergerbrant 2019).

of population numbers (see above) – probably several hundred kilograms up to a few tons per year were sufficient for the whole of northern Germany and southern Scandinavia (Bunnefeld 2016a, 167-68; Kristiansen and Stig Sørensen 2019, 324). In each case, the amount of metal needed did not require very substantial transport capacities. Several groups of people each year, for instance using river transportation or pack animals, would have been enough. Without doubt, the metal supply was of key importance, and we should also not dismiss long-distance contacts in general, as shown – besides metal imports – most impressively by the presence of blue glass beads from Mesopotamia and Egypt in Denmark (Varberg *et al.* 2015; 2016). Furthermore, some individuals buried in Denmark likely had a different geographical origin (Frei *et al.* 2019). However, exchange at local, regional or interregional levels, e.g. within Scandinavia or across the Baltic Sea by ship, and its control might have been of larger economic and social importance than generally presumed. In addition to all kinds of exchange, and as the real basis for the Nordic Bronze Age economy and inequality, we should take agriculture more into account, perhaps including unequal land ownership as well as the fortunes and misfortunes of farming and cattle-breeding, increased by inheritance over generations (Bunnefeld 2016c, 256-57; cf. Brusgaard 2016). Unfortunately, our knowledge of the potentials of farming and cattle-breeding in the Nordic Bronze Age is still lacking in many regions (as an exception cf. Bech *et al.* 2018).

To conclude, the societies of the Early Nordic Bronze Age were probably built up of families or kin groups of different status which were connected to each other and competing in a decentralised and unstable network without central power (cf. Kristiansen 2007). Within these societies, sword-bearers most likely were free men and owners of farmsteads. Apart from this, they might have been of different social status. Bearers of golden armrings probably were of a significantly higher status than the ordinary sword-bearers and could have been political leaders, chiefs or patrons with a clientele of free or unfree men (Bunnefeld 2016c). It is possible that such persons were in control of a large part of the exchange activities on the Baltic Sea carried out by ship (cf. Ling *et al.* 2018).

Swords in the south-eastern and eastern Baltic region

In contrast to the substantial amounts of Early Bronze Age swords in southern Scandinavia and northern Germany, the situation in the south-eastern and eastern Baltic regions – Pomerania, Warmia and Masuria in Poland, the Kaliningrad area in Russia, Lithuania, Latvia, Estonia and Finland – is completely different. Only about 30 swords and daggers from these regions are published so far. Even if some finds remain unpublished, they will probably not change the emerging picture entirely. Most of the swords date to Montelius period III and some to period II. No swords are known from period I in this region (see Figures 1; 3-4).

From period II we know an octagonal-hilted sword in Panelia in western Finland (Salmo 1955) (Figure 5,1). A Nordic full-hilted dagger was found in a burial cairn in Dragsfjärd (Figure 5,2) and a fragmented plate-hilted sword was discovered in Bromarv Framnäs (Figure 5,5), both of them in south-western Finland near the coast (Meinander 1954, 211 no. 8; Siiriäinen 1984, 51-52). In a cairn at Vanhalinna, a cremation burial with a plate-hilted dagger was excavated, accompanied by a pin (*Rollenkopfnadel*) and a possible bone arrowhead (Edgren 1969) (Figure 5,6). The dagger with its broad grooves on both sides of the plain central ridge and the pin are similar to finds from the northern German Lüneburg cultural group and from the Tumulus Culture of southern Germany (Laux 1971, 71; Piesker 1958, 26 no. 19, 29 no. 68; Torbrügge 1959, 69; Wels-Weyrauch 2015, 101 no. 361). A small full-hilted dagger, with hilt and blade cast in one piece, was found further inland in Luopioinen on an island in a lake (Siiriäinen 1984, 52-53) (Figure 5,7). In Sund on the island of Åland a Nordic sword and a Nordic plate-hilted dagger with a metal pommel were excavated in a cairn together with burnt bones (Meinander 1954, 211 no. 5) (Figure 5,3-4). "Near Raseiniai or Telšiai" in Lithuania a fragmented flange-hilted sword of type Sprockhoff Ia was found (Čivilytė 2009, 619 no. 3035; cf. Sprockhoff

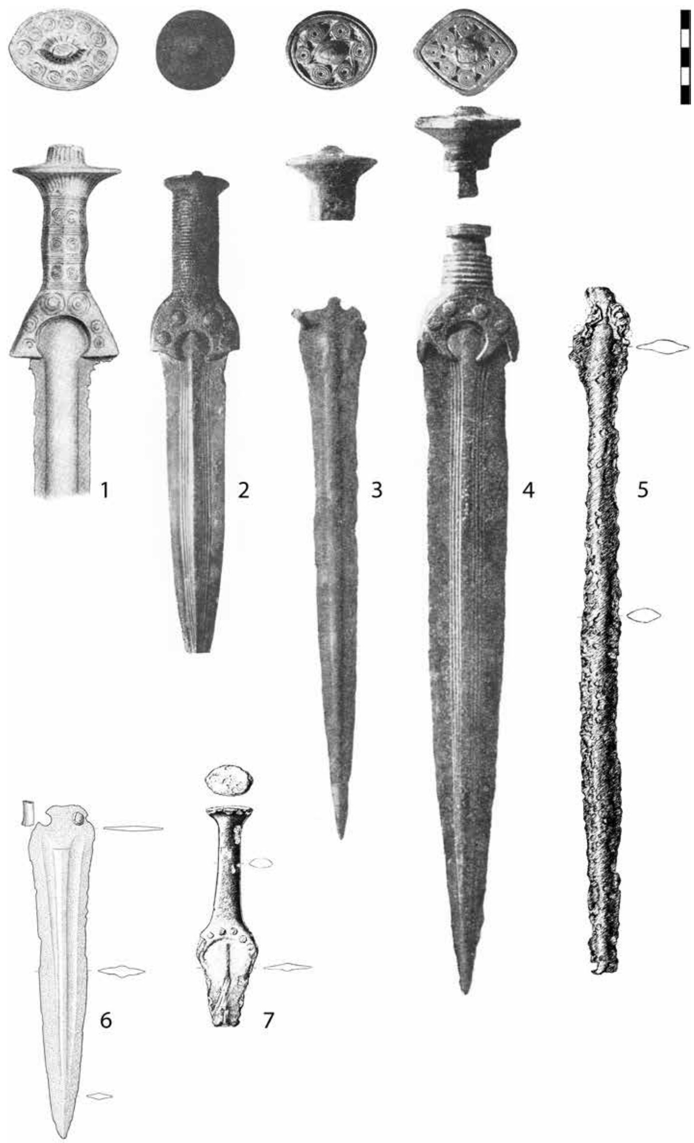


Figure 5. Swords and daggers of period II in Finland: 1 Panelia (Salmo 1955, 72 fig. 2); 2 Dragsfjärd (Meinander 1954, plate 5a); 3-4 Sund (Meinander 1954, plate 3a-b); 5 Bromarv Framnäs (Siiriäinen 1984, 52 fig. 1); 6 Vanhalinna (Edgren 1969, 77 fig. 2a); 7 Luopioinen (Siiriäinen 1984, 53 fig. 2).

1931, 1-8) (Figure 6,8). In northern Pomerania we know a broken dagger with metal hilt, cast in one piece, from a burial mound in Prusiewo (Gedl 1980, 23-24 no. 36) (Figure 6,9) and a plate-hilted dagger with rounded plate and two rivets from a flat grave in Pruszcz Gdanski (Gedl 1980, 54-55 no. 132; Šturms 1936, 84) (Figure 6,10).

Dating to period II or III, there are three Nordic plate-hilted daggers from cairns in Perniö (Figure 6,11), Uskela (Figure 6,12) and Lappi parish (Figure 6,13) in south-western Finland (Meinander 1954, 213 no. 17, 214 no. 23, 217 no. 40). A small plate-hilted dagger is known from Bisztynek in Warmia (Čivilytė 2009, 548 no. 2534; Gedl 1980, 58 no. 152) (Figure 6,14).

In period III we see an increase in swords and daggers in this region. Flange-hilted swords of type Sprockhoff IIa (also known as Naue II, Nenzingen or Reutlingen) were found in Isokyrö in western Finland (Figure 7,21) and in a burial cairn at Kirkkonummi in southern Finland (Meinander 1954, 223 no. 64, 225 no. 73; cf. Sprockhoff 1931, 13-21) (Figure 7,22). In western Lithuania a broken sword blade is known from Bandužiai (Čivilytė 2009, 617 no. 3015). Further inland, “near Raseiniai or Telšiai” two fragmented flange-hilted swords/daggers of type Sprockhoff IIa were discovered (Čivilytė 2009, 619-20 no. 3036-3037) (Figure 7,23-24). In Zaostrowie (formerly known as Rantau) near Kaliningrad, a flange-hilted sword, which

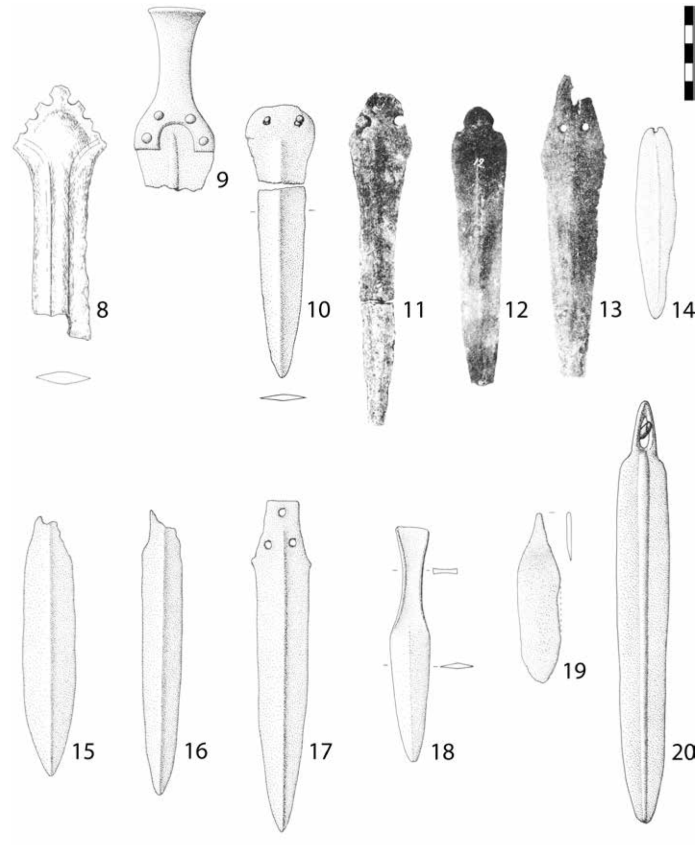


Figure 6. Swords and daggers of periods II and III in the eastern and south-eastern Baltic region:
8 "Near Raseiniai or Telšiai" (Čivilytė 2014b, 53 fig. 10);
9 Prusiewo (Gedl 1980, plate 6,36); 10 Pruszcz Gdanski (Gedl 1980, plate 16,132); 11 Perniö (Meinander 1954, plate 5d); 12 Uskela (Meinander 1954, plate 5c); 13 Lappi parish (Meinander 1954, plate 5b); 14 Bisztynek (Gedl 1980, plate 18,152);
15-16 Malczkowo (Gedl 1980, plate 21,193-194);
17 Pomysk Mały (Gedl 1980, plate 20,184); 18 Radusz (Gedl 1980, plate 20,178);
19 Pustniki (Gedl 1980, plate 19,164); 20 Krawczyki (Gedl 1980, plate 19,167).

is hard to assign to a certain type, was excavated in a burial mound with stone circles, a stone core and probably a wooden coffin oriented south-north (Figure 7,25). The sword was accompanied by a battle axe of Nortycken type, two pins, two armrings and nine glass beads (Čivilytė 2005, 331; 2009, 616 no. 3010; Šturms 1936, 108-09). In Marjinskoje (formerly known as Marscheiten), also near Kaliningrad, a flange-hilted sword of type Sprockhoff IIa was found in a burial mound with at least one stone circle (Figure 7,28). There were also a battle axe of Nortycken type and three armrings (Čivilytė 2005, 331; Stöckmann 2013, 332; Šturms 1936, 106-07). Two flange-hilted swords of type Sprockhoff IIa were discovered in bogs in Gostkowo in Pomerania (Figure 7,26) and Paprotki in Masuria (Čivilytė 2009, 559 no. 2613, 580 no. 2770; Kersten 1958, 91 no. 866, 96 no. 930) (Figure 7,29). In Czaple Nowe in Pomerania a flange-hilted sword of type Sprockhoff IIa was deposited possibly in a hoard, together with a pin (Blajer 1999, 157 no. 19; Čivilytė 2009, 553 no. 2566) (Figure 7,27). Daggers of different kinds were found in burial mounds in Malczkowo (Figure 6,15-16) and Pomysk Mały (Figure 6,17) and in a cremation grave in Radusz in Pomerania (Figure 6,18), the last two finds are similar to daggers from Peschiera del Garda, Italy (Čivilytė 2009, 573 no. 2716-2717, 584 no. 2792, 587 no. 2812; Gedl 1980, 64 no. 178, 65 no. 184, 66 no. 193-194; cf. Müller-Karpe 1959, pl. 107). Other daggers were discovered in a cremation grave in Pustniki in Masuria (Figure 6,19) and under uncertain circumstances in Krawczyki in Warmia (Figure 6,20), in the last instance also with parallels in Peschiera del Garda (Čivilytė 2009, 568 no. 2679, 586 no. 2807; Gedl 1980, 61 no. 164, 62 no. 167; cf. Müller-Karpe 1959, pl. 106).

In sum, in the eastern or south-eastern Baltic region there are mainly plate-hilted and flange-hilted swords and daggers which appear rather simple compared to the finds in southern Scandinavia. Considering the types and their distribution, most of the objects from Finland, Lithuania and Sambia show clear connections to the western Baltic area. Otherwise, the finds from Poland show parallels to daggers from south-central Europe. In period II finds came almost exclusively from near the south-western coast of Finland, while in period III more swords and daggers appeared there and in the south-eastern Baltic region. In Finland and Sambia they were mostly found in cairns or burial mounds. Due to the low number of finds but also to the lack of other relevant data – e.g. estimates on the ratio of archaeological finds compared to the “Bronze Age reality” and estimates of population numbers (cf. Lang 2011) – we cannot develop models of the numbers of simultaneously existing swords and daggers or sword-bearers in the south-eastern and eastern Baltic regions in the same way as was possible for the Nordic Bronze Age (see above).

Besides swords and daggers, some spearheads and – most importantly – axes of different kinds were found in the eastern and south-eastern Baltic region, mostly as single finds (Čivilytė 2005; 2009, map 31-32; Meinander 1954, 15-23; Stöckmann 2013; Stöckmann *et al.* 2021, 38-44, 68-70; Šturms 1936, map 2). Most of them are imported from or at least influenced by the western Baltic region or north-central Europe (Čivilytė 2005, 331-36; 2014a, 234; 2014b, 51, 54-55; Meinander 1954, 15-23; Stöckmann 2013).

Remarkably, the ornamented Nordic palstaves of period II are – like Nordic full-hilted swords and daggers – restricted to the western Baltic region and south-western Finland (Meinander 1954, 11 fig. 2, 212 no. 13, 225 no. 74; cf. Bunnefeld 2016a, map 13). Specific ornamented Early Nordic Bronze Age objects were obviously not distributed in significant numbers in eastern and south-eastern Baltic societies (Meinander 1954, 49; Stöckmann 2013, 336-38; Stöckmann *et al.* 2021; Šturms 1936, 38-44, 60-75).

In this context the statuette of a walking warrior-god from Šernai, Lithuania, probably dating to period II or III, which originally came from the eastern Mediterranean, is noteworthy. Since such statuettes influenced statuettes in southern Scandinavia, we may assume that the find from Šernai found its way to the south-eastern Baltic coast via southern Scandinavia (Čivilytė *et al.* 2015).

However, why are swords and daggers so rarely found in the societies of the eastern and south-eastern Baltic region, especially compared to the Nordic Bronze Age societies? There are several possibilities.

Firstly, some researchers assume a hierarchical social organisation for these regions in the Bronze Age, similar to that proposed by K. Kristiansen (e.g. 2007) for southern Scandinavia (e.g. Lang 2007, 41-48; Merkevičius 2005; 2007). However, there would have had to be an obstacle which prevented the eastern and south-eastern Baltic elites from receiving swords, either by import or by local production. This scenario seems highly unlikely since we do neither see any large differences in wealth or status between or inside communities, nor centres of wealth and power in this region in the Early Bronze Age (Čivilytė 2012; Sidrys and Luchtanas 1999, 181).

Alternatively, there may have been a different martial tradition in the eastern and south-eastern Baltic region, since it lacks stabbing weapons, not only in metal but also in stone. Axes were much more common as weapons, and perhaps as tools (Čivilytė 2005, 333, 336-37). However, this cannot be the only reason since we know few bronze objects in general (Čivilytė 2014a; Paavel 2017; Sidrys and Luchtanas 1999, 169-73).

If we do not assume a society that was rich in metal weapons and ornaments, but simply did not deposit them in hoards or in graves[2], we need to consider a different social organisation in the eastern and south-eastern Baltic region. Here, swords obviously did not play as important a role as weapons and status symbols as they did in the Nordic Bronze Age. Taking into account the largely missing evidence for “chiefs” and social stratification as well as other ornamented weapons and graves containing weapons[3], the societies in this region were not based on a warrior ethos and probably less ranked (Čivilytė 2005; Sidrys

2 Of course we know a large variety in depositional practices across Bronze Age Europe. Yet taking into account the numbers of swords from other regions with different depositional practices – including regions where swords are not found in burials (Harding 2006) – it seems more likely that swords and other metal weapons simply did not play an important role in the eastern and south-eastern Baltic regions.

3 A more detailed investigation of this question would require the collection of all known graves from the area and the statistical comparison of their grave goods assemblages, which is beyond the scope of this article.

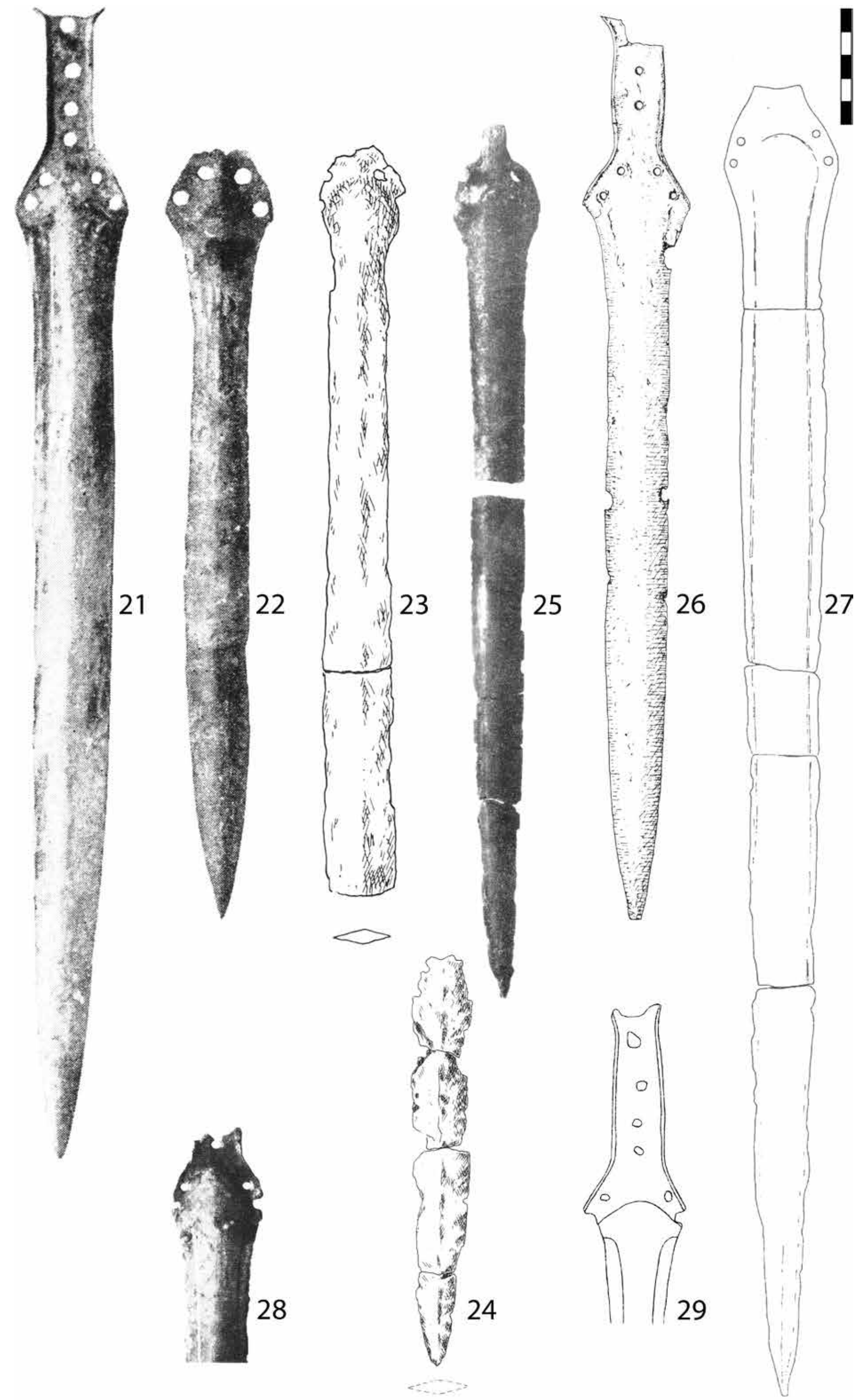


Figure 7. Swords and daggers of period III in the eastern and south-eastern Baltic region: 21 Isokyrö (Meinander 1954, plate 4a); 22 Kirkkonummi (Meinander 1954, plate 4b); 23-24 "Near Raseiniai or Telšiai" (Čivilytė 2014b, 53 fig. 10); 25 Zaostrowie (formerly Rantau) (Šturms 1936, plate 16); 26 Gostkowo (Kersten 1958, plate 104,930); 27 Czaple Nowe (Blajer 1999, plate 19,1); 28 Marjinskoje (formerly Marscheiten) (Šturms 1936, plate 19k); 29 Paprotki (Kersten 1958, plate 98,866).

and Luchtanas 1999, 174, 181-82; Vasks 2007, 36). Metal seems to have had no great impact on these societies and was important rather as a curiosity and gift to the gods. There is no certain evidence for an Early Bronze Age tradition in metal crafting in the south-eastern Baltic region (Čivilytė 2014a, 238-39; Podėnas and Čivilytė 2019, 171-72; contra Girininkas 2012, 39-40). Remarkably, in the eastern Baltic region most societies still depended on hunting and foraging and not or at least not completely on agriculture and husbandry for subsistence (e.g. Čivilytė 2014a, 233; Girininkas 2012; Grikpėdis and Motuzaite Matuzeviciute 2018). This factor cannot be overestimated in terms of social organisation.

However, why were some scattered swords and daggers found in regions like Sambia and also western Lithuania? As often suggested, amber must have been the most important reason. In the coastal areas rich in natural amber sources we know 24 times more Early Bronze Age metal objects than along coastlines with little or no drift amber and even 43 times more than in inland regions (Czebreszuk 2007; Sidrys and Luchtanas 1999, 171-72, 181). Amber was likely exchanged for bronze objects, including weapons, with societies in Pomerania, north-eastern Germany and Denmark. Direct long-distance contacts from the south-eastern Baltic region to the south or south-east are almost undetectable (Sidrys and Luchtanas 1999, 171-73). We can thus assume that particular persons or groups, most probably the high-ranking sword-bearers from the western Baltic, organised expeditions by ship, controlled the exchange with the south-eastern Baltic region and acted as middlemen for amber to central and southern Europe and to the Mediterranean, as well as for metal to the south-eastern Baltic coasts. The modes of exchange are open to discussion and it seems possible that there was forced alongside consensual exchange (cf. Horn 2018; Ling *et al.* 2018). However, the people of the south-eastern Baltic apparently received comparatively few metal objects in exchange for the amber. This might be due to the frequently observed fact that it is mainly the middlemen who benefit from exchange and not necessarily the producers (cf. Earle *et al.* 2015; Risch 2016, 43). It is likely that some Nordic individuals settled down in these regions, provided the necessary infrastructure for the exchange and had some influence on the local culture, but the archaeological finds – only few artefacts and nearly no jewellery from the Nordic Bronze Age – do not support large numbers of persons or even whole groups from the western Baltic settling down here (cf. Stöckmann 2013, 338-39; contra Šturms 1936, 129-47).

Apart from some burial finds mostly near the coast, these contacts apparently did not have much impact on the societies in Sambia, western Lithuania or even other parts of the south-eastern Baltic. Most of the metal weapons in this region were not found in graves of individuals, but as single finds, which were probably intentionally deposited. Thus the metal objects were treated in a similar way as for instance most stone axes, both contemporary examples and those in the preceding Neolithic (Čivilytė 2005, 337; Paavel 2017, 27; Vasks 2007, 33). Metal therefore seems to have been incorporated into the local social and ritual customs and did not change these societies immediately. They rather seem to have remained more or less egalitarian, and perhaps we can even note an example for resistance against foreign social norms and structures here (cf. Anfinset 2012).

The situation in south-western Finland is different since there are no natural amber sources. Nevertheless, in the coastal area we know some swords and daggers as well as other weapons mostly from southern Scandinavia found in cairns of period II and III or as single finds. For many decades it has been discussed whether this is due to a large number of settlers or rather to influences from the west (e.g. Lavento 2012; Meinander 1954; Tallgren 1931). At the same time we can recognise some eastern influences and finds from the Sejma-Turbino phenomenon, distributed widely in northern Eurasia, in Finland (Lavento 2012, 164). Connections to Sweden cannot be denied in light of more than 10,000 Bronze Age cairns near the western and south-western coasts and a little way inland, containing some metal finds of Nordic or central European origin, as well as rectangular houses similar to those in Sweden and the golden plate from Harjavalta

(Lavento 2012, 157-58; cf. Asplund 2008, 67-92). Particularly because the cairns in Finland show the same construction details as those in eastern Sweden and on Gotland, where some of them can be dated already to period I, we can assume intensive, long-lasting connections and at least some immigration from the western shores (cf. Lavento 2012, 162-63; Meinander 1954, 118).

Summary

This paper has discussed the reasons why swords have been buried in large numbers in Nordic Bronze Age societies of the western Baltic region, while only very few swords and daggers have been found in the eastern and especially in the south-eastern Baltic region. The main reason probably is a different social structure, which in the latter area was much more egalitarian and did not know significant hereditary status differences and competition about rank. The eastern and south-eastern Baltic societies were often not even completely dependent on farming and husbandry, and did not have a local metal production. In contrast, in the Early Nordic Bronze Age many kin groups, with numerous sword-bearers playing an important role, competed for status and wealth in a decentralised and unstable system. In this context, high-ranking individuals from this region, probably bearers of swords and golden armrings, organised maritime exchange – peaceful or not – with the south-eastern Baltic coastal areas, which were rich in natural amber, and distributed this valuable resource to southern Scandinavia and then further to the south. Most likely, some people from the west settled in Sambia, but did not have an immediate far-reaching impact on the local communities. Thus, the few metal weapons from the western Baltic which reached its south-eastern shores were often deposited as single finds or in hoards, much like stone axes had been since the Neolithic. Between eastern Sweden, Gotland and south-western Finland even closer connections and migrations existed. However, in this case amber was not the stimulus.

Afterwards, during the Late Bronze Age, Nordic Bronze Age societies intensified their contacts with the eastern and south-eastern Baltic, increasing their impact on the local societies and their social and economic structures (cf. Podėnas und Čivilytė 2019, 172-89). However, in order to understand these processes better and to conduct more thorough comparisons between the societies along the east Baltic shore and the communities in southern Scandinavia or other regions, we still need much more published data on the Bronze Age in the eastern and south-eastern Baltic (cf. Sperling 2016a; 2016b).

Bibliography

Acsádi, G. and Nemeskéri, J. 1970. *History of human life span and mortality*. Budapest: Akadémiai Kiadó.

Aner, E. and Kersten, K. 1973-1995. *Die Funde der älteren Bronzezeit des nordischen Kreises in Dänemark, Schleswig-Holstein und Niedersachsen*. Neumünster: Wachholtz.

Aner, E., Kersten, K. and Willroth, K.-H. 2001-2017. *Die Funde der älteren Bronzezeit des nordischen Kreises in Dänemark, Schleswig-Holstein und Niedersachsen*. Neumünster: Wachholtz.

Anfinset, N. 2012. Social response or resistance to the introduction of metal? Western Norway at the edge of the "globalized" world. In N. Anfinset and M. Wrigglesworth (eds), *Local societies in Bronze Age northern Europe*, 232-50. London, New York: Routledge.

Asplund, H. 2008. *Kymittæ. Sites, centrality and long-term settlement change in the Kemiönsaari region in SW Finland*. Turku: University of Turku.

Bech, J.-H., Eriksen, B.V. and Kristiansen, K. 2018. *Bronze Age settlement and land-use in Thy, Northwest Denmark*. Aarhus: Jutland Archaeological Society.

Bergerbrant, S. 2019. Wool textiles in the Early Nordic Bronze Age: local or traded? In S. Sabatini and S. Bergerbrant (eds), *The textile revolution in Bronze Age Europe. Production, specialisation, consumption*, 255-73. Cambridge: Cambridge University Press.

Bergerbrant, S., Kristiansen, K., Allentoft, M.E., Frei, K.M., Price, T.D., Sjögren, K.-G. and Tornberg, A. 2017. Identifying commoners in the Early Bronze Age: burials outside barrows. In S. Bergerbrant and A. Wessman (eds), *New perspectives on the Bronze Age. Proceedings of the 13th Nordic Bronze Age symposium held in Gothenburg 9th to 13th June 2015*, 37-64. Oxford: Archaeopress.

Blajer, W. 1999. *Skarby ze starszej i środkowej epoki brązu na ziemiach polskich*. Kraków: Polska Akademia Nauk.

Brusgaard, N. 2016. "Wives for cattle"? Bridewealth in the Bronze Age. In A. Müller and R. Jansen (eds), *Metaaltijden 3. Bijdragen in de studie van de metaaltijden*, 9-19. Leiden: Sidestone Press.

Bunnefeld, J.-H. 2013. Häuptlinge oder freie Bauern? – Versuch einer quantitativen Auswertung bronzezeitlicher Schwerter der Perioden II und III in Dänemark und Schleswig-Holstein. In I. Heske, H.-J. Nüsse and J. Schneeweiß (eds), *„Landschaft, Besiedlung und Siedlung". Archäologische Studien im nordeuropäischen Kontext. Festschrift für Karl-Heinz Willroth zu seinem 65. Geburtstag*, 417-26. Neumünster: Wachholtz.

Bunnefeld, J.-H. 2016a. *Älterbronzezeitliche Vollgriffschwerter in Dänemark und Schleswig-Holstein. Studien zu Form, Verzierung, Technik und Funktion.* Kiel, Mainz: Wachholtz.

Bunnefeld, J.-H. 2016b. Crafting swords. The emergence and production of full-hilted swords in the Early Nordic Bronze Age. *Praehistorische Zeitschrift* 91, 379-430.

Bunnefeld, J.-H. 2016c. Reiche Bauern, arme Bauern – Zur sozialen Differenzierung in der älteren nordischen Bronzezeit. In H. Meller, H.P. Hahn, R. Jung and R. Risch (eds), *Arm und Reich – Zur Ressourcenverteilung in prähistorischen Gesellschaften. 8. Mitteldeutscher Archäologentag vom 22. bis 24. Oktober 2015 in Halle (Saale)*, 243-72. Halle (Saale): Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt, Landesmuseum für Vorgeschichte.

Bunnefeld, J.-H. 2018. The chief and his sword? Some thoughts on the swordbearer's rank in the Early Nordic Bronze Age. In C. Horn and K. Kristiansen (eds), *Warfare in Bronze Age society*, 198-212. Cambridge: Cambridge University Press.

Čivilytė, A. 2005. Zur Seltenheit metallener Waffen der Bronzezeit im Ostbaltikum. *Archäologisches Korrespondenzblatt* 35, 329-44.

Čivilytė, A. 2009. *Wahl der Waffen. Studien zur Deutung der bronzezeitlichen Waffendeponierungen im nördlichen Mitteleuropa*. Bonn: Rudolf Habelt.

Čivilytė, A. 2012. In search of a theoretical assessment of Bronze Age society in the Baltic countries. *Archaeologia Baltica* 18, 14-27.

Čivilytė, A. 2014a. *Žmogus ir metalas priešistorėje: žvilgančios bronzos trauka.* Vilnius: Piemedžio leidykla.

Čivilytė, A. 2014b. Die Bronzezeit in Litauen. In M. Wemhoff (ed.), *Die vor- und frühgeschichtlichen Funde aus Litauen*, 47-63. Berlin: Staatliche Museen zu Berlin.

Čivilytė, A., Duberow, E. and Pernicka, E. 2015. His left foot: a new investigation of the oriental Bronze Age figurine from Šernai (Western Lithuania) and the question of its authenticity. *Germania* 93, 97-120.

Czebreszuk, J. 2007. The role of the Sambian centre in creating cultural meaning of amber in the third and second millennium BC. The outline of major problems. In J. Baron and I. Lasak (eds), *Long distance trade in the Bronze Age and Early Iron Age. Conference Materials Wrocław, 19-20th April 2005*, 179-93. Wrocław: Wydawnictwo Uniwersytetu Wrocławskiego.

Dąbrowski, J. 2004. *Ältere Bronzezeit in Polen.* Warszawa: Wydawnictwo Instytutu Archeologii i Etnologii Polskiej Akademii Nauk.

Earle, T., Ling, J., Uhnér, C., Stos-Gale, Z. and Melheim, L. 2015. The political economy and metal trade in Bronze Age Europe: understanding regional variability in terms of comparative advantages and articulations. *European Journal of Archaeology* 18, 633-57.

Edgren, T. 1969. Kotokaillo in Lieto. Ein Grabfund der älteren Bronzezeit im Dorf Vanhalinna. *Suomen Museo* 76, 74-84.

Endrigkeit, A. 2014. *Älter- und mittelbronzezeitliche Bestattungen zwischen Nordischem Kreis und süddeutscher Hügelgräberkultur. Gesellschaftsstrukturen und kulturhistorische Beziehungen.* Bonn: Rudolf Habelt.
Engedal, Ø. 2010. *The Bronze Age of northwestern Scandinavia*. Bergen: University of Bergen.
Frei, K.M. 2019. Wool production and the evidence of strontium isotope analyses. In S. Sabatini and S. Bergerbrant (eds), *The textile revolution in Bronze Age Europe. Production, specialisation, consumption*, 239-54. Cambridge: Cambridge University Press.
Frei, K. M. [+ 9 others] and Frei, R. 2015. Tracing the dynamic life story of a Bronze Age female. *Scientific Reports* 5:10431. DOI: 0.1038/srep10431.
Frei, K.M. [+ 9 others] and Kristiansen, K. 2019. Mapping human mobility during the third and second millennia BC in present-day Denmark. *PLoS ONE* 14 e0219850. DOI: 10.1371/journal.pone.0219850.
Gedl, M. 1980. *Die Dolche und Stabdolche in Polen*. München: C. H. Beck.
Girininkas, A. 2012. The structure of the economy and society in the Early Bronze Age in Lithuania. *Archaeologia Baltica* 18, 28-42.
Grikpėdis, M. and Motuzaite Matuzeviciute, G. 2018. A review of the earliest evidence of agriculture in Lithuania and the earliest direct AMS date on cereal. *European Journal of Archaeology* 21, 264-79.
Harding, A. 2006. What does the context of deposition and frequency of Bronze Age weaponry tell us about the function of weapons? In T. Otto, H. Thrane and H. Vandkilde (eds), *Warfare and society. Archaeological and social anthropological perspectives*, 505-13. Aarhus: Aarhus University Press.
Helbling, J. 2006. *Tribale Kriege*. *Konflikte in Gesellschaften ohne Zentralgewalt.* Frankfurt a. M.: Campus.
Holst, M.K. 2013. South Scandinavian Early Bronze Age barrows – a survey. In M.K. Holst and M. Rasmussen (eds), *Skelhøj and the Bronze Age barrows of southern Scandinavia 1. The Bronze Age barrow tradition and the excavation of Skelhøj*, 27-128. Aarhus: Jutland Archaeological Society.
Horn, C. 2018. Warfare vs. exchange? Thoughts on an integrative approach. In C. Horn and K. Kristiansen (eds), *Warfare in Bronze Age society*, 47-60. Cambridge: Cambridge University Press.
Jensen, J. 2002. *Danmarks Oldtid. Bronzealder 2000-500 f. Kr.* Copenhagen: Gyldendal.
Kersten, K. 1936. *Zur älteren nordischen Bronzezeit*. Neumünster: Wachholtz.
Kersten, K. 1958. *Die Funde der älteren Bronzezeit in Pommern*. Neumünster: Wachholtz.
Kristiansen, K. 1985. Early Bronze Age burial finds. In K. Kristiansen (ed.), *Archaeological formation processes. The representativity of archaeological remains from Danish prehistory*, 116-28. Copenhagen: Nationalmuseet.
Kristiansen, K. 2007. The rules of the game. Decentralised complexity and power structures. In S. Kohring and S. Wynne-Jones (eds), *Socialising complexity. Structure, interaction and power in archaeological discourse*, 60-75. Oxford: Oxbow Books.
Kristiansen, K. 2018a. The rise and fall of Bronze Age societies in Thy, northwest Jutland. In J.-H. Bech, B.V. Eriksen and K. Kristiansen (eds), *Bronze Age settlement and land-use in Thy, northwest Denmark*, 107-32. Aarhus: Jutland Archaeological Society.
Kristiansen, K. 2018b. The rise of Bronze Age peripheries and the expansion of international trade 1950-1100 BC. In K. Kristiansen, T. Lindkvist and J. Myrdal (eds), *Trade and civilisation. Economic networks and cultural ties, from prehistory to the early modern era*, 87-112. Cambridge: Cambridge University Press.
Kristiansen, K. and Stig Sørensen, M.L. 2019. Wool in the Bronze Age: concluding reflections. In S. Sabatini and S. Bergerbrant (eds), *The textile revolution in Bronze Age Europe. Production, specialisation, consumption*, 317-32. Cambridge: Cambridge University Press.
Lang, V. 2007. *The Bronze and Early Iron Ages in Estonia*. Tartu: Tartu University Press.
Lang, V. 2011. Traceless death. Missing burials in Bronze and Iron Age Estonia. *Estonian Journal of Archaeology* 15/2, 109-29.
Laux, F. 1971. *Die Bronzezeit in der Lüneburger Heide*. Hildesheim: Lax.

Lavento, M. 2012. Local centres in the periphery: the Late Neolithic, Bronze Age and Early Metal Age in Finland. In N. Anfinset and M. Wrigglesworth (eds), *Local societies in Bronze Age northern Europe*, 148-68. London, New York: Routledge.
Ling, J., Hjärthner-Holdar, E., Grandin, L., Billström, K. and Persson, P.-O. 2013. Moving metals or indigenous mining? Provenancing Scandinavian Bronze Age artefacts by lead isotopes and trace elements. *Journal of Archaeological Science* 40, 291-304.
Ling, J., Earle, T. and Kristiansen, K. 2018. Maritime mode of production. Raiding and trading in seafaring chiefdoms. *Current Anthropology* 59, 488-524.
Meinander, C.F. 1954. Die Bronzezeit in Finnland. *Finska fornminnesföreningens tidskrift* 54, 5-242.
Melheim, L. [+ 9 others] and Kristiansen, K. 2018. Moving metals III: possible origins for copper in Bronze Age Denmark based on lead isotopes and geochemistry. *Journal of Archaeological Science* 96, 85-105.
Merkevičius, A. 2005. Material culture and the east Baltic Bronze Age society. In V. Lang (ed.), *Culture and material culture. Papers from the first theoretical seminar of the Baltic archaeologists (BASE) held at the University of Tartu, Estonia, October 17th-19th, 2003*, 39-52. Tartu, Riga, Vilnius: University of Tartu, University of Riga, University of Vilnius.
Merkevičius, A. 2007. Material culture and the Bronze Age in Lithuania. In A. Merkevičius (ed.), *Colours of archaeology. Material culture and the society. Papers from the second theoretical seminar of the Baltic archaeologists (BASE) held at the University of Vilnius, Lithuania, October 21st-22nd, 2005*, 93-107. Vilnius, Helsinki, Riga, Tartu: University of Vilnius, University of Helsinki, University of Riga, University of Tartu.
Müller-Karpe, H. 1959. *Beiträge zur Chronologie der Urnenfelderzeit nördlich und südlich der Alpen*. Berlin: de Gruyter.
Nørgaard, H.W. 2018. *Bronze Age metalwork. Techniques and traditions in the Nordic Bronze Age 1500-1100 BC.* Oxford: Archaeopress.
Nørgaard, H.W., Pernicka, E. and Vandkilde, H. 2021. Shifting networks and mixing metals: changing metal trade routes to Scandinavia correlate with Neolithic and Bronze Age transformations. *PLoS ONE*, 16:e0252376.
Oldeberg, A. 1974. *Die ältere Metallzeit in Schweden I*. Stockholm: Almqvist & Wiksell.
Ottenjann, H. 1969. *Die nordischen Vollgriffschwerter der älteren und mittleren Bronzezeit*. Berlin: de Gruyter.
Paavel, K. 2017. Pattern or random? Contextualising Estonian Bronze Age bronze stray finds on the landscape. *Archaeologia Baltica* 24, 26-42.
Piesker, H. 1958. *Untersuchungen zur älteren Lüneburgischen Bronzezeit*. Lüneburg: Nordland.
Podėnas, V. and Čivilytė, A. 2019. Bronze casting and communication in the southeastern Baltic Bronze Age. *Lietuvos Archeologija* 45, 169-99.
Poulsen, J. 1983. Landwirtschaft und Bevölkerungsverhältnisse in der dänischen Bronzezeit. *Zeitschrift für Archäologie* 17, 145-58.
Risch, R. 2016. How did wealth turn into surplus profit? From affluence to "scarcity" in prehistoric economies. In H. Meller, H.P. Hahn, R. Jung and R. Risch (eds), *Arm und Reich – Zur Ressourcenverteilung in prähistorischen Gesellschaften. 8. Mitteldeutscher Archäologentag vom 22. bis 24. Oktober 2015 in Halle (Saale)*, 33-48. Halle (Saale): Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt, Landesmuseum für Vorgeschichte.
Salmo, H. 1955. Ein süddeutsches Bronzeschwert aus Finnland. *Suomen Museo* 62, 71-76.
Sidrys, R.V. and Luchtanas, A. 1999. Shining axes, spiral pins. Early metal consumption in the east Baltic. *Acta Archaeologica* 70, 165-84.
Siiriäinen, A. 1984. Bromarv and Luopioinen: two Early Bronze Age finds from Finland. *Fennoscandia Archaeologica* 1, 51-57.
Sperling, U. 2016a. Visitors to the other side. Some reflections on the Baltic Sea as a frontier and contact zone in late prehistory. In A. Kannike and M. Tasa (eds), *The dynamics of cultural borders*, 106-32. Tartu: University of Tartu Press.

Sperling, U. 2016b. Bronze Age connections across the Baltic Sea. Discussing metalwork as source of maritime contacts in prehistory. In H.B. Bjerck, H.M. Breivik, S.E. Fretheim, E.L. Piana, A.M. Tivoli, A.F.J. Zangrando and B. Skar (eds), *Marine ventures – archaeological perspectives on human-sea relations*, 399-416. Sheffield: Equinox Publishing.
Sprockhoff, E. 1931. *Die germanischen Griffzungenschwerter*. Berlin, Leipzig: de Gruyter.
Steffgen, U. 1997/98. Die Gräber der frühen und älteren Bronzezeit in Schleswig-Holstein und Dänemark. Studien zu Grabbau und Grabeinrichtung. *Offa* 54/55, 97-219.
Stöckmann, K. 2013. Die älter- und mittelbronzezeitlichen Metallfunde im Gebiet des ehemaligen Ostpreußens. In I. Heske, H.-J. Nüsse and J. Schneeweiß (eds), *„Landschaft, Besiedlung und Siedlung". Archäologische Studien im nordeuropäischen Kontext. Festschrift für Karl-Heinz Willroth zu seinem 65. Geburtstag*, 331-41. Neumünster: Wachholtz.
Stöckmann, K., Heske, I. and Jahn, C. 2021. *Bronzezeitliche Metallfunde aus Ostpreußen. Forschungs- und Überlieferungsgeschichte, Typologie und Chronologie unter besonderer Berücksichtigung der Tüllenbeile. Berliner Beiträge zur Vor- und Frühgeschichte 26*. Berlin: Staatliche Museen zu Berlin – Preußischer Kulturbesitz.
Šturms, E. 1936. *Die ältere Bronzezeit im Ostbaltikum*. Berlin, Leipzig: de Gruyter.
Tallgren, A.M. 1931. *Suomen muinaisuus*. Porvoo: Söderström.
Thomsen, E. and Andreasen, R. 2019. Agricultural lime disturbs natural strontium isotope variations: Implications for provenance and migration studies. *Science Advances* 5, eaav8083. DOI: 10.1126/sciadv.aav8083.
Thrane, H. 2006. Swords and other weapons in the Nordic Bronze Age: technology, treatment, and contexts. In T. Otto, H. Thrane and H. Vandkilde (eds), *Warfare and society. Archaeological and social anthropological perspectives*, 491-504. Aarhus: Aarhus University Press.
Torbrügge, W. 1959. *Die Bronzezeit in der Oberpfalz*. Kallmünz/Opf.: Lassleben.
Vandkilde, H. 1996. *From stone to bronze. The metalwork of the Late Neolithic and Earliest Bronze Age in Denmark*. Aarhus: Jutland Archaeological Society.
Varberg, J., Gratuze, B. and Kaul, F. 2015. Between Egypt, Mesopotamia and Scandinavia: Late Bronze Age glass beads found in Denmark. *Journal of Archaeological Science* 54, 168-81.
Varberg, J., Gratuze, B., Kaul, F., Haslund Hansen, A., Rotea, M. and Wittenberger, M. 2016. Mesopotamian glass from Late Bronze Age Egypt, Romania, Germany, and Denmark. *Journal of Archaeological Science* 74, 184-94.
Vasks, A. 2007. Weapons and warfare during the Bronze Age in the area of present-day Latvia. *Archaeologia Baltica* 8, 32-38.
Wels-Weyrauch, U. 2015. *Die Dolche in Bayern. Auf der Grundlage einer Materialaufnahme von Eugen Friedrich Mayer.* Stuttgart: Franz Steiner.
Wendt, K.P., Hilpert, J. and Zimmermann, A. 2010. Landschaftsarchäologie III. Untersuchungen zur Bevölkerungsdichte der vorrömischen Eisenzeit, der Merowingerzeit und der späten vorindustriellen Neuzeit an Mittel- und Niederrhein. *Bericht der Römisch-Germanischen Kommission* 91, 217-338.
Willroth, K.-H. 1992. *Untersuchungen zur Besiedlungsgeschichte der Landschaften Angeln und Schwansen von der älteren Bronzezeit bis zum frühen Mittelalter. Eine Studie zur Chronologie, Chorologie und Siedlungskunde*. Neumünster: Wachholtz.
Wüstemann, H. 2004. *Die Schwerter in Ostdeutschland*. Stuttgart: Franz Steiner.

The arrowheads of the Tollense Valley

From use-wear analysis to the sequence of violence

Hella Harten-Buga, Birte Meller, Thomas Terberger, Frank Nikulka, Detlef Jantzen, Jörg Orschiedt

Introduction

During the first half of the thirteenth century BCE the Tollense Valley in Mecklenburg Western-Pomerania, in the Baltic region of north-east Germany (see Jantzen and Lidke in this volume), became an arena of warlike hostilities that many predominantly young adult men fell victim to. Since 2007, extensive archaeological research has revealed thousands of skeletal (mostly human) remains, tools, jewellery and weapons along the river banks. Over the last few years the results of the excavations and the scientific analyses have been published by an interdisciplinary group of international researchers. Among the different weapons recovered from the Tollense Valley site were several lithic and bronze arrowheads found intermingled with human remains; some points were even still embedded in the bones (e.g. Flohr *et al.* 2015). In addition, a number of lesions apparent on many of the human remains have been considered as being caused by ballistic weapons (e.g. Brinker *et al.* 2016).

Several of the lithic arrowheads show breakage and traces of organic matter at the base (Terberger 2014). Some of these projectiles are currently subject to an in-depth residue and use-wear analysis at the University of Hamburg in close cooperation with the DFG-funded project *"Palaeomechanical investigations concerning the coherence of injury patterns and weapon efficiency on the basis of Bronze Age human bones and weapons"* (grant no. 332621647), based at the Universities of Hamburg and Berlin and the State Authority for Culture and Preservation of Monuments, Mecklenburg-Western Pomerania. The aim of the present study is to generate additional data about possible mechanical impact marks and traces of contact with materials such as human or animal bone and tissue on the arrowheads. The trace evidence, generated with digital microscopy and the pre-processing of high resolution computer tomography, is based on the identification of e.g. abrasion, micro-polish, gloss and striations on the weapon surfaces, as well as on the analysis of the chemical composition of the residues. This paper can only highlight a few aspects and preliminary results of our ongoing study.

Material

The assemblage of around 60 arrowheads discovered at different sites in the Tollense Valley consists of more than 50 bronze and 10 flint points (Terberger *et al.* 2018, 106). Several projectiles were discovered in the same layers as the human remains and therefore can be associated with the armed conflict. Based on the close association with the skeletal remains, for some arrowheads it can be assumed that they could originally have been deposited within body tissues of those killed in action (Lidke *et al.* 2019, 38). In addition, dated wood fragments persevered in the sockets of arrowheads found outside the bone-rich layers suggest a direct connection to the violent events (Terberger *et al.* 2018).

Seven flint projectiles were selected for our initial use-wear analysis, chosen according to the circumstances of deposition and in order to include a representative variation of

In D. Hofmann, F. Nikulka and R. Schumann (eds) 2022. *The Baltic in the Bronze Age. Regional patterns, interactions and boundaries*, Leiden: Sidestone Press, pp. 91-102.

Ref. No	Inv. No. ALM	Cat. No.	Site	Length (mm)	Width (mm)	Weight (g)
1	ALM 2012/991,6	2	Weltzin 32	18	12	0.62
2	ALM 2008/462,217	3	Weltzin 32	25	12	1.27
3	ALM 2010/1093,1068	4	Weltzin 20	31	14	1.47
4	ALM2011/1145,668	6	Weltzin 20	31	15	1.56
5	ALM2011/1145,720	7	Weltzin 20	27	16	1.15
6	ALM2012/855,257	8	Weltzin 20	36	15	1.63
7	ALM2012/855,1033	9	Weltzin 20	41	19	3.42

Table 1. Overview of the seven flint projectiles from the Tollense Valley selected for the initial use-wear analysis.
ALM = Archäologisches Landesmuseum, Collections of the State Authority for Culture and Preservation of Monuments, Mecklenburg-Western Pomerania, Schwerin.

size, weight and overall morphology (Table 1). All flint arrowheads are triangular, five are barbed with basal concavity and one shows a contracting stem. Three points have excurvated edges and four straight edges. They vary in length between 18 mm (0.71 in) and 41 mm (1.61 in) and in weight between 0.62 g (9.57 gr) and 3.42 g (52.78 gr).

Methods

One of the research questions in the Tollense Valley/Palaeomechanics-Project involves the analysis of wear traces on the projectiles found at the site to develop criteria for identifying use-wear traces and (maybe even) reconstructing the course of action on a forensic basis. Therefore the projectiles were systematically scanned for traces in a High Power Approach by using high-microscopy (Digital microscope Keyence VHX-2000 and VHX-6000) and all evidence of use documented in writing and image. This also includes a detailed 3D-analysis deploying high-resolution Xtreme-CT scans[1] and white-light photogrammetry[2]. Based on the 3D-models we aim to generate detailed data on the overall morphology, the cross-sections and possible micro-fractures.

Microwear analysis as an optical analysis aims to describe traces and indicators of the use of an artefact (Odell 2004, 136), to reconstruct activities carried out with the item and add a functional component to the interpretation of the artefact (Grace 1996). Besides use traces, microwear also includes traces of production and post-depositional changes due to modern handling, such as GTM-retouch[3], which have to be distinguished from natural influences like bioturbation. The traces appear as (micro-) polish, striations, hafting traces and residues (Pawlik 2001). The polish usually becomes visible at a high resolution, except for sickle gloss, which can already be macroscopically visible, and is so characteristic in appearance that it is often identifiable at the outset of the investigation (Van Gijn 2010, 60). Striations are characterised by a series of punctiform, parallel linear marks which are present in a small area, mostly connected to polished areas, and have not penetrated deeply into the surface. The striations clearly indicate the direction of a particular movement (d'Errico 1985).

As in an analysis of macrowear, microwear also focuses on the identification and classification of (impact) fractures, while abrasion and attributes such as distribution, quantity and classification can indicate the sources likely to be responsible for their origin and formation. In our study we can expect mainly impact fractures due to shot entry (Lee and Sano 2019) or hafting traces (Rots 2016; Rots and Plisson 2014). Last but not least are residues, which can already be visible macroscopically but in most cases are only revealed by microscopy. Residues are connected to other components used with and present on the artefact. For example, if a point was used as a projectile and hit a living target, it is possible to detect traces of collagen or tissues.

1 Xtreme-CT-Scans by the Institute of Osteology und Biomechanics, University Medical Center Hamburg-Eppendorf by Dr.-Ing. M. Hahn und F. Schmidt M.Sc.
2 University of Hamburg, open science project 3D & audiovisual research data; Scans by F. Schwenn MA, https://www.hamburg.de/bwfg/openscience/12102172/3dav/
3 GTM-retouch refers to traces caused by **G**rabung (excavation), **T**ransport and handling at a **M**useum.

Figure 1. Overview of traces located on projectile 2012/991,6 (© H. Harten-Buga and B. Meller (HHBM) 2018, Keyence 2000).

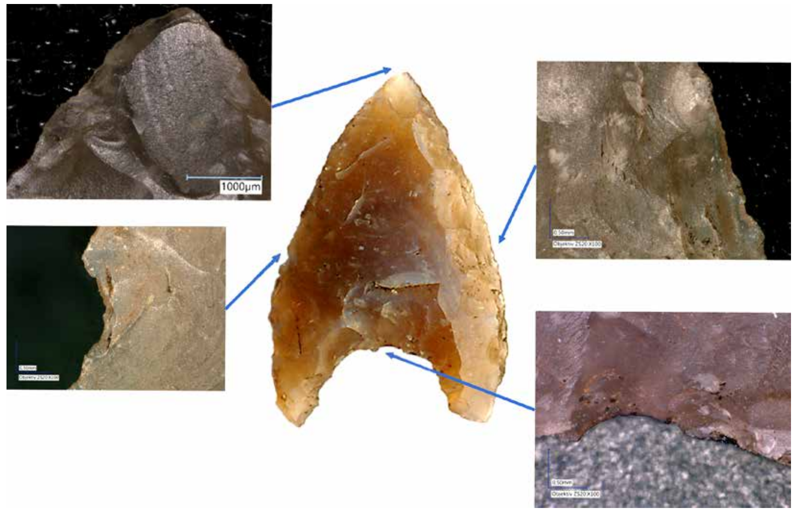


Figure 2. Overview of traces located on projectile 2012/855,1033 (© H. Harten-Buga and B. Meller (HHBM) 2018, Keyence 2000).

Despite extensive investigations in the field of use-wear analysis, it should be pointed out that the analysis of wear can only allow an interpretation of the general contact material and the movement sequence into which the tool was integrated (Little and Van Gjin 2017, 3; Van Gijn 1990). Therefore, usually only suggestions regarding specific actions and related end products can be offered.

Of course, in this case the traces found on the flint pieces can be related to a shooting incident, given the typological identification as projectiles and the overwhelming evidence of a violent clash between at least two groups. Our research is based on careful review of other publications (e.g. Lammers-Keijsers *et al.* 2014; Lombard and

Wadley 2007; Osipowicz and Nowak 2017; Rots 2016; Sano and Oba 2015) concerning the microwear and micro-residue analysis of projectiles. In addition, the traces found were compared with our own experimental reference collection and tailor-made experiments were carried out to match the observed traces (see also Coppe and Rots 2017, 111, 114-15).

Results

Following our protocol and catalogue of criteria, we documented traces left due to modern handling, mostly fingerprints from unprotected touching of the projectiles, drawing/measuring the objects or using metal installations for exhibition, alongside

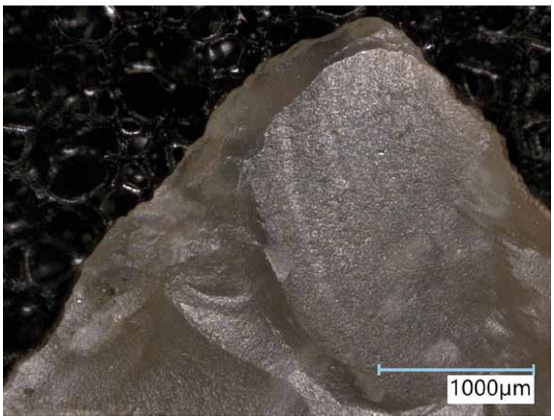


Figure 3. Projectile 2012/991,6, flint. Proximal end (tip) with linear streaks of polish (MLIST), polish areas and striations (©Harten-Buga, H. and Meller, B. (HHBM) 2018, Keyence 2000, x150).

Figure 4. Projectile ALM 2012/991,6, flint. Lateral view with linear streaks of polish (MLIST) on the body and fields of polish. Microflaking and microchipping along the edge combined with fractures and residues. Residues of the former glue are visible, and in the upper half of the picture the plasma-like residue can be seen (©HHBM 2019; Keyence 6000).

Figure 5. ALM 2012/855,1033. Projectile, flint. Edge with crescent-shaped fracture, most likely due to impact or hafting. Different kinds of both prehistoric and modern polish are visible. The almost transparent covering seen on the right side is caused by a modern varnish that has been painted over the inventory number (©HHBM 2019; Keyence 6000).

Figure 6. ALM 2012/855,1033. Projectile, flint. Proximal end with missing tip, different kinds of polish are visible; on the edges are former retouches as well as microflaking and fractures (©HHBM 2019; Keyence 6000).

prehistoric residues and traces. In the following, the major traces connected to the use as deadly weapons are described for three of the examined examples.

The first two projectiles (Table 1, Ref. Nos 1 and 7) described here show different kinds of polish, namely short but wide linear streaks (MLITS) connected to a small spot of polish (Figures 1, 2, 3, 4). In addition, both projectiles displayed edge removals and a crescent-shaped fracture (Figures 4, 5). Micro-bits of the tips of most projectiles were missing (Figures 4, 5, 6). Otherwise all of the seven examined projectiles were complete and had not broken into pieces, as seen in several experiments with flint arrowheads (Osipowicz and Nowak 2017). Recent experiments carried out within the Paleomechanics Project left more or less all of the used replicas intact – the projectiles are still awaiting in-depth micro-wear analysis.

The base of the projectiles also showed some use-wear at the edges, but this is more evident in portions which can be related to the process of shafting and subsequent use (Figure 7, 8, 9). There were no signs of polish on the protruding parts at the base of the projectiles. Only some small edge removals and little micro retouch along the edge could be identified.

The third projectile (Table 1, Ref. No. 2) is not only very well preserved, with in-situ hafting traces, but was also subject to AMS-dating, which included sampling remains of the shaft. Consequently this unique point underwent an in-depth analysis with a focus on micro-residues, traces of contamination and the loss of residues due to sample extraction. The loss and modification of traces and residues was documented by analysing the disparity between high-resolution photography taken prior to the sampling and microscopic images of the current condition. We identified scratches on the stone's surface and on the hafting, as well as displacement and loss of fibres originally preserved on the projectile. In addition, traces of contamination became visible, such as a likely cotton fibre (based on the twisted structure) right above a starch fibre and next to a blueish fibre embedded in the hafting. A red fibre appears to come from a modern synthetic material, perhaps deposited during storage (Figure 10). Other use-wear and micro-residues are most likely due to the original use of the artefacts, such as striations near the tip of the point and a small residue that is likely a bronze micro-fragment.

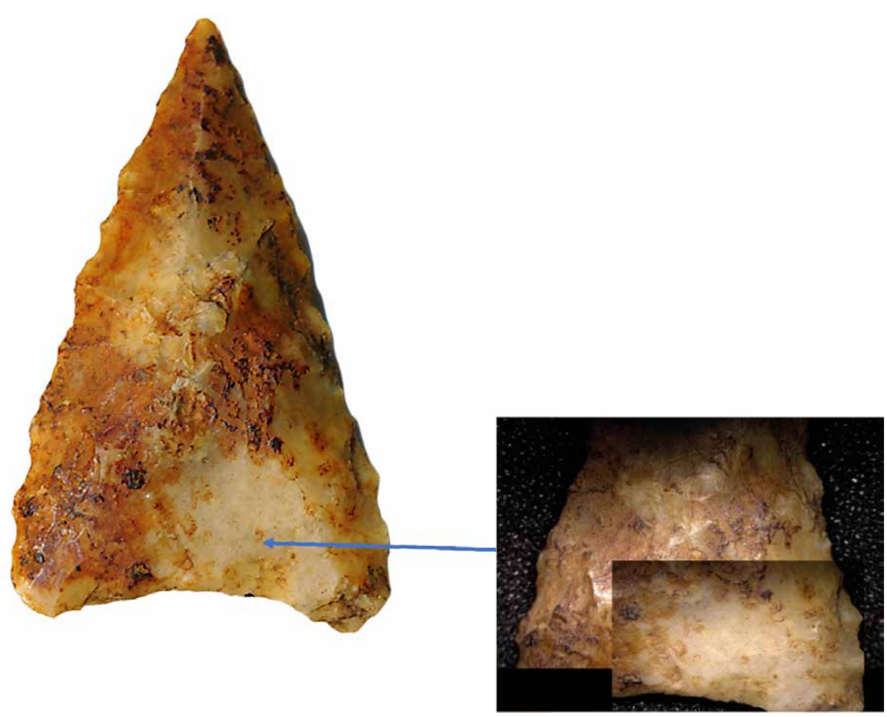


Figure 7. Overview of traces located on projectile 2012/1145,720 (© H. Harten-Buga and B. Meller, (HHBM) 2018, Keyence 2000).

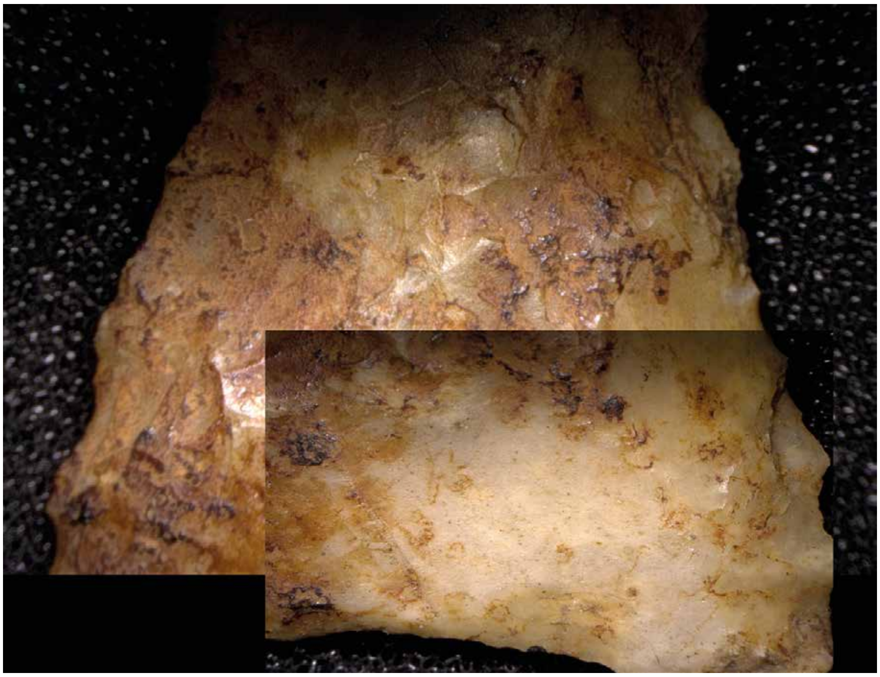


Figure 8. ALM 2011/1145,720. Projectile, flint. Blank spot at the distal end of the arrowhead due to hafting, with residue and traction covering the rest of the point (©HHBM 2019; Keyence 2000, x30).

Figure 9. Projectile ALM 2012/991,6, flint. Distal end with residue of glue and microchipping due to hafting and impact. Hafting polish is slightly visible (©HHBM 2019; Keyence 6000).

Furthermore, we identified material that seems to be fat. Close to the tip of the point, on side A of the blade (Figure 11), a glossy white film residue with directional striations and spots of dark residues was located. At high magnification (1000 x) the region appears reddish to dark violet and a residue that is likely organic tissue (skin or muscle) was identified. A very similar pattern can also be observed on the opposite side of the blade close to the tip, with dark-reddish spots in combination with a greasy film and directional striations and tissue. Examining side B of the arrowhead, almost identical residues could be located in the corresponding areas near the tip (Figure 11). High magnification (500 x) revealed that the dark spots consist of numerous doghnut-like structures embedded in glossy film (Figure 12).

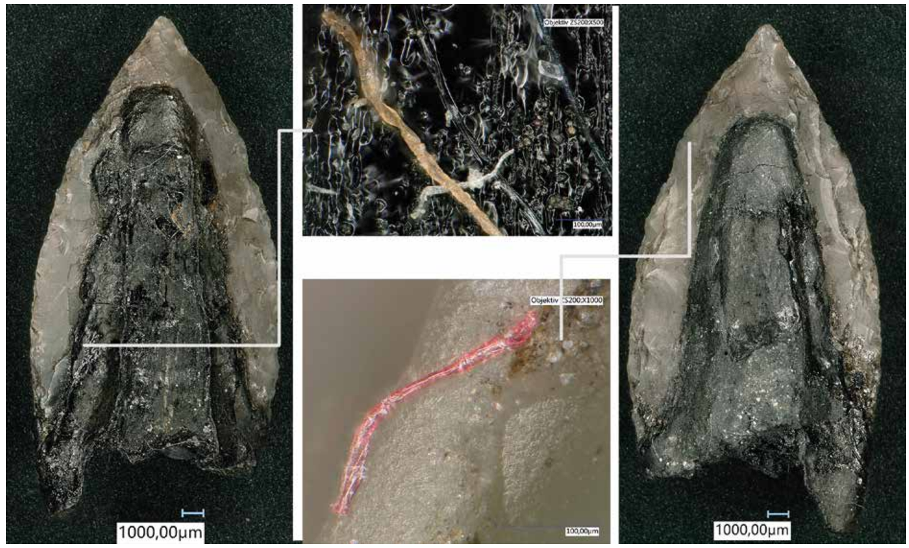


Figure 10. Projectile ALM 2008/462,217. Contamination after sampling for AMS dating and handling (©HHBM 2019; Keyence 6000).

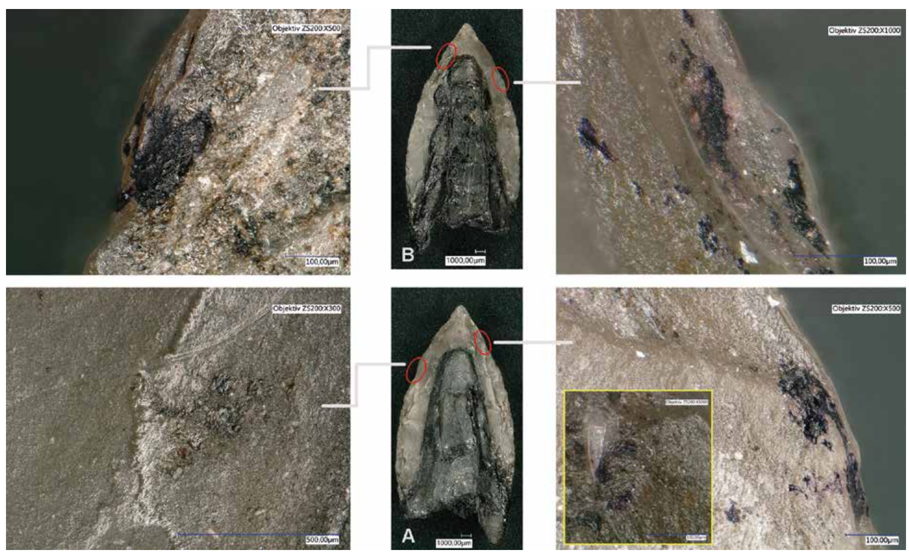


Figure 11. Projectile ALM 2008/462,217. Dark, reddish spots in combination with a greasy film and directional striations and tissue (yellow frame). Identical residues (red circles) in the corresponding areas near the tip on both sides A and B.

Discussion

Thanks to the application of High Power Microscopy it was possible to identify micro-traces of contact and impact. Specific kinds of polish, described above, mark the contact zones to wet skin tissue, created for instance during the penetration of skin (Lammers-Keijsers *et al.* 2014, 463; La Porta *et al.* 2018). Polish with striations can also relate to contact with some kind of mammal tissue, but stresses the movement of the arrowhead within the body (La Porta 2019; La Porta *et al.* 2018). The edge removals and crescent-shaped fractures can be regarded as impact fractures (Lammers-Keijsers *et al.* 2014, 461) and the missing micro-fragments at the tip of the projectiles indicate impact as well. Still, the micro-damage could conceivably also have happened during manufacturing, hafting and handling (Lee and Sano 2019, fig. 5). Therefore, these observations alone are not sufficient evidence for the use as an actual projectile. However, since these traces are accompanied by the occurrence of burin-like fractures and as the sides show crushing as well as post-manufacture transverse fractures mostly on the edges, it is possible to suggest that these are signs of use and impact (Figures 4, 5, 6). In contrast, no polish was identified on the base of the projectiles, where there is therefore no indication for direct contact/impact with tissue or bone.

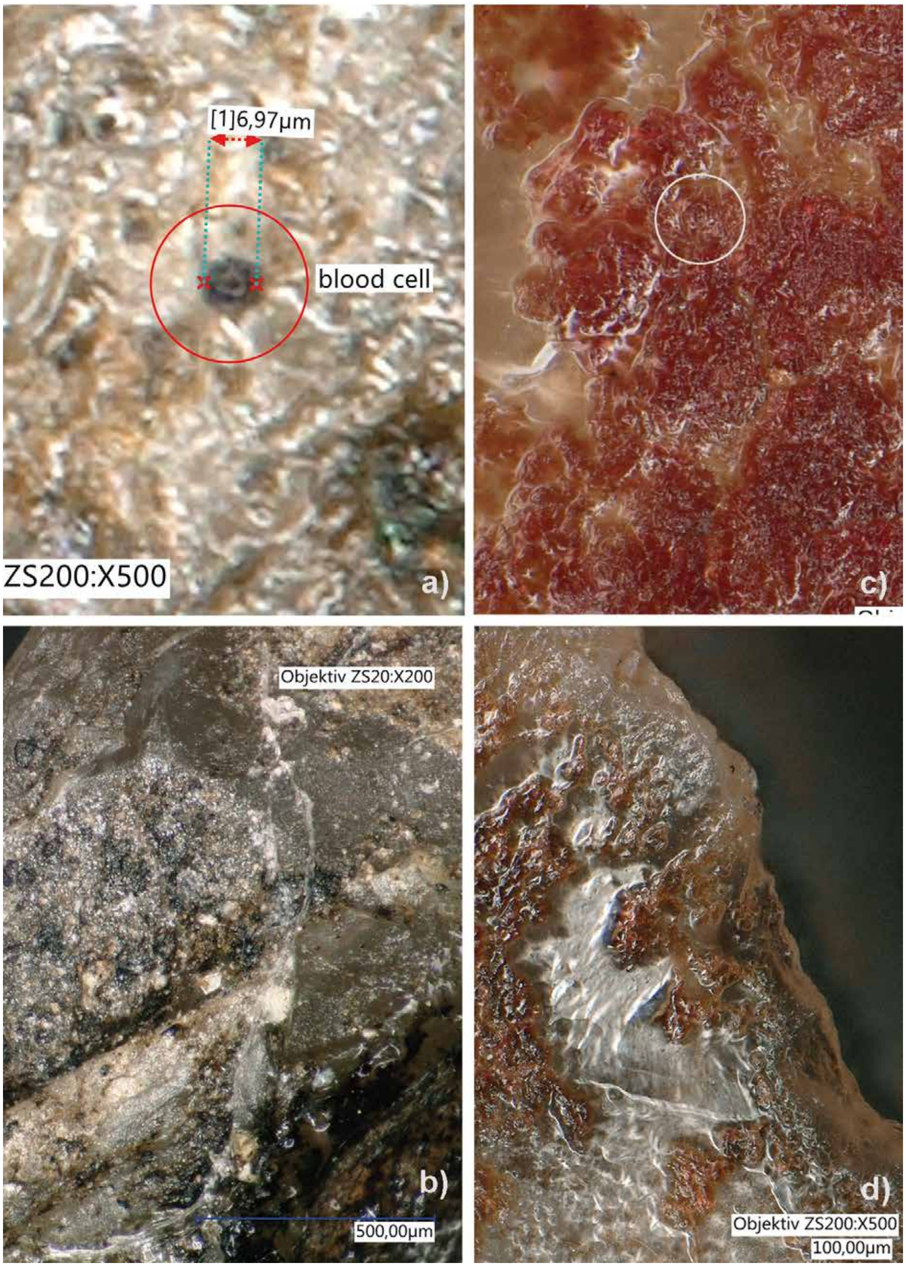


Figure 12. Left: projectile ALM 2008/462,217. Red circle highlights one of the doghnut-like structures (a) embedded in glossy film (a, b), consistent with red blood cells and plasma. Right: modern mammal blood on replicas of stone arrowheads after a short drying process (c, d). The white circle highlights one of the blood cells (c) (©HHBM 2019; Keyence 6000).

This absence of traces is likely caused by the presence of hafting material in this area, leaving no space for traces of contact.

This in turn provides indirect evidence that the projectiles were hafted. Yet there is also direct evidence in the form of bright spots, gloss, striations and use-retouches related to hafting, such as the already mentioned crescent-shaped fracture as well as residues of hafting glue (Figure 9). While remains of the arrow shaft were preserved in situ on the third projectile we analysed (Table 1, Ref. No. 2), hafting traces on the first two projectiles are less extensive (Table 1., Ref. Nos 1 and 7). Nevertheless, the optical analysis suggests the use of wood tar, as small fragments consistent with wood were visible under the microscope. In addition, one of the more striking residues was a plasma-like substance covering parts of the projectile, which suggests contact with tissue and blood (Figures 4, 5).

In case of the third arrowhead (Table 1, Ref. No. 2) the identified use-wear and well preserved hafting indicate the use as a projectile. Moreover, the residues, in particular the dark-reddish doughnut-like microstructures, support the interpretation that red blood cells and plasma are present. Comparing the size and shape of these structures with blood cells identified on other archaeological artefacts (e.g. Lombard 2014) suggests that this point penetrated mammalian, likely human tissue. In order to strengthen these results, we conducted experiments during which fresh human blood was applied to replicas of stone arrowheads. In addition, replicas were inserted into bovine muscle tissue. The examination of the samples after drying indicates residues consistent with those found on the Bronze Age arrowhead (Figure 12).

In order to further validate the results, we are planning to conduct a non-invasive test for identifying blood used in forensic work (BlueStar® Forensic), which has already been successfully used in other prehistoric cases (e.g. Lombard 2014), in order to detect micro-traces of ancient blood on stone tools. Considering the risk of contaminating the prehistoric arrowhead, we first conducted a series of tests with the active chemical compound on our experimental material to evaluate its possible impact on archaeological artefacts.

Further tests with a chemical reagent should also be conducted on the possible blood residues. Should all these results confirm our identification, DNA analysis could be considered. In that case, the micro-traces on the small arrowheads might shed a bit more light on the question of who the people who fought and died in the Tollense Valley were (Burger *et al.* 2020). Yet this will depend on the extraction of enough genetic material with an adequate number of base pairs for sequencing. Even though recent advances in the field of DNA amplification are promising (Spigelman *et al.* 2012), the effects of contamination on the DNA preservation must also be taken in account.

Conclusion

The identified use-wear and residues provide evidence that the projectiles we have investigated were used in shooting events and penetrated organic material such as skin, muscle tissue and fat. Hence the deposition of these arrowheads can be seen as closely connected to the deposition of human and perhaps animal bones. This strongly supports the above-mentioned suggestion (Lidke *et al.* 2019, 38) that the projectiles were originally embedded in the bodies of the deceased. In order to enhance these results, an experimental series using replicas of the Tollense Valley flint projectiles is currently under way, following a protocol designed to meet use-wear related requirements. The evaluation of the results will provide important additional reference data for the interpretation of the micro-traces found on the prehistoric projectiles. Our ongoing study also demonstrates the importance of a stricter and more sophisticated protocol in terms of handling prehistoric artefacts, starting at the excavation site and spanning documentation, restoration and exhibition practice.

In sum, we are confident that our holistic approach, which includes a combination of use-wear and residue analysis using digital microscopy, 3D-analysis, ballistic properties, impact fractures, chemical tests and experimental data, can make a contribution to research on weapon use and efficiency in the context of armed conflicts in the Baltic region during the Bronze Age. It has been suggested that changes in trade routes enhanced the economic importance of Mecklenburg during Montelius period III (Kristiansen and Suchowska-Ducke 2015; see also Jantzen and Lidke this volume). This renegotiation of trading networks could have caused violent encounters over resources and territory. Considering that the reliability of networks and the safety of the interlinked trade routes are the main guarantors for a lasting economic success, the Tollense Valley finds raise questions about the stability and nature of the economic and political networks in the circum-Baltic area during the Late Bronze Age.

Bibliography

Brinker, U., Schramm, A., Jantzen, D., Piek, J., Hauenstein, K. and Orschiedt, J. 2016. The Bronze Age battlefield in the Tollense Valley, Mecklenburg-Western Pomerania, Northeast Germany – Combat marks on human bones as evidence of early warrior societies in northern Middle Europe? In F. Coimbra, D. Delfino, V. Sîrbu and C. Schuster (eds), *Late prehistory and protohistory: Bronze Age and Iron Age. Proceedings of the XVII UISPP world congress (2014, Burgos, Spain). 1. The emergence of warrior societies and its economic, social and environmental consequences,* 39-56. Oxford: Archaeopress.

Burger, J. [+24 others] and Wegmann, D. 2020. Low prevalence of lactase persistence in Bronze Age Europe indicates ongoing strong selection over the last 3,000 years. *Current Biology* 30, 4307-15.

Coppe, J. and Rots, V. 2017. Focus on the target. The importance of a transparent fracture terminology for understanding projectile points and projecting modes. *Journal of Archaeological Science Reports* 12, 109-23.

d'Errico, F. 1985. Traces d'usure sur l'industrie lithique: approche méthodologique et proposition d'une technique. *L'Anthropologie* 89, 439-56.

Flohr, S., Brinker, U., Schramm, A., Kierdorf, U., Staude, A., Piek, J., Jantzen, D., Hauenstein, K. and Orschiedt, J. 2015. Flint arrowhead embedded in a human humerus from the Bronze Age site in the Tollense valley, Germany – A high-resolution micro-CT study to distinguish antemortem from perimortem projectile trauma to bone. *International Journal of Paleopathology* 9, 76-81.

Grace, R. 1996. Use wear analysis: the state of the art. *Archaeometry* 38, 209-29.

Lammers-Keijsers, Y., Verbaas, A., Van Gijn, A. and Pomstra, D. 2014. Arrowheads without traces: not used, perfect hit or excessive hafting material? In J. Marreiros, N. Bicho and J.F. Gibaja (eds), *International conference on use-wear analysis: Use-wear 2012*, 457-65. Newcastle upon Tyne: Cambridge Scholars Publishing.

Kristiansen, K. and Suchowska-Ducke, P. 2015. Connected histories: the dynamics of Bronze Age interaction and trade 1500-1100 BC. *Proceedings of the Prehistoric Society* 81, 361-92.

La Porta, A. 2019. *Neanderthal stone-tipped spear technology: an experimental and archaeological investigation.* Doctoral thesis, University of Exeter (available at https://ore.exeter.ac.uk/repository/handle/10871/37483).

La Porta, A., Hosfield, R. and Hurcombe, L. 2018. Searching for diagnostic projectile traces: use-wear analysis on experimental and archaeological Levallois points. *Union Internationale des Sciences Préhistoriques et Protohistoriques* 2018; conference paper abstract.

Lee, G. and Sano, K. 2019. Were tanged points mechanically delivered armatures? Functional and morphometric analyses of tanged points from an Upper Palaeolithic site at Jingeuneul, Korea. *Archaeological and Anthropological Sciences* 11, 2453-67.

Lidke, G., Brinker, U., Schramm, A., Jantzen, D. and Terberger, T. 2019. Warriors' lives: the skeletal remains sample from the Bronze Age battlefield site in the Tollense Valley, north-eastern Germany. In M. dal Corso, W. Kirleis, J. Kneisel, N. Taylor, M. Wieckowska-Lüth and M. Zanon (eds), *How's life? Living conditions in the 2nd and 1st millennia BCE*, 35-55. Leiden: Sidestone.

Little, A. and Van Gijn, A.L. 2017. Enigmatic plant-working tools and the transition to farming in the Rhine/Meuse Delta. *Analecta Praehistorica Leidensia* 47, 1-9.

Lombard, M. 2014. In situ presumptive test for blood residues applied to 62 000-year-old stone tools. *The South African Archaeological Bulletin* 69, 80-86.

Lombard, M. and Wadley, L. 2007. Micro-residues on stone tools: the bigger picture from a South African Middle Stone Age perspective. In H. Barnard and J.W. Eerkens (eds), *Theory and practice of archaeological residue analysis*, 18-28. Oxford: Archaeopress.

Odell, G.H. 2004. *Lithic analysis*. New York: Kluwer Academic/Plenum Publishers.

Osipowicz, G. and Nowak, D. 2017. Complexity of use-wear traces formed on flint projectile points – a voice in discussion. *Cuadernos de Prehistoria y Arqueología de la Universidad de Granada* 27, 83-109.

Pawlik, A.F. 2001. Microscopic use-wear analysis. A basic introduction on how to reconstruct the functions of stone tools. *Hukay* 3, 1-25.

Rots, V. 2016. Projectiles and hafting technology. In R. Iovita and K. Sano (eds), *Multidisciplinary approaches to the study of Stone Age weaponry*, 167-85. Dordrecht: Springer.

Rots, V and Hugues P. 2014. Projectiles and the abuse of the use-wear method in a search for impact. *Journal of Archaeological Science* 48, 154-65.

Sano, K. and Oba, M. 2015. Backed point experiments for identifying mechanically-delivered armatures. *Journal of Archaeological Science* 63, 13-23.

Spigelman, M., Shin, D.H. and Bar Gal, G.K. 2012. The promise, the problems, and the future of DNA analysis in paleopathology studies. In A.L. Grauer (ed.), *A companion to paleopathology*, 133-51. Chichester: Wiley-Blackwell.

Terberger, T. 2014. Bronzezeitliche Feuersteinartefakte aus dem Tollensetal. In D. Jantzen, J. Orschiedt, J. Piek and T. Terberger (eds), *Tod im Tollensetal. Forschungen zu den Hinterlassenschaften eines bronzezeitlichen Gewaltkonfliktes in Mecklenburg-Vorpommern 1*, 125-30. Schwerin: Landesamt für Kultur und Denkmalpflege Mecklenburg-Vorpommern.

Terberger, T., Jantzen, D., Krüger, J. and Lidke, G. 2018. Das bronzezeitliche Kampfgeschehen im Tollensetal – ein Großereignis oder wiederholte Konflikte? In S. Hansen and R. Krause (eds), *Bronze Age hillforts between Taunus and Carpathian mountains*. *Proceedings of the first international LOEWE conference, 7-9 December 2016 in Frankfurt/M.,* 103-23. Bonn: Rudolf Habelt.

Van Gijn, A.L. 1990. *The wear and tear of flint. Principles of functional analysis applied to Dutch Neolithic assemblages*. *Analecta Praehistorica Leidensia* 22. Leiden: University of Leiden.

Van Gijn, A.L. 2010. *Flint in focus. Lithic biographies in the Neolithic and Bronze Age*. Leiden: Sidestone Press.

Craftspeople in the Late Bronze Age

Bone and antler working at fortified settlements in the eastern Baltic region

Heidi Luik

Introduction

During the Late Bronze Age (1300/1100-500 BC), fortified settlements first appeared within the settlement pattern of the eastern Baltic region (Figure 1) in the beginning of the first millennium BC, reflecting the important changes that were taking place here at that time (Lang 2018a; Podėnas 2019; Vasks and Zariņa 2014). No traces of significant fortifications have been discovered at many of these settlements, but in these cases, they were built in places with natural defences (Figure 2) (Lang 2007, 15, 55-71).

Valter Lang (2014) describes this phenomenon as one of the three models for cultural behaviour characteristic of the eastern shore of the Baltic Sea in the Late Bronze Age, what he calls the south-eastern model. This cultural model was mainly followed in the southern part of the eastern Baltic region, especially in east Lithuania. In Estonia, the distribution of such settlements was sparse and all known sites were located in coastal areas. According to the latest research based on a number of radiocarbon dates, fortified settlements did not spread before the first quarter of the first millennium BC and reached coastal Estonia around 850/800 BC (Lang 2018a, 28; Podėnas 2019; Vasks and Zariņa 2014; see Merkevičius in this volume). Fortified settlements were centres of authority as well as of trade and crafts and played an important role in the organisation of bronze circulation (Lang 2007, 117-20). In the light of archaeological and archaeogenetic evidence, it is considered likely that new people arrived in the eastern Baltic region during the first quarter of the first millennium BC (Lang 2018a; 2018b; this volume).

Among Late Bronze Age find assemblages in the region, bronze artefacts and ceramics have been more thoroughly studied compared to other classes of artefacts. The aim of this article is to consider bone and antler artefacts found at fortified settlement sites on the eastern shore of the Baltic Sea and to search for the answer to the question of who the makers of these objects were. Was bone working a household craft, with bone and antler tools made mostly by their users, or is it possible to observe some degree of specialisation in Late Bronze Age bone working? Were these bone objects made by local bone workers or by itinerant craftspeople (or both)?

Crafts at Late Bronze Age sites in the eastern Baltic region

The most important craft practised at fortified settlements was probably bronze casting, as witnessed by the numerous clay moulds and their fragments found at such settlements (Čivilytė 2014; Čivilytė and Mödlinger 2010; Graudonis 1989; Grigalavičienė 1995; Lang 1996; 2007; Podėnas and Čivilytė 2019; Podėnas *et al.* 2016b; Sperling 2014; Sperling *et al.* 2015; 2020; Vasks 1994). Most clay moulds found on eastern Baltic fortified sites were moulds for casting bronze rings, although moulds for other objects (e.g. axes, spearheads, decorative pins) also occur. Bronze rings manufactured in these moulds were of quite similar thickness and had characteristic diameters. Probably, these rings played an important role in the economic strategies of these fortified settlements – they were probably bronze ingots manufactured as exchange items (Čivilytė 2014, pl. XVIII-XXIII;

In D. Hofmann, F. Nikulka and R. Schumann (eds) 2022. *The Baltic in the Bronze Age. Regional patterns, interactions and boundaries*, Leiden: Sidestone Press, pp. 103-122.

Figure 1. Late Bronze Age fortified settlements in the eastern Baltic region mentioned in the text: 1 Iru, 2 Kaali, 3 Asva, 4 Ridala, 5 Ķivutkalns, 6 Klaņģukalns, 7 Daugmale, 8 Vīnakalns, 9 Mūkukalns, 10 Brikuļi, 11 Madalāni, 12 Moškėnai, 13 Vosgėliai, 14 Kereliai, 15 Petrešiūnai, 16 Sokiškiai, 17 Garniai I, 18 Narkūnai, 19 Nevieriškė, 20 Zazony, 21 Ratyunki, 22 Gorani (drawing by Kersti Siitan).

Lang 2007, 117-20; Podėnas and Čivilytė 2019, 174 fig. 3; Sperling 2014, 132-67; Vasks 1994, pl. XV). There are large numbers of moulds and crucibles from fortifications, for instance at Brikuļi and Ķivutkalns in Latvia and Asva in Estonia, with finds connected to bronze casting distributed everywhere on these sites (Sperling 2014, 167-71; Vasks 2007, 67-69 figs 2-4). Uwe Sperling (2014, 167-71) suggests that metalworking was not the occupation of an elite: the moulds and other bronze casting equipment attest that the technology of bronze casting in the eastern Baltic region was simple and not of a very high level although it was quite comparable with other metalworking sites around the Baltic Sea.

Pottery making was also of great importance. Many sherds of both coarse and fine ceramic vessels have been found (Graudonis 1989; Grigalavičienė 1995; Lang 1996; 2007; Podėnas *et al.* 2016a; 2016b; Sperling 2014; Sperling *et al.* 2015; Vasks 1994). In the opinion

Figure 2. Fortified settlements were built in places with natural defensive qualities: 1 Sokiškiai fortified settlement (north-eastern Lithuania) is located on the coast of Lake Samanis (photo by Valter Lang); 2 Asva fortified settlement (Saaremaa Island in Estonia) is on a narrow north-south moraine ridge which was located on the sea shore during the Late Bronze Age (photo by Richard Indreko, 1931, in the archives of Archaeological research collection of Tallinn University).

of Valter Lang, the division of ceramics into coarse and fine ware that can be observed in the Late Bronze Age pottery marked a significant change in food customs. This division in quality probably derived from both social and cultural structures. It is believed that coarse pottery was used for cooking and preserving food while fine bowls were used for serving food and drinks. The coarse ceramics had a quite wide distribution area, whereas the groups of fine ceramics were much more localised (Lang 2007, 230-31; 2014, 150; see Visocka *et al.* in this volume).

Many other crafts were certainly practised, including wood and leather working, bark preparation and bast weaving and textile production, but since objects made from these perishable materials have not been preserved these activities can only be traced using indirect data, such as the presence of tools suitable for such activities and textile impressions on ceramic vessels (e.g. Kriiska *et al.* 2005; Lang 2007, 136-43 figs 67-78; Rammo 2018; Vedru 1999, 108-11).

Bone and antler artefacts constitute the most numerous find group after ceramic vessels and clay moulds. Such an assemblage composition is of course influenced by the fact that artefacts from other organic substances are not preserved and broken bronze objects could have been melted and recast. Nevertheless, the large number of bone and antler artefacts among the finds from Bronze Age sites demonstrates the importance of bone and antler as raw materials at this time.

Bone and antler tools have been previously published in books about the Bronze Age on the eastern coast of the Baltic Sea (e.g. Egorejchenko 2006; Graudonis 1967; 1989; Grigalavičienė 1995; Lang 2007). Mostly, their functions, typology and dating have been discussed in these publications, but less attention has been paid to the use of materials. Manufacturing methods used to make these objects, or the question of who could have made them, have not been tackled. Since 2006, the author of this article has studied about 2,500 bones and antler tools, as well as bone and antler fragments with working traces found at eastern Baltic Late Bronze Age sites: more than 1000 items from Estonia, most of them from Asva, c. 750 from Latvia, mostly from Ķivutkalns, and also c. 750 from Lithuania, most of them from Narkūnai and Nevieriškė. In addition to the objects I have studied myself, published bone objects have also been included. Besides the functions of bone and antler artefacts I have paid attention to their manufacture. Archaeozoologist Liina Maldre has helped in identifying the materials used to make these objects. In the case of the manufacturing techniques, only macro-traces that can be examined with the naked eye or with a magnifying glass have so far been analysed. Microscopes have not been used and therefore micro-traces have not been examined.

Carefully worked bone and antler tools and weapons

Although simple *ad hoc* tools are well represented among bone tools, a certain standardisation in both the selected material and the shape is characteristic of many bone and antler tool types of the period. More standardised artefact types included bone arrowheads and spearheads, awls from sheep/goat (*Ovis aries/Capra hircus*) metapodial bones, scapular tools with notched edges and hoes or ard points made of elk (*Alces alces*) antler. Antler handles, spoons, cheek pieces and harpoon heads are also always made of the same material and have the same shape, but they are represented in much smaller numbers. Materials used for making artefacts and the approximate numbers of artefacts discussed in this text are given in Table 1. These tools are carefully planned and made from the bones of particular species and skeletal elements. Such standardisation probably reflects some degree of organisation and social control in bone and antler working. They are also elaborately finished and sometimes also curated, for example by being repeatedly reworked. The effort put into the manufacturing of objects reflects the cultural attitudes towards them and the tasks they were used for (Choyke 1997, 66-68; 2005, 131). For example, at the settlement sites of Asva in Estonia and Narkūnai in Lithuania, carefully made and standardised bone artefacts constitute about one quarter of all bone and antler objects.

Arrowheads

Carefully worked bone arrowheads (Figure 3: 1-2) are typical of Latvian and Estonian sites. Such arrowheads are most numerous at Ķivutkalns and Mūkukalns (Latvia) and at Asva and Ridala (Estonia), while they are found in lower numbers at sites in Lithuania and also in north-west Belarus (Egorejchenko 2006, pl. 19, 20; Graudonis 1989, pl. XVI-XVIII; Luik 2006; 2013b, 397-98 fig. 13; Luik and Maldre 2007, 25 fig. 32). Most arrowheads are long and slender, with oval or lozenge-shaped cross-sections and with a distinctively

	Artefact type	Used material	Approximate number of finds
1	arrowheads	large ungulate long bone	>100
2	spearheads	sheep/goat tibia	> 40
3	awls	sheep/goat metapodium	>120
4	scapular tools	large ungulate scapula	>20
5	hoes or ard points	elk antler	>30
6	handles	elk antler	>20
7	spoons	elk antler	<10
8	cheek pieces	elk antler	>10
9	large curved harpoons	elk antler	<10
10	smaller straight harpoons	large ungulate long bone	>10
11	double buttons	elk antler	>20
12	decorative pins	large ungulate long bone	>100
13	antler disc	elk antler	1

Table 1. Approximate numbers of bone and antler artefacts used in this study and the material of their manufacture. Approximations are given because not all collections could be completely examined.

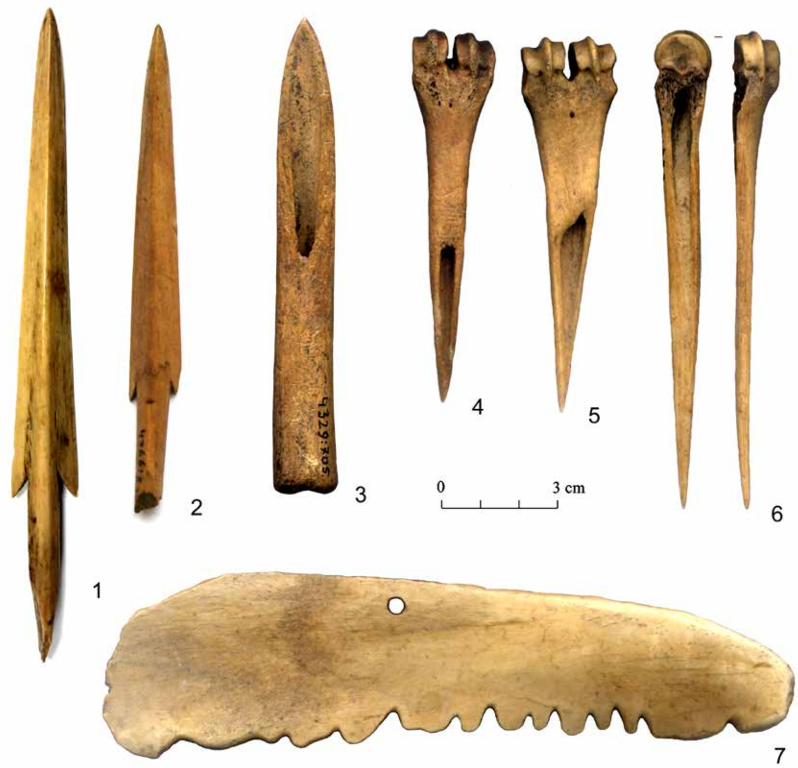


Figure 3. Late Bronze Age bone tools from Asva (1-2, 4-7) and Ridala (3): 1-2 arrowheads made from large ungulate long bones; 3 spearhead from sheep/goat tibia; 4-6 awls from sheep/goat metapodial bones; 7 notched scapular tool (photos by Heidi Luik; finds in the Archaeological research collection of Tallinn University (= AI): AI 3799: 338; 4366: 634, 4329: 705; 1558, 1435, 823; 4012: 94).

shaped tang. All arrowheads of this type are made from long bones of large ungulates. Such Late Bronze Age bone arrowheads are very carefully worked and beautiful. Their manufacture requires know-how and skill. It seems likely that these long and slender bone arrowheads were meant for warfare, not hunting (Luik 2006, 141-43).

Spearheads

Bone spearheads (Figure 3: 3) are highly standardised in terms of the choice of material – nearly all spearheads were made of sheep/goat tibiae. The proximal end of the bone was used for the socket of the spearhead; the epiphysis and part of the diaphysis were cut off so that the medullary cavity formed a socket. The blade of a spearhead was shaped by cutting the distal end of the bone and sharpening the tip. Bone spearheads are numerous in Lithuania (e.g. Nevieriškė, Narkūnai, Sokiškiai, Moškėnai) and north-west Belarus (Ratyunki, Gorani, Zazony), some examples are known from Brikuļi in Latvia and only one was found at Ridala in Estonia (Egorejchenko 2006, pl. 15, 17; Grigalavičienė 1995, figs 58-59; Luik 2013a, 26-27 fig. 2; 2013b, 397 fig. 12; Luik and Maldre 2007, 19-20 figs 26-27; Vasks 1994, pl. VIII: 3-7).

Awls

Awls are the most numerous bone tools in fortified settlements in the eastern Baltic, there are some hundreds of awls, made from different skeletal parts. Awls made from sheep/goat metapodials are the most numerous and homogenous type among the awls found at these fortified sites (Figure 3: 4-6). Such awls could have two different shapes depending on the manufacturing technique used. At Lithuanian sites (Nevieriškė, Narkūnai) and in north-west Belarus (Ratyunki, Zazony) the majority were made by splitting the bone along its natural longitudinal groove (Egorejchenko 2006, pl. 11: 19-27; Grigalavičienė 1995, fig. 80: 1-4; Luik 2009, fig. 4; Luik and Maldre 2007, 15-16 figs 16-18); in Estonia and Latvia (Asva, Ridala, Ķivutkalns, Vīnakalns, Daugmale) most awls were made without longitudinal splitting of the bone, so the whole epiphysis formed the handle and the point was shaped by cutting the bone diagonally (Graudonis 1989, pl. XXII: 7-18; Luik 2009, figs 2-3; 2013b, 390-91 fig. 2). The choice of material was connected to functionality since these bones are of suitable size and shape for making an awl. The choice of technology was cultural and depended on the customs and traditions of the given society (Luik 2009, 47-53).

Scapular tools

Scapular tools (Figure 3: 7) with notched edges are found at Estonian sites (Asva, Ridala, Kaali). They are made from cattle (*Bos taurus*) and elk scapulae (Luik and Lang 2010). Some fragments of similar tools have been found at Ķivutkalns and Klaņģukalns in Latvia (Graudonis 1989, pl. XXVI: 3, XXXI: 2). Comparable tools can be found elsewhere in central Europe, most of them dating to the Late Neolithic, but some also date to Bronze Age and Early Iron Age contexts (e.g. Bąk 1985, fig 2: 1-11; Hásek 1966; Kłosińska 1997, 98 fig. 13: 4, pl. XLIII: 8-10, LIV: 1, LXXIII: 6; Northe 2001). The function of such tools is unknown, although there have been many suggestions: they may have been used in hide working, pottery making, strap or cord processing, meat preparation, or as tools for processing flax or harvesting crops (Hásek 1966, 265-67; Luik 2013a, 27-29; 2013b, 395; Luik and Lang 2010, 162-71; Northe 2001, 179-82).

Hoes or ard points

Antler hoes or ard points (Figure 4: 1) are made from elk antler beams and palmate sections. In Estonia such tools were mostly found at Asva, one artefact comes from Iru and some fragments were found at Ridala (Luik and Lang 2013; Sperling *et al.* 2015, 59 fig. 12: 4). In Latvia, most examples come from Ķivutkalns and some from Vīnakalns (Graudonis 1989, pl. XIIa, XLII: 12). In Lithuania, a couple of finds came from Narkūnai and Sokiškiai (Luik and Maldre 2007, 13 fig. 10). Although these tools have been called axes as well, based on the use-wear data and the morphology of artefacts it seems more likely that they were used as agricultural implements (Lang 2007, 107-08; Luik and Lang 2013, 173-84).

Handles

Antler handles (Figure 4: 3) are usually carefully smoothed and polished. Sometimes they are decorated with profiled ridges and grooves. In Estonia, such handles were mostly found at Asva (Luik 2011, fig. 7) and in Latvia primarily from Ķivutkalns, including some unfinished specimens. Some pieces also come from the Latvian site of Mūkukalns (Graudonis 1967, pl. XVIII: 4-5; 1989, pl. XV). Antler handles also came to light at sites in Lithuania (Narkūnai, Sokiškiai, Moškėnai and Vosgėliai) and north-west Belarus (Gorani, Zazony, Ratyunki) (Egorejchenko 2006, pl. 24-26; Grigalavičienė 1995, fig. 61; Luik and Maldre 2007, 13 figs 11-12). Based on the shape of the cavity carved into the handle for the blade, it seems more probable it held a flint or quartz blade, although it could also have held a small and short bronze blade (Graudonis 1989, 33 pl. XV: 5).

Spoons

Antler spoons (Figure 4: 2) are made by carving the bowl from the palmate part of the elk antler rack and the stem of the spoon from a tine. In Estonia four spoons have been found at Asva and one at Iru; in Latvia at least three spoons are known from Ķivutkalns and Brikuļi (Graudonis 1989, pl. XXVI: 6-7; Lang 1996, pl. VIII: 5; Luik 2011, 42 fig. 6: 11-12; Vasks 1994, pl. IX: 20). The role of food and the rules or manners governing the way it was served and eaten underwent changes in Late Bronze Age Europe (Sørensen 2000, 112-15). Valter Lang (2007, 230-31; 2014, 150) suggests that the appearance of small, fine ceramic bowls and bone spoons in the Late Bronze Age indicates that more attention was probably paid to table manners in Estonia also.

Figure 4. Late Bronze Age elk antler tools from Asva: 1 hoe or ard point; 2 spoon; 3 handle; 4 cheek piece for horse harness; 5-7 harpoon heads (photos by Heidi Luik; finds in the Archaeological research collection of Tallinn University (= AI): AI 4366: 1534, 700, 1792, 122; 4012: 113; 4366: 1942, 1863).

Cheek pieces

All cheek pieces belonging to horse harnesses are made from elk antler tines (Figure 4: 4). Such objects are not numerous, about a dozen specimens altogether are known from Estonia (Asva, Iru), Latvia (Brikuļi, Mūkukalns) and Lithuania (Petrešiūnai) (Graudonis 1967, pl. XVIII: 10-11; Grigalavičienė 1995, fig. 100: 11; Lang 1996, pl. VIII: 2; Maldre and Luik 2009, 41 fig. 6; Vasks 1994, 115 pl. VII: 19-20). Various disc- and bar-shaped antler and bronze cheek pieces have been known since the Middle Bronze Age in many parts of Europe (e.g. Choyke *et al.* 2004, fig. 10; Harding 2000, fig. 5: 3; Jaeger 2016, 134; Usatschuk 2004); it has been suggested that in central Europe antler fittings from horse harnesses were manufactured by semi-specialised craftsmen – largely as some pieces were ornamented with elaborate incised decorations and made by people with specialist knowledge in the use of metal tools (Choyke 2005, 140; Choyke *et al.* 2004, 184; Jaeger 2016, 141; Sofaer *et al.* 2013, 482 fig. 26.5). However, the cheek pieces in the eastern Baltic region are simple and not decorated.

Harpoon heads

Large curved harpoon heads (Figure 4: 5-7) with hemicylindrical sockets are made from antler tines. Such harpoon heads are found only at Estonian sites located near the coast (Asva, Iru, Ridala) and were probably used for seal hunting (Lang 2007, fig. 80: 1-3; Luik 2013b, 396 fig. 10; 2013c, 81-83 fig. 8.6: 6-9). Smaller harpoon heads made of long bone diaphyses and with a somewhat different shape are found in Asva (Luik 2013b, fig. 11), but also at Latvian, Lithuanian and Belarusian sites not located on the coast (Egorejchenko 2006, pl. 23; Graudonis 1989, pl. XVIII: 1-7; Grigalavičienė 1995, fig. 64: 1-3). These harpoons could have been used for fishing or for hunting smaller animals, for example beavers.

Dress accessories made of bone and antler

Some exotic bronze dress accessories were replicated in more easily available local materials such as bone, antler, and probably wood. Double buttons imitating Scandinavian bronze double buttons and tutuli were made from antler, while bone was used to make decorative pins in shapes that resembled bronze pin types distributed across Scandinavia and central Europe (Lang 2007, 144-45 fig. 81; Luik 2007, 51-53 figs 2-4). There are great differences in the number of these types of objects: the pins are quite numerous, there are significantly fewer double buttons, and a large antler disc is the only one known to date (Table 1: 11-13).

People never copy things blindly; copying often involves the idea that the copy gains some power or value from the thing copied (Hodder 2012, 123). Imitations made in other raw materials have been regarded as characteristic of periods when important social changes took place in society (Choyke 2008, 7-8; 2010, 202-04). Presumably, the Late Bronze Age was a time when a new social rank arose whose needs of display were met by such replicated artefacts. Craftspeople with the necessary skills to make them also became necessary.

Double buttons

Antler double buttons (Figure 5: 1-4) are mostly made from antler tine tips. Such buttons have been recovered in Latvia (Ķivutkalns, Brikuļi), Lithuania (Narkūnai, Kereliai, Moškėnai, Garniai I), Belarus (Ratyunki) and Estonia (Asva and Kaali) (Egorejchenko 2006, pl. 34; Graudonis 1989, pl. XXV: 20-21; Grigalavičienė 1995, fig. 100: 1-4; Luik and Ots 2007, 125-27 fig. 4; Sperling *et al.* 2015, fig. 12: 1; Troskosky *et al.* 2018, fig. 3; Vasks 1994, 115 pl. IX: 18-19). An unfinished button was discovered at the site of Ķivutkalns in Latvia (Graudonis 1989, pl. XXV: 19), while a tine tip with working traces, evidently intended to be made into a double button, comes from Kereliai in Lithuania (Luik and Maldre 2007, fig. 9: 1). Antler double buttons are made very carefully – some of them look like they were made on a lathe (Figure 5: 4), although manufacturing traces indicate that they were not. Similar buttons were also made from amber, which was a valued and impressive-looking material (e.g. Graudonis 1989, pl. X: 1-6; Luik and Ots 2007, 124-25 fig. 3). These double buttons imitate similar bronze buttons and tutuli from central Europe and Scandinavia. Their presence may also reflect the distribution of the ideologies and symbolic meanings connected to them on the eastern shore of the Baltic Sea (Luik and Ots 2007, 130-34).

Antler double buttons are not numerous, but bronze double buttons are even rarer on the eastern shore of the Baltic Sea. They have not been found in the fortified settlements at all, but two bronze double buttons, probably originating from Scandinavia, were found at the Jõelähtme stone grave in Estonia (Luik and Ots 2007, 124 fig. 2). Large bronze tutuli are also rare finds in the eastern Baltic region, only a few examples are known (e.g. Jonuks and Johanson 2017, 96-97; Lang 2007, 253; Urtāns 1977, 131 fig. 36: 3).

Bone pins

Decorative bone pins (Figure 5: 6-12) made from long bones of large ungulates are numerous at fortified settlements both in Estonia, Latvia, Lithuania and north-west Belarus, but such pins have also been found in graves (Denisova *et al.* 1985; Egorejchenko 2006, pl. 28-33; Graudonis 1967, pl. VII-VIII; 1989, pl. XXVII-XXXI; Grigalavičienė 1995, figs 92, 94-98; Luik 2013b, 398-400 figs 15-16). Bone pins are quite numerous at these sites, more than 500 pins and their fragments are known. However, only some can be considered imitations. It is difficult to arrive at a precise number, because the decision which of them could be considered as imitations is undoubtedly to some extent subjective. I estimate there could be about a hundred (Table 1: 12). In addition to carefully manufactured pins made from the diaphysis of long bones of large ungulates, there are also simple bone pins made from pig fibulae – these were made of bones with suitable shape and did not require much effort to manufacture (e.g. Graudonis 1967, pl. XI: 14-16, 21; 1989, pl. XXVII: 1-7; Grigalavičienė 1995, fig. 99: 1-7). There are also many fragmentary pins whose original appearance is unknown.

Comparing bone pins from the Baltic countries, one can observe differences in the occurrence of certain pin types on different sites and in different regions. For example, in Latvia the ratio of pins with flat round or oval heads is high at Ķivutkalns (Denisova *et al.* 1985, figs 33-34; Graudonis 1989, pl. XXIX-XXX), while at Brikuļi most of the pins have cylindrical heads and flat-headed pins are rare (Vasks 1994, pl. IX: 1-14). In Estonia spade-headed pins are found in stone graves, while different types were found at fortified settlements (Lang 2007, 144-45, 155-56 figs 81: 1-6, 88; Luik 2007, figs 2, 7-10; 2013b, 399 fig. 15). Pins decorated with dots and circles were favoured in Belarusian territories (Ratyunki, Zazony), but are almost unknown in the eastern Baltic region, with the exception of some pins from south-eastern Latvia (Egorejchenko 2006, pl. 28; 2008, fig. 2; Vasks 1994, pl. IX: 3). Nevertheless, some pin types are very similar in the whole eastern Baltic region. Bronze pins were widespread in central and northern Europe, but bone pins were also used in those regions. Bone pins in the eastern Baltic region imitate various types of bronze pins found in central Europe and Scandinavia (e.g. Kłosińska 1997, fig. 12, pl. VIII: 5-6, XIV, XC: 8-9; Laux 1976; Malinowski 2006, fig. 72: 1-8). Some of these imitations are carved very skilfully, requiring certain skills and experience from their producer.

In the Baltic countries finds of bronze pins are relatively rare (e.g. Graudonis 1967, 93 pl. XX: 11-12, 21, 26; Lang 2007, 119, 156 fig. 55; Paavel 2017, tab. 1: 9, fig. 2: 9). For example, a bronze pin with nail-shaped head known from Narkūnai has quite similar bone counterparts at other Lithuanian sites (Grigalavičienė 1995, figs 92-93).

Figure 5. Late Bronze Age dress accessories from Asva: 1-4 antler double buttons; 5 antler disc; 6-12 bone pins (photos by Heidi Luik; finds in the Archaeological research collection of Tallinn University (= AI): AI 4366: 132, 1591, 614; 3658: 500; 4366: 1165; 3799: 136, 39, 78; 3307: 230; 4366: 1735; 3994: 604; 3307: 304).

Antler disc

A disc (Figure 5: 5) from Asva is made of elk antler. The disc is carefully worked but not decorated. Similar antler discs have been found in central Europe, although these are decorated with dots and circles, curves and meanders (e.g. Daróczi 2011, 123 pl. 3: 1; Kimmig 1992, 53-54 pl. 21, 22: 5-6). Such antler discs may have served as decorative elements of dress, bags or belts, like the large bronze discs and tutuli (Becker 2005, 170 fig. 7; Kimmig 1992, 54; Kristiansen and Larsson 2005, 298-303 figs 135-37). A large, white and carefully worked antler disc, even if not ornamented, could have created a decorative contrast if it was attached to a dark dress (Becker 2005, 170; Luik 2007, 56), like the bronze disc with its golden shine.

Bone and antler working in Late Bronze Age fortified settlements in the eastern Baltic

Bone and antler artefacts constitute a considerable part of the archaeological record of the eastern Baltic fortified settlements, thus indicating the importance of bone and antler working in Late Bronze Age society in the area.

Raw materials

The choice of raw material may provide clues to the degree of specialisation in craft production at these fortified sites. Fortuitously broken bones from kitchen waste were often used in household craft production at these settlements. It appears that for more professional production the raw material usually had to be especially selected and procured in a more organised manner (Choyke 1997, 66-68; 2013; Provenzano 2001, 98-99; Sofaer *et al.* 2013, 486), and this may also have been the case here. What may have been the reasons behind craftspeople's choices of raw material and manufacturing techniques in the Late Bronze Age of the region? Why were certain species or skeletal elements chosen for making particular objects?

The percentage of elk antler is larger in the worked osseous materials than is the share of other elk skeletal elements in the unworked faunal remains. Shed antlers were presumably also used in addition to antlers of hunted animals. Nevertheless, the use of antler may have been regulated to a certain extent and rules might have existed about who could or could not make or use certain materials. For instance, Alice Choyke (2005, 44) has suggested, on the basis of the composition of finds (finished production vs. bone working refuse) and the location of refuse (most of it was recovered from the central mound of the settlement) that in the socially differentiated society of the Hungarian Middle Bronze Age settlement of Jászdózsa-Kápolnahalom, people of different strata might have had different access to red deer (*Cervus elaphus*) antler as a valuable material, and rules stipulated who had the right to collect, stock and work antler and trade in antler artefacts.

Antler may have been preferred as a raw material because of its dimensions and physical and ascribed cultural properties. Antler, especially elk antler, is suitable for making larger objects because of the mass of compacta available. Antler has also been shown to be tougher and more resilient to shock than bone, so that antler was preferred especially for making artefacts or components subject to sudden shock (Choyke 2012, 90; Luik 2011, 36; MacGregor 1985, 25-29).

Wild animal bones are rare both among worked and unworked faunal remains in the Late Bronze Age fortified settlement sites in the eastern Baltic region. Bones of domestic animals – cattle, sheep/goat, pig (*Sus scrofa domestica*), horse (*Equus caballus*) – prevail (Lang 2007, 110-11; Luik 2013b, 401-05; Luik and Maldre 2007, 6-7 fig. 2; Vasks 1994, 57-58 tab. 8) and were also used for manufacturing bone tools, so the choice of raw material largely depended on availability. Nevertheless, the choice of certain species and particular skeletal elements depended on its suitability for a given tool type.

At present, antler working waste in the eastern Baltic region in the Late Bronze Age is known only from fortified settlements. It is possible that the inhabitants of these central fortified settlements had, for some reason, greater access to antler, which was a valued raw material. However, this is uncertain at the current stage of research, since Late Bronze Age open settlements, which were small and have only thin cultural layers, are less well-known and only few of them have been investigated (Lang 2007, 49-55; Luik 2011, 38). Hopefully, in the future more research will be carried out into other settlement types, which will provide an opportunity to find out more about whether different groups of the population may have had different access to antler.

Manufacturing techniques and tools

Late Bronze Age bone and antler artefacts were manufactured using techniques that had mostly been used earlier already: chopping, breaking, splitting, grooving, carving, grinding, sawing, and polishing (Luik 2011; 2013b; Luik and Maldre 2007). The first operation in antler working was to cut the beam into pieces of the required size: the compact part of the antler was cut or hacked around and the porous tissue inside the antler was simply snapped off (Figure 6).

Both antler and bone were also dissected by grooving and splitting. Some of the antler fragments have traces of further working on them: their rough surface was partly removed and the pieces were scraped smoother, producing facets. Chopping and cutting traces are also visible on some unfinished artefacts and on some tools which were not very carefully finished (Luik 2011, 38; 2013b, 405). Grinding on a stone was used for shaping as well as finishing the artefacts. The tips of spearheads and smooth facets of arrowheads were shaped by grinding them on a stone. Decorative bone pins also have smooth and polished surfaces, but their final polishing could have been carried out with sand and a piece of leather, ashes, fish skin etc. (MacGregor 1985, 58). Bone artefacts also have various longitudinal and transverse lines on their surfaces left by cutting, carving and

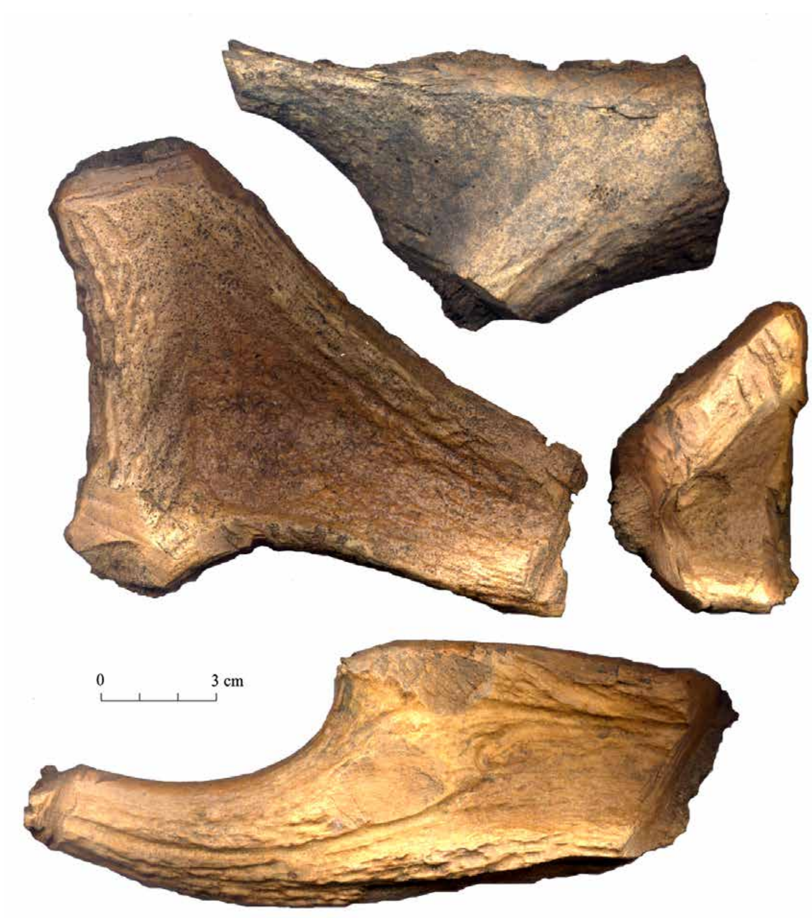


Figure 6. Antler pieces with chopping traces from Asva (photos by Heidi Luik; finds in the Archaeological research collection of Tallinn University (= AI): AI 3307: 224, 114; AI 4366: 1409, 1710).

smoothing the artefact with a flint blade, which was probably neither very sharp nor even (Luik 2006, 140 fig. 10).

Experimental replicating of ancient bone tools also helps scholars to better understand what kinds of manufacturing techniques could have been used. While making a replica bone arrowhead, one of the barbs broke (Figure 7: 2-3). Probably a wrong method was chosen for making the barb – there was an attempt to cut it out, but the bone split and the barb broke. The other barb was successfully shaped by sawing with a sharp-edged piece of sandstone (Luik 2006, 141). This is only a single attempt to make a copy of a Bronze Age bone object. To gain a better understanding of the methods of bone artefact manufacturing, it would be necessary to carry out more experiments, using various methods. For example, softening the bone to facilitate processing could reduce the potential for accidental splitting (e.g. Osipowicz 2007).

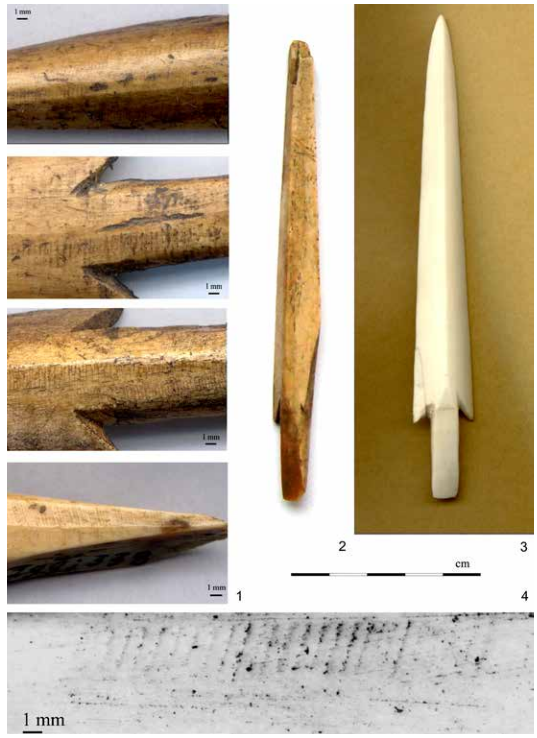


Figure 7. Manufacturing of Late Bronze Age bone arrowheads: 1 chatter-marks on bone arrowheads from Asva (AI 3994: 586, 1636; 3307: 296; 3799: 338); 2 arrowhead from Asva (AI 4366: 1607);
3 replica of arrowhead made by Jaana Ratas and Jaak Mäll; 4 chatter-marks on the replica (photos 1-3 by Heidi Luik, 4 by Jaana Ratas; after Luik 2006, figs 6-8; finds in the Archaeological research collection of Tallinn University (= AI)).

Which tools were used to make such bone and antler artefacts? Were these tools made of stone or were bronze tools sometimes also used? Given the present state of investigations this question remains unanswered. One particular type of manufacturing trace on Bronze Age bone and antler artefacts are chatter-marks, which happen during finishing of the artefact's surface using either a bronze or flint scraping tool – when cutting a rather hard material powerfully and with steady force, the blade may begin to skip over the surface, thus leaving small transverse lines at equal intervals, the so-called chatter-marks (Figure 7: 1) (Luik 2006, 138-40 figs 6, 8; 2013b, 408 fig. 21; Luik and Maldre 2007, 28-29 figs 12, 28, 38-40). Such chatter-marks also appeared on the surface of the experimentally replicated bone arrowhead (Figure 7: 4).

It seems, however, that mostly stone tools were used for antler working in the Late Bronze Age in the eastern Baltic region. Use of metal tools depended on their availability. For example, at Terramare sites in Italy metal tools were often used in bone tool manufacturing, but in Hungary and the Balkans most of the worked osseous objects were made using flint and abrasive stone technologies until the Late Bronze Age (Sofaer *et al.* 2013, 486). From the Late Bronze Age, metal tools were also used in Hungary, especially for making the ornamental details of antler horse harnesses; it is suggested that these fine artefacts were made by (semi-)specialised, and possibly itinerant craftspeople (Choyke 2005, 140; Choyke *et al.* 2004, 184; Sofaer 2010, 211-12; Sofaer *et al.* 2013, 482, 487). At the Late Bronze Age and Early Iron Age Grzybiany lake settlement in Poland, both flint and metal tools were used for scraping bone and antler artefacts (Baron *et al.* 2016, tab. 2). Nevertheless, according to recent studies metal tools were rather rarely used for working osseous materials in the Late Bronze Age in south-west Poland; using metal tools became more common only in the Early Iron Age (Baron and Diakowski 2018).

No artefacts with such complicated decoration as found in central Europe, such as in Hungary, are known in the Late Bronze Age in the eastern Baltic region and probably just the white colour of bone was regarded as decorative enough (Luik 2007). Most of

Figure 8. Decoration of bone pins with cylindrical heads from Ridala (1) and Asva (2-7) (photos by Heidi Luik; finds in the Archaeological research collection of Tallinn University (= AI): AI 4261: 197; 3994: 604; 3799: 39; 3658: 559; 4366: 1656, 1836; 3307: 304).

the bone and antler artefacts here are not decorated, although some antler handles and double buttons are decorated with profiled grooves and ridges or engraved lines (Figure 5: 4). Most bone pins are also plain and simple, with some pins decorated with engraved ornaments or profiled grooves and ridges which in some cases are carved very skilfully (Figure 8). The engraved ornaments may be very regular and carefully made, but sometimes the lines are engraved quite carelessly. Pins with both profiled and engraved ornaments are more numerous on Latvian and Lithuanian sites. Most decorations, such as profiled ridges, diagonal lines and oblique crosses, are distributed throughout the region (Egorejchenko 2006, pl. 29-30; 2008, figs 3-4; Graudonis 1967, pl. VII-VIII; Grigalavičienė 1995, figs 92, 94-96; Luik and Maldre 2007, fig. 31; Vasks 1994, pl. IX). Pins decorated with dots and circles are known only in the eastern part of Latvia at the sites of Brikuļi and Madalāni; such decoration is much more common in Belarus (Egorejchenko 2006, pl. 28; 2008, fig. 2; Vasks 1994, pl. IX: 3). Most likely a compass-like metal tool or centre-bit was used for making circle and dot decorations (e.g. MacGregor 1985, 60-61 fig. 38); however, making such ornaments with stone tools cannot be excluded, as demonstrated by the experiments carried out with replicas of Paleoindian stone tools (Tomenchuk and Storck 1997).

Makers of bone tools

The carefully made bone and antler objects discussed in this article form only a subset of all Late Bronze Age bone objects. Most of the bone and antler tools were probably made by their users themselves. These are objects in which the manufacturer has taken advantage of the natural shape of the bone, which has only been minimally processed. Therefore, everyone was able to make bone tools, and this did not require a specialised bone worker. However, in antler working, as well as in the production of certain bone artefacts, one may assume the existence of a certain degree of organisation and specialisation. Making such beautiful objects demands certain skills and know-how of the producers. These people probably had access to special tools as well.

In the Late Bronze Age of the eastern Baltic, bone and antler tools, as well as bone and antler working waste are mostly found at fortified settlement sites. Only a few bone objects (mostly pins) have been found in graves. Antler and bone working refuse have not been found at contemporary open settlements. However, as mentioned above, such sites are usually small and with thin cultural layers; only a few of them have been archaeologically excavated (Lang 2007, 49-55). The reason why bone working waste has not been found could be that in the case of simple bone objects no recognisable production waste may remain. As already mentioned, in their case a bone of suitable shape was usually chosen from the outset. For example, the bone fragments left over when making a simple pin from a pig fibula (e.g. Graudonis 1989, pl. XXVII: 1-7) or an awl from an elk or horse rudimentary metapodium (e.g. Luik 2013, fig. 3) are so small that they may not have survived or were not recovered. However, recognisable waste, such as removed epiphyses or unused bone strips, may remain when making bone objects from large tubular bone diaphyses (such as carefully carved decorative pins and arrowheads). Antler working also creates more waste and antler waste pieces are more easily recognisable as in contrast to bone they cannot be confused with food waste. At the present stage of investigation, antler artefact production waste is known only from fortified settlements.

Is it possible to trace specialisation of craft activity inside the fortified settlements? For example, at Asva, both bone and antler artefacts and bone working refuse could not be correlated with a particular building or area of the site. They have been found in and around all excavated house floors in the same way as the remains of bronze casting (Lang 2007, 62-63; Sperling 2014, 167-71; Vasks 2007, 67-69 figs 2-4). For bronze casting, which undoubtedly demands more know-how and skill than bone working, it has been supposed that although it was a specialised craft, it was presumably not a full-time occupation (Sperling 2014, 167-71). Probably craft specialisation in the Late Bronze Age in the eastern Baltic region means that some particular sites – the fortified sites with higher populations – were specialised in crafts and trade (Lang 2007, 115-20; 2014, 149-53), but mostly it is not possible to trace evidence of a higher degree of specialisation inside these settlements.

No possible bone and antler workshops have been discovered in Late Bronze Age fortified settlements. Workshops have not usually been found for bronze working either, but in addition to casting moulds the remains of the smelting furnaces indicate where bronze working took place (e.g. Sperling *et al.* 2020, 57-59). As mentioned above, finds related to both bronze working and bone processing are usually scattered in the cultural layers of fortified settlements. As bone working leaves no traces comparable to smelting furnaces, and as bone and antler working waste has not necessarily been deposited exactly where it was created, it is not possible to locate exactly where bone working took place within the settlement.

What was the status of bone workers in the eastern Baltic region? Probably there were no full-time craftspeople at this time. It is also possible that some craftspeople lived an itinerant way of life since some types of very similar artefacts (e.g. double buttons, some bone pin types) were spread throughout the region. For central Europe, it has been suggested that semi-specialised bone carvers may have travelled from centre to centre (Choyke 2005, 140; Choyke *et al.* 2004, 184). In contrast, in the eastern Baltic there are no richly and masterfully decorated artefacts comparable to those from central Europe. Although artisans presumably could travel between fortified settlements, they probably did not move throughout the whole area of distribution of fortified settlements in the eastern Baltic. There are still differences in manufacturing certain types of objects, such as the preference for spearheads or arrowheads, or the preference for a particular method of production of awls from goat/sheep metapodial bones, which indicate restricted networks.

The significance of bone and antler objects

Although bone as material was generally available, being a co-product of the food supply, and the majority of bone and antler artefacts are tools meant for everyday use, some carefully manufactured objects might also have been connected with status or prestige.

One type of carefully worked bone objects are long and slender arrowheads, which given their shape presumably were used not for hunting but for warfare. A long arrowhead was most likely to hit the internal organs, and arrowheads were hafted so that they would detach and remain in the body on any attempt to remove the arrow from the wound, also aided by the presence of barbs. Even if the wound was not fatal, removing the arrowhead would take time, and the pain would immobilise the enemy. On the other hand, arrowheads with a shorter, wider and thinner blade, causing heavy bleeding, would be more suitable for hunting (Luik 2006, 142; Sperling and Luik 2012, 144). However, dividing arrowheads for hunting and military weapons has been controversially discussed, and some researchers suggest that the same/similar arrowheads were used for both purposes (Christenson 1997, 134 and references therein). The occurrence of bone arrowheads in

Bronze Age fortified settlements, their standardisation and the skill required for their manufacture indicate their essential significance and meaning in the Late Bronze Age society of the eastern Baltic (Luik 2006, 144). Considering the shape and properties of bone arrowheads, as well as the absence or scarcity of arrowheads made from other materials at these sites, it still seems probable that the carefully made bone arrowheads were used for warfare (Luik 2006, 143; Sperling and Luik 2012, 144-45).

Objects belonging to a warrior's equipment, including horse gear, are regarded as important in the development of prestige goods (Harding 2000, 405; Kristiansen 1998, 152, 161). The appearance of cheek pieces from horse harnesses is probably connected with the use of horses as draught and riding animals, which can also be associated with a wealthier population and elite (Choyke 2005, 140; Choyke *et al.* 2004, 184; Jaeger 2016, 71, 134). Although the number of cheek pieces in the eastern Baltic region is quite small, they still suggest that the horse may have been used for riding, although certainly to a much lesser extent than, for example, in central Europe (Maldre and Luik 2009, 41, 44).

As mentioned above, it has been supposed that the role of food and how it was served were changing in Late Bronze Age Europe (Sørensen 2000, 112-15). If the antler spoons, together with fine ceramics, are connected with new table manners emerging in the eastern Baltic, as Valter Lang (2007, 230-32) suggests, they could also indicate a higher social status of their users. At the present stage of research, both fine pottery and the carefully worked bone and antler objects have been found mostly at fortified settlements, while most pottery from open sites is coarse-grained.

One reason for valuing bone and antler objects could have been the shiny white colour of bone, which made the carefully manufactured and polished bone artefact impressive and conspicuous. In addition, the white colour could also have had some symbolic meaning (Becker 2005, 169-70; Luik 2007, 56; Vitezović 2012, 223).

Bone pins and antler double buttons could possibly also hold symbolic meanings, as these are artefacts based on foreign examples. Objects and styles taken over from other groups are given meaning in their new context, but these meanings may rely on meanings from the old context and bring these meanings with them (Hodder and Hutson 2003, 140). Presumably the double buttons could allude to the sun cult, which was widespread in Scandinavia (e.g. Kristiansen and Larsson 2005, 294, 303, 319) and the existence of which has also been assumed on the basis of Estonian Bronze Age material (e.g. Jonuks 2005, 90; 2009, 191-93; Luik and Ots 2007, 131-33).

Some objects for status display had to be similar across wide territories, since they had to be read the same way by many more people. Clothing has an important role in non-verbal communication since it provides information on people's identity and social relationships (Grömer *et al.* 2013, 221). In Bronze Age northern Europe, cloth and the cut of clothing were simple and uniform and therefore the main expression of identity were the accessories – ornaments and items for fastening clothes (Sørensen 1997; 2000, 134-42). The differences in the number and/or quality of objects might reflect personal social position, they were meaningful for living people and enabled conclusions to be drawn about social identities (Sørensen 1997, 93-95, 110-11 fig. 3; 2000, 134-42). The use of different pins was probably possible or permitted for people of different status. Thus one may assume that carefully finished pins imitating foreign bronze models and plain pins made on pig fibulae, which anybody could make, carried different messages in the eastern Baltic region.

It is still possible that bronze accessories were more common as it seems and are just not preserved. The habit of hoarding bronze objects was not as common in the eastern Baltic as in Scandinavia and central Europe and bronze hoards have been only rarely found here. Overall, there are far fewer bronze artefacts in the eastern Baltic, and presumably broken and unusable items were recast into new objects. However, even if bronze dress accessories were used more often than it appears from known finds, it is still true that some types of bone pins and antler double buttons imitate foreign bronze examples. Presumably the foreign shape and meaning of these objects was of most importance, expressing the status and/or identity of the wearer, and the use of imported bronze was not essential to convey this meaning.

In the opinion of Timothy Earle (2002), locally made copies of foreign prototypes were valuable prestige objects. But although copies made from locally available materials could be suitable for demonstrating wealth and status, the manufacture and spread of such objects would be more difficult to monopolise than in the case of rare and/or imported materials. The use of such symbolic objects thus demonstrates that ideological power remained diffuse (Earle 2002, 221, 322, 355, 363). Probably, the bone and antler copies of bronze artefacts in the Late Bronze Age eastern Baltic region similarly indicate that power was not highly concentrated (Luik 2007, 55).

Summary

Stratification in Late Bronze Age society created a need to demonstrate wealth and prestige. Beautiful and skilfully worked bone artefacts were probably also suited for display purposes. The need for such objects created a need for skilled and experienced craftspeople who were able to produce such high-quality artefacts. However, fortified sites in the eastern Baltic region were probably not large enough to provide a full-time livelihood for bone carvers. Social stratification in the Late Bronze Age society here was probably not very extreme. The fortified sites were not very large and buildings at these sites were quite similar to each other in terms of both their size and find assemblages. Nevertheless, the rise of such fortified sites in the eastern Baltic in the Late Bronze Age is a new phenomenon attesting to important changes in the society and economy of the period.

Acknowledgements

I am grateful to the Research Council of Lithuania (Nr. S-MIP-20-46), National History Museum of Latvia and National Museum of Lithuania for their permit to use their archaeological finds. I also thank Liis Soon for her help with English, Jaana Ratas and Jaak Mäll who made the replica of a bone arrowhead and Kersti Siitan, Valter Lang and Jaana Ratas for their help with illustrations. My special thanks go to Alice Choyke for her kind help and advice.

Bibliography

Baron, J. and Diakowski, M. 2018. Tools make tools: changes in bone and antler manufacture at Late Bronze and Early Iron Age Polish sites. *Antiquity* 92, e5. DOI:10.15184/aqy.2018.98.

Baron, J., Diakowski, M. and Stolarczyk, T. 2016. Bone and antler artefacts from an 8-5th century BC settlement at Grzybiany, south-western Poland. In S. Vitezović (ed.), *Close to the bone. Current studies in bone technologies*, 28-47. Belgrade: Institute of Archaeology.

Bąk, U. 1985. Przemysł kościany i rogowy w grupe Nowocerekwiańskiej na Górnym Śląsku. *Archeologia Polski* XXX, 311-28.

Becker, C. 2005. Spindle whorls or buttons? Ambiguous bone artefacts from a Bronze Age *castelliere* on Istria. In H. Luik, A.M. Choyke, C.E. Batey and L. Lõugas (eds), *From hooves to horns, from mollusc to mammoth. Manufacture and use of bone artefacts from prehistoric times to the present*, 157-74. Tallinn: Institute of History.

Choyke, A.M. 1997. The bone tool manufacturing continuum. *Anthropozoologica* 25-26, 65-72.

Choyke, A.M. 2005. Bronze Age bone and antler working at the Jászdózsa-Kápolnahalom tell. In H. Luik, A.M. Choyke, C.E. Batey and L. Lõugas (eds), *From hooves to horns, from mollusc to mammoth. Manufacture and use of bone artefacts from prehistoric times to the present*, 129-56. Tallinn: Institute of History.

Choyke, A.M. 2008. Shifting meaning and value through imitation in the European Late Neolithic. In P.F. Biehl and Y.Ya. Rassamakin (eds), *Import and imitation in archaeology*, 5-21, Langenweißbach: Beier & Beran.

Choyke, A.M. 2010. The bone is the beast: animal amulets and ornaments in power and magic. In D. Campana, P. Crabtree, S.D. de France, J. Lev-Tov and A.M. Choyke (eds), *Anthropological approaches to zooarchaeology. Colonialism, complexity, and animal transformations*, 197-209. Oxford: Oxbow Books.

Choyke, A.M. 2012. Hunting the Bezoar goat: sympathetic magic in Early Bronze Age Arslantepe. In D.C.M. Raemaekers, E. Esser, R.C.G.M. Lauwerier and J.T. Zeiler (eds), *A bouquet of archaeozoological studies. Essays in honour of Wietske Prummel*, 83-91. Groningen: Barkhuis.

Choyke, A.M. 2013. Hidden agendas: ancient raw material choice for worked osseous objects in central Europe and beyond. In A. Choyke and S. O'Connor (eds), *From these bare bones: raw materials and the study of worked osseous objects*, 1-11. Oxford: Oxbow Books.

Choyke, A.M., Vretemark, M. and Sten, S. 2004. Levels of social identity expressed in the refuse and worked bone from the Middle Bronze Age Százhalombatta-Földvár, Vatya culture, Hungary. In S. Jones O'Day, W. van Neer and A. Ervynck (eds), *Behavior behind bones. The zooarchaeology of ritual, religion, status and identity*, 177-89. Oxford: Oxbow Books.

Christenson, A.L. 1997. Side-notched and unnotched arrowpoints: assessing functional differences. In H. Knecht (ed.), *Projectile technology*, 131-42. New York: Plenum Press.

Čivilytė, A. 2014. *Žmogus ir metalas priešistorėje: žvilgančios bronzos trauka*. Vilnius: Piemedžio leidykla.

Čivilytė, A. and Mödlinger, M. 2010. Bronzos amžiaus metalurgija: atkraštinių kirvių gamybos technologijos ir funkcijos klausimu. *Lietuvos Archeologija* 36, 121-52.

Daróczi, T.-T. 2011. Associations of archaeological finds in Middle Bronze Age centres of the eastern Carpathian Basin – aspects of power. *Acta Terrae Septemcastrensis* X, 113-40.

Denisova, R.Ya., Graudonis, Ya.Ya. and Gravere, R.-U. 1985. *Kivutkalnskij mogil'nik epokhi bronzy*. Riga: Zinātne.

Earle, T. 2002. *Bronze Age economics. The beginning of political economics.* Oxford: Westview Press.

Egorejchenko, A.A. 2006. *Kul'tury štrikhovannoj keramiki.* Minsk: Belorusskij Gossudarstvennyj Universitet.

Egorejchenko, A.A. 2008. Kostyanye bulavki s gvozdevidnym navershiem v lesnoj polose vostochnoj Evropy. In M. Mogielnicka-Urban (ed.), *Opera ex aere. Studia z epoki brązu i wczesnej epoki żelaza dedykowane profesorowi Janowi Dąbrowskiemu przez przyjaciół, uczniów i kolegów z okazji siedemdziesięciolecia urodzin,* 177-83. Warszawa: Instytut Archeologii i Etnologii Polskiej Akademii Nauk.

Graudonis, Ya.Ya. 1967. *Latviya v epokhu pozdnei bronzy i rannego železa. Natshalo razloženiya pervobytno-obschinnogo stroya*. Riga: Zinātne.

Graudonis, Ya.Ya. 1989. *Nocietinātās apmetnes Daugavas lejtecē*. Riga: Zinātne.

Grigalavičienė, E. 1995. *Žalvario ir ankstyvasis geležies amžius Lietuvoje*. Vilnius: Mokslo ir enciklopedijų leidykla.

Grömer, K, Rösel-Mautendorfer, H. and Bender Jørgensen, L. 2013. Visions of dress. Recreating Bronze Age clothing from the Danube region. *Textile* 11, 218-41.

Harding, A.F. 2000. *European societies in the Bronze Age*. Cambridge: Cambridge University Press.

Hásek, I. 1966. *Pravěké kostěné a parohové nástroje s ozubenou pracovní hranou*. Praha: Orbis.

Hodder, I. 2012. *Entangled. An archaeology of the relationships between humans and things.* Oxford: Wiley-Blackwell.

Hodder, I. and Hutson, S. 2003. *Reading the past: current approaches to interpretation in archaeology.* 3rd edition. Cambridge: Cambridge University Press.

Jaeger, M. 2016. *Bronze Age fortified settlements in central Europe. Studien zur Archäologie in Ostmitteleuropa 17*. Poznań: Wydawnictwo Nauka i Innowacje.

Jonuks, T. 2005. Principles of Estonian prehistoric religion with special emphasis to soul beliefs. In V. Lang (ed.), *Culture and material culture. Papers from the first theoretical seminar of the Baltic archaeologists (BASE) held at the University of Tartu, Estonia, October 17th-19th, 2003*, 87-95. Tartu, Riga, Vilnius: University of Tartu, University of Latvia, University of Vilnius.

Jonuks, T. 2009. *Eesti muinasusund. Dissertationes archaeologiae Universitatis Tartuensis 2*. Tartu: Tartu Ülikooli Kirjastus.

Jonuks, T. and Johanson, K. 2017. *101 Eesti arheoloogilist leidu*. Tallinn: Varrak.

Kimmig, W. 1992. *Die „Wasserburg Buchau" – eine spätbronzezeitliche Siedlung. Forschungsgeschichte – Kleinfunde.* Stuttgart: Theiss.

Kłosińska, E. 1997. *Starszy okres epoki brązu w dorzeczu Warty*. Wrocław: Instytut Archeologii i Etnologii Polskiej Akademii Nauk.

Kriiska, A., Lavento, M. and Peets, J. 2005. New AMS dates of the Neolithic and Bronze Age ceramics in Estonia: preliminary results and interpretations. *Estonian Journal of Archaeology* 9, 3-31.

Kristiansen, K. 1998. *Europe before history*. Cambridge: Cambridge University Press.

Kristiansen, K. and Larsson, T.B. 2005. *The rise of Bronze Age society. Travels, transmissions and transformations*. Cambridge: Cambridge University Press.

Lang, V. 1996. *Muistne Rävala, I-II. Muistised, kronoloogia ja maaviljelusliku asustuse kujunemine Loode-Eestis, eriti Pirita jõe alamjooksu piirkonnas.* Tallinn: Eesti Teaduste Akadeemia Ajaloo Instituut.

Lang, V. 2007. *The Bronze and Early Iron Ages in Estonia.* Tartu: Tartu University Press.

Lang, V. 2014. Where did Asva culture go? Three models of cultural behaviour in the Bronze Age eastern Baltics. In V. Lang and K. Kull (eds), *Estonian approaches to culture theory*, 136-60. Tartu: University of Tartu.

Lang, V. 2018a. Fortified settlements in the eastern Baltic: from earlier research to new interpretations. *Archaeologia Lituana* 19, 13-33.

Lang, V. 2018b. *Läänemeresoome tulemised*. Tartu: University of Tartu.

Laux, F. 1976. *Die Nadeln in Niedersachsen. Prähistorische Bronzefunde XIII: 4*. München: Beck.

Luik, H. 2006. For hunting or for warfare? Bone arrowheads from Late Bronze Age fortified settlements in eastern Baltic. *Estonian Journal of Archaeology* 10, 132-49.

Luik, H. 2007. Dazzling white. Bone artefacts in Bronze Age society – some preliminary thoughts from Estonia. In A. Merkevičius (ed.), *Colours of archaeology. Material culture and the society. Papers from the second theoretical seminar of the Baltic Archaeologists (BASE) held at the University of Vilnius, Lithuania, October 21st-22nd, 2005*, 49-64. Vilnius, Helsinki, Riga, Tartu: University of Vilnius, University of Helsinki, University of Latvia, University of Tartu.

Luik, H. 2009. Skill, knowledge and memory. How to make a bone awl properly? In A. Šnē and A. Vasks (eds), *Memory, society and material culture. Papers from the third theoretical seminar of the Baltic Archaeologists (BASE) held at the University of Latvia, October 5-6, 2007*, 45-58. Riga, Helsinki, Tartu, Vilnius: University of Latvia, University of Helsinki, University of Tartu, University of Vilnius.

Luik, H. 2011. Material, technology and meaning: antler artefacts and antler working on the eastern shore of the Baltic Sea in the Late Bronze Age. *Estonian Journal of Archaeology* 15, 32-55.

Luik, H. 2013a. Late Bronze Age bone crafting in the eastern Baltic: standardization of artefact types and individual ingenuity. *Estonian Journal of Archaeology* 17, 24-37.

Luik, H. 2013b. Luu- ja sarvetöötlemisest Läänemere idakaldal nooremal pronksiajal: sarnasused ja erinevused Eesti, Läti ja Leedu leiuaineses. In K. Johanson and M. Tõrv (eds), *Man, his time, artefacts, and places. Collection of articles dedicated to Richard Indreko*, 387-426. Tartu: University of Tartu.

Luik, H. 2013c. Seals, seal hunting and worked seal bones in Estonian coastal region in the Neolithic and Bronze Age. In A. Choyke and S. O'Connor (eds), *From these bare bones: raw materials and the study of worked osseous objects*, 73-87. Oxford: Oxbow Books.

Luik, H. and Lang, V. 2010. Scapular artefacts with serrated edges from Late Bronze Age fortified settlements in Estonia. *Archaeologia Baltica* 13, 162-74.

Luik, H. and Lang, V. 2013. Late Bronze Age elk antler tools in the eastern Baltic region. In F. Lang (ed.), *The sound of bones. Proceedings of the 8th meeting of the ICAZ worked bone research group in Salzburg 2011*, 173-84. Salzburg: University of Salzburg.

Luik, H. and Maldre, L. 2007. Bronze Age bone artefacts from Narkūnai, Nevieriškė and Kereliai fortified settlements. Raw materials and manufacturing technology. *Archaeologia Lituana* 8, 5-39.

Luik, H. and Ots, M. 2007. Bronze Age double buttons in Estonia. *Estonian Journal of Archaeology* 11, 122-40.

MacGregor, A. 1985. *Bone, antler, ivory and horn. The technology of skeletal materials since the Roman Period*. London: Croom Helm.

Maldre, L. and Luik, H. 2009. Horse in Estonia in the Late Bronze Age: archaeozoological and archaeological data. *Archaeologia Baltica* 11, 37-47.

Malinowski, T. 2006. *Komorowo, stanowisko 1: Grodzisko kultury Łużyckiej – faktoria na szlaku bursztynowym.* Rzeszów: Instytut Archeologii Uniwersytetu Rzeszowskiego.

Northe, A. 2001. Notched implements made of scapulae – still a problem. In A.M. Choyke and L. Bartosiewicz (eds), *Crafting bone: skeletal technologies through time and space. Proceedings of the 2nd meeting of the (ICAZ) worked bone research group Budapest, 31 August – 5 September 1999*, 179-84. Oxford: Archaeopress.

Osipowicz, G. 2007. Bone and antler. Softening techniques in prehistory of the north eastern part of the Polish Lowlands in the light of experimental archaeology and micro trace analysis. *EuroREA: Journal for (Re)construction and Experiment in Archaeology* 4, 1-22.

Paavel, K. 2017. Pattern or random? Contextualising Estonian Bronze Age bronze stray finds on the landscape. *Archaeologia Baltica* 24, 26-42.

Podėnas, V. 2019. Emergence of hilltop settlements in the southeastern Baltic: new AMS 14C dates from Lithuania and revised chronology. *Radiocarbon* 62, 1-17.

Podėnas, V. and Čivilytė, A. 2019. Bronze casting and communication in the southeastern Baltic Bronze Age. *Lietuvos Archeologija* 45, 169-99.

Podėnas, V., Luchtanas, A. and Čivilytė, A. 2016a. Narkūnų piliakalnių ir papėdės gyvenvietės keramika: elgsenos atspindžiai. *Lietuvos Archeologija* 42, 191-241.

Podėnas, V., Čivilytė, A., Bagdzevičienė, J. and Luchtanas, A. 2016b. Techologiniai ir diagnostiniai Narkūnų didžiojo piliakalnio techinės keramikos tyrimai. *Lietuvos Archeologija* 42, 151-89.

Provenzano, N. 2001. Worked bone assemblages from northern Italian Terramares: a technological approach. In A.M. Choyke and L. Bartosiewicz (eds), *Crafting bone: skeletal technologies through time and space. Proceedings of the 2nd meeting of the (ICAZ) worked bone research group Budapest, 31 August – 5 September 1999*, 93-109. Oxford: Archaeopress.

Rammo, R. 2018. Textile-impressed pottery revisited: its usefulness for studying Bronze Age textile craft in Estonia. *Światowit* LVI, 111-19.

Sofaer, J. 2010. Technology and craft. In T. Earle and K. Kristiansen (eds), *Organizing Bronze Age societies. The Mediterranean, central Europe, and Scandinavia compared*, 185-217. Cambridge: Cambridge University Press.

Sofaer, J., Bender Jørgensen, L. and Choyke, A. 2013. Craft production: ceramics, textiles, and bone. In H. Fokkens and A. Harding (eds), *The Oxford handbook of the European Bronze Age*, 469-91. Oxford: Oxford University Press.

Sørensen, M.L.S. 1997. Reading dress: the construction of social categories and identities in Bronze Age Europe. *Journal of European Archaeology* 5, 93-114.

Sørensen, M.L.S. 2000. *Gender archaeology.* Cambridge: Polity Press.

Sperling, U. 2014. *Aspekte des Wandels in der Bronzezeit im Ostbaltikum. Die Siedlungen der Asva-Gruppe in Estland*. Tallinn: Estonian Academy Publishers.

Sperling, U. and Luik, H. 2010. Arrowheads, palisades and an attack-scenario. Ridala Bronze Age hill-fort revisited. *Archaeologia Baltica* 13, 140-52.

Sperling, U., Lang, V., Paavel, K. and Kimber, A. 2015. Neue Ausgrabungen in der Bronzezeitsiedlung von Asva – vorläufiger Untersuchungsstand und weitere Ergebnisse. *Archaeological Fieldwork in Estonia in 2014*, 51-64.

Sperling, U., Karlsen, H.-J., Lang, V., Lõugas, L., Kimber, A. and Lau, R. 2020. Ausgrabungen in der Bronzezeitsiedlung von Asva im Jahr 2019. *Archaeological Fieldwork in Estonia in 2019*, 51-60.

Tomenchuk, J. and Storck, P.L. 1997. Two newly recognized Paleoindian tool types: single- and double-scribe compass gravers and coring gravers. *American Antiquity* 62, 508-22.

Troskosky, C.B., Podėnas, V. and Dubinin, N. 2018. Quaternary geomorphology and viewshed analysis of the Garniai I. *Chronika* VIII, 64-77.

Urtāns, V. 1977. *Senākie depozīti Latvijā (līdz 1200. g.)*. Rīga: Zinātne.

Usatschuk, A. (ed.) 2004. *Psalii. Elementy upryaži i konskogo snaryaženiya v drevnosti. Sbornik statei*. Donetsk: Donetskij Objastnoj Kraevedscheskij Muzej.

Vasks, A. 1994. *Brikuļu nocietinātā apmetne. Lubāna zemiene vēlajā bronzas un dzelzs laikmetā (1000. g. pr. Kr. – 1000. g. pēc Kr.)*. Rīga: University of Latvia.

Vasks, A. 2007. Bronze-working centres in the system of social relations in the territory of Latvia during the early metal period. In A. Merkevičius (ed.), *Colours of archaeology. Material culture and the society. Papers from the second theoretical seminar of the Baltic Archaeologists (BASE) held at the University of Vilnius, Lithuania, October 21st-22nd, 2005,* 65-77. Vilnius, Helsinki, Riga, Tartu: University of Vilnius, University of Helsinki, University of Latvia, University of Tartu.

Vasks, A. and Zariņa, G. 2014. Ķivutkalna pilskalns un kapulauks: jauni dati un jaunas problēmas. *Latvijas Vēstures Institūta Žurnāls* 92, 5-36.

Vedru, G. 1999. Värtnakedrad Eesti arheoloogilises leiumaterjalis. *Journal of Estonian Archaeology* 3, 91-114.

Vitezović, S. 2012. The white beauty – Starčevo culture jewellery. *Documenta Praehistorica* XXXIX, 215-26.

Hoards, metallurgy and points

Proposal of an analytical tool for describing hoards with components related to metalworking

Marcin Maciejewski, Kamil Nowak

The aim of this study

In this text, we would like to propose clear determinants (as far as is possible in archaeology) which can indicate the relationship of a given hoard with metallurgical activity, and will also help determine the degree of this relationship – a metalworking index. We will also try to use this tool for a selected group of finds and indicate similarities or differences. On the one hand, this is a proposal for a discussion about hoards with elements related to metalworking (while not imposing a clear interpretation as "bronzesmith's hoards"). On the other, this is a reflection on the specificity of both the hoards containing this type of artefacts, as well as more broadly on the organisation of metallurgical production and other aspects of Bronze Age social structure associated with the acquisition, production, distribution, use and decommissioning (depositing) of metal artefacts, including the social position of the people involved.

As many other researchers working on metal hoards, we will analyse the inventory of this type of finds and focus on a categorisation based on an unambiguous relationship with the metalworking process (unambiguous as far as is possible in archaeology). Its construction enables us to add new categories of finds.

As the area in which we will test our analytical tool, we chose Pomerania (understood not as a historical region, but for convenience using the modern administrative divisions of the Pomeranian and West Pomeranian Voivodeships) and Mecklenburg-Vorpommern (also designated by modern administrative boundaries). On the one hand, these regions are similar in terms of landscape and were equally far away from potential metal deposits. On the other hand, they were part of the same broader network – the circum-Baltic area, in which of course the most dynamic area was the Nordic zone. Some differences do however exist, especially when it comes to the importance of influences from the Urnfield cultures. So this is an area that is both similar and different, which will enable us to indicate potential differences or similarities. As for the period, we will focus on the most developed phase of the Bronze Age, when social and economic organisation in these zones was relatively similar – Montelius periods IV and V.

Long-lasting dichotomy

In archaeology some terms have been used for so long and so widely that it is impossible to unambiguously define them, or there are so many definitions that it is difficult to list them all. Different concepts are adopted by successive generations of researchers and inscribed in various paradigms. Obviously, this changes the way of understanding these terms. We also know "catch-all words" often used to simplify the complicated nature of the archaeological heritage, thanks to which it is possible to create a suggestive narrative – addressed, for example, to the reader of the local press. Such formulations influence the imagination by referring to what is known today. One concept that combines all of these

In D. Hofman, F. Nikulka and R. Schumann (eds) 2022. *The Baltic in the Bronze Age. Regional patterns, interactions and boundaries*, Leiden: Sidestone Press, pp. 123-144.

qualities is that of “bronzesmith’s hoards” (sometimes “metalworker” or “craftsman’s” hoards, in German Handwerkerdepot, Gießerfund)[1].

While reading some archaeological publications, one may get the impression that authors using the term “bronzesmith’s hoards” do not always realise that it imposes a specific understanding of other terms and processes (as is the case for every term used in scientific works). For the concept of “bronzesmith’s hoards”, these inseparable terms and processes are, among others: the vision of ownership in ancient times, the organisation of metallurgical production, rules for trade and exchange, and even – because of the significance of bronze for the community of this period – the overall functioning of Bronze Age society.

For decades, the term “bronzesmith’s hoards” has appeared repeatedly in various works in many languages. It is not our goal to report these publications in detail, as this is too large an undertaking. Here we will merely draw out the main trends and changes in the understanding of this term in European archaeology, drawing on selected examples for illustration.

The classic understanding of the term “bronzesmith’s hoards” can be combined with the concept of “itinerant bronzesmith” (Wanderhandwerker). Its dissemination should be attributed to Childe (1930), who claimed that these highly specialised and independent craftsmen made the skill of bronze production known throughout the continent in a relatively short period and made the Bronze Age world go round, also in social terms. Much earlier, attention had been paid to the relationship of some (or perhaps all) hoards with the economic sphere, as well as more specifically with the activities of bronzesmiths (e.g. Chantre 1875-76, 68; Evans 1881, 457; Sadowski 1876 – who identified hoards with trade routes; Schumacher 1903). The prominent Romanian religious scholar Eliade (1956), who, thanks to his narrative skills and erudition, had a great influence on the imagination of many archaeologists, also disseminated the “itinerant bronzesmith” vision.

One of the most important papers that was critical of Childe’s proposal was Rowlands’ study (1971) focusing on ethnographic data on metallurgy. This paper, as well as others relating to traditional and early historical communities (Dietrich 2012, 211-14; Forbes 1950; Helms 1993; Neipert 2006, 132-35), indicates that “itinerant bronzesmiths” functioning as described by Childe (1930) are not known in traditional and early historical societies. Rather, the operating models for metallurgy – both highly specialised and with basic skills – are numerous and very diverse, both in terms of knowledge transfer, production organisation, time devoted to this type of work and distribution of finished products, as well as social status of practitioners. All this is more related to the organisation of the community as a whole than to the specifics of metalworking.

Nowadays, the concept of highly mobile people with a wide range of competences (including metallurgical) can be found, among others, in the intellectually influential work of Kristiansen and Larsson (2005; more broadly on metallurgy in Kristiansen’s earlier works, which present bronzesmiths as specialists associated with the elites, e.g. Kristiansen 1987), although it should be pointed out that they do not refer to “bronzesmith’s hoards” in their arguments. It should also be emphasised that in this concept mobility is not forced by economic factors (as in the works of Childe and Eliade), but is related to the functioning of the Bronze Age elite and the need for prestige, resulting, among others, from exceptional competences and distant connections.

Similarly, Nørgaard (2018) in her very extensive, thorough and erudite analysis tries to answer the question of what the mobility of bronzesmiths looked like in the Bronze Age. In addition to the indication of mobility within the local groups, it also proposes an alternative – firmly embedded in the elite vision of Scandinavian societies of that time – a vision of the “itinerant bronzesmith”. Highly specialised craftsmen associated

1 A similar term is also “trader’s hoards”, which in conventional approaches fall under the same current of interpretation of the phenomenon of mass deposition of goods (for a critical discussion see e.g. Fontijn 2008), but we will not deal with this term in this text.

with (dependent on) local elites would travel to exchange gifts, as was the case in Middle Eastern societies (Nørgaard 2018, 365-68).

There are many direct references to Childe's vision or similar interpretations of the phenomenon of metal hoards, as well as many critical reviews of the concept. Sometimes the authors do not know – or at least acknowledge – that they are using Childe's reasoning (e.g. Mierzwiński 2003). The announcement of the "death of a salesman" (Gibson 1996) is, however, too early, because the concept of "itinerant bronzesmiths" has not died and probably will never die in Bronze Age discourse.

A simplified and dichotomous approach to interpreting hoards, limited only to the division into ritual and non-ritual (see Bradley 1998, 4-42; 2017, 8-30), is also visible in the case of "bronzesmith's hoards". Finds from wetlands, which include casting moulds or other metallurgical artefacts, are used as arguments for the relationship between metallurgical production and the ritual sphere (Kuijpers 2008, 63).

For several decades, especially in western European archaeology, there has been a tendency to interpret hoards as a form of ritual or social activity (see Bradley 2017), which excludes the simple equation of "bronzesmith's hoards" with "itinerant bronzesmiths". In contrast, in Polish archaeology this approach is still used and widely discussed (Bukowski 1998, 257-64; Dąbrowski and Mogielnicka-Urban 2004; Mierzwiński 2003, 223-60; 2004), often without any reference to other aspects of the organisation of metallurgical production and the specificity of Bronze Age society (e.g. Orlicka-Jasnoch 2013), and sometimes – in our opinion – even overused (Wawrzyniak and Wawrzyniak 2018). However, it is worth emphasising that alternative ways of understanding the term "itinerant bronzesmith" are also suggested (e.g. Kośko 1979, 171-79).

The discussion of Bronze Age hoards thus differs markedly between countries, generally following wider theoretical trends (Bradley 1998, 15; Neipert 2006, 9-19, 33) and perhaps also the views of intellectually influential researchers. Among other things, this complexity of discourse shows the importance of tackling this significant term.

The concept of "bronzesmith's hoards" in the classical sense is often questioned, but it is impossible not to link some of the hoards of metal objects with metallurgical activity (Bradley 2017, 140). Bearing in mind the complicated biographies of various metal artefacts, they cannot all be merely a source of raw material. However, hoards often reveal objects – e.g. casting moulds, anvils – related to the manufacture of metal objects or perhaps associated with this field – e.g. chisels, grooved stones (Kannelurenstein).

The interpretative dichotomy between ritual or non-ritual (mainly economic) activities is also visible in the considerations on the organisation of metallurgical production in the Bronze Age. On the one hand, the bronzesmith is perceived as a representative of a professional, economically determined group with a specific specialisation, on the other he is presented as a person with broad magical competence. The extraction of raw material from ores, especially copper, is seen as either an almost industrial activity or a point in the annual work cycle (Budd and Taylor 1995)[2]. This "scientific trench warfare", in which the same data can be used to argue for opposite conclusions (see Bradley 2017, 40-41; Fontijn 2002, 13-21 tabs 2.1-2.3), and which at other times results in an endless series of archaeometallurgical measurements devoid of humanistic interpretation, does not lead to new proposals but rather cements the usual divisions. One of the solutions may be a critical and systematic return to the old concepts, which does not assume either their absolute rejection or adoption.

---

2 Another issue is related to the question of the extent to which a bronzesmith was only a specialist in metalworking or rather a craftsman with many competences – technical or magical (understood as initiation, the right to perform certain actions or use categories of items)? Helms (2009), based on Old English, Latin and Greek texts, indicates that there could be "masters of hard materials" working on metal, wood and stone. Similarly, Kowalski (2000), based on the analysis of Indo-European vocabulary, suggests that various materials (metal, flint, stone, bone, amber) were perceived very similarly in early Indo-European societies (including the Bronze Age). In this text, we limit ourselves to metallurgy as a separate field. This is connected rather with established traditions of discourse than with our deep convictions.

Between a rock (a hammer) and a hard place (an anvil)

The analytical tool which will give us control over the described chaos is very simple, you could say archaic. As many other researchers have done, we will analyse the inventory of hoards of metal objects according to a categorisation based on an as far as possible unambiguous relationship with the metalworking process in order to define new categories of finds.

Our research interest is focused on the metalworking process, understood as the stages from raw material to the finished metal object, but excluding the stages of ore extraction and processing[3]. We are aware that casting bronze items required many treatments and additional raw materials, such as wax necessary for making models, appropriate quality clay and stone raw material for the production of casting moulds, fuel (charcoal), skins for bellows, etc. Consequently, items used in bee keeping, tree felling (e.g. axes) and hunting (e.g. spearheads) can also be combined with the broadly understood chaîne opératoire of metallurgical production. However, we focus directly on the process of casting and surface preparation of finished objects (understood as removing casting jets, overflows, casting seams, grinding, sharpening, ornamentation, cold hammering etc.), which for us is the essence of the work of a metallurgist – the transformation of the shapeless mass of raw material into the liquid metal and then an object with its function and meaning, characterised by technical and aesthetic features preferred by the given community.

There are many papers and books whose authors propose a list of tools used in Bronze Age metallurgy (e.g. Armbruster 2000, 34-65; Găvan 2015, 51-63; Jantzen 2008; Jockenhövel 2019, 27; Kuijpers 2008, 81-106; Nessel 2010; 2019; Overbeck 2018), also experimental research provides knowledge on a set of objects necessary in such works (e.g. Armbruster 1995; Jantzen 1991; Nowak 2018). Such a set of tools, as well as residues from the metalworking process and raw material resources, can be called a metalworking toolkit. An important problem is to indicate which objects unambiguously – in the context of our knowledge and sources – were associated with the metalworking process, and which were only possibly associated with it, despite frequent references in the literature. This division will be a basis for our categorisation.

As objects most likely related to the metalworking process, we consider those that can only be used in the following type of manufacturing: (1) all types of casting moulds (made of various raw materials: clay, stone, metal, and used in various technologies: so-called permanent moulds as well as disposable ones used in the lost-wax method); (2) casting cores; (3) anvils; (4) so-called models and stamps (feste Modelle) used for the production of casting moulds; (5) crucibles; (6) tuyeres; (7) tongs used for both holding hot objects (e.g. crucibles) and other methods of processing, such as twisting.

A peculiar category of sources that are not part of the set of metallurgical utensils but are undoubtedly related to the metalworking process is casting waste: (8) casting jets; (9) bronze droplets and small, amorphous metal lumps – probably formed during the casting process; (10) removed overflows; (11) slags. Similarly classified can be: (12) unfinished objects, which we define only as artefacts with casting jets not removed, gaps and casting overflows or casting seams that prevent their use. At this point, one should also mention failed castings, i.e. objects with casting defects preventing their use. However, knowing examples of artefacts with significant casting defects, but which bear clear use-wear traces (e.g. Nowak 2019, 183), we are sceptical if it can be determined which casting defects indisputably indicate that an object could not be used. A similarly difficult group to define is "semi-finished products"; we realise that some finds can be interpreted as a raw material that someone began to process (e.g. cold hammering), but the ambiguity of such terms inclines us not to include such an ambiguous category in our classification.

Of course, metal was necessary for the metalworking process. There are various suggestions pointing to a very wide range of metal objects which fulfil the function of

3 Some authors point out that the metallurgical process (understood as the stages from raw material to the finished metal object) was divided into two parts – casting and smithing – and performed by specialised craftsmen (Dietrich 2012 footnote 3; Nessel 2019 and references therein).

raw material supplies (for example, this was how flat axes of the Early Bronze Age were classified, although based on metallographic studies, which indicate that their blades were cold hammered, i.e. prepared for use, this proposal seems unlikely – Kienlin 2010). The specificity of metallurgical technology means that all bronze objects may have been smelted (Kuijpers 2008, 71-79), but from an analytical perspective, it makes any consideration of raw material resources pointless. So-called scrap hoards, which some authors interpret just as a raw material store, while for others they are the result of ritual activities (e.g. Brück 2016; Dietrich 2014; Rezi 2011, 303-07), have been extensively discussed in the literature. This lively discussion and multiplicity of proposals results partly from the lack – in many regions of Europe and for most of the Bronze Age periods – of forms that would be equivalent to the ox-hide ingots known from the Mediterranean. We believe that only raw material resources in the form of (13) ingots and casting cakes can be considered as an unambiguous indicator of the relationship between hoards and metallurgy, as objects with shapes repeatable in large series (or their fragments) can have no function other than that of raw material resource.

The next category is objects that in the literature are sometimes – and in some cases even often, indisputably – connected with metalworking processes, but could also be used in other areas of life. An example are chisels, which could be used for instance for removing casting jets, but also could be tools for woodworking (see Drescher 1968; Gedl 2004, 73; Nessel 2019, 88). In our opinion, they are not sufficiently clear. Similarly, hammers[4] (and according to some authors even stone axes – see Kujipers 2008, 100-02; Nessel 2019, 75-84) are very commonly associated with metallurgical production. In our opinion, there is no doubt that they were used in such work. However, they could also be used in woodworking (together with chisels), or for other work that remains beyond our perception and, more importantly, imagination, especially as a large part of the material culture of the Bronze Age comprised organic artefacts.

Another problem is related to stone tools (which can perform very different functions – hammers, anvils, grinding stones etc.), for which there are only a few cases where the results of analysis indicate intense contact with metal, and therefore use in the metalworking process. Bearing in mind all these reservations, the list of items that could have been part of the set of metallurgical tools includes: (14) chisels; (15) punches; (16) awls; (17) scribers and gravers; (18) hammers; (19) files; (20) saws (rather with fine teeth, reminiscent of modern metal-cutting saws); (21) stone objects that are probably grinding-, whet- and polishing stones; (22) grooved stones (whose function is described in various ways in the literature – see Horst 1981; 1986; Ialongo and Rahmstorf 2019; this volume).

Our classification contains very different items, from those that were unambiguously associated with the metalworking process and allowed to make numerous series of items (in most cases we can call these items tools), through casting waste and potential raw material resources, to tools with an uncertain function. To express this diversity, and thus distinguish hoards, we suggest giving different points scores to individual categories: category No. I (1-7) – 3 points, No. II (8-13) – 2 points and No. III (14-22) – 1 point.

The points are awarded depending on the occurrence or not of given items in the hoard. The number of artefacts from each category does not matter. We also propose to give an additional 1 point when items in the presented categories represent more than half of the entire inventory. The sum of points is the metalworking index.

For example, a hoard including an anvil, two casting jets, and an axe would have 6 points: 3 points (anvil) + 2 points (casting jets) + 1 point (3 of 4 items related to the metalworking process). In the case of an assemblage consisting of two casting moulds

---

4 Catalogues and typologies of hammers are created based mainly on the shaping of their working surface (e.g. Jockenhövel 1982, 459-61, with further literature). The large variety of shapes allowed for versatile use. The weight of a hammer was also important. A rich literature on the function and use of hammers, as well as their typology has been recently collected and synthesised in a work from Romania (Gogâltan 2005, 371-72).

and 20 sickles, we would award 3 points. Similarly, 3 points would be given to a deposit consisting of only 6 casting cakes: 2 points (casting cakes) + 1 point (6 out of 6 items related to the metalworking process). The proposed tool is purely theoretical and aims to order the information available. The value of the metalworking index indicates the number, significance, differentiation and proportion of objects directly related to the metalworking process.

3… 2… 1… START – hoard competition

Turning now to our case study, it is also very important that at this time (Montelius periods IV and V) in this area (Pomerania and Mecklenburg-Vorpommern) we are dealing with many metal object hoards. On the one hand, they constitute a sufficient source base, and also suggest that metal was an important part of society and circulated intensively, even though (e.g. based on the style of metal artefacts) local metallurgical workshops were active in the different regions (Bukowski 1998; Fogel 1988; Jockenhövel 2000, 11-14; Kaczmarek 2017, 286-88; Keiling 1987; Probst 1996, 257; Żychlińska 2008).

As a source base for our research, we will use published regional studies on hoards (for Pomerania: Blajer 2001; 2013; Maciejewski 2016; finds related to metallurgy are also described in detail in Bukowski 1998, 257-64, 313-16; Sprockhoff 1937; 1956; for Mecklenburg-Vorpommern: Hundt 1997; Maraszek 1998; 2006; Sprockhoff 1937; 1956). We are aware that in recent years new hoards have been found on both sides of the Oder (e.g. the Babke hoard, containing a casting jet and chisel – Schanz 2015, 225), but as we were not able to perform a full source review, we rely on already published lists.

Hoards are a very specific category of archaeological finds. They are very rarely found during archaeological excavations, but usually by accident, for example during field and construction works. Most of them were found at the end of the nineteenth and the beginning of the twentieth century. All this means that we often do not know the exact place of their discovery and context. Artefacts included in such hoards went to various people, not always museums, less spectacular objects may not have been excavated or were omitted later. Fragments of bronze, which could have been casting jets or lumps of raw material, were not documented and not published so widely, sometimes photographs or drawings were made only of selected objects. A large part of the artefacts found before World War II did not survive, and this also applies to the documentation that could help in determining the details of the discovery or composition of hoards. In the case of the lists we present here, we encountered most or even all of these problems. So in our lists, there are many question marks for which it is difficult or impossible to find answers.

We used the proposed categorisation for 153 hoards from Pomerania dated to Montelius periods IV and V and 4 finds of unknown chronology[5]. In the case of Mecklenburg-Vorpommern, 76 hoards were included (according to Hundt 1997 for Montelius period IV and Maraszek 2006 for Montelius period V). Below are the tables (Tables 1 and 2) presenting basic information about those hoards which contain artefacts that may be part of the metalworking process and the metalworking index determined based on the above method. The locations of these hoards are presented on the map (Figure 1).

Analysing the presented data (Tables 1 and 2), one can point to several trends (or maybe a lack thereof). First of all, the hoards are very diverse in terms of metalworking index. Several contain a very large number of items related to the metalworking process, but most contain only single items from our categories, which are sometimes difficult to unambiguously identify.

---

5 Hoards in which tin objects/ingots were found were omitted; several such cases are known from Pomerania. From the period of interest to us, there is at least one find containing such objects – Sianiożęty (also known in the literature as Mirogniew or Kozia Góra); in addition there are several hoards and single finds of unknown date. In the literature, opinions on tin objects differ, they are described both as fragments of tin ornaments (it is important that some of them were ornamented; Blajer 2001, 350; Kostrzewski 1953, 210), as well as tin ingots (Bukowski 1998, 262-63).

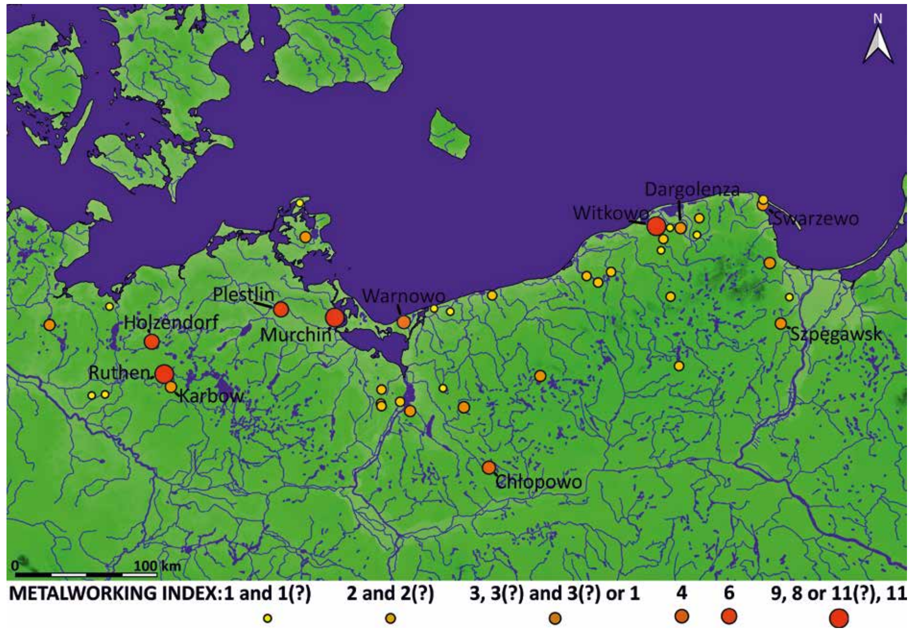


Figure 1. Distribution map of Late Bronze Age hoards (Montelius periods IV and V) with elements related to metalworking from Pomerania and Mecklenburg-Vorpommern (based on Tables 1 and 2).

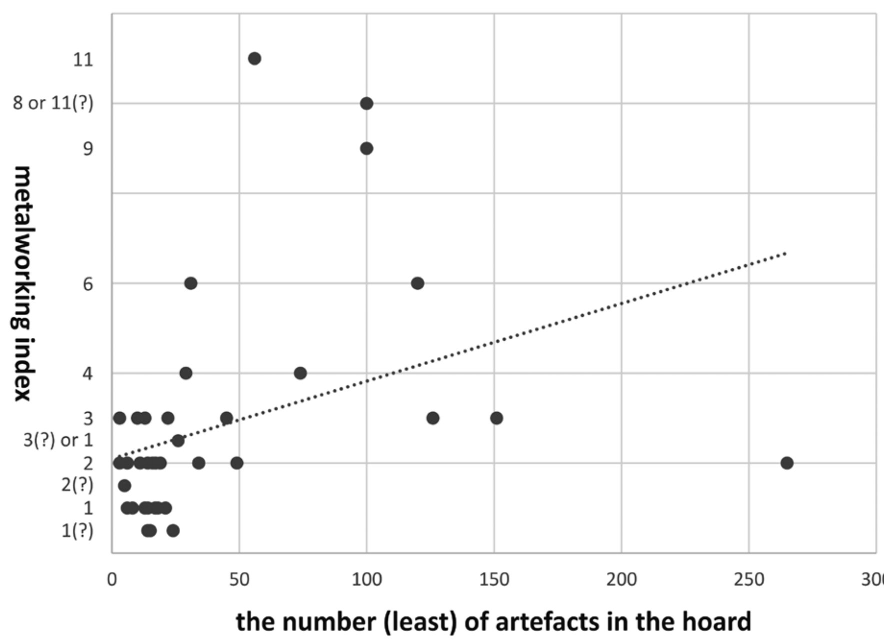


Figure 2. Correlation number of artefacts in hoards and metalworking index (based on Tables 1 and 2).

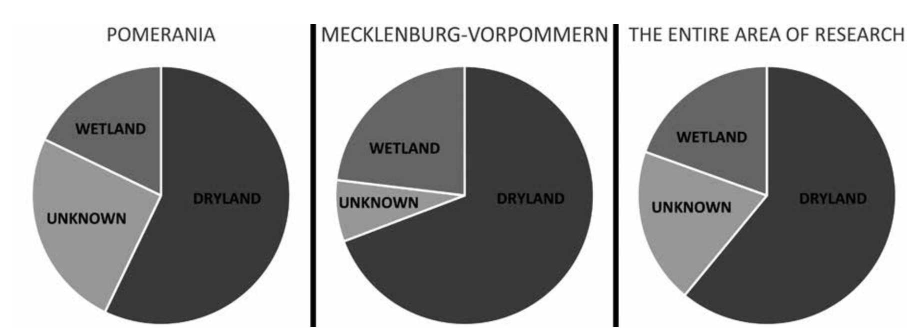


Figure 3. Incidence of hoards with elements related to metalworking found in wetland and dryland contexts (based on Tables 1 and 2).

HOARD	CHRONOLOGY (Mont. periods)	ARTEFACTS (TOOLS) UNAMBIGUOUSLY RELATED TO THE METALLURGICAL PROCESS (the numbers correspond to those used in the text)							PRODUCTION RESIDUES AND RAW MATERIAL RESOURCES (the numbers correspond to those used in the text)					
		1	2	3	4	5	6	7	8	9	10	11	12	13
Budzieszowce	V	-	-	-	-	-	-	-	-	-	-	-	-	-
Buk	V	-	-	-	-	-	-	-	2*	-	-	-	-	-
Chlebowo	V	-	-	-	-	-	-	-	-	-	-	-	-	2
Chłopowo	V	-	-	-	-	-	-	-	1	1	-	-	-	-
Chojniczki	V	-	-	-	-	-	-	-	-	4	-	-	-	-
Czarnówko	V	-	-	-	-	-	-	-	-	-	-	-	-	-
Damno	V	-	-	-	-	-	-	-	1*	-	-	-	-	-
Dargoleza	?	-	-	-	-	-	-	-	-	-	-	-	-	X*
Dąbrówka Bytowska	V	-	-	-	-	-	-	-	-	1 (?)	-	-	-	-
Dzwonowo	V	-	-	-	-	-	-	-	-	1 (?)	-	-	-	-
Gdańsk Klukowo	?	-	-	-	-	-	-	-	-	-	-	-	-	X (?)
Główczyce	V	-	-	-	-	-	-	-	-	-	-	-	-	-
Gwiazdowo	V	-	-	-	-	-	-	-	-	-	-	-	-	1
Kopaniewo	V	-	-	-	-	-	-	-	-	1	-	-	-	-
Niedysz	V	-	-	-	-	-	-	-	-	-	-	-	-	-
Niemica	V	-	-	-	-	-	-	-	-	2	-	-	-	-
Pszczółki	V	-	-	-	-	-	-	-	-	-	-	-	-	-
Stara Dąbrowa	V	-	-	-	-	-	-	-	-	-	-	-	-	-
Stary Borek	V	-	-	-	-	-	-	-	1	-	-	-	-	-
Strzeżewko	IV*	-	-	-	-	-	-	-	-	-	-	-	-	-
Swarzewo	?	-	-	-	-	-	-	-	-	-	-	-	-	151 (al)*
Szczecin Klęskowo	V	-	-	-	-	-	-	-	1	-	-	-	-	-
Szczecin (Wzgórze Zamkowe)*	V	-	-	-	-	-	-	-	-	-	-	-	-	1 (al)
Szpęgawsk	?	-	-	-	-	-	-	-	-	-	-	-	-	10 (al)
Warnowo	V	-	-	-	-	-	-	-	1	3*	-	-	-	-
Witkowo	V	-	1	1	-	-	-	-	-	X	-	-	-	3 (al)
Władysławowo	V	-	-	-	-	-	-	-	-	-	-	-	-	4
Zielenica	V	-	-	-	-	-	-	-	-	-	-	-	-	2 (fr.)

Table 1. Late Bronze Age hoards (Montelius periods IV and V) with elements related to metalworking from Pomerania (based on Blajer 2001; 2013; Bukowski 1998, 257-64, 313-16; Maciejewski 2016). al = at least; fr. = fragments; (?) denotes doubtful cases.

ARTEFACTS (TOOLS) PROBABLY RELATED TO THE METALLURGICAL PROCESS (the numbers correspond to those used in the text)									**ITEMS IN THE HOARDS / ARTEFACTS THAT ARE PART OF THE METALWORK TOOLKIT**	**METALWORKING INDEX**	**CONTEXT / COMMENTS**
14	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**			
-	-	-	-	-	-	-	1 (?)*	-	14/1	1(?)	found in 1868 during gravel extraction, at a depth of 6 inches / the stone artefact marked with * is described as “faced stone plate with a hole”
-	-	-	-	-	-	-	-	-	49/2	2	found in 1934 during spreading of a modern potato storage mound on a Late Bronze Age settlement, hoard placed in a pot near the probable hearth / * casting jets or casting cakes
-	-	-	-	-	-	-	-	-	3/2	3	- / -
-	-	-	-	-	-	-	-	-	74/2	4	discussed in the text / -
-	-	-	-	-	-	-	-	-	17/4	2	found during fieldwork, at a depth of 0.25 m / -
1 (fr.)*	-	-	-	-	-	-	-	-	13/1	1	found in 1893 in a former pond on sandy ground / -
-	-	-	-	-	-	-	-	-	11/1	2	found during field work at a depth of 0.20-0.30 m, within a small pot / * casting jet or casting cake
-	-	-	-	-	-	-	-	-	X/X	3	discussed in the text / -
-	-	-	-	-	-	-	-	-	5/1	2(?)	found in 1892 / -
2	-	-	-	-	-	-	-	-	26/3 or 2	3(?) or 1	found during road construction in the 1840s, the items were lying next to a large stone / -
-	-	-	-	-	-	-	-	-	X/X	3(?)	information forwarded to W. Blajer by M. Gedl, very likely a find from the Early Bronze Age; the Pomeranian breastplate from Gdańsk Klukowo may be part of the same find
1 (fr.) (?)	-	-	-	-	-	-	-	-	15/1	1(?)	found in 1842 in the court fields / -
-	-	-	-	-	-	-	-	-	6/1	2	found around 1935 while digging (or dredging) a manure pit in farmer Kautz’s buildings / -
-	-	-	-	-	-	-	-	-	19/1	2	found in a swamp, the items were in a “wooden box” made of logs / -
-	-	-	-	1	-	-	-	-	6/1	1	found in a swamp / -
-	-	-	-	-	-	-	-	-	17/2	2	found during ploughing, the items were in a pot / -
1 (fr.) (?)	-	-	-	-	-	-	-	-	24/1	1(?)	found in 1921 while ploughing the meadow / -
-	-	-	-	-	-	-	4	-	18/4	1	found during ploughing / -
-	-	-	-	-	-	-	-	-	3/1	2	- / -
1	-	-	-	-	-	-	-	-	21/1	1	found in 1934 during drainage at a depth of 0.50 m, probably in an unnamed watercourse or in its valley / * 1st half of period IV
-	-	-	-	-	-	-	-	-	151(al)* / 151(al)*	3	discussed in the text / -
-	1, 1 (fr.)	-	-	-	-	-	-	-	45/3	3	found at or near the urnfield cemetery, the items were in an “urn” or pot, lying next to a large stone / -
-	-	-	-	-	-	-	-	-	14(al) / 1(al)	2	found during excavations in 1973 in a pot; the location and the finds of other excavations carried out at this place suggest that there was a Late Bronze Age settlement / * Castle Hill
-	-	-	-	-	-	-	-	-	10(al) / 10(al)	3	discussed in the text / -
-	-	-	-	-	-	-	-	-	29/4	4	discussed in the text / * described as “molten bronze nuggets”, but could also be casting cakes
1	-	-	-	-	-	-	-	-	56(al) / 7 (al)	11	discussed in the text / * commentary on the inventory in the text
-	-	-	-	-	-	-	-	-	34/4	2	found in 1874 on an elevation, at a depth of 0.5 feet, one of three hoards from Władysławowo dated to Montelius Period V / -
-	-	-	-	-	-	-	-	-	6/2	2	found during the spreading of a modern potato storage mound / -

HOARD	CHRONOLOGY (Mont. periods)	ARTEFACTS (TOOLS) UNAMBIGUOUSLY RELATED TO THE METALLURGICAL PROCESS (the numbers correspond to those used in the text)							PRODUCTION RESIDUES AND RAW MATERIAL RESOURCES (the numbers correspond to those used in the text)					
		1	2	3	4	5	6	7	8	9	10	11	12	13
Bäk	IV	-	-	-	-	-	-	-	1	-	-	-	-	-
Barnekow	IV	-	-	-	-	-	-	-	-	-	-	-	-	-
Bergen	V	-	-	-	-	-	-	-	-	1	-	-	-	-
Holzendorf	V	1	-	-	-	-	-	-	4	-	-	-	-	-
Karbow	V	1	-	-	-	-	-	-	-	-	-	-	-	-
Klein Krams	V	-	-	-	-	-	-	-	-	-	-	-	-	-
Lanken	V	-	-	-	-	-	-	-	-	-	-	-	-	-
Ludwigslust	V	-	-	-	-	-	-	-	-	-	-	-	-	-
Murchin	V	-	-	1 (?)	-	-	-	-	13	-	-	-	3	6 (al)
Plestlin	V	-	-	1	-	-	-	-	-	-	-	-	-	2
Schwennenz I	V	-	-	-	-	-	-	-	-	-	-	-	-	2
Schwennenz II	V	-	-	-	-	-	-	-	-	-	-	-	-	1
Ruthen	V	-	-	-	1	-	-	-	1 (al)	-	-	-	2	1 (al)

Table 2. Late Bronze Age hoards (Montelius periods IV and V) with elements related to metalworking from Mecklenburg-Vorpommern (based on Hundt 1997; Maraszek 1998; 2006; Sprockhoff 1937; 1956). al = at least; (?) denotes doubtful cases; (fr.) = only a fragment of the object was deposited or survives; X = number of artefacts unknown.

Secondly, the higher the value of the metalworking index, the more hoards with a large number of artefacts are represented (Figure 2). We believe that hoard inventories reflect cultural patterns. It is also worth considering what was more important for people depositing metal objects – the cultural significance of metal (bronze) and the symbolism attributed to it, or maybe the form, category, function, biography of specific artefacts. If the desire to assemble metal in itself was dominant, then the relationship between hoard size and metalworking index may be associated with a greater chance that a large collection will include objects to which we give special meaning – because they are related to the metalworking process.

Thirdly, the hoards were found (deposited) in various contexts. Here we use only a simplified division into wetland or dryland (Figure 3). Bearing in mind the rudimentary archival descriptions and lake disappearance processes (the Trzcińsko-Zdrój hoard is a very suggestive example – Rogalski 2017), it can even be suggested that originally a larger number of hoards were deposited in lakes or swamps. Even without this reservation, it is clear that hoards with objects associated with the metalworking process were assembled in different contexts (see below).

Maybe context is the key?

In the case of Pomerania, most of the finds that can be associated with the metalworking process belong to the category of casting waste and raw material resources (category No. II). Tools that can be uniquely associated with metallurgy (category No. I) are very rare, they appeared in one hoard. There are also a few tools included in category No. III.

ARTEFACTS (TOOLS) PROBABLY RELATED TO THE METALLURGICAL PROCESS (the numbers correspond to those used in the text)									ITEMS IN THE HOARDS / ARTEFACTS THAT ARE PART OF THE METALWORK TOOLKIT	METALWORKING INDEX	CONTEXT / COMMENTS
14	15	16	17	18	19	20	21	22			
-	2	-	-	-	1	-	-	-	126 (al) /2	3	found near the steep slope of lake Ratzeburg, at a depth of about 0.5 m in the sand / -
-	-	1	-	-	-	-	-	-	17/1	1	found in 1880, in peat, some thrown back into the swamp by workers / -
1	-	-	-	-	-	-	-	-	13 or 14 / 2	3	found next to Nonnensee lake near Bergen, while excavating stones, under a stone slab / -
1	-	-	-	-	-	-	-	-	31/7	6	discussed in the text / -
-	-	-	-	-	-	-	-	-	22/2	3	discussed in the text / -
1	-	-	-	-	-	-	-	-	8/1	1	found in 1935 in a place called Klöter-Berg while ploughing, under a large stone / -
1	-	-	-	-	-	-	-	-	13/1	1	found in 1887, at a shallow depth in an open field while digging and removing large stones that were located directly next to each other; all artefacts were wrapped in a thin wire, now lost / -
-	-	1	-	-	-	-	-	-	14/1	1	found in 1837, a few feet below ground level (sand) in a pot that has not survived / -
4	1	-	-	-	-	-	-	-	100 (al) / 23 (al)	8 or 11(?)	discussed in the text / it is uncertain whether the artefact described as the anvil really was one
-	-	-	-	1	-	-	-	-	120 (al) / 4	6	discussed in the text / -
-	-	-	-	-	-	-	-	-	16 (?) /2	2	found in the sand, at a depth of about 2 feet in a pit, the artefacts were in a bronze vessel, in a pot and next to the vessels / -
-	-	-	-	-	-	-	-	-	265 (al) / 1	2	- / -
-	-	-	-	-	-	-	-	-	100 (al) / 4 (al)	9	discussed in the text / -

Among the finds from Pomerania is the Witkowo hoard. It is the only assemblage that includes tools undoubtedly related to metallurgy – an anvil and a casting core[6]. In addition, this hoard included a chisel and numerous examples (in the literature there is no accurate information) of casting waste and casting cakes, weighing about 4.5 kg in total. In addition to these items, the hoard consisted of very different objects: a fragment of a sword, five spearheads, a battle axe, a knife, 24 axes of various types, two cheek-pieces, fragments of bronze vessels, a necklace, 11 fully preserved or damaged bracelets (one of them referred to as a leg ring), fragments of two fibulae and a phalera. Thus, the hoard included very different categories of bronze artefacts, some were complete, some were fragmented. They also came from different regions, many were characteristic of the circum-Baltic area, but other areas, e.g. the Alpine area, are also represented. The context of this find is also interesting. It was found close to low hills, near a large stone. The metal artefacts were said to be in a pottery vessel (probably only some of them), while some (or all) of the bronze fragments were found around the stone. The site is located at the foot of hills inhabited in the Late Bronze Age (based on the results of fieldwalking), there is also a small watercourse nearby (Maciejewski 2016, 108, 144; Sprockhoff 1956, 66).

The next two hoards with a relatively high metalworking index are the Chłopowo hoard and the Warnowo hoard. In both cases, the assemblage included casting waste – casting jets and amorphous bronze lumps referred to as "casting lumps". Both hoards are extensive (74 and 29 artefacts) and their composition – as in the case of Witkowo – is varied. What makes the described assemblages different is the context of their discovery. The Chłopowo hoard was found in 1857 in a "pit with water", "about 3 feet below the water

6 Some publications mention two anvils – e.g. Kostrzewski 1953, 195; Sprockhoff 1956, 66; however, we are inclined to follow Gedl's (2004, 113) opinion that one was a casting core used for producing socketed axes.

table", probably "in a box made of copper sheet" (Sprockhoff 1956, 60). It is uncertain how to interpret the information about the pit with water, whether it was a small lake that also existed in the Bronze Age, or a feature created in the nineteenth century (maybe a well). It should be noted, however, that Chłopowo is located in an area rich in lakes, which confirms the interpretation that it was a water reservoir also present in the Bronze Age. The Warnowo hoard was found on a hill near a muddy meadow, it lay "loosely in the ground" in a pottery vessel (Sprockhoff 1956, 67). This description may suggest similar circumstances to the case of Witkowo. In the case of the Chłopowo and Warnowo hoard we do not know the exact location of the discovery, so it is not possible to establish a relationship with local Bronze Age settlement, which could be particularly interesting in the case of Warnowo, given its other similarities with the Witkowo hoard, which was found near a settlement (Hidde 1997; Maciejewski 2016, cat. item 41, 387; Sprockhoff 1956, 60, 66-67; www.geoportal.gov.pl).

In the context of the issues discussed in this paper, the Dargolenza, Szpęgawsk and Swarzewo hoards are also of interest (perhaps also the Gdańsk Klukowo hoard, but information about this find consists only of a brief mention based on oral information – Blajer 2001, 372). The metalworking index of all these finds is 3. However, their composition is unique within the study area. In the first hoard, there are only ingots; their number is unknown. The only information about the circumstances of discovery is that they were unearthed by pigs. The Szpęgawsk hoard consists only of casting cakes. The available information indicates that between ten and 14 objects were found next to a large stone. They would have to be quite large, because the whole hoard weighed about 100 kg. Unfortunately, the artefacts are lost and we cannot say anything more about the context of their discovery. Before World War II, metal composition analyses were carried out which indicated a significant proportion of iron in the alloy. The last assemblage – the Swarzewo hoard – also consists of ingots (various numbers are given in the literature – 151 or at least 156), together weighing about 27 kg. This assemblage was found in 1872 or 1874 on the shores of Puck Bay and the bronzes were said to lie next to a large stone at a depth of about 1 metre. It is difficult to unambiguously establish the chronology of these finds; usually, the Early Iron Age is suggested (Blajer 2001, 370-71; Bukowski 1998, 261-63; Kostrzewski 1953, 210-11).

Among the hoards from Mecklenburg-Vorpommern which contain the largest number of items that can be associated with the metalworking process are the Plestlin, Holzendorf, Ruthen, Karbow and Murchin hoards (Table 2). The first four assemblages were found at the end of the nineteenth century, and for this reason the information on the contexts of their discovery is not precise. Generally, compared to Pomerania, hoards from Mecklenburg-Vorpommern contain a larger number of tools (importantly, in a smaller group of finds), both those unambiguously associated with the metalworking process and those whose relationship with metallurgy is doubtful. In both regions, the largest number of finds of interest are casting waste and raw material resources.

The Plestlin hoard was found in 1822 under a large heap of stones while the stones were being broken or blown up. According to reports, 120 similar axes were found, alongside two large casting cakes and smaller items. The cakes and some of the axes went to the Königliche Kunstkammer in Berlin in 1824, the others were mainly sold to private individuals. The coppersmith from the town of Demmin bought most of the items for a barrel of beer. Some items that were in farmers' hands were collected in 1823. These relics include mainly socketed axes (39 pieces), winged axes with a lobe (9), a bracelet, as well as a socketed hammer, anvil and fragments of bronze (Maraszek 1998, 156-57; Sprockhoff 1956, 51).

The Holzendorf hoard was found in 1858 during peat extraction in a bog. The objects were found lying together in one place. The assemblage includes about 30 items: a bronze casting mould for the production of socketed axes, a "recycled" chisel made of a twisted necklace, four casting jets, ornaments (a tutulus, tubes, pins, necklaces, bracelets), as well as fragments of a sickle and a socketed axe (Gärtner 1969, 57-58; Hundt 1997, 60; Sprockhoff 1956, 32).

The Ruthen hoard was found in 1874 during peat extraction in a very small bog (Hundt 1997, 63; Sprockhoff 1956, 32). About 100 objects lay at the bottom of the peat bog, side by side. Most of the hoard consisted of fragments of metal objects, including ornaments (necklaces, bracelets, fibulae and pins), weapons (one sword in four fragments, a spearhead), tools (socketed axes and sickles) and bronze vessels. Only three knobbed sickles and three sets of metal rattles (Klapperschmuck), which have casting defects in the form of misruns, were preserved in their entirety. Part of the fragments derived from circular ornaments, as well as tweezers, were repaired using the cast-on method (Überfangguß). The inventory also includes items with casting jets, such as two bracelets similar to each other, one complete and the other represented by one fragment. In addition, there were one casting jet and a stamp-shaped object with two diagonal lines on one of the surfaces; such artefacts are identified as models for the production of casting moulds (Sommerfeld 1994, 250; this is how we categorise this artefact) or as metal anvil (Nessel 2019, 588).

The Karbow hoard was found in 1881 (Sprockhoff 1956, 34) scattered loosely in a swampy arable field. It was found near the surface, almost directly below the ground level. The assemblage includes five large and four small phalerae and four cheek-pieces. In addition, the hoard contained a two-part bronze casting mould for the production of socketed axes. All items are preserved in full and in good condition. It is interesting that one or two sets probably associated with horse harnesses and a complete two-piece casting mould were deposited in one place.

The hoard found in Murchin is among the largest Bronze Age hoards in Mecklenburg-Vorpommern and undoubtedly contains the largest number of items that can be related to the metalworking process (Schoknecht 1975). In 1968, two bronze objects were found on the surface of the arable field – a knobbed sickle and a spearhead. It was decided to undertake a survey at the site, suspecting that the items could be part of the inventory of a damaged hoard. In 1969, after repeated surveys, a considerable number of metal objects had been found. Most likely, after deep-ploughing the field, most of the deposit was pulled to the surface. In the zone where the largest number of items had been found in the surveys, excavations were also carried out, leading to the discovery of several more bronze objects. No discoloration was identified that could indicate either a pit in which the hoard was deposited or the location of a potential pottery vessel into which the metal artefacts might have been placed. As no sherds were found, the hoard was either not in any container or in one made of organic material which has not survived. In the area with the densest concentration of objects, just below the surface, there was a huge erratic stone, on which the hoard could once have been deposited. Schoknecht (1975) claims that as the assemblage was disturbed by the plough, it could not have been deep and not too far from the stone. During excavation, a feature dating to the Roman period (furnace) was also found. It cannot be unambiguously stated whether the stone was part of the furnace construction, or whether the association was accidental. Depending on the interpretation of the function of the large stone, the description of the depositional act may hence vary.

The hoard was found in the northern part of the present-day village, near the last buildings. It is a flat area of clay farmland located north-east of the Küchensee lake. Another hoard of metal objects dating to Montelius period III/IV also comes from the same town. Its inventory included a “bronze box” (Bronzedose) – probably some kind of metal vessel.

The assemblage found in 1968-1969 consists of over 100 items. The majority are socketed axes (27 whole and eight in fragments). In addition, the inventory included four socketed chisels, three spearheads and seven sickles of different types, of which three have preserved casting jets. Ornaments, found both whole and in fragments, include various types of bracelets, necklaces, rings and pins. Besides, there were fragments of a sword, knife, bit, winged axe, probably of an anvil, as well as fragments of a chisel or punches. The hoard’s inventory is supplemented with casting jets (13 pieces) and numerous remains of casting cakes and metal ingots. The total weight of the bronze artefacts is 8130 g. In addition to items of the local, Nordic type, the hoard also included imported items, mainly from western and north-western Europe (Schoknecht 1975, 170).

Casters or bronzesmiths

Some authors suggest that the Bronze Age metallurgical process was divided into two stages – casting and bronze smithing – and that both groups of craftsmen collaborated (Dietrich 2012, 211; Jockenhövel 1982, 300; Nessel 2019). This interpretation is based mainly on finds from graves. This trend is especially visible in Eneolithic and Early Bronze Age graves (cf. Bátora 2003), and the phenomenon is not common in the Late Bronze Age. Additionally, the graves are rarely equipped with an anvil and casting tools or other bronzesmith tools (Nessel 2019, 275). Based on grave goods, Jockenhövel (2018, 314; 2019, 23) distinguishes two main categories of activities: primary metallurgy, which includes extraction and processing of ore, as well as casting (pyrometallurgy), and secondary metallurgy related to the plastic shaping of metal objects (bronze smithing).

Accepting that the grave goods show the professions of the deceased requires the assumption that all artefacts belonged to him (and where we have information, these are mostly males) and were not gifts from other members of society. In the case of hoards, such interpretations also suggest that the metal objects belonged to one person, or that a caster or a bronzesmith was a member of the group that deposited the metal objects.

In the case of the hoards with elements related to metalworking discussed in this paper, is there a clear distinction between casting and bronze smithing artefacts? The Holzendorf hoard contains a bronze casting mould, chisel and four casting jets, the Ruthen hoard contains an item that could be used to make a negative in a casting mould or wax model, unfinished items and a casting jet. These sets may suggest that the caster both made molds (primary metallurgy), as well as preformed the manufactured objects – he removed casting jets and overflows (secondary metallurgy). In turn, the Plestlin hoard contains an anvil and a hammer, and the Murchin hoard contains tools that could be used from the stage of cleaning the casting to its ornamentation, as well as unfinished items and casting jets. This may suggest that the caster's work was finished before the casting jets and overflows were removed. The classification of the Witkowo hoard is problematic, it contains both the casting core used at the casting stage (some authors classify this object as an anvil, see note 6 above), as well as tools that can be associated with the bronzesmith's work; additionally, numerous difficult to characterise casting remnants were included in the hoard. It should be emphasised that in the case of hoards dominated by bronzesmith tools (Murchin, Plestin and Witkowo), there were also casting cakes and ingots, which should be associated with casting work[7].

The interpretations separating the metallurgical process into two parts are based mainly on the few graves with metallurgical tools, as well as hoards with elements related to metalworking, which also constitute a small percentage of all finds (this is also confirmed by the presented database; see Nessel 2019). Hoards with both bronzesmith's tools and casting moulds are extremely rare (e.g. the Génelard hoard – Armbruster *et al.* 2019, fig. 18). In the study area, the pattern is in any case not so obvious, as objects related to casting and bronze smithing can occur in the same assemblages. The previously indicated assumptions about the properties of metallurgical tools also make the model for the division of tasks controversial (especially in the case of hoards). It is probable that there were many models of the organisation of metallurgical production in the Bronze Age, which is also indicated by the previously mentioned ethnographic sources.

---

7 The find in Rannersdorf in Lower Austria (Reiter and Linke 2018) may indicate the possibility that casting and smithing activities were combined "in one workshop". Object No. 5802 was defined as a workshop area, including a hearth with burnt clay and charcoal, a large stone (about 50 x 25 cm) serving as an anvil, a metal bracelet, a stone most likely used as a hammer, fragments of domestic cattle bones (possibly tools) and potsherds. The site was defined as a workshop where the surface of objects was shaped by forging, and the hearth located within it was not associated with casting, but with annealing the objects between successive stages of forging. A hoard of metal objects (many fragments of casting cakes; object no. 5720) was deposited in a pottery vessel very close to the workshop. Most likely, the workshop was not only related to forging and annealing, but also to casting, as the raw material deposited (stored) in a vessel near the workshop may indicate.

Unique or similar?

In the analysed database of 229 hoards known from Pomerania and Mecklenburg-Vorpommern and dated to Montelius periods IV and V, there are 41 hoards with artefacts more or less likely to be associated with the metalworking process. Of course, the question arises whether an assemblage with a piece of bronze that may be casting waste and a hoard containing objects that could have been used for casting dozens or maybe hundreds of artefacts should be interpreted in a similar way. In our opinion, this is not the correct approach. That is why we proposed the metalworking index, which systematises the description of such finds and helps to distinguish finds with high potential for research about metallurgy in the Bronze Age from those whose potential is significantly lower.

Undoubtedly, an important group are hoards containing tools that can be unambiguously associated with metalworking. The metalworking index scores such finds the highest, so this should not come as a surprise. However, it should be emphasised that in the majority of assemblages, alongside artefacts of category No. I (1-7), there was also casting waste, raw material resources or tools ambiguously related to the metalworking process. The exception is the Karbow hoard, in which, apart from the casting moulds, there were only elements of horse harness. The Pomeranian Kiełpino hoard (Montelius period VI) has a similar character (Ebert 1926, 14-15, plate 10; Kozłowska-Skoczka 2012, 179-81). Besides, we should note that all these hoards are very large: the Karbow hoard has 22, the Holzendorf hoard 31 and the Witkowo hoard at least 56 artefacts. Other deposits of this type – Murchin, Plestlin and Ruthen – have over 100 metal objects. All these collections are also very diverse, they contain various categories of metal artefacts interpreted as weapons, tools, ornaments, elements of horse harness, as well as bronze vessels. Interestingly, items of the same category (e.g. axes) are often represented by very different archaeological types and even manufacturing methods (e.g. socketed axes and winged axes occur in the same assemblages).

Most of the hoards with a high metalworking index are known from Mecklenburg-Vorpommern, only Witkowo lies east of the Oder. The described assemblages have been found in various contexts. The Holzendorf and Ruthen hoards, perhaps also the Karbow hoard, were deposited in wetlands. Others were found on dry land and some were near stones/large stones or even stone constructions. It is worth emphasising here that the Witkowo hoard was deposited very close (about 200-300 m) to a Bronze Age settlement. The place where the metal objects were deposited was thus inscribed in the sociotopography of the area used by the group inhabiting the settlement. Stone and hoard were part of the Late Bronze Age landscape.

In turn, in the case of the Plestlin hoard, the stones under which the metal objects were supposedly located were described as a probable grave construction. The chronology of this construction, found at the beginning of the nineteenth century, is problematic. Was it earlier than the hoard (in the literature it is suggested that it could have been a megalith)? But why were the metal artefacts – according to the description – found under the stones? This would suggest that the stone structure was later. This, in turn, indicates that the memory of this place remained active among local communities for some, maybe even quite a long time. Another alternative is to compare the find to the Rosko hoard (Maciejewski 2019a), which was also deposited near a stone (stone-earth) construction. The excavations carried out there suggest that the erection of this construction was part of the act of deposition of the metal objects. Had the Plestlin hoard been placed under a similar construction? This is difficult to unambiguously confirm, because our information is too limited, but it is worth considering such a possibility. It does not matter if there was an earlier grave (burial mound, megalith etc.) in this place, or instead a Late Bronze Age construction similar to that at Rosko, or indeed a grave with a monumental construction post-dating the hoard – what matters is that regardless of the chronology of the stone construction, this place was an important element of the landscape (memory) of the communities living around modern Plestin.

Another, not so common but repeatable feature of hoards with a high metalworking index is the deposition of metal objects in containers – pots or boxes made of sheet metal (which have not survived and seem unique in Bronze Age Europe).

A group of finds which do not have such a high metalworking index, but are interesting in the context of the problems discussed here, are three raw material hoards: Dargolenza, Szpęgawsk and Swarzewo (and maybe the Gdańsk Klukowo hoard). Of course, we can say that they have a very similar composition, we can also point out that they were deposited in a similar context, on dry land near large stones (Szpęgawsk and Swarzewo, although it is worth noting that this second hoard was found "on the shore of Puck Bay" – Blajer 2001, 371, which may indicate a specific place in the Bronze Age landscape). All these finds occur in the east of the study area. The problem, however, is the lack of information for establishing their chronology. It is suggested in the literature that they were deposited in the Early Iron Age, which would coincide with the development of local – spectacular – metallurgy and the intensification of amber exchange along the Lower Vistula at that time (see Dzięgielewski 2017). These are, of course, indirect premises, so it is difficult to unambiguously interpret these findings as an expression of similar – simultaneous – processes.

Business as usual, more questions than answers – discussion

At this point, it is worth asking whether the described finds, especially those with a high metalworking index, stand out in a way other than by the presence of objects unambiguously associated with the metalworking process. The features that characterise and connect most of them – numerous and varied inventory and deposition near stones – are recurring features of Late Bronze Age hoards in the southern Baltic area (see Blajer 2001; 2013; Bukowski 1998; Maciejewski 2016; Maraszek 1998; 2006; Sprockhoff 1937; 1956). So it is difficult to say whether these hoards are distinguished by specific characteristics of depositional acts, whether there is some deposition scheme, and even whether there are features such as deposition site (wetland/dryland) that unambiguously distinguish them.

An important question seems to be at which stage of the cultural biography individual artefacts (especially tools) were deposited. Could they still be used? If so, it is necessary to think about whether and why people stopped using them. Was it impossible to pass them on? Perhaps the objects had lost their functional qualities in a technical sense, but also in an aesthetic or symbolic sense (e.g. in the case of casting moulds). Answers to these questions are very difficult, but we are convinced that detailed analyses and new methods (e.g. 3D modelling of tools or even all casting-related objects – see e.g. Garbacz-Klempka *et al.* 2016) will allow them to be answered in the future, at least for those cases in which the artefacts are still available.

The aforementioned lack of clear depositional patterns for Late Bronze Age hoards (not only hoards with elements related to metalworking) may be related to the frequency of such acts. Could they have been associated with agricultural work, hunting or preparing food supplies for the winter, which took place on an annual basis? Births of children, funeral rites or construction of houses in communities of several dozen or even several hundred people also had to take place quite often, at least every few years. Based on the number of known hoards (even making extrapolations – for example, assuming we only know 10 % of hoards deposited in the Late Bronze Age), the act of deposition of metal objects by members of one community took place very rarely, probably less than once a generation (see Maciejewski 2016, 160-61; 2019b). Thus, reproducing the sequence of such an act in a society based solely on oral tradition was not easy, or at least, it was difficult to maintain the kind of repeatability that would be legible after 3,000 years, based on such a specific category of finds as hoards.

On the other hand, the patterns contained in various aspects available to us – mainly composition (number, origin, function of artefacts, production and use-wear traces etc.) and context (place and specificity of the act of deposition, relations with a settlement of the same period, etc.) – may be the result of their different symbolism, and symbolism resulting from combining several aspects in one act. What we read as differences may be a reflection of the emphasis placed on various mythical messages functioning within one ideological system, and their selection during the act of hoard deposition depended on the purpose of the people involved. Did adding metallurgical items have a purpose? Probably yes. Did they indicate that the owner of the hoard was a metallurgist? Could it be a message that the metallurgist was part of the depositing community, which gave it prestige? Or did it celebrate supernatural powers (gods) associated with metallurgy? There are different possible explanations, and to identify the most likely interpretation requires more detailed, contextual studies.

Both adherents of ritual and non-ritual interpretations will find arguments in support of their favourite models in the data we have presented. Of course, we are also embedded in this discourse and closer to one of the sides of this intellectual dispute. Our goal in this text, however, was not to convince the reader of the interpretation we prefer, but to give the discourse a more reliable framework by proposing a tool – the metalworking index – that can be used to organise and grade finds. Organising what is difficult to organise – after all, this is the goal of science. The examples presented in our text show how diverse hoards with elements related to metalworking are. Searching for one interpretation encompassing them all – and not taking into account the context – will most likely be a simplification.

Acknowledgements

This paper was financially supported by the National Science Centre, Poland (project no. UMO-2017/27/N/HS3/01097 and project no. 2021/41/B/HS3/00038).

Bibliography

Armbruster, B.R. 1995. Funktionale Analogien als Quellen für die experimentelle Archäologie – Metalltechniken und Werkstätten aus Westafrika. *Experimentelle Archäologie* 8, 347-61.

Armbruster, B.R. 2000. *Goldschmiedekunst und Bronzetechnik. Studien zum Metallhandwerk der Atlantischen Bronzezeit auf der Iberischen Halbinsel.* Montagnac: Editions Mergoil.

Armbruster, B.R., Jockenhövel, A., Kapuran, A. and Ramadanski, R. 2019. The moulds from Velebit and European Bronze Age metal anvils. *Starinar* 69, 139-82.

Bátora, J. 2003. Contributions to the problem of „craftsmen“ graves at the end of the Aeneolithic and in the Early Bronze Age in central, western and eastern Europe. *Slovenská Archeológia* 50, 179-228.

Blajer, W. 2001. *Skarby przedmiotów metalowych z epoki brązu i wczesnej epoki żelaza na ziemiach polskich.* Kraków: Księgarnia Akademicka.

Blajer, W. 2013. *Młodsza epoka brązu na ziemiach polskich w świetle badań nad skarbami.* Kraków: Towarzystwo Wydawnicze „Historia Iagellonica”.

Bradley, R. 1998. *The passage of arms. An archaeological analysis of prehistoric hoards and votive deposits.* Oxford: Oxbow Books.

Bradley, R. 2017. *A geography of offerings. Deposits of valuables in the landscapes of ancient Europe.* Oxford: Oxbow Books.

Brück, J. 2016. Hoards, fragmentation and exchange in the European Bronze Age. In S. Hansen, D. Neumann and T. Vachta (eds), *Raum, Gabe und Erinnerung. Weihgaben und Heiligtümer in prähistorischen und antiken Gesellschaften,* 75-92. Berlin: Edition Topoi.

Budd, P. and Taylor, T. 1995. The faerie smith meets the bronze industry: magic versus science in interpretation of prehistoric metal-making. *World Archaeology* 27, 133-43.

Bukowski, Z. 1998. *Pomorze w epoce brązu w świetle dalekosiężnych kontaktów wymiennych.* Gdańsk: Gdańskie Towarzystwo Naukowe.

Chantre, E. 1875-76. *Études paléoethnologiques dans le bassin du Rhône II. Âge du Bronze: recherches sur l'origine de la métallurgie en France. Deuxième partie: gisements de l' Âge du Bronze.* Paris: J. Baudry.

Childe, V.G. 1930. *The Bronze Age.* Cambridge: Cambridge University Press.
Dąbrowski, J. and Mogielnicka-Urban, M. 2004. Znaki nie utrwalone w glinie. Kilka uwag o tezach pracy A. Mierzwińskiego (2003). *Archeologia Polski* 49, 125-29.
Dietrich, O. 2012. Travelling or not? Tracing individual mobility patterns of Late Bronze Age metalworkers in the Carpathian Basin. *Satu Mare – Studii şi Comunicări* 28, 211-29.
Dietrich, O. 2014. Learning from "scrap" about Late Bronze Age hoarding practices. A biographical approach to individual acts of dedication in large metal hoards. *European Journal of Archaeology* 17, 468-86.
Drescher, H. 1968. Punzen der jüngeren Bronzezeit aus Altmaterial. *Jahresschrift für Mitteldeutsche Vorgeschichte* 52, 131-42.
Dzięgielewski, K. 2017. Late Bronze and Early Iron Age communities in the northern part of the Polish Lowland (1000-500 BC). In U. Bugaj (ed.), *The past societies. Polish lands from the evidence of human presence to the Early Middle Ages. Volume 3, 2000-500 BC*, 295-340. Warszawa: Wydawnictwo Instytutu Archeologii i Etnologii Polskiej Akademii Nauk.
Eliade, M. 1956. *Forgerons et alchimistes.* Paris: Flammarion.
Ebert, M. 1926. *Reallexikon der Vorgeschichte VII*. Berlin: De Gruyter.
Evans, J. 1881. *The ancient Bronze implements, weapons, and ornaments of Great Britain and Ireland*. London: Longmans, Green & Co.
Fogel, J. 1988. *"Import" nordyjski na ziemiach polskich u schyłku epoki brązu.* Poznań: Wydawnictwo Uniwersytetu im. Adama Mickiewicza w Poznaniu.
Fontijn, D.R. 2002. Sacrificial landscapes. Cultural biographies of persons, objects and "natural" places in the Bronze Age of the southern Netherlands, c. 2300-600 BC. *Analecta Praehistorica Leidensia* 33/34, 1-392.
Fontijn, D.R. 2008. "Traders' hoards". Reviewing the relationship between trade and permanent deposition: the case of the Dutch Voorhout hoard. In C. Hamon and B. Quilliec (eds), *Hoards from the Neolithic to the Metal Ages. Technical and codified practices. Session of the XIth annual meeting of the European Association of Archaeologists,* 5-17. Oxford: Archaeopress.
Forbes, R.J. 1950. *Metallurgy in antiquity. A notebook for archaeologists and technologists.* Leiden: E.J. Brill.
Garbacz-Klempka, A., Ścibior, D. and Kwak, Z. 2016. Badania i wizualizacja technologii odlewniczej w epoce brązu na podstawie ceramicznych i kamiennych form z Legnicy z ul. Spokojnej. In K. Nowak and T. Stolarczyk (eds), *Metalurdzy znad Kaczawy. Cmentarzysko ciałopalne z epoki brązu odkryte w Legnicy przy ul. Spokojnej*, 109-28. Legnica: Muzeum Miedzi w Legnicy.
Gärtner, G. 1969. *Die ur- und frühgeschichtlichen Denkmäler und Funde des Kreises Sternberg*. Schwerin: Museum für Ur- und Frühgeschichte Schwerin.
Găvan, A. 2015. *Metal and metalworking in the Bronze Age tell settlements from the Carpathian Basin*. Cluj-Napoca: Mega Publishing House.
Gedl, M. 2004. *Die Beile in Polen IV (Metalläxte, Eisenbeile, Hämmer, Ambosse, Meißel, Pfrieme).* Stuttgart: Franz Steiner Verlag.
Gibson, D.B. 1996. Death of a salesman: Childe's itinerant craftsman in the light of present knowledge of late prehistoric European craft production. In B. Wailes (ed.), *Craft specialization and social evolution: in memory of V. Gordon Childe,* 109-19. Philadelphia: The University Museum of Archaeology and Anthropology, University of Pennsylvania.
Gogâltan, F. 2005. Zur Bronzeverarbeitung im Karpatenbecken. Die Tüllenhämmer und Tüllenambosse aus Rumänien. In T. Soroceanu (ed.), *Bronzefunde aus Rumänien II*, 343-86. Cluj Napoca: Accent.
Helms, M.W. 1993. *Craft and the kingly ideal. Art, trade, and power*. Austin: University of Texas Press.
Helms, M.W. 2009. The master(y) of hard materials: thoughts on technology, materiality, and ideology occasioned by the Dover boat. In P. Clark (ed.), *Bronze Age connections. Cultural contact in prehistoric Europe,* 149-58. Oxford: Oxbow Books.

Hidde, B. 1997. Warnow, Kr. Usedom-Wollin, Prov. Pommern (Warnowo, Gm. Wolin, Woj. Szczecin, Polen). In A. Hänsel and B. Hänsel (eds), *Gaben an die Götter. Schätze der Bronzezeit Europas. Ausstellung der Freien Universität Berlin in Verbindung mit dem Museum für Vor- und Frühgeschichte, Staatliche Museen zu Berlin – Preußischer Kulturbesitz,* 217-19. Berlin: Staatliche Museen Preußischer Kulturbesitz, Museum für Vor- und Frühgeschichte.

Horst, F. 1981. Bronzezeitliche Steingegenstände aus dem Elbe-Oder-Raum. *Bodendenkmalpflege in Mecklenburg* 29, 33-83.

Horst, F. 1986. Die jungbronzezeitlichen Kannelurensteine des mitteleuropäischen Raums – Werkzeuge für die Bronzeverarbeitung? *Helvetia Archaeologica* 17, 82-91.

Hundt, H.-J. 1997. *Die jüngere Bronzezeit in Mecklenburg*. Lübstorf: Archäologisches Landesmuseum für Mecklenburg-Vorpommern.

Ialongo, N. and Rahmstorf, L. 2019. The identification of balance weights in pre-literate Bronze Age Europe: typology, chronology, distribution and metrology. In L. Rahmstorf and E. Stratford (eds), *Weights and marketplaces from the Bronze Age to the Early Modern Period. Proceedings of two workshops funded by the European Research Foundation (ERC),* 105-26. Kiel, Hamburg: Wachholtz.

Jantzen, D. 1991. Versuche zum Metallguß der nordischen Bronzezeit. *Experimentelle Archäologie* 6, 305-16.

Jantzen, D. 2008. *Quellen zur Metallverarbeitung im Nordischen Kreis der Bronzezeit.* Stuttgart: Franz Steiner Verlag.

Jockenhövel, A. 1982. Zu den ältesten Tüllenhämmern aus Bronze. *Germania* 60, 131-49.

Jockenhövel, A. 2000. Raum und Zeit – Gliederung der Bronzezeit. In A. Jockenhövel and W. Kubach (eds), *Bronzezeit in Deutschland,* 11-14. Hamburg: Nikol Verlagsgesellschaft.

Jockenhövel, A. 2018. Alteuropäische Gräber der Kupferzeit, Bronzezeit und Älteren Eisenzeit mit Beigaben aus dem Gießereiwesen (Gießformen, Düsen, Tiegel). Contribution in M. Overbeck, *Die Gießformen in West- und Süddeutschland (Saarland, Rheinland-Pfalz, Hessen, Baden-Württemberg, Bayern)*, 213-337. Stuttgart: Franz Steiner Verlag.

Jockenhövel, A. 2019. Nemo nascitur artifex. Zum Kontext bronzezeitlichen Wissens. In D.l. Neumann, G. Woltermann and R. Gleser (eds), *Spezialisierungen in der Bronzezeit,* 11-42. Münster: Lit Verlag.

Kaczmarek, M. 2017. The snares of ostensible homogeneity. Lusatian culture or Lusatian urnfields? In P. Urbańczyk and U. Bugaj (eds), *The past societies. Polish lands from the evidence of human presence to the Early Middle Ages. Volume 3, 2000-500 BC*, 263-93. Warszawa: Wydawnictwo Instytutu Archeologii i Etnologii Polskiej Akademii Nauk.

Keiling, H. 1987. *Die Kulturen der mecklenburgischen Bronzezeit*. Schwerin: Museum für Ur- und Frühgeschichte Schwerin.

Kienlin, T.L. 2010. *Traditions and transformations: approaches to Eneolithic (Copper Age) and Bronze Age metalworking and society in eastern central Europe and the Carpathian Basin.* Oxford: Archaeopress.

Kośko, A. 1979. *Rozwój kulturowy społeczeństw Kujaw w okresach schyłkowego neolitu i wczesnej epoki brązu*. Poznań: Wydawnictwo Naukowe Uniwersytetu Adama Mickiewicza.

Kostrzewski J. 1953. Wytwórczość metalurgiczna w Polsce od neolitu do wczesnego okresu żelaza. *Przegląd Archeologiczny* 9, 177-213.

Kowalski, A.P. 2000. Genealogia sztuk III. Najstarsza metalurgia. Od sensów magicznych do wartości estetycznych. In H. van den Boom, A.P. Kowalski and M. Kwapiński (eds), *EIDOLON Kultura archaiczna w zwierciadle wyobrażeń, słów i rzeczy*, 195-215. Gdańsk: Muzeum Archeologiczne w Gdańsku.

Kozłowska-Skoczka, D. 2012. The Bronze Age – Early Iron Age. Catalogue of the archaeological finds. In K. Kowalski and D. Kozłowska-Skoczka (eds), *Lost – Saved. The Pomerania Antiquities Collection of Szczecin,* 179-81. Szczecin: Muzeum Narodowe w Szczecinie.

Kristiansen, K. 1987. From stone to bronze: the evolution of social complexity in northern Europe, 2300-1200 BC. In E.M. Brumfiel and T.K. Earle (eds), *Specialization, exchange, and complex societies*, 30-51. Cambridge: Cambridge University Press.

Kristiansen, K. and Larsson, T.B. 2005. *The rise of Bronze Age society. Travels, transmissions and transformations*. Cambridge: Cambridge University Press.

Kuijpers, M.H.G. 2008. *Bronze Age metalworking in the Netherlands (c. 2000-800 BC). A research into the preservation of metallurgy related artefacts and the social position of the smith.* Leiden: Sidestone Press.

Maciejewski, M. 2016. *Metal – granica – rytuał. Badania nad depozytami przedmiotów metalowych w kontekście sieci osadniczej.* Poznań: Wydawnictwo Nauka i Innowacje.

Maciejewski, M. 2019a. The Rosko Hoard – a roadsign? Research and its perspectives: mass depostion of metal objects, Late Bronze and Early Iron Ages in Poland. *Praehistorische Zeitschrift* 94, 233-51.

Maciejewski, M. 2019b. In the midst of Godelier, Facebook and bloody forays. Several comments on metal and its availability in the Bronze and Early Iron Ages. In M.S. Przybyła and K. Dzięgielewski (eds), *Chasing Bronze Age rainbows. Studies on hoards and related phenomena in prehistoric Europe in honour of Wojciech Blajer,* 141-55. Kraków: Profil-Archeo.

Maraszek, R. 1998. *Spätbronzezeitliche Hortfunde entlang der Oder.* Bonn: Rudolf Habelt.

Maraszek, R. 2006. *Spätbronzezeitliche Hortfundlandschaften in atlantischer und nordischer Metalltradition.* Halle (Saale): Landesamtes für Denkmalpflege und Archäologie Sachsen-Anhalt, Landesmuseum für Vorgeschichte.

Mierzwiński, A. 2003. *Znaki utrwalone w glinie. Społeczno-obrzędowe aspekty działań wytwórczych końca epoki brązu i wczesnej epoki żelaza. Model nadodrzański.* Wrocław: Wydawnictwo Instytutu Archeologii i Etnologii Polskiej Akademii Nauk.

Mierzwiński, A. 2004. Oczami dalekowidza albo autorytet w opałach. *Archeologia Polski* 49, 130-36.

Neipert, M. 2006. *Der "Wanderhandwerker". Archäologisch-ethnographische Untersuchungen.* Rahden: Marie Leidorf.

Nessel, B. 2010. Schmiede und Toreuten in den urnenfelderzeitlichen Depotfunden des Karpatenbeckens? Funktionsanalyse von Handwerksgerät und soziale Implikationen. In B. Horejs and T.L. Kienlin (eds), *Siedlung und Handwerk. Studien zu sozialen Kontexten in der Bronzezeit. Beiträge zu den Sitzungen der Arbeitsgemeinschaft Bronzezeit 2007 und 2008*, 373-86. Bonn: Rudolf Habelt.

Nessel, B. 2019. *Der bronzezeitliche Metallhandwerker im Spiegel der archäologischen Quellen*. Bonn: Rudolf Habelt.

Nørgaard, H.W. 2018. *Bronze Age metalwork. Techniques and traditions in the Nordic Bronze Age 1500-1100 BC.* Oxford: Archaeopress.

Nowak, K. 2018. Badania nad rekonstrukcją sposobów wytwarzania wybranych typów narzędzi metalowych w późnej epoce brązu. Dwuczęściowe gliniane formy odlewnicze. *Śląskie Sprawozdania Archeologiczne* 60, 97-124.

Nowak, K. 2019. Analiza traseologiczna przedmiotów brązowych wchodzących w skład skarbu z Nowego Kramska. In A. Michalak and J. Orlicka-Jasnoch (eds), *Skarb z Nowego Kramska. Analizy. Konteksty,* 179-96. Zielona Góra: Muzeum Archeologiczne Środkowego Nadodrza w Zielonej Górze.

Orlicka-Jasnoch, J. 2013. Skarb przedmiotów brązowych i żelaznych z Bieszkowa, gm. Jasień. In A. Jaszewska and S. Kałagate (eds), *Wicina. Badania Archeologiczne w latach 2008-2012 oraz skarb przedmiotów pochodzących z Wiciny,* 491-537. Zielona Góra: Fundacja Archeologiczna.

Overbeck, M. 2018. *Die Gießformen in West- und Süddeutschland (Saarland, Rheinland-Pfalz, Hessen, Baden-Württemberg, Bayern)*. Stuttgart: Franz Steiner Verlag.

Probst, E. 1996. *Deutschland in der Bronzezeit: Bauern, Bronzegießer und Burgherren zwischen Nordsee und Alpen*. München: Bertelsmann.

Reiter, V. and Linke, R. 2018. Ein Werkplatz mit Brucherzdepot der ausgehenden Bronzezeit aus Rannersdorf, Niederösterreich. *Fundberichte aus Österreich* 55, 144-82.
Rezi, B. 2011. Voluntary destruction and fragmentation in Late Bronze Age hoards from central Transylvania. In S. Berecki, R.E. Németh and B. Rezi (eds), *Bronze Age rites and rituals in the Carpathian Basin. Proceedings of the international colloquium from Târgu Mureş 8-10 October 2010,* 303-34. Târgu Mureș: Mega.
Rogalski, B. 2017. Badania rozpoznawczo-weryfikacyjne na stanowisku 75 w Trzcińsku-Zdroju, pow. gryfiński (AZP 40-06/133) w 2016 roku. *Materiały Zachodniopomorskie Nowa Seria* 13, 237-41.
Rowlands, M.J. 1971. The archaeological interpretation of prehistoric metalworking. *World Archaeology* 3, 210-24.
Sadowski, J.N. 1876. Drogi handlowe greckie i rzymskie przez porzecza Odry, Wisły, Dniepru i Niemna do wybrzeży morza Bałtckiego. Rzecz czytana na posiedzeniach Komisji archeologicznej. *Pamiętniki Akademii Umiejętności w Krakowie, Wydział: Filologiczny i Historyczno-Filozoficzny* 3, 1-88.
Schanz, E. 2015. Kurze Fundberichte 2015. Babke, Lkr. Mecklenburgische Seenplatte. *Bodendenkmalpflege in Mecklenburg-Vorpommern* 63, 225.
Schoknecht, U. 1974. Ein bronzezeitlicher Hortfund der Periode V von Murchin, Kreis Anklam. *Bodendenkmalpflege in Mecklenburg Jahrbuch* 1974, 145-72.
Schumacher, K. 1903, Die bronzezeitlichen Depotfunde Südwestdeutschlands. *Correspondenz-Blatt der Deutschen Gesellschaft für Anthropologie, Ethnologie und Urgeschichte* 34, 90-101.
Sommerfeld, C. 1994. *Gerätegeld Sichel. Studien zur monetären Struktur bronzezeitlicher Horte im nördlichen Mitteleuropa.* Berlin-New York: De Gruyter.
Sprockhoff, E. 1937. *Jungbronzezeitliche Hortfunde Norddeutschlands (Periode IV).* Mainz: Verlag des Römisch-Germanischen Zentralmuseums.
Sprockhoff, E. 1956. *Jungbronzezeitliche Hortfunde der Südzone des nordischen Kreises (Periode V)* I-II. Mainz: Verlag des Römisch-Germanischen Zentralmuseums.
Wawrzyniak, P. and Wawrzyniak M. 2018. Skarb przedmiotów brązowych z Wilenka, gm. Szczaniec. In A. Michalak (ed.), *Księga abstraktów. II Lubuska Sesja Sprawozdawcza. Świdnica k/Zielonej Góry, 15-16 marca 2018 roku*, 3. Zielona Góra: Muzeum Archeologiczne Środkowego Nadodrza.
Żychlińska, J. 2008. *Recepcja "importu" nordyjskiego na ziemiach polskich we wczesnych fazach kultury łużyckiej.* Poznań: Wydawnictwo Poznańskie.

"Kannelurensteine"

Balance weights of the Bronze Age?

Nicola Ialongo, Lorenz Rahmstorf

Introduction

The main difficulty in pinpointing the activity of merchants in prehistoric societies lies in the ambiguity of the material traces correlated to trade. The materiality of market exchange is elusive in the archaeological record and actual marketplaces are seldom clearly identified in various pre-modern societies (Rahmstorf and Stratford 2019). Trade is mostly a matter of interpersonal relationships, negotiation, and customer retention. Even in our contemporary world, the purchase of an object or a service does not leave any material trace other than a receipt written or printed on a piece of paper. Hence, what kind of unambiguous materiality can we realistically expect from market exchange in prehistoric societies? Is the absence of direct evidence for sales and purchases sufficient proof of their nonexistence? Yet, it is impossible to discern whether an object changed hands as a gift or as a purchase: the acts of selling something as a commodity or giving it away as a gift simply do not leave any material trace, in one way or another. Hence, the lack of direct evidence for market exchange is never a valid proof that market exchange did not exist.

However, trade has indeed its peculiar materiality, and our insufficient understanding of the commercial component of the economy of Bronze Age Europe largely derives from the scarce attention that has always been devoted to the specialised tools of trade *par excellence*: balance scales and weights. Weighing equipment is always a correlate of the commercial component of Bronze Age economies in western Eurasia (e.g. Rahmstorf 2016a, 303-04). In Mesopotamia, it emerges in parallel with writing and, since their origins, weight systems are established as the main method of accounting for economic value (Powell 1996). In Europe – with the exception of Greece, where weights were used since the early third millennium BC (Rahmstorf 2016b) – balance weights are documented since c. 2000 BC in southern Italy (Ialongo 2019), and by c. 1400-1200 BC are widespread throughout most of the continent (Ialongo and Rahmstorf 2019). The strategy of the WEIGHTANDVALUE project[1], from which this paper stems, is to systematically test different types of finds through rigorous statistical analyses, in order to identify which object categories are most likely to have been used as weights. The first results seem to suggest that a limited number of types of simply shaped objects – mostly made of stone – possess recurrent metrological properties that support their interpretation as balance weights. Systematic research on weighing equipment in Bronze Age Europe is still at its beginnings, and the testing of material evidence still ongoing.

1 This work was supported by ERC-2014-CoG "WEIGHTANDVALUE: Weight metrology and its economic and social impact on Bronze Age Europe, West and South Asia" [Grant no. 648055]. Testing the "balance weight hypothesis" for *Kannelurensteine* is one of the main aims of the project. Since 2016, Nicola Ialongo has been recording these objects in Germany and Italy. At the end of 2018 the project started a collaboration with Martin Trachsel, who had documented the mass values of numerous *Kannelurensteine* in Switzerland in 2004. However, he did not want to be included in the publication of the analysis of the data. We would like to express our sincere gratitude for allowing us to use the vast amount of data he compiled 16 years ago.

In D. Hofmann, F. Nikulka and R. Schumann (eds) 2022. *The Baltic in the Bronze Age. Regional patterns, interactions and boundaries*, Leiden: Sidestone Press, pp. 145-160.

In this paper, we present the results of research on the so-called *Kannelurensteine*, a peculiar class of stone objects widespread in Bronze Age Europe between Sicily and the Baltic Sea, whose actual use has been debated for decades. Our statistical analyses indicate that *Kannelurensteine* possess remarkably regular typological and metrological properties, and we propose that, of all the possible explanations that have been suggested over the years, the interpretation as balance weights is the one that best explains the evidence.

The main characteristics of *Kannelurensteine*

Kannelurensteine (sometimes also referred to as *Rillensteine*) are lenticular-shaped objects, always made of stone, with mass values ranging between c. 10 g to c. 5000 g. The name *Kannelurenstein* (in English "stone with a groove") derives from the fact that most of these objects possess a thick groove running along their diameter. *Kannelurensteine* present a certain typological variability, while maintaining an overall uniform appearance (Figure 1 A). The general shape is mostly biconical or lenticular (Figure 1 A, 3-12), more rarely ovoid or barrel-shaped (Figure 1 A, 15-17). Many objects have circular indentations on the upper and lower faces (Figure 1 A, 2. 4-7. 9. 11-12). A few objects do not present an actual groove but simply an artificially flattened surface on the diameter (Figure 1 A, 8-9). In rare cases, there can be two crossing grooves (Figure 1 A, 14) or three parallel ones (Figure 1 A, 17). The most common type (the simple lenticular shape with horizontal groove) is attested in the entire territory covered by the distribution (Figure 1 B, 18-21). *Kannelurensteine* are mainly made of sandstone/quartzite and granite; sometimes porphyry and limestone are also used. A systematic determination of the stone type was not, however, the focus of the project.

The first systematic study of *Kannelurensteine* addressed central and northern Europe (Horst 1981), and provided a distribution map with notable concentrations in Switzerland, eastern Germany and southern Scandinavia (Figure 2 A). As we discuss below, however, Horst's list is highly problematic, and the map should only be taken as an impression of the possible overall spread of *Kannelurensteine* in central and northern Europe. At least a few *Kannelurensteine* were recorded in southern Sweden by Indreko (1956). His classification of "stone objects with groove" in Scandinavia deals, however, mainly with tools (hammers) potentially relevant for mining and metallurgy (cf. Melheim 2015, 151-55, 168-76 tab. 33). Indreko's form G1 is the only type that seems to correspond to our classification of a *Kannelurenstein*. Only eight objects belong to this form (all coming from southern Sweden), and an image is provided for only three of them. The overall distribution in Scandinavia is hard to assess in detail, as the published documentation often does not include images.

As far as we know, there are no *Kannelurensteine* of the definition used here in the eastern Baltic Sea region. In the north-western Baltic region (Denmark, Sweden) they are apparently rare during the later Nordic Bronze Age, but they do occur in some numbers in the south-western Baltic region in the Lusatian culture in eastern Germany and western Poland, as demonstrated by Horst (1981). Some further examples from Pomerania and Wielkopolska in western Poland in the eastern part of the Lusatian culture's distribution can be added here (e.g. Gackowski 2007, 161 fig. 2c; Kaczmarek 2002, 121-22 fig. 48. 4-6; Krzyszowski 2019, 55, 229 no. 227, pl. 95, 5). In Polish literature they are called "serki kamienne" – "little stone cheeses", however, a recent synthetic study of these objects in Poland is lacking to our knowledge. An important hint that weights were used in the Lusatian culture is given by an as yet unpublished grave from Saxony-Anhalt which contained a bone balance beam. This indicates that the western Baltic region should receive more systematic investigation on the use of weighing equipment during the Late Bronze Age.

After Horst, the distribution was expanded thanks to a study of northern Italian contexts, providing extensive graphic documentation (Cardarelli *et al.* 1997; 2001). *Kannelurensteine* have also been found in southern Italy, in the Aeolian Islands and in

Sardinia (Ialongo and Rahmstorf 2019; Rahmstorf and Ialongo 2020). *Kannelurensteine* are particularly common in lakeside dwellings in Switzerland (see footnote 1). To our knowledge, only one site has provided conclusive evidence for *Kannelurensteine* in Croatia (Vrdoljak and Forenbaher 1995). The map in Figure 2 B shows the location of all the finds that can be certainly attributed to the *Kannelurenteine* type as defined above.

In general, *Kannelurensteine* seem to have a distribution between Denmark and southern Sweden to the north, Italy and Croatia to the south, eastern France to the west and Poland and western Slovakia to the east (Figure 2 B). Mostly, *Kannelurensteine* are settlement finds. They are rarely part of hoards. So far, we documented only nine *Kannelurensteine* from a few cremation burials, all located in the Lusatian culture in eastern Germany and western Poland. In these regions they have long been dated to period IV and V (c. 1100-700 BC) of the Nordic Bronze Age (Kostrzewski 1958, 153-56).

Most of the objects come from old excavations and lack precise archaeological contexts, and many of them are simply sporadic finds. Based on the limited number of well-dated examples, the earliest *Kannelurensteine* are documented in the Aeolian Islands

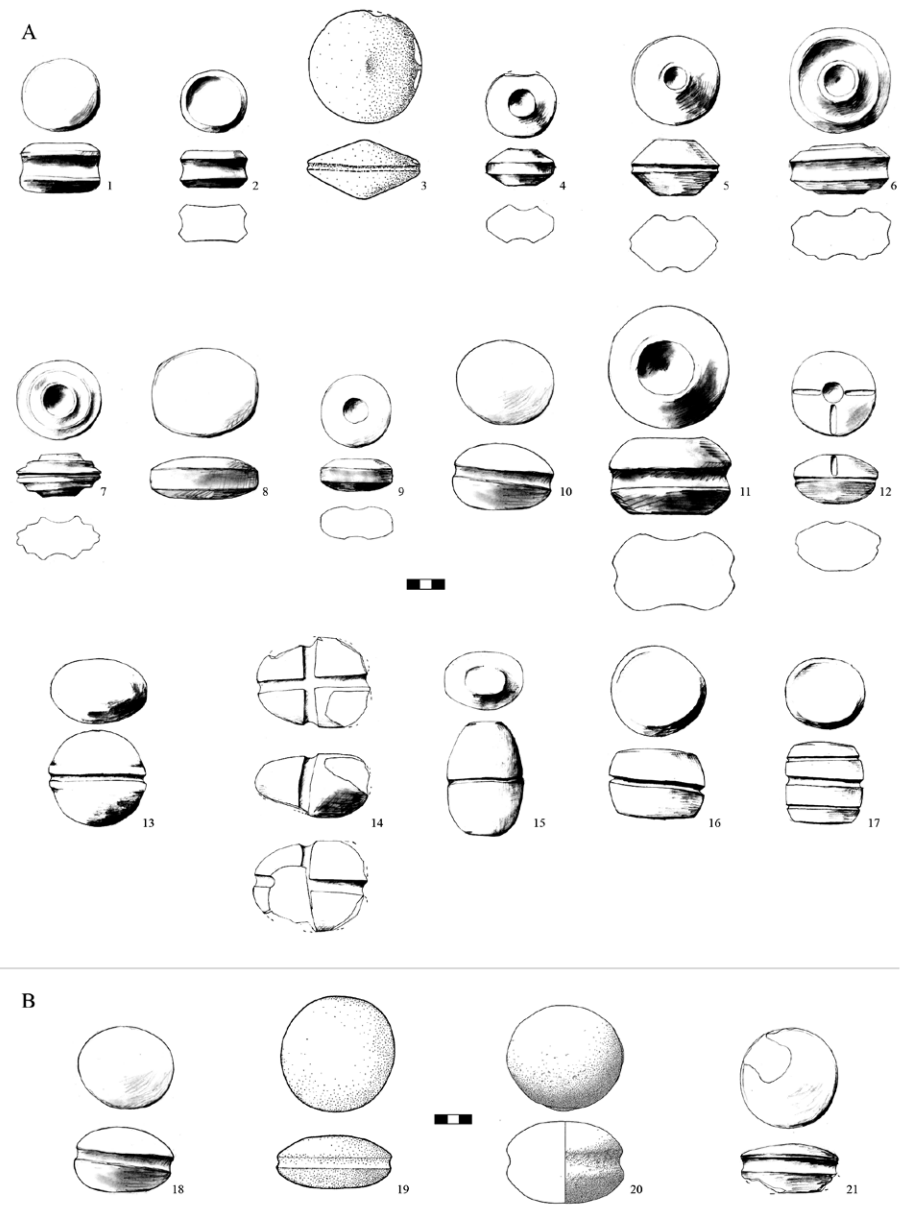


Figure 1. Typology. A) Typological variability of *Kannelurensteine*. B) Examples of the most widespread type. 18: southern Italy (Lipari, Aeolian Islands, Sicily); 19: northern Italy (Santa Rosa di Poviglio, Emilia Romagna); 20: Switzerland (Zug-Sumpf); 21: eastern Germany (Groß Glienicke, Berlin-Brandenburg).

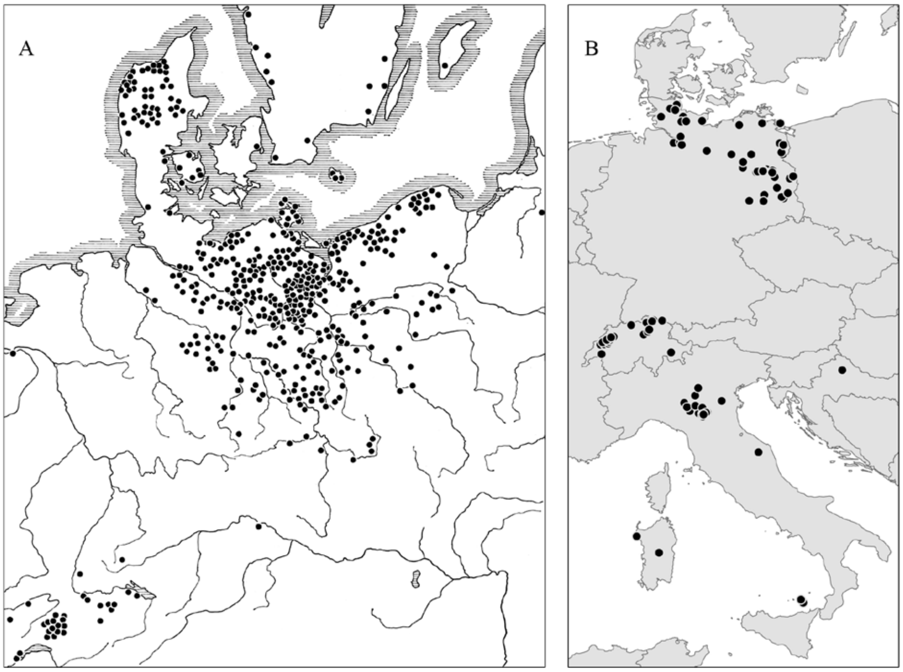


Figure 2. A) Distribution of the *Kannelurensteine* collected by Horst in 1981. B) Distribution of the sample of *Kannelurensteine* analysed in this article.

and in the Po Plain (Italy) in the Middle Bronze Age (c. 1500-1350 BC) and spread to other parts of Italy (including its islands) and central Europe between c. 1350-800/700 BC (Ialongo and Rahmstorf 2019).

History of research and possible interpretations

It has been proposed that *Kannelurensteine* were used as fixed pulleys (Leuvrey 1999, 79-81), based on the relatively frequent occurrence of the type with opposed circular indentations in Swiss sites. According to Leuvrey, the indentations would have been used as pivots for wooden poles. This interpretation, however, is extremely unlikely, because it would require the objects to be completely perforated. Moreover, only a limited number of *Kannelurensteine* present the circular indentations, and Italian ones never do. These objects are sometimes interpreted generically as “working tools”, without further specification. However, the low occurrence of use-wear makes it unlikely that they were systematically used for working activities. Moreover, the generic working-tool hypothesis does not explain the grooves and the indentations. Similar objects are documented at the Iron Age site of Manching, and were interpreted as “door-holders”, hanging from a cord (Jacobi 1974, 243-44, 346 plates 96. 1790-1971, 107. 5-6; Rahmstorf and Pare 2007, 273). There is no chronological continuity between the Bronze Age *Kannelurensteine* and the objects from Manching, therefore their respective functions can be completely different. However, a similar interpretation does not seem plausible for the Bronze Age objects. First of all, not all *Kannelurensteine* have a groove; second, the mass range is too wide, including objects that are either too light or too heavy for the purpose; and third, they are documented in open-air smelting facilities and burials, where doors were probably of little use. For the eastern German sample, F. Horst (1981) emphasised that even though the majority of the known *Kannelurensteine* are single finds, there are indications of a connection to craftsmanship and especially metalworking. However, in 1991 K. Raddatz pointed out that there is still no real explanation for the function of these strange tools (Raddatz 1991).

A. Cardarelli and others (Cardarelli *et al.* 1997) were the first to propose the interpretation as balance weights for the Italian *Kannelurensteine*. The authors attempt a reconstruction of the alleged underlying weight system. The metrological study is based on descriptive and inductive methodologies, and its results have been partially contested in a recent study (Ialongo and Rahmstorf 2019). Even though the reconstruction of the weight system was not validated, the new analyses showed that *Kannelurensteine* do possess regular mass values, and that the intuition behind the interpretation as potential balance weights was probably correct.

This new interpretation of the *Kannelurensteine* as balance weights remained largely unknown in German-speaking archaeology, with few exceptions (e.g. Rahmstorf and Pare 2007, 273). As a consequence, in all regions outside northern Italy the objects were and are still published without any information about their mass. We have already proposed elsewhere (Ialongo and Rahmstorf 2019, 108) that an object category can be confidently identified as a class of balance weights if:

- It has a standardised shape that is not plausibly connected to any other practical function;
- It is made of a hard and durable material, like stone or metal;
- It does not show systematic presence of use-wear that can be plausibly connected to any other practical function;
- It is found at least occasionally also in sets (two or several similar objects appear together in a closed archaeological context);
- Individual objects can be ascribed to rational multiples of one or more unit-systems;
- Deviation from the norm, in every aspect, must be within an acceptable margin of error.

So far, we can state that points 1-3 apply. We will discuss points 4-6 below.

Archaeological contexts

Find contexts are very important, since they provide clues to connect the shape of the objects to their function. Unfortunately, the basic problem arises from the fact that a very large majority of *Kannelurensteine* throughout Europe are stray finds. Only in a few cases do the contexts provide clues for their interpretation. The site of Greifensee-Böschen in Switzerland was occupied towards the end of the second millennium BC, it was very short-lived, and all the finds were accurately mapped (Eberschweiler *et al.* 2007), which allows connecting the finds to the houses with a certain accuracy. Figure 3 shows the distribution of *Kannelurensteine* and of metal objects. The distribution of metal tools highlights concentrations in houses M and F, and these concentrations are associated with *Kannelurensteine*. In house M a *Kannelurenstein* is associated with four awls, one hammer, one axe and two knives. In house F, two *Kannelurensteine* are associated with three awls and one axe. In the Middle Bronze Age settlement of Salina in the Aeolian Islands, two *Kannelurensteine* are associated with a casting mould and a clamp made of pure tin, probably imported as an ingot (Ialongo 2019). At the site of Kalnik-Igrišče in Croatia, *Kannelurensteine* are associated with smelting facilities (Vrdoljak and Forenbaher 1995).

Kannelurensteine are documented in burials only in eastern Germany and western Poland towards the end of the second millennium BC. In the cemetery of Battaune, Kr. Delitzsch in Saxony, such an object was found together with two casting moulds in a cremation grave (Schmalfuß 2008). In western Poland, *Kannelurensteine* were found in the cemetery of Wartosław, c. 60 km north-west of Poznań (Krzyszowski 2019, pl. 36). Finally, the hoard of Krampnitz, Ldkr. Potsdam in Brandenburg in eastern Germany is the only hoard containing one of these objects. It also includes a spearhead, ornaments, scrap metal and an awl with a preserved wooden handle (Reinbacher 1956). To sum up, it appears that *Kannelurensteine* are somehow associated with metallurgy and metallurgy-related tools, as already observed by Horst in 1981. However, as shown by the distribution in Greifensee-Böschen, the association is not exclusive.

The eastern Mediterranean and the Near East provide sound documentation about balance weights. Both textual and archaeological evidence provide clear indications that weight-based exchange was mainly associated with metals and textiles (Breniquet and Michel 2014; Bartash 2019, 173-221). In Europe, the contextual – albeit sparse –

Figure 3. Distribution of the *Kannelurensteine* and metal tools from the pile dwelling site of Greifensee-Böschen, Switzerland (based on Eberschweiler *et al.* 2007).

information available for *Kannelurensteine* hints also at the fact that they were somehow correlated to metallurgy; however, conclusive evidence is still lacking.

Regarding point 4, we can state that *Kannelurensteine* have so far never been found together in sets of two or more specimens. However, it must be noted that several sites have yielded considerable amounts of *Kannelurensteine* without clear contextual indications. For now, we are lacking any direct evidence that they were used in sets. Nevertheless, as the vast majority of *Kannelurensteine* are heavy objects it is a possible assumption that they were indeed most often used as single weights to weigh out amounts of material of similar magnitude: a similar amount of material (metal?) in one pan on one side, while the *Kannelurenstein* was hanging on the other side of the balance.

Methods

The sample

The documentation on *Kannelurensteine* is sparse and discontinuous. Horst (1981) collected 526 objects (Figure 2 A). Horst's list, however, is problematic. In 2018, Nicola Ialongo consulted the archives of the Museum für Vor- und Frühgeschichte in Berlin, which contains the biggest lot of materials mentioned by Horst, and could ascertain that the archives show systematic inconsistencies with the published list. It was not possible to establish whether Horst relied entirely on the archive (misreporting many of its entries), or accessed at least some of the materials preserved in the storerooms. This implies that we could not check most of the objects in the list first-hand, hence we cannot certify that they all belong to the typological class of *Kannelurensteine*, as defined above. It follows that the map in Figure 2 A is simply meant to provide an impression of the overall distribution reported by Horst, and it should not be considered reliable. Furthermore, some of these objects do not even belong to the class of *Kannelurensteine* proper, as Horst (1981) does not provide images for most of the objects. On the other hand, it is certain that Horst includes objects that do not belong to the *Kannelurensteine* type, such as stone hammers (Horst 1981, figs 14 a-c, 15 b. f, 17 a-b, 18 c) and probable net-sinkers (Horst 1981, fig. 16 g-h). Due to the many inconsistencies, it was decided not to invest further time in verifying Horst's list and to focus, instead, on the first-hand documentation of finds. Martin Trachsel, in his unpublished study, collected 1449 objects. His database includes Horst's list and other published objects from central Europe and Italy, but he focused on the first-hand documentation of *Kannelurensteine* from Swiss sites, amounting to 326 objects. Between 2016 and 2019, in the framework of the WEIGHTANDVALUE project, Nicola Ialongo collected 92 unpublished *Kannelurensteine* from Italy and Germany (Ialongo 2019).

If one considers the three databases collected by Horst, Trachsel and Ialongo, eliminating double entries, the total number of *Kanneluresteine* amounts to 1630 objects. This figure, however, is definitely overestimated, as it includes finds that could not be checked, such as many entries in Horst's list. The sample used in our statistical analyses only includes complete objects with a known mass value and fragmented objects that could be reconstructed (see further below). The sample corresponding to these criteria amounts to 323 objects. Of these, 93 come from sites in Italy, 175 from Switzerland and 55 from Germany (Figure 2 B). The mass values range from 11.8 g to 5050 g (Table 1).

Statistics

Cosine quantogram analysis (CQA) is the most reliable technique in metrological studies of the ancient world (Kendall 1974). It represents the state of the art in ancient weight metrology and has been further developed in recent years (e.g. Hafford 2012; Ialongo 2019; Pakkanen 2011; Petruso 1992). CQA allows to determine if a sample of metrical observations is the product of one or more basic units, by looking for *quanta* in a distribution of mass values. A *quantum* is a single value for which most of the mass values in a sample are divisible for a negligible remainder. If the sample is "quantally configured" (i.e. if most of the values are divisible by the same number), then most values will give a rational number (such as 2, 5, 8, 1/2, 1/3 and so on) when divided for the best quantum. All values are divided by a series of quanta and the analysis gives positive results for those *quanta* that give a negligible remainder for most of the values in the distribution. CQA tests whether an observed measurement X is an integer multiple of a quantum q plus a small error component $\boldsymbol{\varepsilon}$. X is divided for q and the remainder ($\boldsymbol{\varepsilon}$) is tested. Positive results occur when $\boldsymbol{\varepsilon}$ is close to either to 0 or q, i.e. when X is (close to) an integer multiple of q:

$$\phi(q) = \sqrt{2/N} \sum_{i=1}^{n} \cos\left(\frac{2\pi\varepsilon_i}{q}\right)$$

where N is the sample size and $\boldsymbol{\phi}(q)$ is the test statistic. The resulting graph shows peaks where a quantum gives a high positive value for $\boldsymbol{\phi}(q)$, which indicates, in turn, that the corresponding quantum is a "good fit" (Ialongo 2019; the online version of the article contains a downloadable applet for the calculation of the CQA).

Monte Carlo tests can exclude the occurrence of false positives (Kendall 1974; Pakkanen 2011). The test is based on the reiterated generation of random numbers, in order to check whether random datasets would give better results than the actual sample. The null hypothesis is that the sample is randomly constituted, i.e. that the observed quantal configuration is only due to chance. Following Kendall's method, we produced a simulation of 1000 randomly generated datasets. The original sample was randomised by adding a random fraction of ±15 % to each measurement. As shown by Kendall (1974), a slightly different dataset can produce higher peaks; if this happens consistently, it means that the real dataset is not perfectly quantally configured and that the results are likely due to chance. Each generated dataset was then analysed through CQA. If equal or better results occur more often than a predetermined threshold (typically 1 % or 5 % of iterations), it means that it cannot be excluded that the results obtained from the actual sample are simply due to chance, and therefore they should be rejected. For our experiment, we set the threshold (alpha level) to 1 %. In other words, if better results occur in less than 1 % of the iterations, then the null hypothesis is rejected and the sample is very likely the result of an intentionally quantal portioning.

3D reconstruction

The fragmented objects that were documented directly during this research were subject to 3D scanning and digitally reconstructed (Ialongo and Rahmstorf 2019). The volume before and after the reconstruction was measured and the original mass was calculated based on density. Density (d) is a function of volume (v) and mass (m) (d=m/v), and the reconstruction is based on the assumption that, whatever the material employed, every object has an approximately uniform density. Hence, the reconstructed mass (m1) is obtained from a reconstructed volume (v1), given its density (m1=d* v1). Obviously, this method is only valid for those objects whose original shape can be easily reconstructed (like the example in Figure 4).

Analysis

The frequency distribution analysis (FDA) shows that the sample forms four remarkable clusters around c. 100-130 g, 400-500 g, 800-900 g and 1200-1400 g (Figure 5). The first cluster is mainly constituted by German finds, the second mainly by objects from Italy, and the third and fourth clusters are mainly composed by *Kannelurensteine* from Swiss sites. However, finds from all regions are present in every cluster, except the fourth one, which only includes objects from Germany and Switzerland. The clusters are loosely organised along a sequence of multiples: if we take the value of c. 400-500 g as a "unit", the series can be roughly broken down as 1/4 : 1 : 2 : 3.

The CQA supports the observations derived from the FDA, highlighting a high positive quantum at c. 450 g, well above the 1 % significance threshold (Figure 6). The dotted line in the graph shows the results of φ(q) for the quantum of 444 g for every single measurement in the sample. The graph clearly illustrates that the quantum fits very well all the main clusters in the distribution. The quantum of 444 g does not fit the smallest cluster at c. 100-130 g because the value of the cluster is smaller than the quantum itself. This happens simply because CQA cannot give high positive values for measurements that are significantly smaller than the tested quantum. However, the first cluster can be easily approximated to ¼ of 444 g, so c. 111 g.

Discussion

FDA and CQA support the hypothesis that the European *Kannelurensteine* were meant to comply with a standard system of measurement, and thus support their possible interpretation as balance weights. The Monte Carlo test shows that the quantum of c. 450 g is highly significant, and that most measurements in the sample are fairly accurate multiples and fractions of that quantum. Furthermore, the peaks in the distribution always include objects from two or more regions. Nonetheless, the FDA also shows that the distribution has some "background noise": the peaks, in fact, are not extremely sharp and present outliers. In other words, the quantum of c. 450 g is a good descriptor for most of the variability of the sample, but a minority of measurements still seem to escape the quantal logic. While maintaining the balance weight hypothesis, the presence of outliers in the distribution can have several explanations, for example:

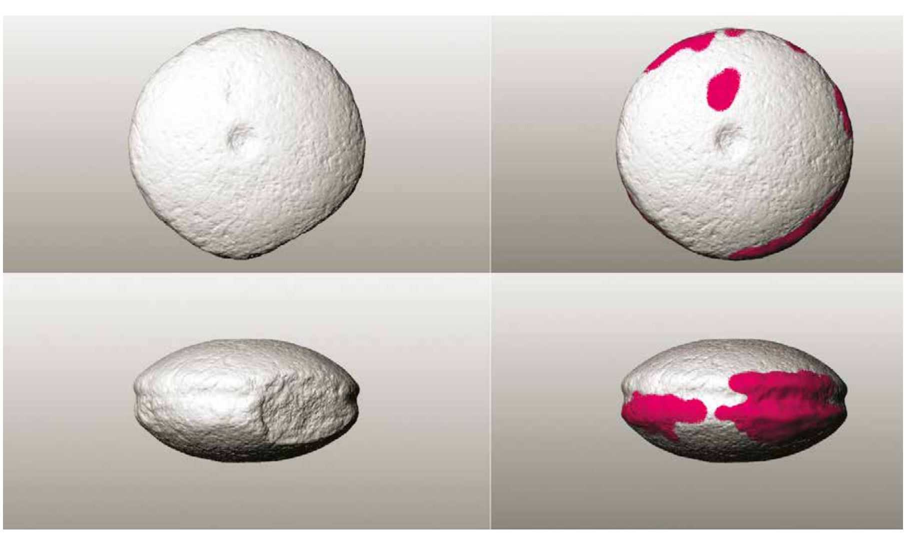


Figure 4. Example of a 3D reconstruction of a *Kannelurenstein.* Left: original. Right: reconstructed model.

The inherent inaccuracy of balance weights. There is a widespread preconception among non-specialists that balance weights must be extremely accurate in order to function properly. On the contrary, the evidence rather speaks in favour of a certain variability, quantified between c. 5-10 % in terms of relative standard deviation (Hafford 2012; Ialongo *et al.* 2018b).

More than a single weight system is represented in the sample. The background noise can be generated by the simultaneous presence of two or more weight systems. While the quantum of c. 450 g can explain the majority of data, other weight systems can have been in use, which may have generated the outliers observed in the distribution. Since CQA is highly reliant on the size of the sample (Pakkanen 2011), it tends to identify only those quanta that are most represented, and to ignore the less frequently occurring ones.

- Measurement imprecision. For some objects in the sample, our analysis relies on published mass values that we could not verify directly. Furthermore, the Italian sample includes several fragmented objects that were reconstructed manually without the aid of 3D scanning (Cardarelli *et al.* 2001). While there is no reason to think that the reconstructed mass values are inaccurate, the difference in reconstruction methods can have affected the variability of the sample.
- Raw materials. Most *Kannelurensteine* are made of different kinds of sandstone (Figure 7). Sometimes the material is so soft and porous that it is not always clear how much of the original surface was eroded as a consequence of post-depositional modifications. Since the 3D reconstruction was only applied in the case of clearly missing fragments, it is possible that the presence of eroded objects may have affected the accuracy of the measurements.
- Chronological differences. The *Kannelurensteine* from Italy mostly date to the third quarter of the second millennium BC while the *Kannelurensteine* from eastern Germany and western Poland date mainly to the last century of the second and the first quarter of the first millennium BC.

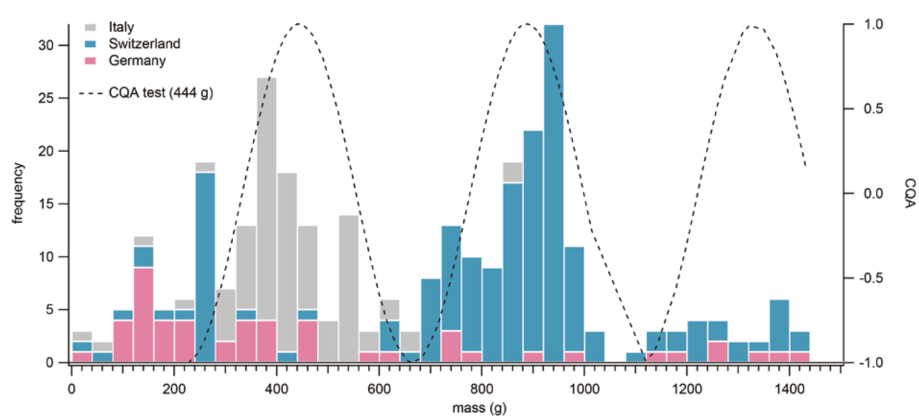


Figure 5. Frequency distribution analysis of the mass values of *Kannelurensteine*. The dotted line illustrates the results of the CQA for each individual measurement.

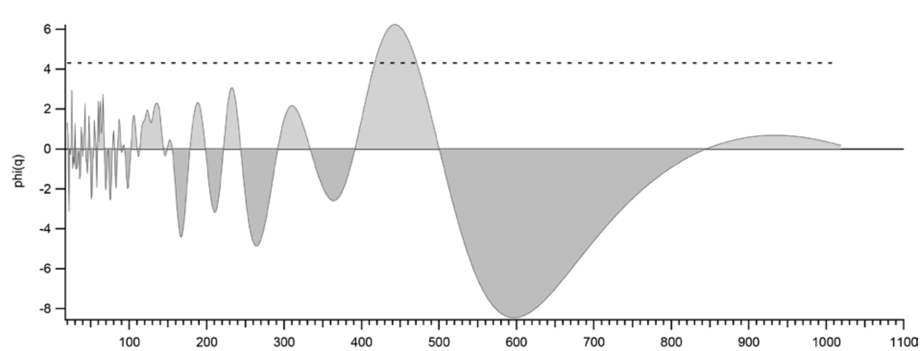


Figure 6. Cosine quantogram analysis of *Kannelurensteine.* The horizontal line indicates the alpha level for 1 % significance.

Figure 7. Examples of different levels of preservation of the surface of *Kannelurensteine* from Hamburg-Marmstorf (left) and Borstel, Schleswig-Holstein (right); see Table 1. Scale 1:2.

The concurrence of all these potential sources of error may have affected the distribution of mass values, artificially producing inaccuracy and altering the variability of the sample. However, the high significance of the results suggests that the majority of the sample is indeed accurate, and was intentionally regulated in order to comply with a quantum of c. 450 g.

As has been pointed out recently (Ialongo and Rahmstorf 2019), the hypothetical weight system resulting from the analyses is peculiar to continental Europe, and does not correspond to other known standards in Greece and in the Near East. The new analyses seem to confirm that the development of weight systems in Bronze Age Europe was largely independent and probably driven by long-distance trade within Europe itself, and that the possible connections with Mediterranean standards must be seen in terms of a complex dialectic rather than a direct dependency (Ialongo 2019). If one accepts the balance-weight hypothesis, the quantum of c. 450 g *does not necessarily indicate the unit.* CQA is a powerful tool in identifying intentional regularities in a sample of metrically-configured objects. However, weight systems – and systems of measurements in general – are mainly abstract concepts, and rely on normative frameworks that are entirely arbitrary. The quantum of c. 450 *can be* a unit, a multiple of a unit, a fraction of a unit or even a multiple or fraction common to two or more different units belonging to different weight systems. A study on weighed goods in contemporary supermarkets revealed that it is not possible to detect normative units only based on CQA even in our supposedly "exact" modern economy (Ialongo and Vanzetti 2016; Ialongo 2019). There is no other way to detect a theoretically-exact normative unit than by relying on written sources and inscribed weights, neither of which is available in pre-literate Bronze Age Europe. Fortunately, for the purpose of determining whether or not a sample of metrical observations is the product of intentional compliance with a normative weight system, the exact identification of "the unit" is completely irrelevant. Since weight systems are simply numbers, the existence of a significant quantum is enough to prove the intentionality of mass regulation (Kendall 1974), and weight systems can be understood and compared even without relying on exact units as ultimate principles (Ialongo *et al.* 2018a). As for the *Kannelurensteine* of Bronze Age Europe, the results of the CQA suggest that one or more weight systems possessed units that were multiples or fractions of c. 450 g.

The balance weight hypothesis – supported by the statistical analyses – also provides plausible explanations for all those specific traits of *Kannelurensteine* that were used in previous studies to support different interpretations. The use-wear that is sometimes observed in the groove – which, as must be remembered, is not always present – can be explained with the frequent use of a cord to keep the weight hanging from one extremity of an equal-arm balance. If the much later objects from Manching (Jacobi 1974, pl. 107. 5) were also used as balance weights, the function of the cord may have been taken over by the metal clamp. While it is likely that in the Bronze Age most balance beams were made of wood (Ialongo 2019; Peyronel 2011), it has been recently demonstrated that even the tiniest and most fragile bone beams (frequently contained in Late Bronze Age burials) could support a weight of at least 5 kg (Hermann *et al.* 2020), and thus they were perfectly capable of handling *Kannelurensteine*. The groove itself and the occasional presence of circular indentations – used to propose the unlikely interpretation as fixed pulleys (Leuvrey 1999) – can be easily explained by the manufacturing process of balance weights. The only way to construct a stone weight is to progressively remove material, until the desired mass is obtained. As balance weights, *Kannelurensteine* were meant to possess an approximately specific form, i.e. a finely shaped lenticular object. The groove and the indentations may have been required to further carve the object in order to obtain the desired mass, once the crafter had already achieved the desired proportions. This can also explain why the groove and the indentations are not present on all objects. Finally, the occasional occurrence of use-wear can be explained with a possible reuse as a tool (as also documented in the Bronze Age Aegean: Rahmstorf 2016b, 246), and even with the use as balance weights. Weights are, after all, still tools: they are often picked up and dropped on different surfaces during their use lives, and rough movements can produce chipping and permanent traces. Finally, the significant spread of the size of *Kannelurensteine* (11.8-5050 g) further supports the interpretation as balance weights, and is not compatible with other interpretations.

Conclusions

In this paper, we presented a study on the so-called *Kannelurensteine*, in order to test the hypothesis that they were used as balance weights. *Kannelurensteine* are a widespread type in Italy, central Europe and southern Scandinavia between c. 1500-800/700 BC. They usually show no signs of use. The association with metallurgy recurs in various regions of Europe, which suggests that the shape was connected with a specific function over a very large area. The mass values are spread out between c. 10-5000 g, and the statistical tests show that there is a very high probability that they were intentionally regulated based on a *quantum* of c. 450 g. The results of the statistical analysis suggest that the interpretation as balance weights is the only one, among all those that have been proposed in the past, that can explain all the typological, contextual and metrological characteristics of the *Kannelurensteine*.

Kannelurensteine are not the only type of balance weights documented in the European Bronze Age (Ialongo and Rahmstorf 2019; Pare 1999). The identification of a limited array of standardised types of balance weights – complying with widespread weight systems – attests that a lively commercial network existed in Europe in the second millennium BC. Within the ever-changing picture of metal production and consumption provided by mining and provenance studies in the past decades, the research on Bronze Age weight-based trade represents one of our best chances to understand how exchange connected the European continent on the verge of the historical era.

In Italy and central Europe, *Kannelurensteine* are one among several types of balance weights, ranging several orders of magnitude, and often associated with balance beams. For the north-central European and western Baltic areas the situation is still difficult to assess in detail. The *Kannelurensteine* would be the first direct type of weight known in this region, whereas further south a greater variety of weight types is present (see Ialongo and Rahmstorf 2019, figs 6-10). More data on *Kannelurensteine* and, in general, on weighing technology are needed for the Lusatian culture and for southern Scandinavia in order to achieve a better understanding of the significance of this innovation in the western Baltic.

Balance weights are the merchants' tools *par excellence*. In Mesopotamian and Aegean texts, there is virtually no other use for weight systems than to account for incomes and expenditures, calculate profits and quantify debts (e.g. Bartash 2019). There is no clear indication that weighing technology had a substantial role in manufacturing activities, such as metallurgy. Hence, the possible connection with metalworking tools and facilities, hinted at by some contextual associations of *Kannelurensteine* and other types of weights

(Ialongo and Rahmstorf 2019), suggests that one of the main applications of weighing technology was metal trade. At the same time, this does not imply that metal trade was the only application. We find connections with metallurgy simply because metallurgy leaves clear and permanent traces, while other productive activities are more elusive. Weighing equipment could be used in connection with every trade dealing with "amorphous" substances, such as wool (Sabatini and Bergerbrant 2019), salt (Harding 2021, 134-36) or alum that could not be measured without an abstract frame of reference. The possible connection with metallurgical tools and facilities simply implies that, since metallurgists had to acquire metals via trade, they needed a technology that allowed them to quantify the amount of the required raw material and hence its price. The adoption of weighing equipment is foremost the adoption of a new technology, one that marks a turning point in economic history: for the first time, economic value could be quantified according to a universally-valid frame of reference (Renfrew 2007, 99-101, 143-45; Pare 1999). The fact that *Kannelurensteine* – as all other types of European balance weights – comply with an international standard widespread at least between Italy and central Europe implies that a tight network of merchants existed that could foster the emergence of such a standard and maintain it through time. In this perspective, tracing the appearance of weighing equipment in different parts of Bronze Age Europe equals to tracing the adoption of a new technology, a new concept of economic value and a new model of trade.

Acknowledgements

We would like to thank the peer reviewers for their very useful comments.

Bibliography

Bartash, V. 2019. *Establishing value. Weight measures in early Mesopotamia*. Berlin/ Boston: De Gruyter.

Breniquet, C. and Michel, C. (eds) 2014. *Wool economy in the ancient Near East and the Aegean: from the beginnings of sheep husbandry to institutional textile industry*. Oxford: Oxbow Books.

Cardarelli, A., Pacciarelli, M. and Pallante, P. 1997. Pesi da bilancia dell'età del bronzo? In M. Bernabò Brea, A. Cardarelli and M. Cremaschi (eds), *Le Terramare. La più antica civiltà padana*, 629-42. Milan: Electa.

Cardarelli, A., Pacciarelli, M., Pallante, P. and Bellintani, P. 2001. Pesi e bilance nell'età del bronzo italiana. In C. Corti and N. Giordani (eds), *Pondera. Pesi e misure nell'Antichità*, 33-58. Modena: Libra 93.

Eberschweiler, B., Riethmann, P. and Ruoff, U. 2007. *Das spätbronzezeitliche Dorf von Greifensee-Böschen: Dorfgeschichte, Hausstrukturen und Fundmaterial*. Zurich, Egg: Baudirektion Kanton Zürich, Hochbauamt Kantonsarchäologie.

Gackowski, J. 2007. Społeczności łużyckie w strefie Pojezierza Chełmińskiego i przyległych dolin Wisły, Drwęcy i Osy – refleksje nad interpretacją niektórych źródeł. In M. Fudziński and H. Paner (eds), *Aktualne problemy kultury łużyckiej na Pomorzu*, 155-72. Gdańsk: Muzeum Archeologiczne w Gdańsku.

Hafford, W.B. 2012. Weighing in Mesopotamia. The balance pan weights from Ur. *Akkadica* 133, 21-65.

Harding, A. 2021. The movement of commodities in Bronze Age Europe. In L. Rahmstorf, G. Barjamovic and N. Ialongo (eds), *Merchants, measures and money. Understanding technologies of early trade in a comparative perspective. Proceedings of two workshops funded by the European Research Foundation (ERC)*, 127-39. Kiel, Hamburg: Wachholtz.

Hermann, R., Steinhoff, J., Schlotzhauer, P. and Vana, P. 2020. Breaking news! Making and testing Bronze Age balance scales. *Journal of Archaeological Science: Reports* 32, 102444.

Horst, F. 1981. Bronzezeitliche Steingegenstände aus dem Elbe-Oder-Raum. *Bodendenkmalpflege in Mecklenburg* 29, 33-83.

Ialongo, N. 2019. The earliest balance weights in the west: towards an independent metrology for Bronze Age Europe. *Cambridge Archaeological Journal* 29, 103-24.
Ialongo, N. and Rahmstorf, L. 2019. The identification of balance weights in pre-literate Bronze Age Europe: typology, chronology, distribution and metrology. In L. Rahmstorf and E. Stratford (eds), *Weights and marketplaces from the Bronze Age to the Early Modern period. Proceedings of two workshops funded by the European Research Foundation (ERC)*, 105-26. Kiel, Hamburg: Wachholtz.
Ialongo, N. and Vanzetti, A. 2016. The intangible weight of things: approximate nominal weights in modern society. In S. Biagetti and F. Lugli (eds), *The intangible elements of culture in ethnoarchaeological research*, 283-91. Cham: Springer.
Ialongo, N., Vacca, A. and Peyronel, L. 2018a. Breaking down the bullion. The compliance of bullion-currencies with official weight-systems in a case-study from the ancient Near East. *Journal of Archaeological Science* 91, 20-32.
Ialongo, N., Vacca, A. and Vanzetti, A. 2018b. Indeterminacy and approximation in Mediterranean weight systems in the third and second millennia BC. In D. Brandherm, E. Heymans and D. Hofmann (eds), *Gifts, goods and money. Comparing currency and circulation systems in past societies*, 9-44. Oxford: Archaeopress.
Indreko, R. 1956. *Steingeräte mit Rille*. Stockholm: Almquist & Wiksell.
Jacobi, G. 1974. *Werkzeug und Gerät aus dem Oppidum von Manching*. Wiesbaden: Steiner.
Kaczmarek, M. 2002. *Zachodniowielkopolskie społeczności kultury łużyckiej w epoce brązu*. Poznań: Uniwersytet Im. Adama Mickiewicza.
Kendall, D.B. 1974. Hunting Quanta. *Philosophical Transactions of the Royal Society of London. Series A, Mathematical and Physical Sciences* 276, 231-66.
Kostrzewski, J. 1958. *Kultura łużycka na Pomorzu*. Poznań: Państwowe Wydawnictwo Naukowe.
Krzyszowski, A. (ed.) 2019. *Nekropola z późnej epoki brązu Wartosław – Biezdrowo – Zakrzewo*. Poznań: Muzeum Archeologiczne w Poznaniu.
Leuvrey, J.-M. 1999. *L'industrie lithique du Bronze final, étude typo-technologique*. Neuchâtel: Musée cantonal d'archéologie.
Melheim, L. 2015. *Recycling ideas: Bronze Age metal production in southern Norway*. Oxford: BAR Publishing.
Pakkanen, J. 2011. Aegean Bronze Age weights, chaînes opératoires and the detecting of patterns through statistical analyses. In A. Brysbaert (ed.), *Tracing social networks through studying technologies: a diachronic perspective from the Aegean*, 143-66. London: Routledge.
Pare, C.F.E. 1999. Weights and weighing in Bronze Age central Europe. In RGZM (ed.), *Eliten in der Bronzezeit. Ergebnisse zweier Kolloquien in Mainz und Athen*, 421-514. Mainz: Verlag des Römisch-Germanischen Zentralmuseums.
Petruso, K.M. 1992. *Ayia Irini. The balance weights: an analysis of weight measurement in prehistoric Crete and the Cycladic Islands*. Mainz: Philipp von Zabern.
Peyronel, L. 2011. Mašqaltum Kittum. Questioni di equilibrio: bilance e sistemi di pesatura nell'Oriente Antico. In E. Ascalone and L. Peyronel (eds), *Studi Italiani di Metrologia ed Economia del Vicino Oriente Antico*, 105-61. Roma: Herder.
Powell, M.A. 1996. Money in Mesopotamia. *Journal of the Economic and Social History of the Orient* 39, 224-42.
Raddatz, K. 1991. Ein Kannelurenstein von Moide bei Soltau, Ldkr. Soltau-Fallingbostel. *Nachrichten aus Niedersachsens Urgeschichte* 60, 161-67.
Rahmstorf, L. 2016a. Die Rahmenbedingungen des bronzezeitlichen Handels in Europa und im Alten Orient einschließlich Ägyptens. In U. Dietz and A. Jockenhövel (eds), *50 Jahre „Prähistorische Bronzefunde". Bilanz und Perspektiven. Beiträge zum internationalen Kolloquium vom 24. bis 26. September 2014 in Mainz*, 291-310. Stuttgart: Steiner.
Rahmstorf, L. 2016b. Emerging economic complexity in the Aegean and western Anatolia during the earlier third millennium BC. In B.P.C. Molloy (ed.), *Of Odysseys and oddities.*

Scales and modes of interaction between prehistoric Aegean societies and their neighbours, 225-76. Oxford: Oxbow Books.
Rahmstorf, L. and Ialongo, N. 2020. Sind Kannelurensteine Gewichte? Rätselhafte Objekte aus der Bronzezeit. *Archäologie in Niedersachsen* 23, 53-56.
Rahmstorf, L. and Pare, C.F.E. 2007. Zu Gewichtssteinen der Späthallstatt- und Latènezeit. *Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz* 54, 265-95.
Rahmstorf, L. and Stratford, E. (eds) 2019. *Weights and marketplaces from the Bronze Age to the Early Modern Period. Proceedings of two workshops funded by the European Research Council (ERC)*. Kiel, Hamburg: Wachholtz.
Renfrew, C. 2007. *Prehistory. The making of the human mind*. New York: Modern Library.
Reinbacher, E. 1956. Ein bronzezeitlicher Hortfund von Krampnitz, Ldkr. Potsdam. *Ausgrabungen und Funde. Nachrichtenblatt für Vor- und Frühgeschichte* 1, 153-58.
Sabatini, S. and Bergerbrant, S. 2019. *The textile revolution in Bronze Age Europe. Production, specialisation, consumption*. Cambridge: Cambridge University Press.
Schmalfuß, G. 2008. Das Gräberfeld Battaune, Kr. Delitzsch in Sachsen. Ein jüngstbronzezeitliches Gräberfeld der Lausitzer Kultur – die Ergebnisse der Grabungen von 1974/75. *Leipziger online-Beiträge zur Ur- und Frühgeschichtlichen Archäologie* 29; available at https://nbn-resolving.org/urn:nbn:de:bsz:15-qucosa2-340050
Vrdoljak, S. and Forenbaher, S. 1995. Bronze-casting and organization of production at Kalnik-Igrišče (Croatia). *Antiquity* 69, 577-82.

Area	Site	Mass	Area	Site	Mass	Area	Site	Mass
Germany	Battin	11.80	Germany	Felchow	179.95	Switzerland	Grandson	266.10
Switzerland	Mörigen	22.54	Germany	Bollensdorf	185.10	Switzerland	Greifensee-Böschen	270.00
Italy	Gorzano	36.80	Switzerland	Ürschhausen	187.00	Switzerland	Nidau	272.00
Italy	Montale	41.00	Germany	Klein Görigk 18	194.28	Italy	Salina	275.43
Switzerland	Nidau	78.60	Germany	Linden	202.40	Switzerland	Estavayer-le-Lac	276.40
Germany	Schönermark	87.78	Switzerland	Zürich	228.50	Switzerland	Ins	277.00
Switzerland	Concise	102.30	Germany	Hitzacker	235.20	Germany	Schwanow	291.86
Germany	Krampnitz	112.23	Italy	Gorzano	235.67	Germany	unknown	297.84
Germany	Lübben	113.72	Germany	Schlieben	235.92	Italy	Basilicanova	299.00
Germany	Klockow	119.05	Germany	unknown	236.27	Italy	Montale	299.06
Germany	Kr. Sorau	120.00	Switzerland	Estavayer-le-Lac	240.30	Italy	Peschiera	304.00
Germany	Starkowo	120.20	Switzerland	Zug-Sumpf	241.90	Italy	Montale	317.95
Germany	Kölpinsee	121.80	Switzerland	Twann	243.80	Italy	Montale	319.91
Germany	unknown	122.97	Switzerland	Zürich	245.50	Italy	Montale	327.19
Germany	unknown	123.27	Switzerland	Zug-Sumpf	250.90	Germany	Hamburg-Marmstorf	330.18
Italy	S'Urbale	123.37	Switzerland	Saint-Blaise	252.00	Switzerland	Hauterive-Champréveyres	332.20
Germany	Wilmersdorf	123.40	Switzerland	Estavayer-le-Lac	254.30	Italy	Montale	332.52
Germany	Müllrose	125.08	Switzerland	Greifensee-Böschen	255.00	Italy	Montale	334.44
Switzerland	Mörigen	125.20	Switzerland	Greifensee-Böschen	256.00	Germany	Gross-Glienicke	336.97
Poland	Dłużyna	127.00	Switzerland	Estavayer-le-Lac	259.00	Italy	Casinalbo	337.40
Germany	Frankfurt "Nussweg"	132.59	Switzerland	Zürich	260.00	Italy	Montale	338.81
Switzerland	Nidau	138.20	Switzerland	Estavayer-le-Lac	260.10	Germany	Michaelisbruch	339.60
Germany	Schleswig	177.50	Switzerland	Greifensee-Böschen	266.00	Italy	Lipari	341.30

Table 1. List of *Kannelurensteine* included in the sample for the statistical analyses.

Area	Site	Mass
Italy	Montale	341.86
Italy	Montale	345.02
Germany	Flintbeck (Kleinflintbeck)	347.20
Germany	unknown	360.40
Italy	Frattesina	361.00
Germany	Friedersdorf	361.07
Italy	Frattesina	362.00
Italy	Montale	365.46
Italy	Montale	375.27
Italy	Montale	375.74
Italy	Montale	377.64
Italy	Frattesina	378.00
Italy	Montale	380.70
Italy	Montale	381.03
Italy	Montale	381.39
Italy	Montale	382.91
Italy	Casinalbo	383.39
Italy	Frattesina	385.00
Germany	Pritzen	385.82
Italy	Montale	387.38
Italy	Gorzano	387.82
Italy	Montale	388.00
Italy	Montale	388.83
Italy	Montale	389.01
Italy	Montale	390.06
Italy	Montale	397.09
Italy	Montale	397.71
Germany	Kr. Prignitz	397.79
Italy	Nuraghe Sant'Imbenia	398.49
Italy	Montale	399.68
Italy	Montale	407.57
Italy	Montale	409.02
Italy	Casinalbo	414.64
Italy	Peschiera	415.00
Italy	Gaggio di Castelfranco	416.64
Italy	Montale	417.00
Italy	Casaroldo	419.00
Italy	Montale	420.80
Italy	Bellanda	424.00
Italy	Montale	427.46
Italy	Gaggio di Castelfranco	427.87
Italy	Montale	428.00
Italy	Montale	429.00

Area	Site	Mass
Italy	Casinalbo	431.06
Italy	Montale	432.46
Switzerland	Savognin	433.50
Italy	Scandiano	436.00
Italy	Montale	438.72
Italy	Frattesina	440.00
Italy	Frattesina	440.00
Italy	Montale	442.00
Italy	Peschiera	443.00
Germany	Dersekow	444.88
Italy	Casinalbo	446.58
Italy	Montale	453.02
Germany	unknown	453.35
Germany	Windeby (Kochendorf)	453.90
Italy	Gaggio di Castelfranco	466.20
Switzerland	Estavayer-le-Lac	471.40
Germany	Neumünster (Tungendorf)	475.20
Italy	Montale	477.08
Italy	Gaggio di Castelfranco	489.63
Italy	Frattesina	490.00
Italy	Redù	492.00
Italy	Cornocchio	494.00
Italy	Montale	520.00
Italy	Montale	520.00
Italy	Montale	521.70
Italy	Montale	521.73
Italy	Cella T. Cassoli	525.00
Italy	Gazzade	533.00
Italy	Montale	539.00
Italy	Redù	542.00
Italy	Santa Rosa di Poviglio	545.00
Italy	Casinalbo	546.00
Italy	Gaggio di Castelfranco	548.00
Italy	Redù	549.00
Italy	Montale	558.36
Italy	Gazzade	559.00
Germany	Moisburg	579.34
Italy	Savana	580.00
Italy	Gorzano	588.04
Switzerland	Hauterive-Champréveyres	600.20
Switzerland	Zug-Sumpf	604.20
Switzerland	Onnens	615.50

Area	Site	Mass
Germany	Wankendorf	616.90
Italy	Montale	630.00
Italy	Gazzade	633.00
Italy	Montale	650.00
Switzerland	Hauterive-Champréveyres	654.30
Italy	Casinalbo	664.00
Switzerland	Grandson	684.00
Switzerland	Hauterive-Champréveyres	707.60
Switzerland	Zürich	708.70
Switzerland	Greifensee-Böschen	714.00
Switzerland	ohne Fundort	715.20
Switzerland	Zug-Sumpf	715.30
Switzerland	Ürschhausen	718.30
Switzerland	Zürich	719.50
Switzerland	Greifensee-Böschen	722.00
Switzerland	Nidau	728.50
Switzerland	Zürich	729.00
Switzerland	Estavayer-le-Lac	729.10
Switzerland	Auvernier	731.70
Switzerland	Nidau	733.90
Switzerland	Auvernier	734.00
Switzerland	Zürich-Wollishofen	735.00
Germany	unknown	737.06
Switzerland	Zürich	748.50
Germany	unknown	751.00
Germany	unknown	752.90
Switzerland	Estavayer-le-Lac	759.60
Switzerland	Grandson	761.40
Switzerland	Ürschhausen	773.00
Germany	Fleestedt	779.00
Switzerland	Estavayer-le-Lac	779.10
Switzerland	Hauterive-Champréveyres	780.00
Switzerland	Forel	782.10
Switzerland	Hauterive-Champréveyres	786.50
Switzerland	Grandson	789.10
Switzerland	Grandson	791.20
Switzerland	Grandson	799.90
Switzerland	Bevaix	801.10
Switzerland	Greifensee-Böschen	807.00
Switzerland	Cortaillod	810.00
Switzerland	Le Landeron	810.00
Switzerland	Haut-Vully	821.60
Switzerland	Grandson	829.30

Table 1 (continued).

Area	Site	Mass
Switzerland	Guévaux	831.30
Switzerland	Grandson	834.40
Switzerland	Grandson	836.30
Switzerland	Nidau	848.00
Italy	Montale	850.00
Switzerland	Grandson	852.10
Switzerland	Avenches	853.50
Switzerland	Auvernier Nord	854.80
Switzerland	Auvernier Nord	858.70
Switzerland	Zürich	861.00
Switzerland	Insel Werd	862.00
Switzerland	Autavaux	863.80
Switzerland	Grandson	864.70
Switzerland	Zürich	868.50
Switzerland	Grandson	870.60
Switzerland	Estavayer-le-Lac	872.40
Switzerland	Zürich	873.40
Italy	Gazzade	876.00
Switzerland	Haut-Vully	876.90
Switzerland	Mörigen	876.90
Switzerland	Zürich	876.90
Switzerland	Nidau	878.90
Switzerland	Zürich	881.70
Switzerland	Auvernier Nord	885.10
Switzerland	Auvernier Nord	886.60
Switzerland	Grandson	889.20
Switzerland	Berg am Irchel	890.60
Switzerland	Zürich	891.10
Switzerland	Andelfingen	898.80
Switzerland	Ürschhausen	899.00
Switzerland	Zürich	900.00
Switzerland	Mörigen	900.90
Germany	Hitzacker	905.60
Switzerland	Nidau	907.50
Switzerland	Estavayer-le-Lac	908.30
Switzerland	Zürich	908.70
Switzerland	Mörigen	909.00
Switzerland	Zürich	909.40
Switzerland	Grandson	910.60
Switzerland	Zürich	911.50
Switzerland	Zürich	912.70
Switzerland	Grandson	914.30
Switzerland	Zürich	914.70

Area	Site	Mass
Switzerland	Mörigen	917.50
Switzerland	Zürich	922.80
Switzerland	Hauterive-Champréveyres	923.20
Switzerland	Nidau	924.90
Switzerland	Zürich	927.90
Switzerland	Zürich	928.00
Switzerland	Grandson	931.20
Switzerland	Zürich	931.90
Switzerland	Zürich	933.90
Switzerland	Zug-Sumpf	934.10
Switzerland	Grandson	937.10
Switzerland	Zürich	937.40
Switzerland	Zürich	939.00
Switzerland	Eschenz	939.80
Switzerland	Zürich	941.80
Switzerland	Nidau	941.90
Switzerland	Grandson	942.20
Switzerland	Zürich	942.20
Switzerland	Zürich	943.30
Switzerland	Zürich	944.10
Switzerland	Mörigen	945.80
Switzerland	Zürich	947.60
Switzerland	Zürich	948.50
Switzerland	Meilen	949.10
Switzerland	Zürich	949.30
Switzerland	Zürich	950.10
Switzerland	Nidau	953.20
Switzerland	Zürich	953.70
Switzerland	Zürich	953.90
Switzerland	Zürich	955.40
Switzerland	Zürich	955.90
Switzerland	Zürich	958.70
Switzerland	Zürich	958.90
Switzerland	Zürich	960.00
Switzerland	Zürich	962.80
Switzerland	Zürich	966.60
Switzerland	Nidau	969.10
Switzerland	Zug-Sumpf	969.50
Switzerland	Zürich	978.10
Switzerland	Grandson	978.90
Switzerland	Zürich	981.00
Switzerland	Auvernier Nord	982.90
Switzerland	Mörigen	984.90

Area	Site	Mass
Germany	Borstel	998.36
Switzerland	unknown	1005.10
Switzerland	Zug-Sumpf	1005.10
Switzerland	Zürich	1014.40
Switzerland	Estavayer-le-Lac	1119.70
Germany	Dollrottfeld	1131.80
Switzerland	Hauterive	1133.40
Switzerland	Mörigen	1141.50
Switzerland	Grandson	1179.00
Germany	Nennhausen	1195.00
Switzerland	Zug-Sumpf	1195.30
Switzerland	Zug-Sumpf	1200.40
Switzerland	Zug-Sumpf	1204.10
Switzerland	Nidau	1222.20
Switzerland	Zug	1234.00
Germany	Hitzacker	1245.00
Germany	unknown	1255.00
Switzerland	Zug-Sumpf	1257.90
Switzerland	Zug-Sumpf	1273.00
Switzerland	Greifensee-Böschen	1309.00
Switzerland	Mörigen	1313.10
Switzerland	Mörigen	1321.00
Germany	Ramelsloh	1350.00
Switzerland	Nidau	1374.20
Switzerland	Nidau	1374.20
Switzerland	Mörigen	1375.30
Switzerland	unknown	1378.50
Switzerland	Zürich	1382.00
Germany	Stepnitzer Moor	1394.77
Switzerland	Scherzingen	1410.00
Switzerland	Mörigen	1428.60
Germany	Kampen/Sylt	1432.20
Germany	unknown	1608.00
Germany	Berlin, Tiergarten, Schlosspark – Bellevue	1844.00
Switzerland	Port	2105.40
Germany	Unknown	2788.20
Italy	Salina	2928.00
Germany	Berlin, Weißensee, Hohenschönhausen	3073.02
Switzerland	Grandson	3756.20
Switzerland	Uster-Riedikon	5050.00

Table 1 (continued).

From the seaside to the inland

Comparing Late Bronze Age pottery production and styles in the eastern Baltic

Vanda Visocka, Vytenis Podėnas, Uwe Sperling

Introduction

The eastern Baltic Bronze Age has for a long time been distinguished for its role in interregional communication and exchange networks, and mainly from the perspective of metalwork trade relations. As the amounts or numbers of metal finds from hoards and graves from this period are modest compared to regions of the Nordic Bronze Age, this role was understood as passive or marginal (Sidrys and Luchtanas 1999). However, peripheral territories of the Nordic Bronze Age world have yielded some of the most intriguing cases of production sites (Earle *et al.* 2015; Jaanusson 1981; Melheim *et al.* 2016) and these have provided impulses for further development of the surrounding regions. The eastern Baltic coast is a case of a similar process, as the most diversified production sites are located in coastal areas (Podėnas and Čivilytė 2019). This article approaches the problem by investigating people's behaviour in pottery production technologies, one of the most common household practices.

Both metal objects and ceramics generally play a minor role in funerary customs of the east Baltic, i.e., are barely found in graves or hoards during the entire Bronze Age. The material culture of this period consists mainly of settlement finds, which are, overall, rich and comprehensive, but unevenly represented by mostly Late Bronze Age fortified settlements (LBA, c. 1100-500 cal BC; Podėnas 2020). That is the time when fortified settlements emerged in the east Baltic region, usually with thick cultural layers containing abundant archaeological and ecofactual data.

Over the last two decades, research progress concerning settlement remains, as well as bronze or pottery production, has resulted in a better understanding of the economic strategies, technical logistics and social relations of the craftsmen and individuals involved (e.g. contributions in Fokkens and Harding 2013; Orton *et al.* 1993; Ringstedt 1992; Woltermann *et al.* 2019). Abandoning the uninspiring view of the south-eastern Baltic's passive role in the exchange of metal objects, a more productive approach would be to look at the region as a unique case of society reacting to late and strong impulses of European intensive agriculture (Lang 2007; Minkevičius *et al.* 2020) and Bronze Age economy (Čivilytė 2014; Podėnas and Čivilytė 2019; Sperling 2014; Vasks 2010). Thus, this is an active territory of people exploring new ideas and adopting them to different degrees.

The study of pottery production is a further step towards understanding the social significance of both stylistic and material patterns. The focus of this paper is on the latter aspect: we will analyse and discuss similarities and differences among LBA groups of eastern Baltic pottery, as well as view pottery as a communication medium. Fortified settlements were mostly widespread on the hilltops and promontories of higher terraces, with concentrated enclosed habitational areas (Graudonis 1967; 1989; Grigalavičienė 1995; Lang 2007; Luchtanas 1992). This kind of site contained most of the communities'

In D. Hofmann, F. Nikulka and R. Schumann (eds) 2022. *The Baltic in the Bronze Age. Regional patterns, interactions and boundaries*, Leiden: Sidestone Press, pp. 161-188.

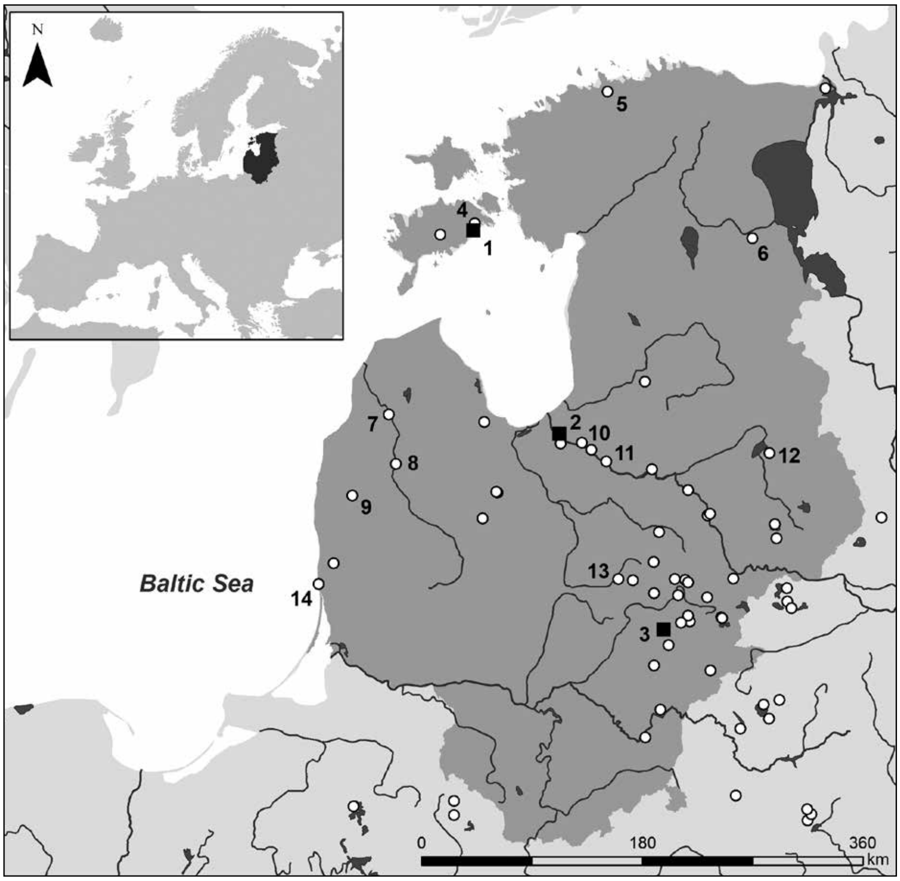


Figure 1. Map of fortified settlements mentioned in the text: 1 Asva, 2 Ķivutkalns, 3 Narkūnai, 4 Ridala, 5 Iru, 6 Kõivuküla, 7 Padure, 8 Krievu kalns, 9 Paplaka, 10 Vīnakalns, 11 Dievukalns, 12 Brikuļi, 13 Kupiškis, 14 Kukuliškiai. The unnumbered dots are other fortified settlements in the eastern Baltic; see Appendix 1 for a complete list of all 65 sites (figure: V. Podėnas).

refuse which accumulated due to the prolonged usage of a limited living area. The three archaeological assemblages chosen for this study were acquired from the fortified settlements of Asva (Estonia), Ķivutkalns (Latvia) and Narkūnai (Lithuania), which are among the most representative sites of the eastern Baltic Late Bronze Age in terms of amounts of finds per site. These sites reflect technologies used in three different ecotones: coastal, island along the river c. 25 km from the sea, and inland near a small stream, c. 200 km from the sea (Figure 1). Our paper aims to identify and compare the technological and stylistic traits of pottery production in these three cases as representative of three different ecological and economic environments in the eastern Baltic.

Background of the sites

Asva

The fortified settlement of Asva is located c. 3 km inland from the south-eastern shore of Saaremaa island (Estonia), but was at the time of its occupation partly surrounded by sea, small islets and brackish water lagoons. The site is situated on a moraine rising up to 5 m from the surrounding flat terrain of the island. Archaeological research was carried out in the 1930s, 1940s and 1960s and again since 2012. The excavations all took place on the edges of the c. 3500 m^2 elongated plateau, mainly in order to investigate the site's stratigraphy and the remains of defensive works (Sperling *et al.* 2019).

The site, leaving thick cultural layers alternating with burning horizons, has been in use some time between 900 and 500 BC based on the finds' typochronology (e.g. pottery and bronze finds; Montelius periods V-VI) and the radiocarbon dates, which span from

917 to 396 cal BC[1] (Sperling 2014; Sperling *et al.* 2015). During the LBA, the Asva site was only temporarily enclosed with a stone wall or fence, but an earthwork and wooden constructions were erected during the Pre-Viking period (600-800 AD; Sperling *et al.* 2019).

The amount of archaeological finds from at least two subsequent LBA habitation phases is remarkable, as only one fifth of the area of the settlement plateau (c. 600 m^2) has been investigated. More than 50,000 pottery fragments, c. 2000 fragments of clay casting moulds and c. 800 bone and antler artefacts testify to intense activities of consumption and production. The rich assemblages of animal bone demonstrate animal husbandry (sheep, cattle, pig, horse, dog) and a seasonal specialisation in hunting seals (grey, ringed, harp and harbour seal; Sperling 2014; Sperling *et al.* 2020).

The style and manufacture of household pottery has common traits with material from many Bronze Age settlements in the eastern European forest belt and has indeed similarities in the pottery of contemporary sites in the east Baltic (such as Ķivutkalns and Narkūnai). This also applies to the spectrum of bone and antler objects (Luik 2013; Luik and Maldre 2007). There is but one particular feature in the LBA Asva pottery, that of bowls and smaller cup-like vessels with characteristic handles and applications that show a different temper, surface treatment and decor than the coarse household vessels. The Asva bowls share similar traits with the late Urnfield culture milieu in eastern central Europe, possibly transmitted via southern Sweden and Gotland (Eriksson 2009; Sperling 2014). Nordic influences are also visible in the metalwork production of the Asva settlement. The vast majority of the casting debris (clay moulds) documents a preference for manufacturing ring-shaped objects (ingots?), but a number of preserved casting moulds also indicate that Nordic-type garment pins, spearheads and socketed axes were among the items produced at Asva (Sperling 2014).

Ķivutkalns

Ķivutkalns fortified settlement was established on Dole island, located in the river Daugava, on a promontory reaching a height of 10 m on that part of the shore and 3 m above the rest of the surroundings (Brastiņš 1930, 15). The promontory was surrounded by the small river Pižaga and its former distributary (Graudonis 1989, 11). Archaeological excavations led by Jānis Graudonis and Jolanta Daiga took place from 1966-1967 (Graudonis 1989, 11). Due to the construction of the Rīga Hydroelectric Power Plant, in whose flooding area Ķivutkalns was situated, the site was fully excavated, over a total area of 2276 m^2 (Graudonis 1989, 11-12). Notably, a cemetery with 247 inhumations and 21 cremations was discovered under the Ķivutkalns fortified settlement, making it a unique Late Bronze Age archaeological site with both burial and residential evidence (Denisova *et al.* 1985, 10).

The archaeological assemblage from the fortified settlement consists of a stray bronze bracelet found in 1942 and excavation finds, which include approximately 38,000 pottery fragments, 2700 other artefacts and 11,600 animal bones (Graudonis 1989, 11, 20). Most of the artefacts were made of stone and bone. Diagnostic LBA finds include various types of bronze and bone dress pins, including bronze pins with a loop, analogous to those from the Lusatian and West Balt Barrow cultures (Vaska 2019, 31), bronze socketed axes, bronze bracelets, ceramic casting moulds for KAM type axes and neck rings, as well as bronze, amber and antler double buttons and pottery (Graudonis 1989, 20-51, 147-48). Notably, there are also two hoards from Ķivutkalns, which include various bronze items – a socketed axe, a spiral pin with flat head, tutuli and neck rings with bent ends (Graudonis 1989, 41; Urtāns 1977, 40). These finds, according to Baiba Vaska (2019, 32), are artefact types typical for Scandinavia, east Prussia, Lithuania and Poland (see also Graudonis 1989, 41).

1 Throughout this paper we are using radiocarbon dates with 95.4 % probability (2 σ).

Based on these finds and ^{14}C analysis of charcoal, Graudonis distinguishes several inhabitation periods in Ķivutkalns: the first to third "layers" are dated to the second half of the first millennium BC, the fourth to sixth "layer" to the second half of first quarter and the second quarter of the first millennium BC, while the seventh to ninth/tenth "layer" span the beginning of the first millennium BC (Graudonis 1989, 21). However, these horizons were distinguished artificially following intuition, and thus do not represent a true stratification. A more precise chronology for the inhabitation period of the settlement was established using ^{14}C dates on bones and charcoal in 2013 and 2014. Based on the interpretation of these results, the inhabitation of the Ķivutkalns fortified settlement began in approximately 650 cal BC and continued periodically until the Pre-Roman Iron Age[2] (Oinonen *et al.* 2013; Vasks and Zariņa 2014).

Narkūnai

Narkūnai fortified settlement was established on a promontory reaching 14 m above its immediate surroundings and located c. 60 m from the Utenėlė rivulet. The promontory was surrounded by a smaller unnamed stream to the west. It was hypothesised that during the establishment of the medieval hillfort in the thirteenth to fifteenth centuries AD the promontory was further isolated by a 14 m deep ditch (Vengalis *et al.* 2020a). Therefore, it is difficult to determine whether the Late Bronze Age site was established on a terrace spanning 55x35 m (Baubonis and Zabiela 2005, 244) or on a significantly longer promontory of at least 125 m. The site was intermittently excavated by antiquarians from 1835 to 1912 (Podėnas *et al.* 2016, 193), and in 1976-1978 an area of 660 m^2 was investigated by a scientific expedition led by Regina Volkaitė-Kulikauskienė and Aleksiejus Luchtanas (Volkaitė-Kulikauskienė 1986).

The archaeological collection acquired during the 1976-1978 investigations included 12,047 pottery fragments, over 800 other artefacts and over 7000 animal bones (Baubonis and Zabiela 2005, 244; Podėnas *et al.* 2016, 204). Diagnostic LBA finds include ceramic casting moulds for KAM type axes and ring-shaped objects (Luchtanas 1981), bronze pins with analogies to Majków-type pins (Čivilytė 2014, 110-11), denoting long-distance contacts, a double button made from antler (Luik and Maldre 2007, 12) and several types of bone pins (Podėnas *et al.* 2016, 201, pav. 4:2-4). Based on the typical profiles of rim sherds, c. 66 % of the pottery could be attributed to the LBA (Podėnas *et al.* 2016, 205). The chronology of the LBA horizon was further narrowed down to 796-550 cal BC by a ^{14}C date on an *Ovis aries*/*Capra hircus* tibia (Podėnas 2020). This bone had been collected in the near vicinity of the earliest enclosure. Recently, an additional six AMS ^{14}C dates were acquired from charred organic residues in pottery and all of them have been calibrated to a range between 798 and 268 cal BC. During the LBA, the site was encircled by a wooden palisade, indicated by two to three lines of small postholes that surround the site. After the LBA horizon, the promontory was settled again from the first century BC to the second century AD and in the thirteenth to fifteenth centuries AD (Podėnas *et al.* 2016; Volkaitė-Kulikauskienė 1986).

Material and methods

The condition of the pottery assemblages in all three studied settlements is good. Assemblages mainly consist of sherds, only a few whole vessels were recovered. For further morphological and stylistic analysis, sherds with specific criteria were used as follows: known context (trench, layer, approximate date), distinguishable surface treatment, shape and wall thickness. Pottery fragments with known coiling technique and rim diameter, as well as ornamentation were also studied. For statistical analysis,

2 Three iron knives were found in the upper layers of Ķivutkalns, indicating possible temporary inhabitation around the second century AD (Graudonis 1989, 49). However, there are no other finds, including pottery, which indicate a settlement phase at that time.

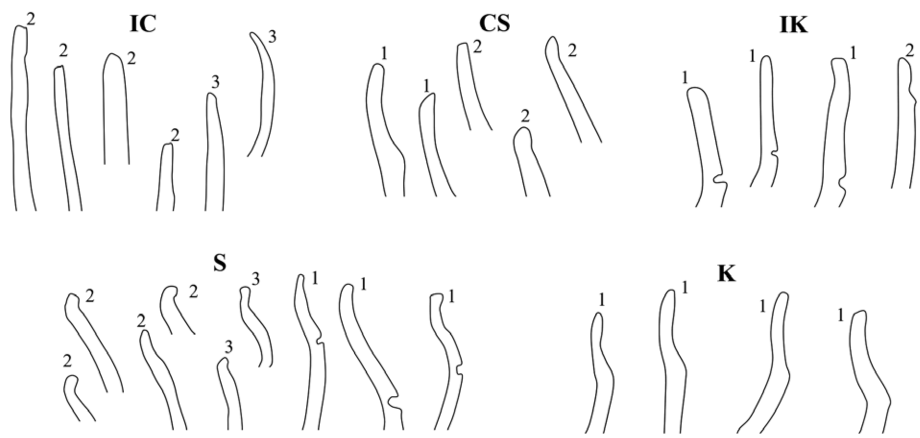


Figure 2. Common vessel rim profile shapes. 1 – Asva, 2 – Ķivutkalns, 3 – Narkūnai (figure: V. Visocka).

sherds of the same vessel were counted as one unit. Overall, 667 units from Asva, 387 form Ķivutkalns[3] and 934 from Narkūnai were studied in detail.

In order to group the material and analyse pottery morphology, the rim profile shape classification developed by Rimutė Rimantienė, with few alterations made by Andrejs Vasks and Vanda Visocka was used in this study (Rimantienė 2005, 45; Vasks 1991, 21-22; Visocka 2020, 86). Accordingly, the rim shapes of the vessels are grouped as follows: IC – barrel-shaped vessels with slightly curved or straight rim as well as those with almost conical body; CS – slightly profiled vessels with short cylindrical or inturned neck; S – strongly profiled vessels with everted rim; IK – semi-biconical vessels with a sinuous profile, vertical rim and soft break on the neck; K – biconical vessels with strong break on the neck (Figure 2).

However, in the case of Asva fine ware the classification developed by Uwe Sperling was used. Accordingly, we used the subdivisions of his type B vessels, whereby bowls are divided into I – with slightly curved rim and rounded break; II – with open rim, angular or rounded curve, weak or classical S profile; III – with curved rim and angular break on the neck part; IV – with long and vertical rim; V – curved rim and rounded break and VI – with open rim (Sperling 2014, 187).

Ceramic petrography

In order to study ceramic fabric in detail, petrography, using thin section analysis under a polarizing microscope, was used (for a detailed description of the method see Braekmans and Degryse 2016; Quinn 2013). Using this method, 57 samples were analysed (20 from Asva, 19 from Ķivutkalns[4] and 18 from Narkūnai; see Appendix 2). Pottery samples for petrographic analysis were chosen by the principle of known context and representativity. Accordingly, the Asva samples consisted of seven fine (polished) and 13 coarse sherds (six with striated surface, five smooth, one textile and one striated-textile); for Ķivutkalns ten striated, five smooth, three textile and one striated-rusticated sample were chosen; and at Narkūnai 17 striated and one smooth sample were studied.

Sherds were cut with a diamond saw (500 rpg/min) in a vertical position towards the rim or putative side of the rim. The cut surface chosen for analysis was impregnated with epoxy resin, previously heated to 50 °C for 15 minutes. Afterwards the surface was ground and polished with silicone carbide powder (abrasives: 150 to 800 grits) and glued to the microscope slide. Then the sample was cut, leaving a 1-2 mm thick slice, and manually ground with silicone carbide powder (abrasive 800 grits) until it was 30 microns thick.

---

3 The Ķivutkalns pottery assemblage is currently being analysed. In this study, pottery from trenches I to VIII, which make up 61.5 % of the excavated area, is presented in detail.

4 The results of the Ķivutkalns pottery petrographic analysis have already been published (Visocka 2020), however in this study the collection has been re-analysed using a different, more developed approach.

Thin section preparation and analysis were carried out at the University of Latvia, Faculty of Geography and Earth Sciences by V. Visocka in 2018.

Wavelength dispersive XRF spectrometry

In order to study and group pottery by its chemical composition, X-ray fluorescence-wavelength dispersive spectrometry (WD-XRF) was used (for a detailed description of the method see Hall 2016). Samples for WD-XRF analysis were chosen randomly from the same sherds which were analysed using ceramic petrography. Overall, 27 samples were analysed using this method (nine samples from each settlement).

We chose a non-destructive approach by irradiating the surface of the selected samples[5]. The *Brucker S8 Tiger* spectrometer with sample holder size of surface irradiation of 5 mm was used. Oxide full analysis in a helium atmosphere was carried out. For each sample three measurements were taken, then the average value and standard error (σ) were calculated. The 14 most common elements in the samples are SiO_2, Al_2O_3, Fe_2O_3, K_2O, P_2O_5, MgO, MnO, CaO, Na_2O, Cl, TiO, BaO, ZnO and SO_3; these were analysed using agglomerative hierarchical clusters (Appendix 3).

The WD-XRF was performed by V. Visocka at the University of Latvia, Faculty of Chemistry, under the supervision of chemist Anna Trubača-Boginska in 2018. Data analysis using agglomerative hierarchical clusters from average values of element concentration in the samples was carried out by data analyst Aigars Mustafājevs.

Results

Clay deposits in the surroundings of the settlements

On-site pottery production at Asva and Ķivutkalns is indicated by irregular clay lumps with granitic rock tempering and with traces of finger impressions and kneading (Sperling 2014, 193; LNVM VI 120: 359; see Figure 3: 1-2). Thus, nearby clay deposits were used. However, more detailed research is needed to clarify this[6]. Here we present only preliminary data from the larger study concerning the use of possible nearby clay sources in these settlements.

Six of the Quaternary clay deposits in Estonia are suitable for pottery production (Raukas and Kajak 1997; Sperling 2014, 194). One of these clay deposits is located in Saaremaa, around 10 km from Asva (Raukas and Kajak 1997; Sperling 2014, 194). As the clay from this deposit is muddy, rich in quartz sand and carbonaceous, it is very suitable for pottery making and therefore might have been used by the Asva potters (Raukas and Kajak 1997; Sperling 2014, 194). Asva itself was established on a moraine, where thick moraine clay layers are common. It is also possible that glacio-lacustrine clay deposits are situated nearby, however, more detailed survey is needed to prove this. Notably, occasional limestone grains and chalk-like impurities[7] have been distinguished in some of the Asva sherds (Figure 3:3-4). Such carbonate concretions often occur naturally in clay deposits, mostly in the upper layer of the clay bed at depths of 0.5-1.5 m (Kuršs and Stinkule 1972, 60, 64). This could mean that potters used the upper areas of the clay deposit (maybe even started to collect from a new clay bed?) for making these vessels; however, more detailed study is necessary.

In the lower reaches of river Daugava, large or even medium-sized high-quality Quaternary clay deposits are not common, as this region mainly consists of Devonian rock outcrops (Kuršs and Stinkule 1972, figs 7, 17). Notably, there is a large Devonian clay

5 This was decided so that the data could be compared with samples where it was not possible to use a destructive approach (i.e. preparing powder from the sherd), such as pottery from graves and unique pieces.

6 Around 30 clay samples have been collected during surveys in the surroundings of Asva, Ķivutkalns and Narkūnai from 2018 to 2020 and are now being analysed.

7 These impurities were identified by geologist Vija Hodireva at the University of Latvia, Faculty of Geography and Earth Sciences in 2019.

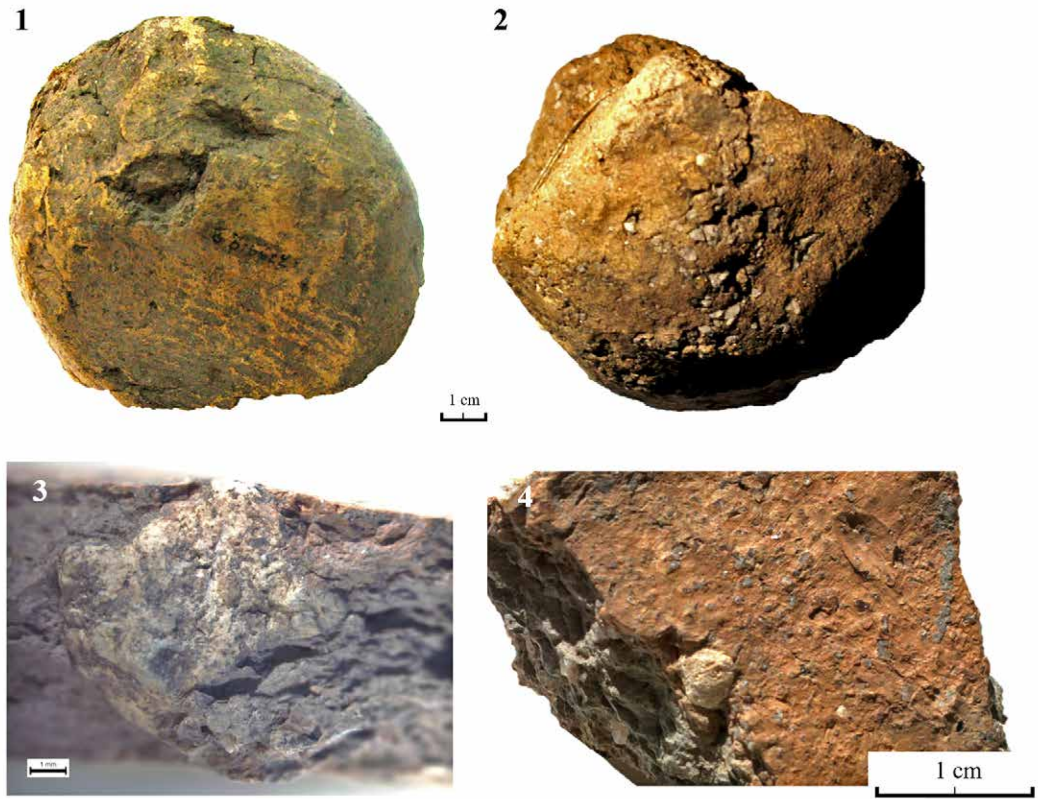


Figure 3. Irregular clay lumps/raw materials found in Asva (1, TÜ AI 3799:22) and Ķivutkalns (2, LNVM VI 120: 359), and limestone and carbonate concretions in Asva pottery paste (3-4, from excavations in 2019 and 2020; photos by U. Sperling (1) and V. Visocka (2-4)).

deposit on Dole island[8] with semi-plastic and carbonaceous clay (Kuršs and Stinkule 1972, 41-43). Although using clay from this deposit would have been very convenient for the Ķivutkalns potters, it is not definitive that this source was used. During survey, several small clay beds were distinguished on both banks of the river Daugava, which could be another potential source for the Ķivutkalns potters[9].

The clay sources around Narkūnai have previously been identified by stereoscopic analysis; however, no further tests on clay quality were carried out. During geological surveys, four large clay deposits were distinguished within a radius of 3 km around Narkūnai (Guobytė 2011; Podėnas *et al.* 2016, 213). Furthermore, Narkūnai itself was established on a clay deposit (Guobytė 2011; Podėnas *et al.* 2016, 213). The surrounding soil of the promontory is clayey as well. Therefore, this material was easily accessible for the community, a trait shared by most LBA fortified settlements in north-east Lithuania (Troskosky *et al*. 2018, 69-70).

Clay matrix of the ceramic vessels

Results of WD-XRF spectroscopy

The major elemental composition data obtained from WD-XRF spectrometry was displayed in a dendrogram using the Ward Linkage method (Figure 4). Overall, three groups with nine subgroups were distinguished.

The first group consists of eight samples from all three settlements. Samples in subgroups correspond with each other. It is notable that there is no subgroup in which samples from all three settlements are linked together. The samples in subgroup 1.1. are more similar to each other than to the rest of the subgroups within this clade.

8 The location of this clay deposit has not been described in detail and is currently unknown to the authors.

9 Survey by Vanda Visocka and Mārcis Kalniņš in 2020; clay samples are being analysed.

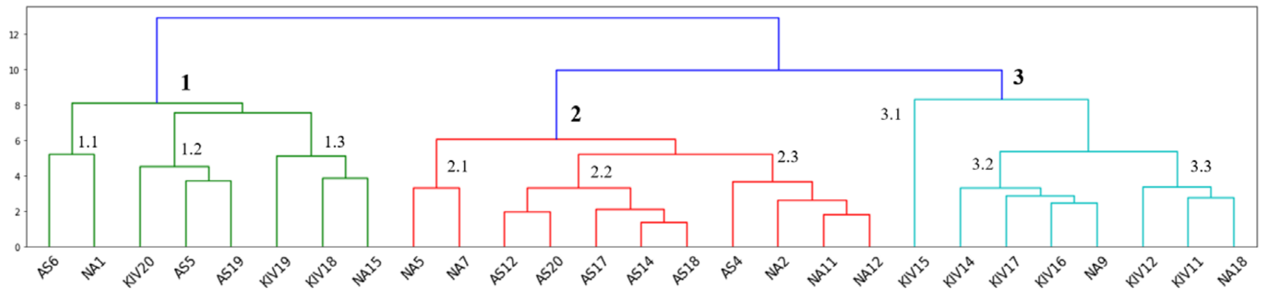


Figure 4. Dendrogram created from WD XRF data (figure: A. Mustafājevs).

The second group is the largest and consists of 11 samples. Notably, this group only includes Asva and Narkūnai samples. Subgroup 2.1. consists of Narkūnai samples, which are more similar to each other than to the rest of the subgroups within this clade. In turn, subgroup 2.2. consists only of Asva samples. It should be noted that samples AS14 and AS18 are the most similar to each other out of all chunks in the dendrogram.

The third group consists of eight samples and includes only Ķivutkalns and Narkūnai material. Sample KIV15 within the third group is simplicifolious and therefore has been completely separated from the other subgroups.

In most cases there are no clear groups characteristic for the different regions. Therefore, clay types similar in their chemical composition were used, resulting in quite random grouping – with the exception of subgroups 2.1. (only Narkūnai samples) and 2.2. (only Asva samples). Notably, these samples do not differ from the rest either morphologically or in their tempering.

Results of visual and petrographic analysis

Visual and petrographic observations show that mainly granitic rock grains (determined by feldspar, quartz and mica minerals in the clay mass) of various sizes were used as a tempering material in all three settlements. The sizes of the temper added to coarse ware vessels vary, with maximum grain size starting from 1 mm and reaching 8 mm. However, in the case of Asva fine pottery, quartz sand and fine crushed granitic rock has been added as tempering material (Sperling 2014, 195). Seemingly no tempering material was added to some miniature and small vessels (2-6 cm in diameter).

Thin section analysis of one sample (KIV8) distinguished a possible grog grain. However, this is not definitive, and thus this aspect will not be taken into account in fabric grouping. Based on clay properties and tempering, as revealed by thin section analysis, 11 clay fabric qualities can be distinguished (Appendix 4).

The data (Figure 5:1) show that each settlement's potters had their own individual preferences regarding preparation of the clay paste, i.e. ware types do not correlate with each other. Notably, in terms of clay paste variations Asva is more similar to Narkūnai than Ķivutkalns. The Asva and Narkūnai pots were mostly made of finer-tempered paste with smaller and less numerous impurities than the Ķivutkalns ceramics. Asva and Narkūnai also have more clay paste recipe variations than Ķivutkalns. Overall, the groups produced from WD-XRF elemental data do not correlate with the pottery ware groups, with the exception of one sample from Ķivutkalns (KIV15) which differed from the others by some of the clay matrix qualities and chemical properties.

Building the vessels

Vessels were hand-made using a coiling method. Potters first created a separate round-bottomed base or one-piece base with sides slightly pulled upwards. Afterwards, clay coils were placed on top of each other and pressed together (Dumpe 2003, 114; Sperling 2014, 199; Vasks 1994, 49). Two types of coiling techniques could be distinguished in this study, U and N. Using the U technique, both sides of the clay band are smoothed downwards, creating an upside down or upright U-shaped distortion in the coils (Dumpe 2003, 115; Neumannová *et al.*

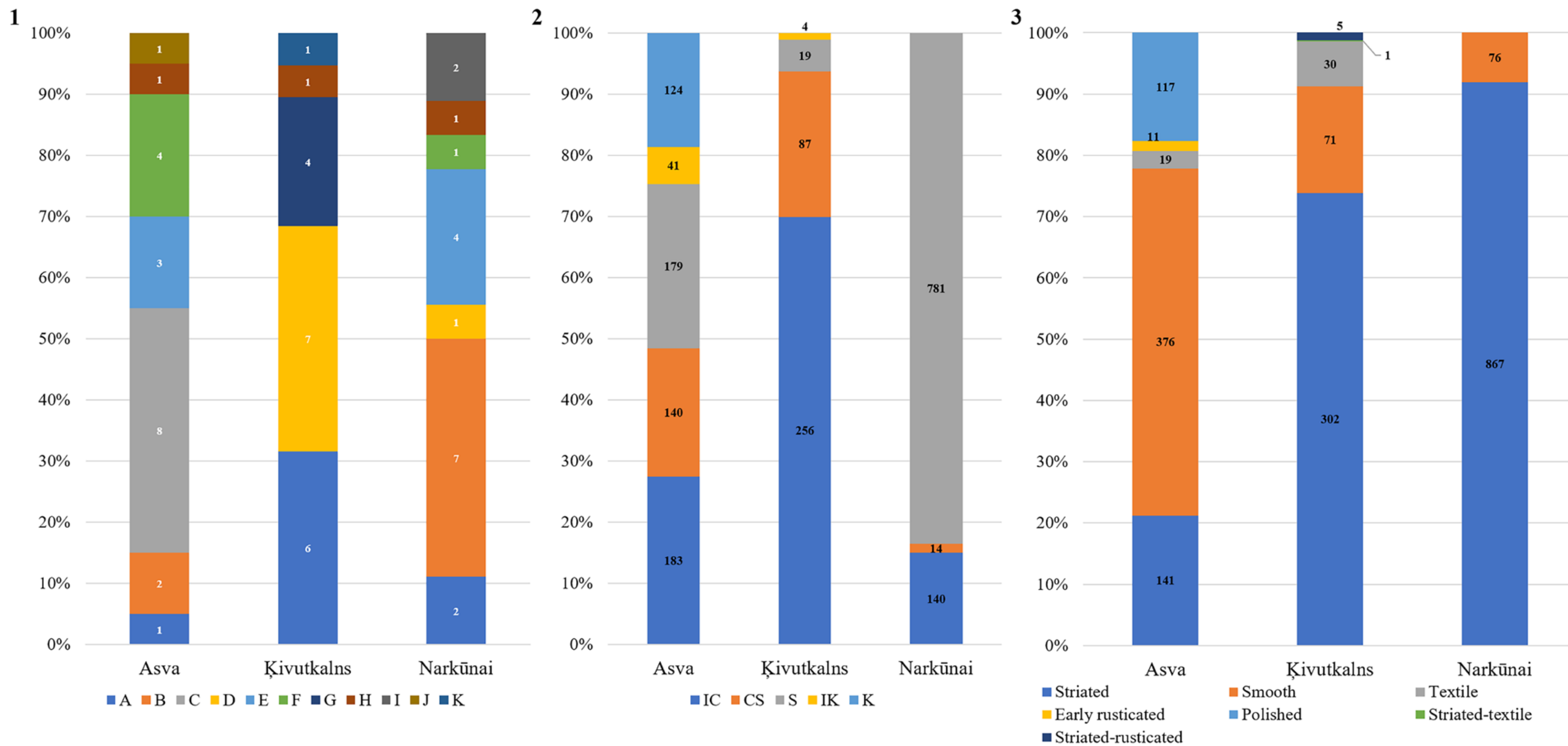


Figure 5. Frequency of ware types (1), rim shapes (2) and surface treatments (3) in the assemblages. For abbreviations of rim shapes, see Figure 2.

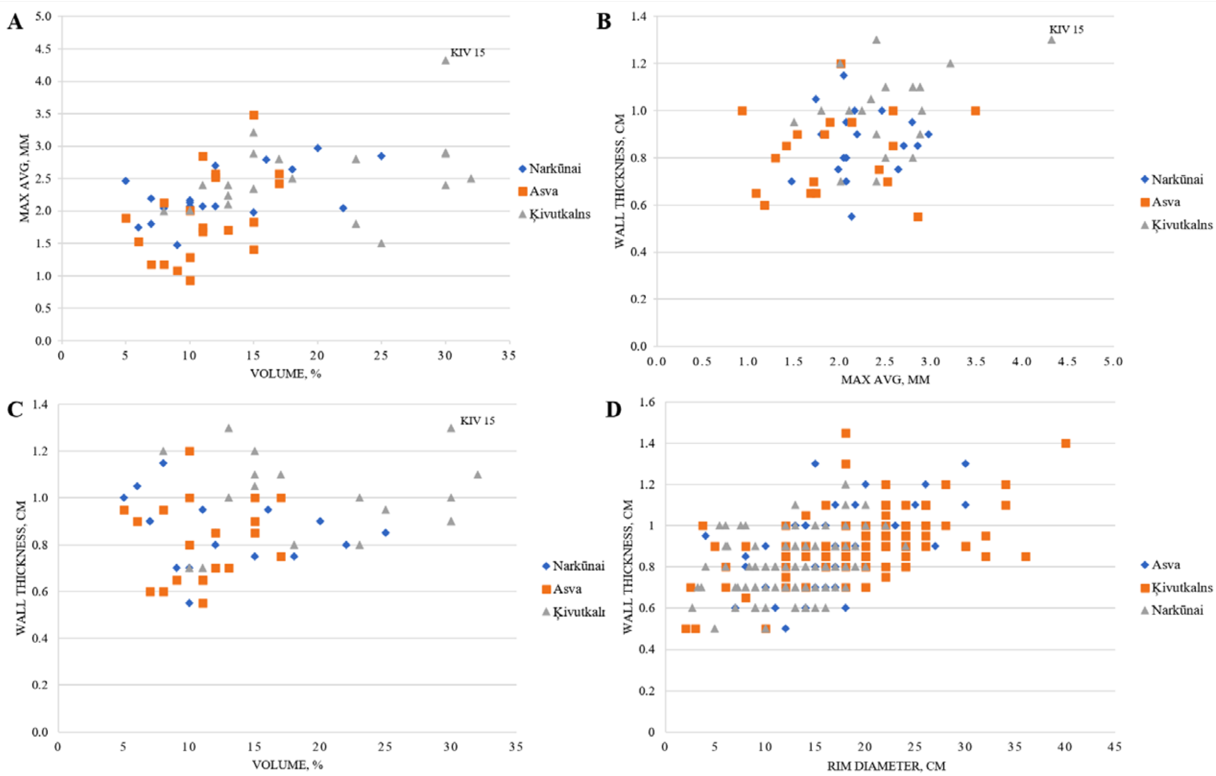


Figure 6. Scatterplots of different vessel qualities. A: tempering volume to maximum average grain size; B-C: tempering qualities to wall thickness; D: vessels size to wall thickness.

2017, 174). In turn, in the N technique coils were smoothed in opposite directions, creating a slanting distortion (Dumpe 2003, 116; Neumannová *et al.* 2017, 174). According to Baiba Dumpe, the N technique makes pottery production faster than the U technique (Dumpe 2003, 116). The dominant coiling technique in all three settlements is N. The U technique has been identified only in Asva and Ķivutkalns. Vessels were built mainly from smoothened clay coils 3-8 cm wide; however, in Ķivutkalns they can reach 10 cm (Visocka 2017a, 61). Notably, miniature vessels are usually made from one clay lump, without coiling (Vasks 1994, 53).

The wall thickness of the vessels varies from 0.4 to 1.6 cm and their rim diameter from 2 to 40 cm. In all three settlements the maximum wall thickness overall correlates with vessel size, tempering maximum average grain size and volume of the added temper (Figure 6). Thus, wall thickness depends on the size and tempering properties, or the other way around – vessel size and temper depend on the intended wall thickness. The exceptions are miniature and small vessels (up to 10 cm in rim diameter), where there is no clear correlation between vessel size and wall thickness (0.5-1.0 cm). Ķivutkalns pottery mostly falls outside the overall production tendencies, having a much coarser clay paste and larger vessels. Especially interesting is sample KIV 15 (Figure 6: A, B, C) which stands out most in terms of temper (volume and grain size). This result also correlates with WD-XRF spectrometry results, where this sample is similar yet different from the third group subgroups. However, it follows the general trends of ware D.

In each settlement, potters had their own preferences regarding rim profile shapes (Figure 5:2). At Asva there is much more diversity in vessel shapes than elsewhere; notably, all of the profile forms distinguished are equally common, except for IK. Not counting the K shape, there are additional shapes which are not found in either Ķivutkalns or Narkūnai, notably category B of fine ware bowls, where the most common ones are those with an S-profiled rim (B II; for details see Sperling 2014, 188-90). However, Ķivutkalns potters preferred barrel-shaped vessels, those with slightly curved mouth are less frequent. Four instances with IK shape have also been found. In turn, Narkūnai potters had the least variation regarding shape; they preferred strongly curved vessels with everted rim, while barrel-shaped pots were far less common.

Overall, each settlement had their own preferences of vessel building techniques and morphology. The only similarities between settlements regarding building are the size and wall thickness ratios of the vessels. However, these parameters are more likely to be dependent on the function of the vessels, not on aesthetic and technological preferences. The Narkūnai potters are more consistent compared to Asva and Ķivutkalns, as they prefer to use only the N technique of vessel building and do not adopt other non-local shapes, such as IK.

Exterior

The exterior of the vessels, such as surface treatment, ornamentation and some plastic elements, is one of the main components in evaluating aesthetic tendencies and possible influences between styles from different regions.

Surface treatment

Overall, seven types of surface treatment were distinguished: striated, smooth, polished, textile, early rusticated[10], striated-textile and striated-early rusticated (Figure 7:1). The proportion of surface treatments in the Ķivutkalns and Narkūnai assemblages is typical of the archaeological culture of Striated Pottery, which is a local vessel exterior type dominating in the territories of Latvia, Lithuania and Belarus (Graudonis 1980, 59). This type of surface treatment is less preferred in Asva, where vessels with smooth surfaces are most common (Figure 5:3). The striations on the pots were made using bundles of sticks or grass in order to make the pottery more resistant to thermal shock (Schiffer *et al.* 1994) and thus more durable. Mostly, the striation of the vessels was irregular, criss-crossed and quite random; the upper part of the rim is often left smooth. Many of the vessels in Ķivutkalns (41.6 %; Vasks 1991, tab. 8) and Narkūnai (59.1 %) have striated interiors. This has been observed in Asva pottery as well (Sperling 2014, 213). In Asva and Ķivutkalns, a small amount of textile-impressed pottery has been found. The textile surface has been created using notched or braided cord which has been wrapped around a stick (Dumpe 2006, 81).

Polished surface treatment is common in pottery from Asva and it is found in small numbers at several sites in the western areas of the east Baltic (such as Kukuliškiai and Paplaka fortified settlements and Kvietiniai open settlement; Vengalis *et al.* 2020b; Visocka 2016a, 30). In the case of Paplaka, the polished sherds could date to the Pre-Roman Iron Age or the beginning of the Roman Iron Age, as the radiocarbon dates from the lower context span 395-104 cal BC (Haferbergs 2018, 84)[11]. However, this type of surface is not found in Ķivutkalns and Narkūnai. Polished pottery has not been found at LBA archaeological sites further inland in south-east Latvia and north-east Lithuania, and thus is not typical in these regions. Until recently, this kind of pottery in Lithuanian multi-period settlements, including Narkūnai, was interpreted to date from the Roman Iron Age (Podėnas *et al*. 2016, 212-13). However, new data from the coastal fortified settlement of Kukuliškiai indicate that it is also present in contexts dating to c. 900-400 cal BC (Vengalis *et al*. 2020b, 32). We need more data to assess whether this is a regional trait of coastal sites or whether polished pottery was also produced in inland settlements. Polished pottery in north-east Lithuanian assemblages lacks charred organic residues for direct dating and is so far absent from sites with short-term occupation records. Mostly bowls and fine ware pottery were made with polished surfaces (Sperling 2014, 209). Notably, the Asva vessels include examples with

---

10 Also known as coarse-slipped. Early rusticated vessels differ from late rusticated ones in the texture of the slip: in the former it is grainy with sand or rock additions and dated to the LBA, in the latter it is finer and more vein-like and is typical of the Iron Age.

11 The Paplaka dates (Haferbergs 2018) were recalibrated to 95.4 % probability using the IntCal20 curve (Reimer *et al*. 2020) in OxCal (Bronk Ramsey 2017).

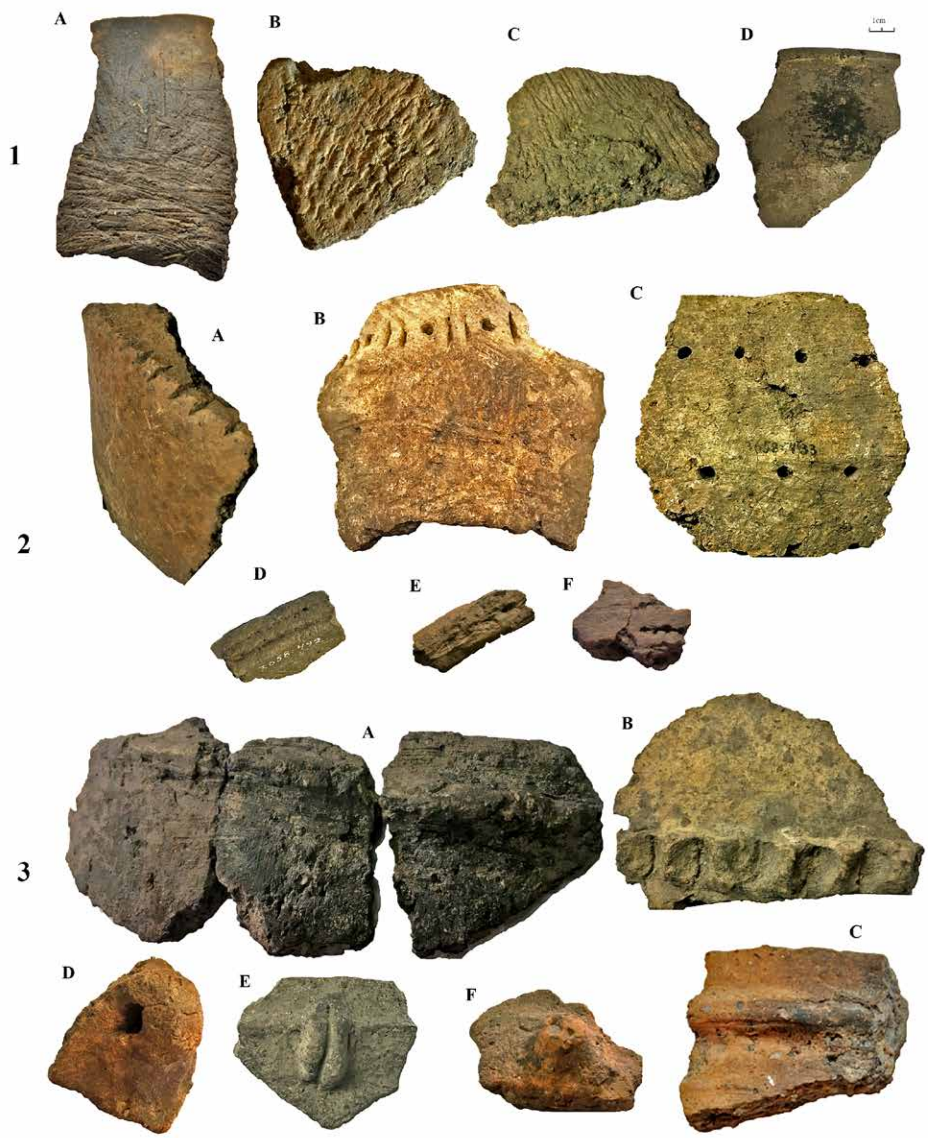


Figure 7. Attributes of vessel exteriors. Row 1: surface treatment. A, striated from Narkūnai (LNM 730, 5 – 1977); B, D, textile and polished from Asva (from excavation in 2019); C, striated-early rusticated from Ķivutkalns (LNVM VI 120). Row 2: ornamentation. A, notches on Asva vessel (TÜ AI 4366:1625); B, dimples and notches from Ķivutkalns; C, dimples from Asva (TÜ AI 3658:433); D-F, cord impressions from Asva (TÜ AI 3658:492) and Ķivutkalns (LNVM VI 120). Row 3: plastic elements. A-C, clay band around vessels from Ķivutkalns (LNVM, VI 120), Asva (TÜ AI 3799:350) and Narkūnai (LNM 1978, 2a, 624); D-E, knobs from Ķivutkalns (LNVM VI 120) and Asva (TÜ AI 3658:313); F, applied oval lens from Ķivutkalns (LNVM VI 120) (Photos: 1A and 3C by V. Podėnas; remainder by V. Visocka).

early rusticated surfaces. A thin clay layer mixed with fine granitic rock or sand was added to the vessel surface (Vasks 1996, 148), perhaps to make the pots more resistant to thermal shock and more waterproof (Schiffer *et al.* 1994; Vasks 2001a, 205).

In Ķivutkalns two subgroups of surface treatments were found, striated-textile and striated-early rusticated. Striated-textile combines the techniques of striation and textile impressions. In turn, striated-early rusticated refers to striated vessels on which a clay layer with rock or sand temper is added (Vasks 1991, 41). Unfortunately, this subgroup is hard to distinguish, as the clay slip needs to have partly fallen off to reveal the striation beneath.

Ornamentation

Regarding ornamentation on the vessels (Figure 7:2), quite different tendencies are seen in each assemblage. Asva has a large number of decorated vessels – c. 75 % of all pots, with various elements and motifs (Sperling 2014, fig. 96). In contrast, in Ķivutkalns ornamented pots make up 0.34 % of the assemblage, the style of decorative elements is much simpler, and motifs are rare (Visocka 2016b, tab. 1). In turn, in Narkūnai ornamentation was an extraordinary practice, as only two fragments were decorated with one line of small pits around the neck of the pot (Podėnas *et al*. 2016, 210).

The most common ornament are dimples. In Asva they make up 80 % of all decorated vessels, in Ķivutkalns 67 % (Sperling 2014, 227; Visocka 2016b, tab. 1). Dimples in these assemblages are usually round or elongated, their diameter varies from 0.4-11 mm. They are made with a stick or stamp-like object, possibly a bone or wooden pin, pressing or "drilling" it into the wet surface of the vessel (Sperling 2014; Visocka 2016b, 82). Fingerprint traces on the inner wall indicate that the inner surface was supported while the dimples were added (Sperling 2014, 227-28). Dimples were mostly pressed in one, sometimes in up to five rows on the shoulder or neck part of the vessel (Sperling 2014, plate 34; Visocka 2016b, 82). In one case the rim was ornamented with dimples (Sperling 2014, 232 plate 35). Notably, dimple ornamentation is less common among the fine ware vessels from Asva.

Another ornamentation found in Asva and Ķivutkalns are cord impressions. In Ķivutkalns this is the second most common ornamentation, making up 18 % of all ornamented sherds (Visocka 2016b, tab. 1). Three fragments had both cord and dimple ornamentation (Visocka 2016b). In Asva, this ornamentation occurs only occasionally. In the case of Asva, the dating of these kinds of vessels is debatable, as the decoration method differs from the rest of the assemblage (Sperling 2014, 230). Cord impressions are made with a cord wrapped around a stick and applied in slanting or horizontal lines (Vasks 1994, 50).

Ornaments made of notches are less common in the Asva and Ķivutkalns assemblages. In Asva coarse ware with notches makes up approximately 5 %, while 21 % of fine ware vessels have this ornamentation (Sperling 2014, 229-30, 233-34). Sometimes notches are used to decorate the rim of the Asva vessels. In Ķivutkalns there is no ornament consisting of just notches, they are always complemented with dimples. Such vessels make up 8 % of all decorated examples (Visocka 2016b, tab. 1). Notches are made with a fingernail or knife-like object.

Asva coarse ware vessels stand out for their finger-pinch ornamentation on the rim or shoulder of the pot. Sometimes this decoration occurs on a clay band wrapped around the vessel (Sperling 2014, 229 plate 34). This ornament makes up 25 % of all decorated sherds (Sperling 2014, 227). Overall, it is not common for settlements in the Daugava basin, but rather in western parts of Latvia (Visocka 2016b, 87). Quite unique among Asva's coarse ware ceramics is a vessel with incised three-row zig-zag lines and dimple ornamentation (Sperling 2014, 231 plate 47).

The fine ware pottery of Asva, where various detailed ornaments and motifs appear on the surface, is the most decorated of all three assemblages. This kind of pottery shows a high quality in both building and ornamentation (for details see Sperling 2014, 233-39).

Plastic elements

The Asva pottery is quite rich in plastic elements, such as handles and knobs, clay bands and oval lenses (Figure 7:3). Overall, elements like handles and knobs are not common on Latvian and Lithuanian LBA pottery. In the Ķivutkalns fortified settlement only one pottery fragment with a small knob has been found (LNVM VI 120: 387).

Two plastic ornament types are distinguished: clay bands wrapped around the vessel and oval applied lenses. Clay bands were found on material from all three settlements (Podėnas *et al.* 2016, pav. 7). As mentioned before, ceramics from Asva are often ornamented with finger-tweaks or dimples. In turn, Ķivutkalns and Narkūnai pots with clay bands either have smooth surfaces or light striation. The clay bands are wrapped around the neck or shoulders of freshly made vessels before firing (Graudonis 1989, 49).

Applied lenses can be considered a rare plastic ornament. Only three sherds from Asva and two from Ķivutkalns have it (Sperling 2014, 214; Visocka 2016b, tab. 1). It is not precisely known how these plastic elements were added to the vessel's surface – while building the vessel or afterwards. Some detached lens fragments from the Krievu kalns fortified settlement in western Latvia (LNVM A13958: 17) indicate that the latter possibility is more likely.

In terms of vessel exterior, Narkūnai seems to be the most "conservative" site, as it has only two surface treatment variations and practically no ornamented vessels, only dimples and one plastic element. In turn, Asva has the full range of ornamentation and plastic elements in its pottery, which is both aesthetic and of high quality. Ķivutkalns shows traces of stylistic interactions between regions, especially because there is a fusion of local and foreign traditions: striated-textile and striated-early rusticated surfaces, alongside some non-local plastic elements, such as applied lenses and knobs.

Discussion

Pottery is a complex informative source due to its technomic (practical-functional) and sociotechnic (style as social gesture) features (Eriksson 2009; 2012). These are integral parts of the socio-cultural system responding to the given economic necessities, constraints (materials, techniques) and choices based on tradition. Asva, Ķivutkalns and Narkūnai pottery assemblages represent people and visitors in three different ecological and economic milieus. Asva was the nearest to the sea. The Tehumardi hoard and the Lülle stone ship setting (Lang 2007, 164; Sperling 2013), both with finds and funerary practices atypical for the eastern Baltic, indicate that this area was actively visited by possible travellers from the western Baltic or Baltic islands such as Gotland. Ķivutkalns occupied a site in the mouth of the Daugava river, an important trade artery to settlements established inland. Following the river to its origins in the Valdai hills, people could have reached areas in the basins of the Baltic, Black and Caspian Seas, opening a large area to long-distance trade. The settlement is also distinguished by two hoards found in its cultural layer with bronze tutuli typical for the Lusatian culture (Graudonis 1989; Urtāns 1977; Vaska 2019). In the vicinity of the Daugava in south-east Latvia and north-east Lithuania, a dense cluster of fortified settlements emerged, whose southern areas were already within the Šventoji river basin. Thus, it was postulated (Podėnas and Čivilytė 2019) that sites like Narkūnai worked as further trading grounds between locals, established in the southern inland open settlements, and northern fortified settlements. The three assemblages share some technological traits of pottery production. In other aspects, coastal and inland practices can be distinguished, and assemblages differentiated based on the intensity of influence from outside the eastern Baltic region, namely from Scandinavia and the Lusatian culture.

Coastal pottery assemblages in the eastern Baltic were more diverse, with a wider range of ornamentations and morphological variety. This was expressed through the appearance of knobs, polished fine ware and semi-biconical profiles, whereas ceramics made in inland settlements are characterised by a more homogenous practice of striated or smooth pottery with semi-coarse and coarse ware and profiled or barrel-shaped forms. Furthermore, Asva and Ķivutkalns, like other coastal assemblages in the region, have yielded low frequencies of early rusticated ware or its subtypes. This is a dominant pottery type for the western and southern Baltic and their presence even in low frequencies in specific eastern Baltic regions[12] is indicative of contacts between these territories. The emergence of striated-early rusticated and striated-textile vessels, where local and non-local surface treatment traditions mix (Vasks 1991, 41), indicates that there was at least some transmission of knowledge and techno-aesthetic influences between communities in different regions. It was previously thought that early rusticated and striated-early rusticated vessels are common only in the eastern and western part of Latvia, such as at the fortified settlements of Brikuļi, Krievu kalns, Padure (Beltes) and Paplaka (Visocka 2017b). However, this type has recently been found in the Vīnakalns and Ķivutkalns pottery assemblages, showing that it occurs along the lower reaches of the river Daugava as well. Moreover, recent reports (Simniškytė-Strimaitienė 2019) also indicate the appearance of this style at the Kupiškis hilltop settlement in north-eastern Lithuania.

12 Especially north of the West Balt Barrow culture and the Neris river.

The situation is different for textile and striated-textile vessels, which occur in small amounts in central and eastern Latvia and in Estonia, such as at Kõivuküla, Asva, Ridala and Iru (Lang 2007; Sperling 2014; Valk *et al.* 2012; Vasks 2001b). Textile pottery from Latvia is very fragmentary and rarely ornamented, in turn textile vessels in Estonia are quite well preserved and ornamented, mainly with dimples (Lang 2007; Sperling 2014). Notably, this type does not occur south and west of the Daugava river, with the exception of the Padure fortified settlement in Courland (Vasks *et al.* 2011). The decrease of ornamentation from the seaside to inland areas is tangible in the pottery assemblages. The most exquisite ornamentation is seen in Asva pottery and decoration was almost non-existent in Narkūnai, where only few samples with dimple ornamentation have been found.

A comparable situation is seen in the vessel profiles. Asva has the most diverse profile shapes and all are roughly equally common. As in other coastal fortified settlements in Estonia (Ridala and Iru), semi-biconical and biconical (IK, K) vessels are present; most likely this shape came from Scandinavia and is due to outside influences either directly from Scandinavia or from continental Europe (Sperling 2014). However, along the lower reaches of the river Daugava and in eastern Latvia, barrel-shaped (IC) vessels are more common (Vasks 1991; Visocka 2017a). West and south of the Daugava there are different tendencies regarding profile shapes, with semi-profiled and profiled (CS, S) shapes being dominant (Vasks 1991; 2011; Vasks *et al.* 2019; Visocka 2017a). The plastic elements of clay bands wrapped around the vessels are a notable feature of settlements in the eastern Baltic. This element could be related to techno-aesthetic influences from Scandinavia and central Europe (i.e. the Lusatian culture), as locals could have attempted creative imitations of semi-biconical and biconical vessels. According to pottery specialist B. Dumpe, semi-biconical and biconical vessels are not harder to build than barrel-shaped and profiled ones; however, potters have to adapt their skills for creating vessels of different shapes[13].

The greatest similarities between our studied sites are seen in tempering material. In all cases, except where quartz sand was used as a temper, crushed granitic rock was added to the clay paste. This is no surprise as this material is the dominant temper in eastern Baltic LBA pottery. Similar size ratios of added grains in each sample indicate that sieving was used to create differently sized tempers. Eleven variations of clay recipes were distinguished. Mostly, semi-coarse and coarse temper was added to the clay paste in various volumes. This is also a common trait of LBA pottery in the east Baltic, therefore the analysed settlements fit into the overall regional tendencies. Fine ware pottery of the kind found at Asva is also quite common in Estonia (Lang 2007; Sperling 2014). Our data indicate that morphologically coarse ware can sometimes be tempered with fine material or the other way around. Thus, possibly the same clay paste was used at the time of production. Notably, the Ķivutkalns assemblage is characterised by coarser clay, as more tempering material was used compared to the Asva and Narkūnai assemblages. Similar tendencies occur in other settlements along the lower reaches of the Daugava, for instance at Dievukalns and Vīnakalns (Visocka 2017a; 2017b). Therefore, this is a regional pattern, which could result from the available kinds of clay in the area.

An overall decline in the morphological variation of pottery is evident when moving from coastal to inland settlements, with assemblages progressively more uniform and modest. Estonian Saaremaa pottery traditions are techno-aesthetically strongly influenced from other regions due to active exchange and communication. Although being likewise an active trade and communication region, fewer traces of Scandinavian or central European influences are recognisable in the pottery of communities settled along the lower Daugava. In these assemblages there are some possible imports, e.g. vessels with knobs and applied lenses. However, vessels in this region have a much coarser clay matrix and less ware variations compared to coastal and inland pottery. The morphologically most uniform pottery is found inland (Narkūnai).

13 B. Dumpe (National History Museum of Latvia), pers. comm.

Conclusions

Ceramic vessels contain much information about socio-cultural values and techno-aesthetic tendencies, as well as culinary practices. Communities established in the three different ecotones studied here produced pottery with varied degrees of stylistic variation in applied surface treatment technologies and ornamentation. However, pottery makers in Asva, Ķivutkalns and Narkūnai expressed similar behaviour up to the point when the vessel exterior was designed; the only exception is the production of fine ware in Asva.

The clay used in pottery production was mostly purified. Only Ķivutkalns vessels were made from coarse clay with varied impurities of different sizes, perhaps dependent on the clay source used. A similar situation is seen in other settlements established along the lower Daugava, making this a micro-regional trait. In terms of their chemical composition, samples were grouped randomly, indicating that chemically similar clay had been used throughout. There are two subgroups, respectively containing only Asva or Narkūnai vessels. A single sample from Ķivutkalns differs chemically and in temper. Two types of tempering material were distinguished – sand (in Asva) and crushed granitic rock. Overall, 11 ware types were identified which fit with the general tempering tendencies of eastern Baltic pottery. The fine ware from Asva is characteristic of other Estonian coastal settlement pottery, such as that from Iru and Ridala.

The assemblages from the fortified settlements studied here show different influences and individual preferences. Coastal pottery was more diverse than that found inland, with more outside influences apparent in the variety of vessel morphology, surface treatment and ornamentation. This diversity declines further inland, where fewer decorative elements and different morphological preferences are noted, representing a more uniform tradition. Plastic ornaments, such as knobs, clay bands and applied lenses, as well as polished fine ware and biconical shapes are most likely inspired from Scandinavia and central Europe. Thus, the clearest techno-aesthetic influences between regions are identified rather in the vessels' visual appearance than in the ways they were produced.

Concerning how such influences were spread, we consider personal mobility and transfer of ideas as likely mechanisms. None of the pottery types in the three sites were made for transportation, therefore we rule out the possibility of trade. Based on comparanda from burial sites and on metallurgical assemblages from settlements, there is a possibility of transregional communication enacted by visitors, whose behaviour was learnt or imitated by the local inhabitants of the eastern Baltic. Varying quantities of different stylistic elements are found in different regions. Most of the plastic elements occur in coastal areas, whereas early rusticated wares permeate territories connected to the Baltic Sea via the Daugava. The pottery traditions in other inland areas along other river systems follow more conservative traditions and could indicate more restricted communication between these inland communities, who were less well incorporated into the interregional communication networks.

Acknowledgments

The authors would like to thank the State Culture Capital Foundation (SCCF) of Latvia for financing materials for petrographic analysis (project no. 2018-3KMA001-P), the National History Museum of Latvia, the National Museum of Lithuania and the University of Tallinn Institute of History, Archaeology and Art History for allowing us to use pottery assemblages for analysis, as well as the geologist Vija Hodireva, the pottery specialist Baiba Dumpe, the data analyst Aigars Mustafājevs and the chemist Anna Trubača-Boginska for consultations and help with analysis, the archaeologist Mārcis Kalniņš for help with survey, as well as two reviewers of our article for their suggestions.

Bibliography

Baubonis, Z. and Zabiela, G. 2005. *Lietuvos piliakalniai. Atlasas. III tomas*. Vilnius: Briedis.

Brastiņš, E. 1930. *Latvijas pilskalni. 4. sējums Vidzeme*. Rīga: Pieminekļu valdes izdevums.

Braekmans, D. and Degryse, P. 2016. Petrography: optical microscopy. In A.M.W. Hunt (ed.), *The Oxford handbook of archaeological ceramic analysis*, 233-65. Oxford: Oxford University Press.

Bronk Ramsey, C. 2017. Methods for summarizing radiocarbon datasets. *Radiocarbon 59*, 1809-33.

Čivilytė, A. 2014. *Žmogus ir metalas priešistorėje: žvilgančios bronzos trauka.* Vilnius: Piemedžio leidykla.

Denisova, R., Graudonis, Ja. and Gravere, R. 1985. *Kivutkalnskij mogilnjik epokhi bronzi*. Rīga: Zinātne.

Dumpe, B. 2003. Jauni atzinumi par neolīta klājošās auklas keramiku. *Arheoloģija un Etnogrāfija* XXI, 110-17.

Dumpe, B. 2006. Agrās tekstilās keramikas faktūru veidošanās īpatnības. *Arheoloģija un Etnogrāfija* XXIII, 71-83.

Earle, T., Ling, J., Uhnér, C., Stos-Gale, Z. and Melheim, L. 2015. The political economy and metal trade in Bronze Age Europe: understanding regional variability in terms of comparative advantages and articulations. *European Journal of Archaeology* 18, 633-57.

Eriksson, T. 2009. *Kärl och social gestik: keramik i Mälardalen 1500 BC-400 AD*. Uppsala: Uppsala universitet.

Eriksson, T. 2012. Pottery, transmission and innovation in Mälardalen. In N. Anfinset and M. Wrigglesworth (eds), *Local societies in Bronze Age northern Europe*, 185-200. London: Routledge.

Fokkens, H. and Harding, A. (eds) 2013. *The Oxford handbook of the European Bronze Age*. Oxford: Oxford University Press.

Graudonis, J. 1967. *Latvija v epokhu pozdney bronzi i rannego zheleza. Natshalo pazlozeniya pervobytno-obschinnogo stroya*. Rīga: Zinātne.

Graudonis, J. 1974. Agro metālu laikmets [Tēva ģints]. 2. g. t. p. m. ē. vidus – m. ē. 1. gs. In A. Bīrons, E. Mugurēvičs, Ā. Stubavs and E. Šnore (eds), *Latvijas PSR Arheoloģija*, 61-93. Rīga: Zinātne.

Graudonis, J. 1980. Shtrihovannaja keramika na territorii Latviskoij SSR i nekotorije voprosi etnogeneza Baltov. In Ē.S. Mugurēvičs (ed.), *Iz Dvernjeisheij Istorii Baltskih Narodov,* 59-69. Rīga: Zinātne.

Graudonis, J. 1989. *Nocietinātās apmetnes Daugavas lejtecē*. Rīga: Zinātne.

Grigalavičienė, E. 1995. *Žalvario ir ankstyvasis geležies amžius Lietuvoje.* Vilnius: Lietuvos istorijos institutas.

Guobytė, R. 2011. A revision of the Quaternary geological maps at a scale 1:50 000. *Lithuanian Geological Survey Annual Report 2010*, 20-21.

Haferbergs, A. 2018. *Celtniecība vēlajā bronzas un senākajā dzelzs laikmetā Latvijas teritorijā. Bakalaura darbs*. Rīga: Latvijas Universitāte.

Hall, M.E. 2016. X-ray fluorescence-energy dispersive (ED-XRF) and wavelength dispersive (WD-XRF) spectrometry. In A.M.W. Hunt (ed.), *The Oxford handbook of archaeological ceramic analysis*, 342-62. Oxford: Oxford University Press.

Jaanusson, H. 1981. *Hallunda. A study of pottery from a Late Bronze Age settlement in central Sweden*. Stockholm: Statens Historiska Museum.

Jegoreichenko, A. 2006. *Kulturi shtrihovannoi keramiki*. Minsk: Belarusian State University.

Kunikita, D., Shevkomud, I., Yoshida, K., Onuki, S., Yamahara, T. and Matsuzaki, H. 2013. Dating charred remains on pottery and analyzing food habits in the Early Neolithic period in northeast Asia. *Radiocarbon* 55, 1334-40.

Kuršs, V. and Stinkule, A. 1972. *Māli Latvijas zemes dzīlēs un rūpniecībā*. Rīga: Liesma.

Lang, V. 2007. *The Bronze and Early Iron Ages in Estonia*. Tartu: Tartu University Press.

Luchtanas, A. 1981. Žalvario apdirbimas ankstyvuosiuose Rytų Lietuvos piliakalniuose. *Lietuvos Archeologija* 2, 5-17.

Luchtanas, A. 1992. Rytų Lietuva I tūkst. pr. m. erą. *Lietuvos Archeologija* 8, 56-85.
Luik, H. 2013. Late Bronze Age bone crafting in the eastern Baltic: standardization of artefact types and individual ingenuity. *Estonian Journal of Archaeology* 17, 24-27.
Luik, H. and Maldre, L. 2007. Bronze Age bone artefacts from Narkūnai, Nevieriškė and Kereliai fortified settlements. Raw materials and manufacturing technology. *Archaeologia Lituana* 8, 5-39.
Melheim, L., Prescott, C. and Anfinset, N. 2016. Bronze casting and cultural connections: Bronze Age workshops at Hunn, Norway. *Praehistorische Zeitschrift* 91, 42-67.
Minkevičius, K., Podėnas, V., Urbonaitė-Ubė, M., Ubis, E. and Kisielienė, D. 2020. New evidence on the southeast Baltic Late Bronze Age agrarian intensification and the earliest AMS dates of *Lens culinaris* and *Vicia faba*. *Vegetation History and Archaeobotany* 29, 327-38.
Neumannová, K., Petřík, J., Vostrovská, I., Dvořák, J., Zikmund, T. and Kaiser, J. 2017. Variability in coiling technique in LBK pottery inferred by experiments and pore structure micro-tomography analysis. *Archeologické Rozhledy* 69, 172-86.
Oinonen, M., Vasks, A., Zariņa G. and Lavento, M. 2013. Stones, bones, and hillfort: radiocarbon dating of Ķivutkalns bronze-working center. *Radiocarbon* 55, 1252-64.
Orton, C., Tyers, P. and Vince, A. 1993. *Pottery in archaeology*. Cambridge: Cambridge University Press.
Piličiauskas, G., Skipitytė, R. and Heron, C. 2018. Mityba Lietuvoje 4500-1200 cal BC maisto liekanų keramikoje bendrųjų mėginių izotopinių tyrimų duomenimis. *Lietuvos archeologija* 44, 9-37.
Podėnas, V. 2020. Emergence of hilltop settlements in the southeastern Baltic: new AMS ^{14}C dates from Lithuania and revised chronology. *Radiocarbon* 62, 361-77.
Podėnas, V. and Čivilytė, A. 2019. Bronze casting and communication in the southeastern Baltic Bronze Age. *Lietuvos Archeologija* 45, 169-99.
Podėnas, V., Luchtanas, A. and Čivilytė, A. 2016. Narkūnų piliakalnių ir papėdės gyvenvietės keramika: elgsenos atspindžiai. *Lietuvos Archeologija* 42, 191-241.
Quinn, P.S. 2013. *Ceramic petrography: the interpretation of archaeological pottery and related artefacts in thin section*. Oxford: Archaeopress.
Raukas, A. and Kajak, K. 1997. Quaternary cover. In A. Raukas and A. Teedumäe (eds), *Geology and mineral resources of Estonia*, 125-36. Tallinn: Estonian Academy Publishers.
Reimer, P.J. [+ 40 others] and Talamo, S. 2020. The IntCal20 northern hemisphere radiocarbon age calibration curve (0-55 cal kBP). *Radiocarbon 62*, 725-57.
Rimantienė, R. 2005. *Die Steinzeitfischer an der Ostseelagune in Litauen. Forschungen in Šventoji und Būtingė.* Vilnius: National Museum of Lithuania.
Ringstedt, N. 1992. *Household economy and archaeology: some aspects of theory and applications*. Stockholm: University of Stockholm.
Schiffer, M.B., Skibo, J.M., Boelke, T.C., Neupert, M.A. and Aronson, M. 1994. New perspectives on experimental archaeology: surface treatments and thermal response of the clay cooking pot. *American Antiquity* 59, 197-217.
Sidrys, R.V. and Luchtanas, A. 1999. Shining axes, spiral pins. Early metal consumption in the East Baltic. *Acta Archaeologica* 70, 165-84.
Simniškytė-Strimaitienė, A. 2019. Aukštupėnų (Kupiškio) piliakalnis. In G. Zabiela (ed.), *Archeologiniai tyrinėjimai Lietuvoje 2018 metais,* 75-79. Vilnius: Lietuvos archeologijos draugija.
Sperling, U. 2013. Der Bronzebruchhort von Tehumardi – Verstecktes Altmetall oder ritueller Weihefund? Ein Deutungsversuch am Erscheinungsbild der Bronzen. In K. Johanson and M. Tõrv (eds), *Man, his time, artefacts, and places. Collection of articles dedicated to Richard Indreko,* 261-316. Tartu: University of Tartu.
Sperling, U. 2014. *Aspekte des Wandels in der Bronzezeit im Ostbaltikum. Die Siedlungen der Asva-Gruppe in Estland.* Tallinn: Estonian Academy Publishers.

Sperling, U., Lang, V., Paavel, K. and Kimber, A. 2015. Neue Ausgrabungen in der Bronzezeitsiedlung von Asva – vorläufiger Untersuchungsstand und weitere Ergebnisse. *Archaeological Fieldwork in Estonia 2014*, 51−64.
Sperling, U., Karlsen, H.-J., Lang, V. and Kimber, A. 2019. Grabungen und geomagnetische Prospektion auf dem vorwikingerzeitlichen Burgberg von Asva. *Archaeological Fieldwork in Estonia 2018*, 47-58.
Sperling, U., Karlsen, H.-J., Lang, V., Lõugas, L., Kimber, A. and Lau, R. 2020. Ausgrabungen in der Bronzezeitsiedlung von Asva im Jahr 2019. *Archaeological Fieldwork in Estonia 2019*, 51-60.
Šmigelskas, R. 2018. Devynios absoliučios datos iš Gedimino kalno tyrimų. *Archaeologia Lituana* 19, 100-19.
Taché, K. and Craig, O.E. 2015. Cooperative harvesting of aquatic resources and the beginning of pottery production in north-eastern North America. *Antiquity* 89, 177-90.
Troskosky, C.B., Podėnas, V. and Dubinin, N. 2018. Quaternary geomorphology and viewshed analysis of the Garniai I. *Chronika* 8, 64-77.
Urtāns, V. 1977. *Senākie depozīti Latvijā (līdz 1200.g.)*. Rīga: Zinātne.
Valk, H., Kama, P., Olli, M. and Rannamäe, E. 2012. Excavations on the hill forts of south-east Estonia: Kõivuküla, Märdi, Truuta and Aakre. *Archaeological Fieldwork in Estonia 2011*, 27-46.
Vaska, B. 2019. *Rotas un ornaments Latvijā no bronzas laikmeta līdz 13. gadsimtam.* Rīga: Latvijas Nacionālais vēstures muzejs.
Vasks, A. 1991. *Keramika epokhi pozdnjei bronzi i rannego zheleza Latvii*. Rīga: Zinātne.
Vasks, A. 1994. *Brikuļu nocietinātā apmetne. Lubāna zemiene vēlajā bronzas un dzelzs laikmetā (1000. g. pr. Kr. – 1000 g. pēc Kr.)*. Rīga: University of Latvia.
Vasks, A. 1996. Apmestās keramikas izplatība Latvijā. *Arheoloģija un Etnogrāfija* XVIII, 147-54.
Vasks, A. 2001a. Agrais dzelzs laikmets 1. – 400. g. In J. Graudonis and J. Apals (eds), *Latvijas senākā vēsture 9. g. t. pr. Kr. – 1200. g*, 186-231. Rīga: Latvijas Vēstures Institūta apgāds.
Vasks, A. 2001b. Par tekstilās keramikas izplatību bronzas un dzelzs laikmetā. *Latvijas Vēstures Institūta Žurnāls* 4, 51-62.
Vasks, A. 2010. Latvia as part of a sphere of contacts in the Bronze Age. *Archaeologia Baltica* 13, 153-61.
Vasks, A. and Zariņa, G. 2014. Ķivutkalna pilskalns un kapulauks: jauni dati un jaunas problēmas. *Latvijas Vēstures Institūta Žurnāls* 92, 5-36.
Vasks, A., Kalniņa, L. and Daugnora, L. 2011. Beltu pilskalns. *Arheoloģija un Etnogrāfija* XXV, 73-99.
Vasks, A., Visocka, V., Daugnora, L., Ceriņa, A. and Kalniņa, L. 2019. Krievu Kalns hill-fort: new data on the Late Bronze Age and Pre-Roman Iron Age in western Latvia. *Archaeologia Baltica* 26, 80-107.
Vengalis, R., Volungevičius, J., Vėlius, G., Kuncevičius, A., Poškienė, J. and Prapiestienė, R. 2020a. Žmogus prieš gamtą: reljefo transformavimas įrengiant XIII-XIV a. Kernavės pilį ir jo sukelti eroziniai procesai. *Lietuvos Archeologija* 46, 207-53.
Vengalis, R., Piličiauskas, G., Pilkauskas, M., Kozakaitė, J. and Juškaitis, V. 2020b. The large-scale rescue excavation of a multi-period site at Kvietiniai sheds light on the so far little explored Bronze Age in western Lithuania. *Archaeologia Baltica* 27, 17-50.
Visocka, V. 2016a. Vēlā bronzas laikmeta keramika Skrundas Krievukalna un Paplakas pilskalnos: reģionālās līdzības un atšķirības. *Jauno Vēsturnieku zinātniskie lasījumi I 2015. gada 26. novembrī Valmierā,* 26-34. Rīga: University of Latvia.
Visocka, V. 2016b. Dekoratīvie elementi vēlā bronzas laikmeta keramikā Latvijas teritorijā. In V. Segliņš (ed.), *Lietišķi ģeoloģiskie pētījumi, jaunas tehnoloģijas, materiāli un produkti. Zinātnisko rakstu krājums*, 78-89. Rīga: University of Latvia.

Visocka, V. 2017a. Pottery and hillforts: some aspects of pottery production during the Late Bronze Age in the territory of Latvia. *Latvijas Universitātes Žurnāls Vēsture* 4, 53-65.
Visocka, V. 2017b. Švīkāts-apmests trauks Vīnakalna pilskalna keramikas kolekcijā. *Latvijas Vēstures Institūta Žurnāls* 105, 5-24.
Visocka, V. 2020. Late Bronze and Pre-Roman Iron Age pottery in the lower reaches of river Daugava. In M. Marila, M. Ahola, K. Mannermaa and M. Lavento (eds), *Archaeology and analogy. Papers from the eighth theoretical seminar of the Baltic archaeologists (BASE) held at the University of Helsinki and Tvärminne zoological station, Hanko, Finland, November 30th-December 2nd, 2017*, 83-104. Helsinki: University of Helsinki.
Volkaitė-Kulikauskienė, R. 1986. Narkūnų Didžiojo piliakalnio tyrinėjimų rezultatai (Apatinis kultūrinis sluoksnis). *Lietuvos Archeologija* 5, 5-49.
Woltermann, G., Neumann, D. and Gleser, R. (eds) 2019. *Spezialisierung in der Bronzezeit. Archäologische Quellen und Modelle. Neolithikum und ältere Metallzeiten. Studien und Materialien 3.* Münster: LIT Verlag.

Appendix 1: Complete list of the fortified settlements in the eastern Baltic mapped in Figure 1

These sites all have associated ^{14}C dates or were dated based on typological studies of Bronze Age metal, clay and bone artefacts (Graudonis 1967; 1974; 1989; Jegoreichenko 2006; Lang 2007; Luchtanas 1992; Podėnas 2020; Šmigelskas 2018; Vasks *et al.* 2019; with our additions and modifications). Chronologically more widely dated artefacts, such as stone axes or various pottery styles, were not considered sufficient for inclusion in the map, as there is a risk of mixing Late Bronze Age and Early Iron Age processes by including these finds. There is significantly more knowledge on Kaliningrad fortified settlements established already in the Late Bronze Age, however the results of an ongoing project are yet to be published[14].

- Estonia: Asva, Iru, Kaali, Kõivuküla, Narva, Ridala;
- Latvia: Asote, Baltkāji, Brikuļi, Dievukalns, Dignāja, Jersika, Klaņģukalns, Klosterkalns, Krievu kalns, Ķenteskalns, Ķivutkalns, Mūkukalns, Madalāni, Padure, Paplaka, Rušenica, Sārumkalns, Smārdes Milzukalns, Stupeļu kalns, Tērvete, Vīnakalns;
- Lithuania: Antilgė, Dūkšteliai I, Garniai I, Juodonys, Kereliai, Kukuliškiai, Kupiškis, Kurmaičiai, Luokesai I, Mineikiškės, Moškėnai, Narkūnai, Nemenčinė, Nevieriškė, Pakačinė, Petrešiūnai, Sokiškiai, Spitrėnai, Velikuškės I, Vilnius (Gedimino kalnas), Vorėnai, Vosgėliai, Žagarė I;
- North-east Poland: Szurpiły, Tarławki, Zubronajcie;
- Russia: Osyno;
- Belarus: Bancerovsčina, Dvorisče, Gatoviči, Gorany, Gorodisče, Kasčelici, Labensčina, Ratjunki, Tarilovo, Zanoroč, Zazony.

14 Timo Ibsen (ZBSA Schleswig), pers. comm.

Appendix 2. Results of the petrographic analysis

CODE	SAMPLE INFORMATION			CLAY								TEMPER					WARE
	Inventory No.	Surface treatment	Wall thickness, cm	Coarseness	Sortedness	Silt	Fine sand	Sand	Mica	Iron oxides	Carbonate concretions	Type	Volume, %	Max. grain size, mm	Max.avg. Size, mm	Homogenity	
ASVA																	
AS1	TÜ, AI 3658: 693	Textile	0.85	fine	sorted	-	-	-	-	-	n	granite	12	3.6	2.58	+	**F**
AS2	TÜ, AI 3994: 951	Striated	0.75	fine	sorted	-	-	-	-	-	n	granite	17	4.05	2.43	+	**F**
AS3	TÜ, AI 3307: 259	Polished	0.6	fine	sorted	*	+	*	*	*	n	granite	8	1.5	1.17	+	**C**
AS4	TÜ, AI 4366: 1535	Smooth	0.65	fine	medium	*	*	*	-	-	n	granite	11	2.55	1.74	+	**D**
AS5	TÜ, AI 3994: 357	Striated	1	fine	medium	-	*	*	-	-	n	granite	17	3.75	2.58	+	**D**
AS6	TÜ, AI 3799: 387	Striated	0.95	medium	unsorted	-	-	*	-	*	*	granite	5	4.05	1.89	+/-	**B**
AS7	TÜ, AI 3658: 699	Striated	0.9	fine	sorted	-	-	*	*	*	n	granite	6	2.1	1.53	+/-	**C**
AS8	TÜ, AI 7065: 2663	Polished	0.6	fine	sorted	-	*	*	*	+	n	granite	7	1.65	1.17	+	**C**
AS9	TÜ, AI 3994: 403	Polished	0.85	fine	sorted	-	*	*	*	*	n	granite	15	1.95	1.41	+	**C**
AS10	TÜ, AI 4366: 1538	Smooth	0.7	fine	sorted	-	-	-	-	-	n	granite	12	6.6	2.52	+	**F**
AS11	TÜ, AI 4366: 1618	Polished	0.8	fine	sorted	-	-	*	*	*	n	granite	10	2.25	1.29	+	**C**
AS12	TÜ, AI 7065: 2476	Smooth	0.9	fine	sorted	-	*	*	*	*	n	granite	15	2.4	1.83	+	**C**
AS13	TÜ, AI 3799: 421	Smooth	0.95	medium	unsorted	-	*	*	-	*	n	granite	8	3.6	2.13	+/-	**B**
AS14	TÜ, AI 7065: 2749	Striated	1	fine	sorted	*	*	*	*	*	n	granite	10	1.5	0.93	+/-	**C**
AS15	TÜ, AI 3658: 687	Polished	0.55	fine	sorted	-	-	-	-	-	n	granite	11	3.75	2.85	+	**F**
AS16	TÜ, AI 3994: 1470	Smooth	0.7	fine	sorted	-	+	*	*	*	n	granite	13	2.1	1.71	+/-	**C**
AS17	TÜ, AI 3658: 561	Striated-textile	1.2	fine	medium	*	-	*	-	-	n	granite	10	2.85	2.01	+	**D**
AS18	TÜ, AI 4366: 308	Polished	0.65	coarse	unsorted	+	+	+	-	-	n	granite	11	2.55	1.68	*	**H**
AS19	TÜ, AI 7065: 2876	Striated	1	coarse	unsorted	*	+	+	*	*	n	granite	15	5.1	3.48	+/-	**A**
AS20	TÜ, AI 4012: 342	Polished	0.65	fine	sorted	-	*	+	*	+	n	sand	9	1.5	1.08	+	**J**
ĶIVUTKALNS																	
KIV1	LNVM, VI 120	Striated	1.1	medium	sorted	+	*	-	-	-	n	granite	32	5	2.5	+	**E**
KIV2	LNVM, VI 120	Striated	1.1	coarse	unsorted	+	*	+	*	-	n	granite	17	3.8	2.8	*	**G**
KIV3	LNVM, VI 120	Striated	0.95	coarse	unsorted	+	*	+	*	-	n	granite	25	2	1.5	*	**G**
KIV4	LNVM, VI 120	Striated	0.8	medium	unsorted	+	+	+	*	+	n	granite	23	3.5	2.8	+/-	**A**
KIV5	LNVM, VI 120	Striated	1	medium	sorted	+	*	-	-	-	n	granite	23	3	1.8	+	**E**
KIV6	LNVM, VI 120	Striated	0.8	medium	medium	+	+	+	*	-	n	granite	18	3	2.5	+/-	**A**
KIV7	LNVM, VI 120	Textile	1	fine	sorted	-	-	*	+	*	n	granite	30	5	2.9	+	**K**
KIV8	LNVM, VI 120	Textile	1.3	coarse	unsorted	+	*	+	*	+	n	granite	13	2.9	2.4	*	**G**
KIV9	LNVM, VI 120	Smooth	0.7	coarse	medium	+	+	+	*	+	n	granite	11	3.9	2.4	+/-	**A**
KIV10	LNVM, VI 120	Smooth	1	coarse	medium	-	+	+	*	-	n	granite	13	4.1	2.1	+/-	**A**
KIV11	LNVM, VI 120	Smooth	1	medium	unsorted	-	+	+	*	-	n	granite	13	2.79	2.24	+/-	**A**
KIV12	LNVM, VI 120	Striated	1.2	coarse	unsorted	+	+	+	-	-	n	granite	8	3.15	2	*	**H**
KIV14	LNVM, VI 120	Striated	1.05	medium	sorted	+	*	-	-	-	n	granite	15	3.3	2.34	+	**E**
KIV15	LNVM, VI 120	Striated	1.3	medium	sorted	+	*	-	-	-	n	granite	30	5.85	4.32	+	**E**
KIV16	LNVM, VI 120	Smooth	0.7	coarse	unsorted	+	*	+	*	-	*	granite	10	3.9	2.01	*	**G**
KIV17	LNVM, VI 120	Striated	0.9	medium	sorted	+	*	-	-	-	n	granite	30	3.75	2.88	+	**E**

CODE	SAMPLE INFORMATION			CLAY								TEMPER					WARE
	Inventory No.	Surface treatment	Wall thickness, cm	Coarseness	Sortedness	Silt	Fine sand	Sand	Mica	Iron oxides	Carbonate concretions	Type	Volume, %	Max. grain size, mm	Max.avg. Size, mm	Homogenity	
KIV18	LNVM, VI 120	Striated-rusticated	0.9	medium	sorted	+	*	-	-	-	n	granite	30	6	2.4	+	**E**
KIV19	LNVM, VI 120	Textile	1.2	medium	unsorted	+	+	+	*	-	n	granite	15	4.8	3.21	+/-	**A**
KIV20	LNVM, VI 120	Smooth	1.1	medium	sorted	+	*	-	-	-	n	granite	15	4.2	2.88	+	**E**
NARKŪNAI																	
NA1	LNM, 1977, 2, 233	Striated	0.75	fine	medium	*	*	*	-	-	n	granite	18	3.75	2.64	+	**D**
NA2	LNM, 1978, 2b, 165	Striated	0.9	medium	unsorted	*	-	*	-	*	n	granite	7	3.6	2.19	+/-	**B**
NA3	LNM, 1978, 2b, 589	Striated	0.95	coarse	unsorted	+	+	-	*	-	n	granite	11	3.75	2.07	+/-	**A**
NA4	LNM, 1977, 3, 2 obj.	Striated	0.7	fine	unsorted	+	-	*	*	*	n	granite	10	3.9	2.07	+/-	**I**
NA5	LNM, 1978, 518	Striated	0.9	medium	unsorted	-	*	*	-	*	n	granite	7	3	1.8	+/-	**B**
NA6	LNM, 1978, 2g, 199	Striated	0.85	fine	medium	-	*	*	-	-	n	granite	12	3.3	2.7	+	**D**
NA7	LNM, 1978, 6, 184	Striated	1.05	medium	unsorted	-	*	*	-	*	n	granite	6	2.55	1.74	+/-	**B**
NA8	LNM, 1978, 2y, 198	Striated	1.15	medium	unsorted	-	-	*	-	*	n	granite	8	3.6	2.04	+/-	**B**
NA9	LNM, 1978, 6, 459	Striated	0.7	coarse	unsorted	+	+	+	-	-	n	granite	9	2.1	1.47	*	**H**
NA10	LNM, 1978, 2b, 588	Striated	1	fine	medium	-	*	*	-	-	n	granite	10	4.5	2.16	+	**D**
NA11	LNM, 1978, 2b, 384	Striated	1	medium	unsorted	*	*	*	-	*	n	granite	5	3.45	2.46	+/-	**B**
NA12	LNM, 1978, 630	Striated	0.8	medium	unsorted	*	-	*	-	*	n	granite	12	4.35	2.07	+/-	**B**
NA13	LNM, 1978, 2b, 581	Striated	0.75	fine	sorted	-	-	-	-	-	n	granite	15	3.3	1.98	+	**F**
NA14	LNM, 1978, 2b, 568	Striated	0.85	medium	sorted	+	*	-	-	-	n	granite	25	3.3	2.85	+	**E**
NA15	LNM, 1978, 2b, 164	Smooth	0.55	fine	unsorted	+	-	*	*	+	n	granite	10	3.9	2.13	+/-	**I**
NA16	LNM, 1978, 641	Striated	0.9	fine	medium	_	*	*	-	-	n	granite	20	3.9	2.97	+	**D**
NA17	LNM, 1978, 549	Striated	0.8	medium	unsorted	_	+	*	*	*	n	granite	22	2.7	2.04	+/-	**A**
NA18	LNM, 1978, 2a, 646	Striated	0.95	medium	unsorted	*	+	*	-	*	n	granite	16	3.75	2.79	+/-	**B**

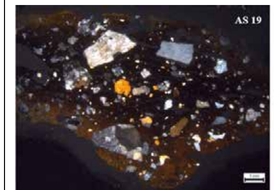
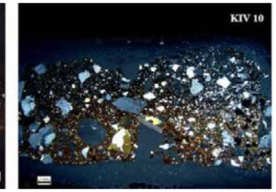
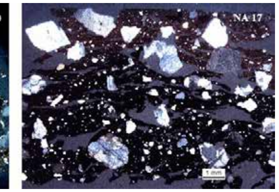
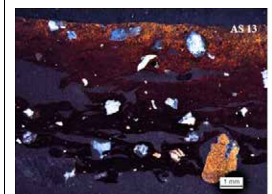
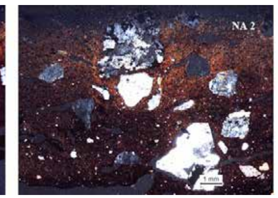
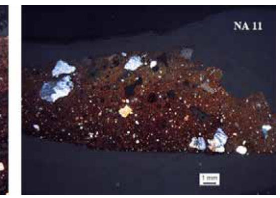
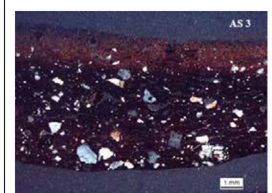
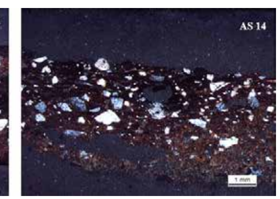
Clay: + rich; * common; - sparse; n none; **Homogenity:** + well, +/- medium, * not homogenous

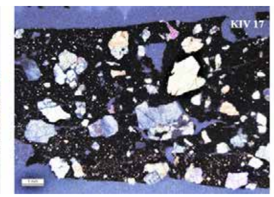
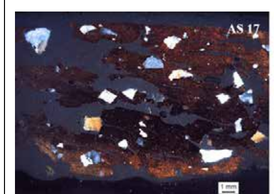
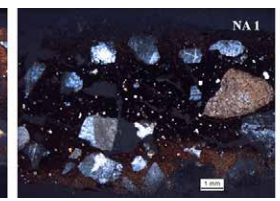
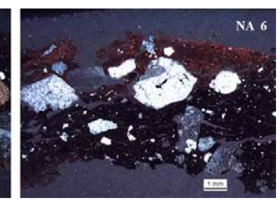
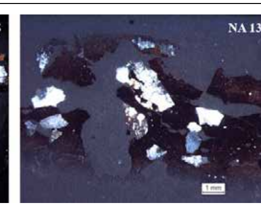
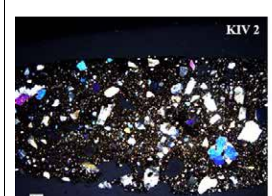
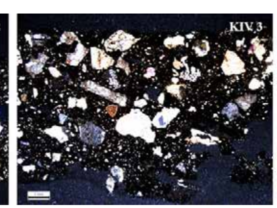
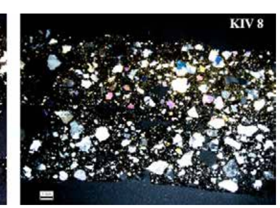
Appendix 3. Results of the WD-XRF Spectrometry

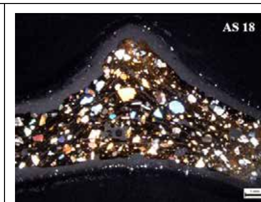
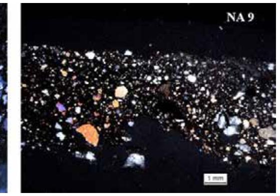
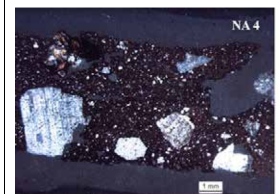
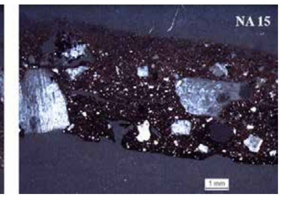
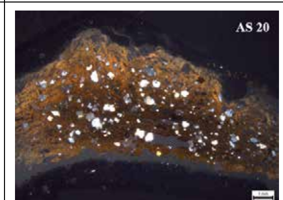
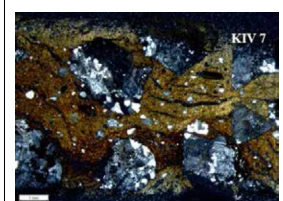
Code	MOST COMMON ELEMENTS, conc., %. NORMALISED							
	SiO2	Al2O3	Fe2O3	K2O	P2O5	MgO	MnO	CaO
AS4	56.39±1.7	18.08±2.2	8.15±2.2	5.3±0.94	1.22±1.35	3.56±1.1	0	3.21±0.9
AS5	37.7±18.53	13.45±6.39	13.56±7.7	6.28±1.4	11.76±13	3.93±1.21	0.06±0.33	9.66±6.41
AS6	42.16±4.15	11.54±1.1	10.14±1	4.48±1.52	9.02±1.94	4.45±0.8	0.07±0.21	13.91±1.9
AS12	48.35±8.2	13.65±4.9	9.31±3.8	4.7±0.62	5.27±3.7	3.26±0.92	0.06±0.17	12.6±5.5
AS14	48.36±7.8	14.38±0.85	10.59±4.4	5.84±0.7	6.45±4.25	3.21±0.85	0.04±0.2	8.19±1.9
AS17	50.23±6.14	12.45±0.5	10.75±0.81	5.99±1.3	6.12±2.5	3.42±1.2	0.06±0.16	7.92±0.74
AS18	49.9±5.2	15.01±4.3	11.57±4.5	5.47±1.54	3.97±0.4	3.34±1.4	0	7.54±4.6
AS19	40.26±33.1	13.48±11.5	14.35±11	4.34±2.01	8.05±6.9	3.16±1.8	0.03±0.18	12.5±29.8
AS20	51.55±5.05	16.07±2.84	9.15±1.81	4.36±1.1	1.17±1.45	3.38±0.91	0.05±0.3	11.13±5.92
KIV11	53.89±13.1	15.96±5.5	10.53±5	4.2±2.1	7.7±6	2.17±0.4	0.16±0.45	2.78±2.15
KIV12	63.45±10	13.91±2.07	4.6±1.73	4.5±0.52	4.72±3.6	2.34±0.64	0.09±0.3	4.21±3.2
KIV14	57.11±0.9	15.77±3	7.73±6.5	5.13±1.24	4.17±1.94	2.17±0.42	0.18±0.2	3.04±8.4
KIV15	58.61±6.94	17.75±7.1	4.53±2.2	3.05±1.5	2.8±1.32	1.19±0.6	0.02±0.11	7.07±0.94
KIV16	65.63±1.3	13.84±1.81	6.8±0.9	3.57±0.5	2.95±1.8	1.92±0.4	0.29±0.1	2.53±1
KIV17	61.89±6.72	13.38±2.6	8.27±5.1	4.13±0.7	3.17±1.75	1.85±0.31	0.12±0	4.5±1.5
KIV18	51.53±2.7	11.37±2.04	5.34±0.6	4.87±1.13	13.52±1.22	2.12±0.3	0.31±0.13	8.69±0.8
KIV19	51.35±24.8	12.21±4.32	6.48±5.1	5.3±1.9	8.14±8	2.53±1.13	0.46±0.42	9.94±14.6
KIV20	52.51±3.23	13.78±1.94	8.18±2.3	4.75±1.1	8.59±3.11	2.56±0.8	0.04±0.24	6.63±3.31
NA1	34.51±16.65	10.55±4.32	11.85±5.45	6.6±1.9	8.7±4.43	4.01±1	0.23±0.71	19.7±13.14
NA2	55.6±3.7	16.73±0.7	10.55±0.76	6.71±0.15	1.32±3.63	3.16±0.4	0	3.18±0.85
NA5	49.57±6.41	15.48±2.82	12.01±1.85	5.8±0.74	5.13±3.72	2.94±0.5	0.46±0.22	5.98±2.94
NA7	55.08±7.6	18.11±2.35	10.51±0.3	5.47±0.7	2.76±4.25	2.65±0.25	0.26±0.32	2.84±2.15
NA9	66.2±3.34	11.12±9.6	6.52±4	4.44±0.75	3.31±3	2.13±0.2	0.15±0.3	3.43±2.53
NA11	56.73±9.5	15.8±1.83	9.51±5	5.21±1.3	1.6±1.24	3.07±0.74	0.08±0.22	5.01±2.7
NA12	55.49±2.72	16.04±1.33	9.52±3.94	5.86±1.42	2.98±2.22	2.99±0.85	0	3.92±1.75
NA15	38.52±13.1	12.39±0.53	11.82±8.75	4.4±1.1	14.47±5.72	2.79±1.9	0.28±0.24	12.76±4.6
NA18	53.91±6	15.62±1.8	7.81±1.01	5.75±1.62	5.39±6.73	2.69±0.8	0.05±0.28	6.29±1.63

MOST COMMON ELEMENTS, conc., %. NORMALISED						Group
Na2O	Cl	TiO	BaO	ZnO	SO3	
2.42±0.41	0.13±0.4	0.86±0.05	0.23±0.08	0.08±0.02	0.25±0.7	**2.3**
0.84±2.32	0.18±0.53	0.74±0.12	0.38±0.34	0.15±0.08	0.67±0.32	**1.2**
1.2±0.1	0.26±0.8	0.71±0.34	0.25±0.1	0.1±0.02	1.31±0.21	**1.1**
0.81±2.22	0.05±0.3	0.81±0.55	0.23±0.1	0.1±0.11	0.12±0.64	**2.2**
0.46±2.5	0.07±0.4	0.86±0.5	0.18±0.2	0.1±0.06	0.33±0.92	**2.2**
0.83±2.4	0.08±0.44	0.82±0.2	0.21±0.11	0.06±0.02	0.44±1.3	**2.2**
0.51±2.8	0.05±0.3	0.88±0.3	0.25±0.4	0.11±0.14	0.34±1	**2.2**
0.71±2.03	0	0.6±1.7	0.31±0.2	0.19±0.4	0.49±1.64	**1.2**
0.47±2.6	0.1±0.57	0.86±0.16	0.24±0.2	0.11±0.02	0.25±0.74	**2.2**
0.92±0.33	0.03±0.18	0.86±0.5	0.18±0.11	0.05±0.03	0.23±1.3	**3.3**
0.5±1.44	0.07±0.4	0.71+/0.14	0.09±0.3	0.03±0.07	0.27±0.74	**3.3**
1.29±0.8	0.14±0.4	0.64±0.8	0.28±0.1	0.08±0.01	0.5±0.6	**3.2**
3.48±4.11	0.39±0.6	0.54±0.3	0.17±0.06	0.02±0.06	0.07±0.4	**3.1**
0.58±1.6	0	0.59±1.13	0.29±0.14	0.08±0.03	0.31±0.9	**3.2**
0	0	0.79±0.5	0.33±0.18	0.11±0.06	0.42±1.22	**3.2**
0.31±1.7	0.07±0.4	0.64±0.3	0.23±0.13	0.07±0.09	0.42±1.2	**1.3**
1.03±0.25	0.29±1.24	0.63±0.11	0.09±0.3	0.06±0.2	0.97±0.9	**1.3**
0.19±1.02	0.12±0.34	0.75±0.6	0.47±0.05	0.15±0.05	0.73±0.3	**1.2**
0	0.4±1.11	1.06±0.5	0.06±0.35	0.09±0.05	1.12±1.3	**1.1**
0.36±2	0.05±0.3	0.98±0.5	0.31±0.04	0.12±0.03	0.09±0.5	**2.3**
0	0.1±0.55	0.84±0.58	0.27±0.3	0.17±0.04	0.4±1.1	**2.1**
0	0	1.03±0.64	0.26±0.07	0.13±0.05	0.08±0.42	**2.1**
0.85±2.5	0.13±0.7	0.6±0.24	0.27±0.25	0.1±0.2	0.16±0.9	**3.2**
0.99±2.9	0.09±0.51	0.84±0.4	0.33±0.22	0.11±0.06	0.2±1.1	**2.3**
1.18±3.3	0	0.81±0.13	0.24±0.1	0.12±0.05	0.35±1.15	**2.3**
0.59±1.63	0.1±0.29	0.68±0.24	0.34±0.6	0.11±0.05	0.28±0.8	**1.3**
0.69±1.9	0.04±0.24	0.8±1.1	0.12±0.03	0.07±0.05	0.12±0.7	**3.3**

Appendix 4. Description and micrographs of the pottery wares (micrographs: V. Visocka)

Ware type	Samples	Description	Micrograph examples (XPL)		
A	AS19, KIV4, KIV6, KIV9, KIV10, KIV11, KIV19, NA3, NA17	Medium coarse, semi-sorted micaceous clay with fine sand and sand, as well as some additional mineral impurities. Tempered with coarse granitic rock grains (max. avg. size 2.04–3.48 mm), volume added: 11–23 %, semi homogenous, semi-dense. This group consists of nine samples and includes all three settlements, with Ķivutkalns dominating.			
B	AS6, AS13, NA2, NA5, NA7, NA8, NA11, NA12, NA18	Fine, semi-sorted ferriferous clay with some silt, fine sand and sand impurities. Small round iron oxide concretions are common (size <1 mm). Tempered with medium coarse granitic rock grains (max. avg. size 1.74–2.79 mm), volume added: 5–16 %, not homogenous, sparse. One sample (AS6) contains a carbonate concretion (size ~ 3 mm). This group consists of nine samples, with only Asva and Narkūnai represented, of which the latter dominates.			
C	AS3, AS7, AS8, AS9, AS11, AS12, AS14, AS16	Fine, sorted micaceous, ferriferous clay with silt, fine sand and additional mineral impurities. Tempered with fine granitic rock grains (max. avg. size 0.93–1.83 mm), volume added: 6–15 %, homogenous, semi-dense. This group consists of eight samples and is only recorded for Asva vessels. Half are identified as fine ware according to their morphological features, the others as coarse ware.			

D	KIV1, KIV5, KIV14, KIV15, KIV17, KIV20, NA14	Medium coarse, sorted silty clay with little sand and additional mineral impurities. Tempered with coarse granitic rock grains (max. avg. size 1.80–4.32 mm), volume added: 15–32 %, homogeneous and dense. In one sample (KIV15) two mixed clays can possibly be distinguished. This group consists of eight samples, mainly from Ķivutkalns; only one sample is from Narkūnai.	  
E	AS4, AS5, AS17, NA1, NA6, NA10, NA16	Fine, semi-sorted ferriferous clay with some sand impurities. Tempered with medium coarse granitic rock grains (max. avg. size 1.74–2.97 mm), volume added: 10–20 %, homogenous, semi-dense. This group consists of seven samples from Asva and Narkūnai.	  
F	AS1, AS2, AS10, AS15, NA13	Fine, sorted ferriferous clay with few silt and sand impurities. Tempered with medium coarse granitic rock grains (1.98–2.9 mm), volume added: 11–17 %, homogenous, semi-dense. This group consists of five samples, mainly from Asva; only one sample is from Narkūnai.	  
G	KIV2, KIV3, KIV8, KIV16	Coarse, unsorted micaceous, silt- and sand-rich clay with accessory mineral impurities. Tempered with medium coarse granitic rock grains (max. avg. size 1.5–2.80 mm), volume added: 10–25 %, not homogenous, dense. One sample (KIV16) possibly contains carbonate concretions (<1 mm). This group consists of four samples from the Ķivutkalns settlement.	  

H	AS18, KIV12, NA9	Coarse, unsorted silt- and sand-rich clay with additional mineral impurities. Tempered with fine granitic rock grains (max. avg. size 1.47–2 mm), volume added: 8–11 %, not homogenous, sparse. This group consists of three samples from all settlements.	  
I	NA4, NA15	Fine, unsorted micaceous silty clay with few quartz sand impurities. Tempered with coarse granitic rock grains (max. avg. size 2.07–2.13 mm), volume added: 10 %, semi homogenous, semi dense. This group consists of two samples from the Narkūnai settlement.	 
J	AS20	Fine, sorted micaceous, ferriferous clay with iron oxide concretions (<1 mm). Tempered with coarse quartz sand, volume added: 9 %, homogenous, semi dense. This group consists only of one sample from Asva.	
K	KIV7	Fine, sorted micaceous, calciferous clay with iron oxide concretions and quartz sand impurities. Tempered with coarse granitic rock grains (max. avg. size 2.9 mm), volume added: 30 %, homogenous, dense. This group consists only of one sample from Ķivutkalns.	

Settlement patterns in the Bronze Age

Western Baltic comparisons at different regional scales

Jutta Kneisel, Stefanie Schaefer-Di Maida, Ingo Feeser

Two phases of change can be identified in central Europe during the Bronze Age. The collapse of the Únětice groups around 1600 BC and the transition from inhumation to cremation around 1300 BC mark far-reaching transformations which essentially determine our understanding of the Bronze Age phase classification. This change is accompanied by a radical transformation of material culture and ritual practices. In northern Germany and southern Scandinavia, the area of the so-called Nordic Bronze Age, the change-over seems less drastic, especially as burial sites were apparently used continuously. Contrary to the central European division into Early, Middle and Late Bronze Age, traditionally only two phases are distinguished in the Nordic Bronze Age, the Older and the Younger Bronze Age. The beginning of the Older Bronze Age is temporally offset to central Europe, with period Ib beginning around 1700 BC (Vandkilde 1996). In the following article, we address the question of how the phases can be correlated and whether the changes which we see in the south, for example with the beginning of the Urnfield culture, are also reflected in the north. We also ask whether other phases of change can be identified. At one level, the article examines the succession of settlement in Schleswig-Holstein and the Jutland peninsula during the Bronze Age. An inter-regional comparison with southern Scandinavia and central Europe will then also be carried out. The article thus provides an overview of western Baltic settlement history during the Bronze Age. The scale of investigation ranges from the macro- and meso- to the micro-level of a single tumulus. As the accuracy of dating and data collection increases from the macro-level to the micro-level, it makes sense to contrast and compare these different analytical scales. The focus is not only on settlement patterns and the burial landscape, but also on material culture, human impact on the landscape and changes in the natural environment.

Phases of change in central Europe, an overview

The first phase of change during the Bronze Age in central Europe, the end of the northern Únětice groups, is the beginning of the Bronze Age in the north (Period Ib /Period II). In the area south of the Nordic region, Únětice settlement stopped at this time (Figure 1).

End of the Únětice groups in the north, 1600-1500 BC

The Únětice groups at the beginning of the second millennium BC are among the first societies to work bronze on a large scale. Their area of influence and material remains reach from the Elbe in the north, include the Harz mountains in the west, and reach as far as the Warta in the east (Zich 2016, 371 fig.1; Kneisel *et al.* this volume fig. 4), where we find one of the few fortified settlements of these northern groups (Czebreszuk and Müller 2015; Müller and Czebreszuk 2003). Sometimes the border between the "metal-owning" and the "metal-poor" regions is quite clear, as in Lower Saxony between the rivers Ocker and Aller at the level of the Elm mountain range (Steinmetz 2003, 349 fig. 9) or in the east between the Únětice and the Trzciniec groups, which lack metal

In D. Hofmann, F. Nikulka and R. Schumann (eds) 2022. *The Baltic in the Bronze Age. Regional patterns, interactions and boundaries*, Leiden: Sidestone Press, pp. 189-218.

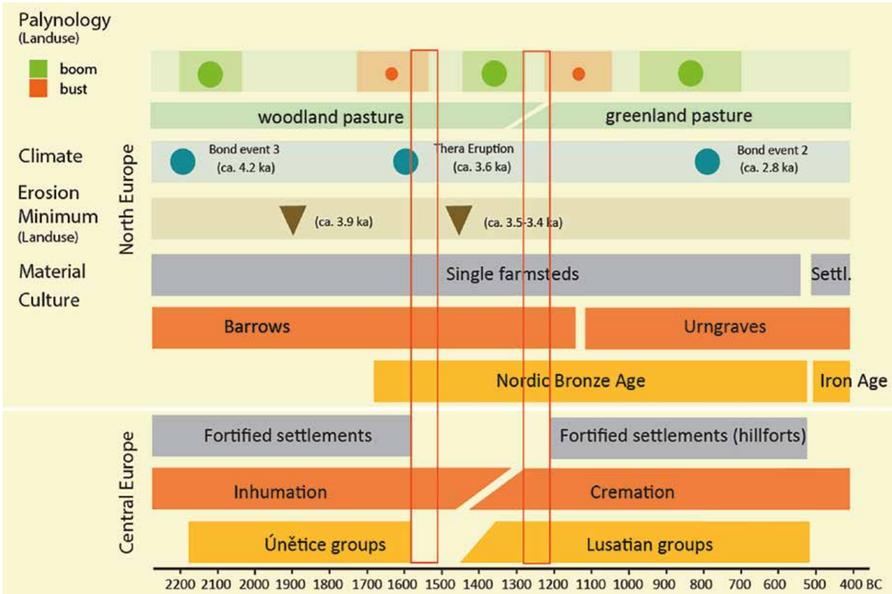


Figure 1. Schematic representation of cultural and palaeo-environmental factors in the Bronze Age of northern and central Europe.

(Czebreszuk 1998; Makarowicz 2010). From the beginning, the Early Bronze Age Únětice groups are significantly involved in trade and exchange, which reaches from Mecklenburg to Sweden (Vandkilde 2017) and southwards to the Carpathian Basin (Kneisel 2013b, 191-92 figs 10-11). The distribution and trade of copper and amber, among others, is controlled by them (Müller and Kneisel 2010). The collapse of these northern metal-working groups can be demonstrated by various changes in the social, ecological and economic spheres, but at the same time is also reflected in environmental changes, reforestation and the decline of soil erosion in the entire region (Dreibrodt *et al.* 2010; Feeser *et al.* 2019; Kneisel 2013a; Kneisel *et al.* 2008). The increase in burials without grave goods towards the end of the Early Bronze Age (Hubensack 2018, 150 fig. 83), the overexploitation of local resources and the end of settlements that had been occupied for several centuries (e.g. Bruszczewo; Kneisel *et al.* 2008), the shifting of trade routes for amber and finally the deposition of the sky disc (Meller 2010, 69 fig. 35) are elements that indicate the collapse of the northern Únětice groups. In the north, on the other hand, a rich independent Bronze Age society developed from Period Ib onwards and at the latest at the beginning of Period II around 1500 BC (Kneisel *et al.* 2019; Thrane 2013, 748). It left its mark on the landscape, with the burial mounds still visible today (Kneisel and Rode 2010/11).

The following Middle Bronze Age starts slowly and from the south (Innerhofer 2010; Kneisel 2012b). The period between 1600/1500 BC and c. 1450 BC is only documented by a few finds. Only after the onset of the Lusatian groups in the south-east does the area between the Elbe and the Warta again show a dense occupation.

Beginning of the Urnfield culture 1300-1200 BC

From a central European point of view, the second major transformation took place with the beginning of the large urn cemeteries. The abandonment of inhumation and the beginning of cremation with the subsequent burial in urns is considered a profound social and ritual change (Figure 1; Schaefer-Di Maida 2020). The abandonment of widely visible funerary monuments, such as the so-called princely mounds of the Únětice groups (Schunke 2016), in favour of more simply constructed urn burials is nowadays understood as a social transformation. Its trigger is often seen in the south with the arrival of the Lusatian groups (Fokkens 1997). This period of change saw events such as the violent episodes in the Tollense valley around 1200 BC (Jantzen *et al.* 2014; Jantzen and Lidke this volume) and the renewed beginning of fortified settlements in Poland, Brandenburg and Mecklenburg-Western Pomerania (Dräger 2014; Nakoinz *et al*. 2017, see Kneisel *et al*. this volume fig. 3). In Schleswig-Holstein and Denmark, by contrast, fortified sites did not appear before the Late Roman Iron Age (Nakoinz *et al*. 2017). We also see a radical change in diet and crop cultivation compared to the Early Bronze Age. Millet as a new cereal reaches central Europe and the north; legumes and oil plants broaden the spectrum of Early Bronze Age crops (Filipović *et al*. 2018; Kneisel *et al.* 2015; Feeser *et al*. 2022). In the north we see similar social changes associated with burial customs, but the burial sites remain constant until the end of the Bronze Age and beyond.

Settlements in the south-west Baltic (macro-level)

This short overview of transformations and breaks in the central European Bronze Age serves as a basis for a comparative analysis of the Bronze Age settlement history in Schleswig-Holstein. There, large-scale settlement studies are rather rare in comparison to its northern neighbouring area in Denmark. Apart from the lack of linear infrastructure or pipeline excavation and systematic large-scale investigations, possible reasons for this include the stronger agricultural activities of modern times. Although Older Bronze Age settlements in Schleswig-Holstein have been investigated in a project of the Academy of Sciences and Literature in Mainz since 2007, the number of sites is rather low compared to Denmark (Meier 2013, 93).

From the Older Bronze Age, 13 sites with a total of ten radiocarbon-dated houses are known so far (Donat 2018; Effenberger 2018a; Meier 2013). For the Younger Bronze Age, the state of research is somewhat more difficult to assess, since we mainly know settlement pits and clusters of storage pits from this period. So far, reliable dates are available only for a few sites of the Younger Bronze Age (Effenberger 2018a; Kneisel *et al.* 2013; Meier 2013). Therefore, the majority of sites are dated typo-chronologically. If sites consisting only of settlement pits are included, 66 sites belong to the Younger Bronze Age (Schmidt 1993). Thanks to investigations during construction work, more and more settlement evidence for the Younger Bronze Age has been found in recent years, but comprehensive publications are still lacking. According to V. Klems (2020), the number has risen to over 120 sites in recent years. A study of Younger Bronze Age settlements, such as Borgdorf-Seedorf, Kr. Rendsburg-Eckernförde (Schäfer 1980a; 1980b), Gönnebek, Kr. Segeberg, Burg on Fehmarn and Schashagen, Kr. Ostholstein (Klems and Müller 2020, 100), as well as Borgstedt, Kr. Rendsburg-Eckernförde LA 37[1], is currently being carried out within the framework of the above-mentioned Academy of Mainz project led by V. Klems. However, additional sporadic indications of settlement activities, mostly in the form of pits or postholes, are repeatedly revealed during the investigation of barrow structures (Kneisel *et al*. in prep.; Lütjens 2013; Schaefer-Di Maida 2020). M. Hornstrup (1999, 124) refers to them partly as ritual features which are related to burial activities. However, other sites such as Flintbek, Brekendorf or Todesfelde prove that there may well be an overlap between settlement areas and burial sites (see below). Therefore, an interpretation of the so-called settlement features on cemeteries remains uncertain as long as the whole site has not been investigated.

Already published are the sites of Archsum on Sylt (Wirth 1994), Handewitt, Kr. Schleswig-Flensburg (Bokelmann 1977), Flintbek (Zich 2005) and Brekendorf, both Kr. Rendsburg-Eckernförde (Meier 2013). Short and often preliminary reports for additional sites can be found in the journal *Archäologische Nachrichten aus Schleswig-Holstein* (e.g. Lütjens 2013). Reliable dating in the form of radiocarbon dates is provided by seven Bronze Age sites. At the settlements of Todesfelde and Brekendorf, several houses are covered by series of dates (Effenberger 2018a, 27; Meier 2013). Additionally, further dates

1 http://www.gemeinde-borgstedt.de/chronik/auf-dem-acker-der-gemarkung-borgstedt.html, last accessed 25.4.2020.

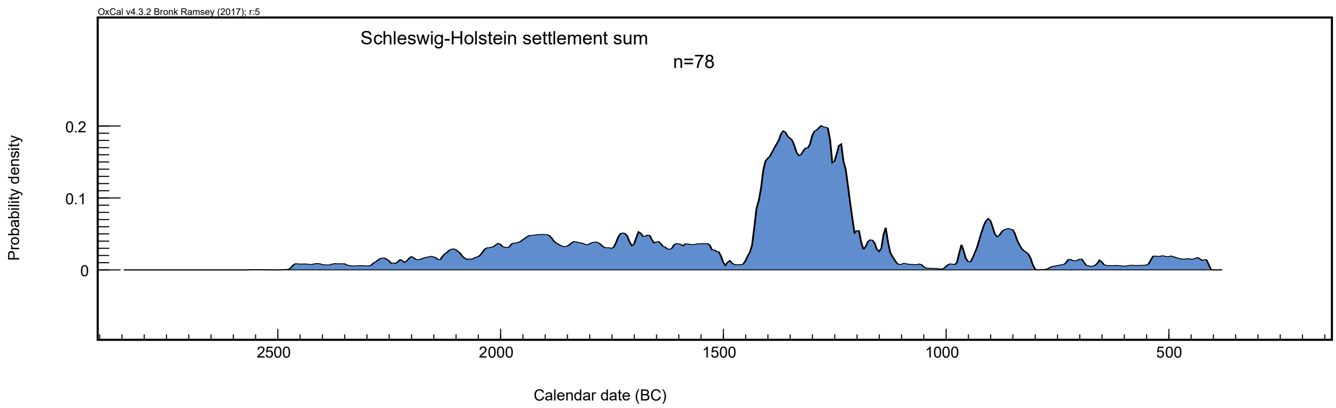


Figure 2. Sum calibration of all ^{14}C-dated Bronze Age settlement sites in Schleswig-Holstein (made using OxCAL 4.3.2).

are available for the settlement pits at Gönnebek (Effenberger 2018a, 35), two dates for the house in Handewitt (Meier 2013) and four for the Flintbek house (Zich 1993/94). Dates on material from single pits are available from Bark, Kr. Rendsburg-Eckernförde (Effenberger 2018a, 33), and Mang de Bargen near Bornhöved, Kr. Segeberg (Schaefer-Di Maida 2020). Although the pit at Bark was classified as a cooking pit, a feature only occasionally found in settlement contexts, in this case it belongs to a settlement site with posts and pit features (Effenberger 2018a, 33). In addition, the date is more than 200 years too old for the so-called cooking pit phenomenon[2], which begins around 1400 cal BC and, according to previous investigations, comprises features with only charcoal and no macro-remains. Therefore, the cooking pit at Bark can be interpreted as a normal fireplace. Another date of a hearth from Frested, Kr. Dithmarschen, was measured at the Cologne laboratory (KN-177), but the uncalibrated date is unknown. The hearth dates to the Younger Bronze Age, 1211-1059 BC (Schmidt 1993, note 50). A sum calibration of these listed dates is naturally imprecise, as some sites have more dates than others. Site-related "binning" of the data has been omitted, as this mainly results in a flatter curve and does not change the general distribution pattern. As a result, the sum calibration of the settlement features (Figure 2) shows maximum values after 1500 cal BC until about 1100 cal BC (Period II-III) for Schleswig-Holstein, mainly representing the houses at Brekendorf. The sites at Flintbek, Todesfelde and individual dates from Brekendorf and Gönnebek, which seems to see uniform occupation activity for the period 2100-1500 cal BC, still fall into Period I or into the Late Neolithic.

The settlement structures and house types in Schleswig-Holstein are in good agreement with the southern Scandinavian and Dutch building traditions. Settlements consist of individual farmhouses, usually only one house beside a storage or economic facility. Stratigraphic observations of house structures indicate that sites were usually inhabited for a longer period of time and that houses were rebuilt at intervals, sometimes with slightly shifted positions or offset by several decimetres. Apart from Todesfelde and Brekendorf there are hardly any published settlement sites that have been extensively researched, so that it is difficult to establish a comprehensive settlement sequence, as available for Denmark (e.g. Bech *et al.* 2018; Mikkelsen 2013; Runge 2010).

The radiocarbon dates for Todesfelde come from two neighbouring houses (houses II-III), both of which are covered by an Older Bronze Age burial mound. Their alignment differs by more than a few degrees, suggesting that houses II and III did not stand at the same time.

2 Cooking pits are pits filled with fire-heated cobblestones. Often, hundreds of these features are arranged in lines, semicircles or unstructured agglomerations near barrows or settlements. There are no finds other than charcoal. So far, they have been interpreted as feasting places with preparation of food (Honeck 2009; Schenk and Goldmann 2004; Schmidt 2005). The start of this phenomenon in northern Europe was some time after 1400 BC, while cooking pits continue to be dug into the Late Iron Age in Scandinavia (Bo Henriksen 2005; see also Kneisel *et al.* this volume).

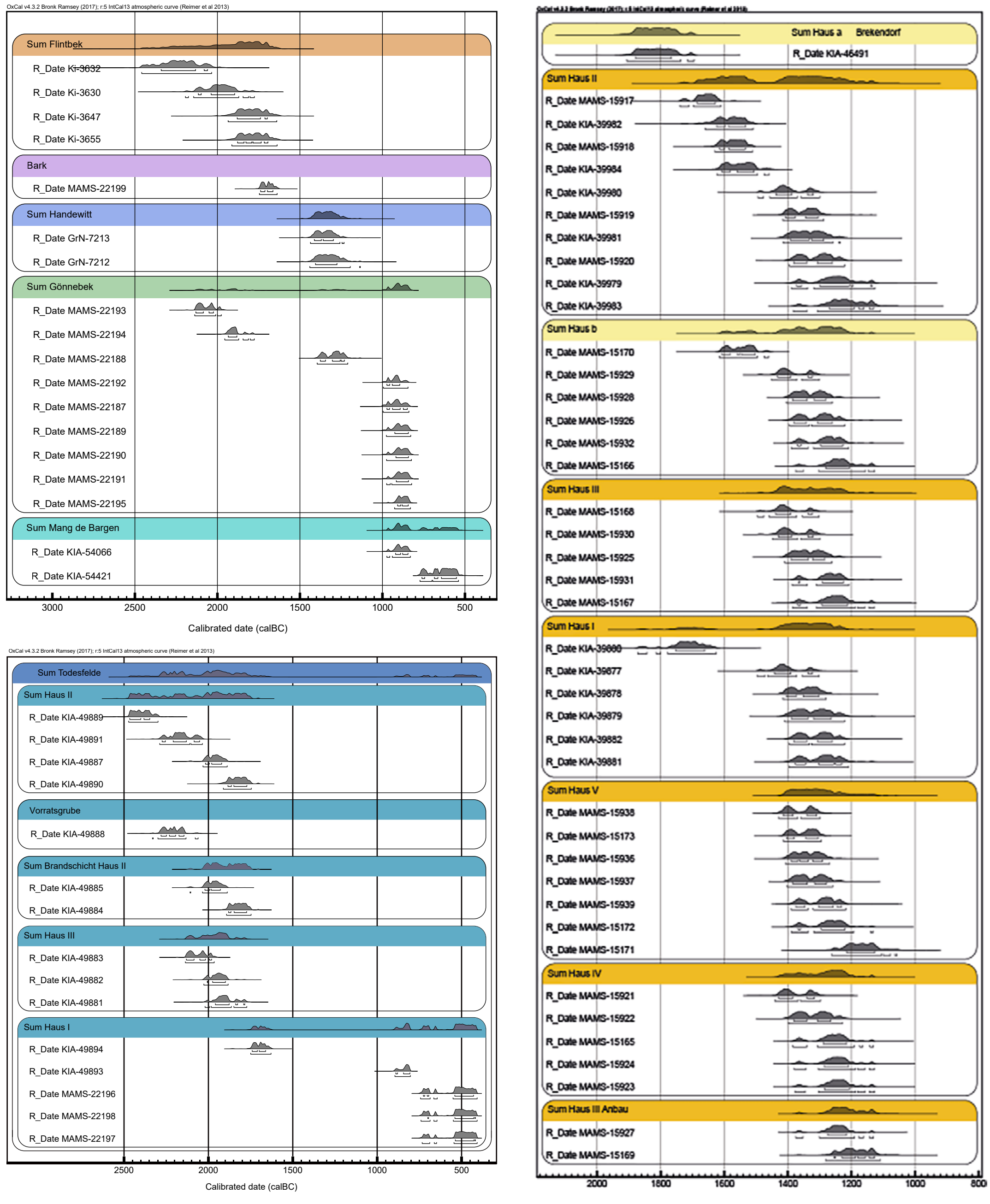


Figure 3. Multiplot of ^{14}C-dated settlement sites with subphases in Schleswig-Holstein (made using OxCAL 4.3.2).

Presumably house III is the older one, while house II was destroyed by fire. Both houses date to the Late Neolithic, possibly to the transition to Period I and are two-aisled. Compared to the two Neolithic houses, house I is considerably shorter and three-aisled (Lütjens 2013, 40). It dates to the end of the Younger Bronze Age (Figure 3) and reflects a second settlement phase during the Younger Bronze Age or beginning Iron Age. Associated older dates from pits and post structures are thought to reflect redeposited material from the first Late Neolithic settlement phase. The younger settlement phase coincides chronologically with the 120 cremation burials north-east of the barrow (Effenberger 2018a, 27; Lütjens 2013). The sequence at the Todesfelde site thus begins with a Late Neolithic settlement, followed by the construction of an Older Bronze Age barrow, which is used as a burial site until the Iron Age, and finally ends with Younger Bronze Age settlement traces south of the mound.

Somewhat different is the situation for the site of Brekendorf. Here, the complete ground plans of houses were given Roman numerals, while the initially more unsubstantiated houses were labelled a and b. The Late Neolithic occupation is only proven by a single ^{14}C-date for house “a”. House II shows two construction phases, the first of which falls between 1600 and 1500 cal BC (outer posts), while the second construction phase (inner construction) and all other buildings date to the period between 1400-1200 cal BC (Meier 2013, fig. 14). House IV appears to be the youngest and also overlaps stratigraphically with house III, which in turn overlaps houses a and b (Figure 4). Therefore, the first traces of human activity at the site obviously date back to the Late Neolithic/Period I while the main settlement phase was in Periods II and III. From a stratigraphic point of view, however, a maximum of one longhouse and two or three other buildings (houses I, II and V) could have existed contemporaneously. The site was re-used in the Younger Bronze Age, as indicated by urn graves in the eastern part of the excavated area and cooking pits in the northern area. The circular ditches are probably associated with the urn burials (Meier 2013, 98 fig. 5). The entire surrounding area of the site, with a Neolithic long barrow and numerous Older Bronze Age tumuli on the eastern hilltops and the cooking pits (Halbwidl 2013, 264 fig. 3), attests to a continuous use as burial site with temporary settlement and other human activities (cooking pits).

Figure 4. Settlement at Brekendorf, Kr. Rendsburg-Eckernförde, with the sequence of the ^{14}C-dated houses (after Maier 2013).

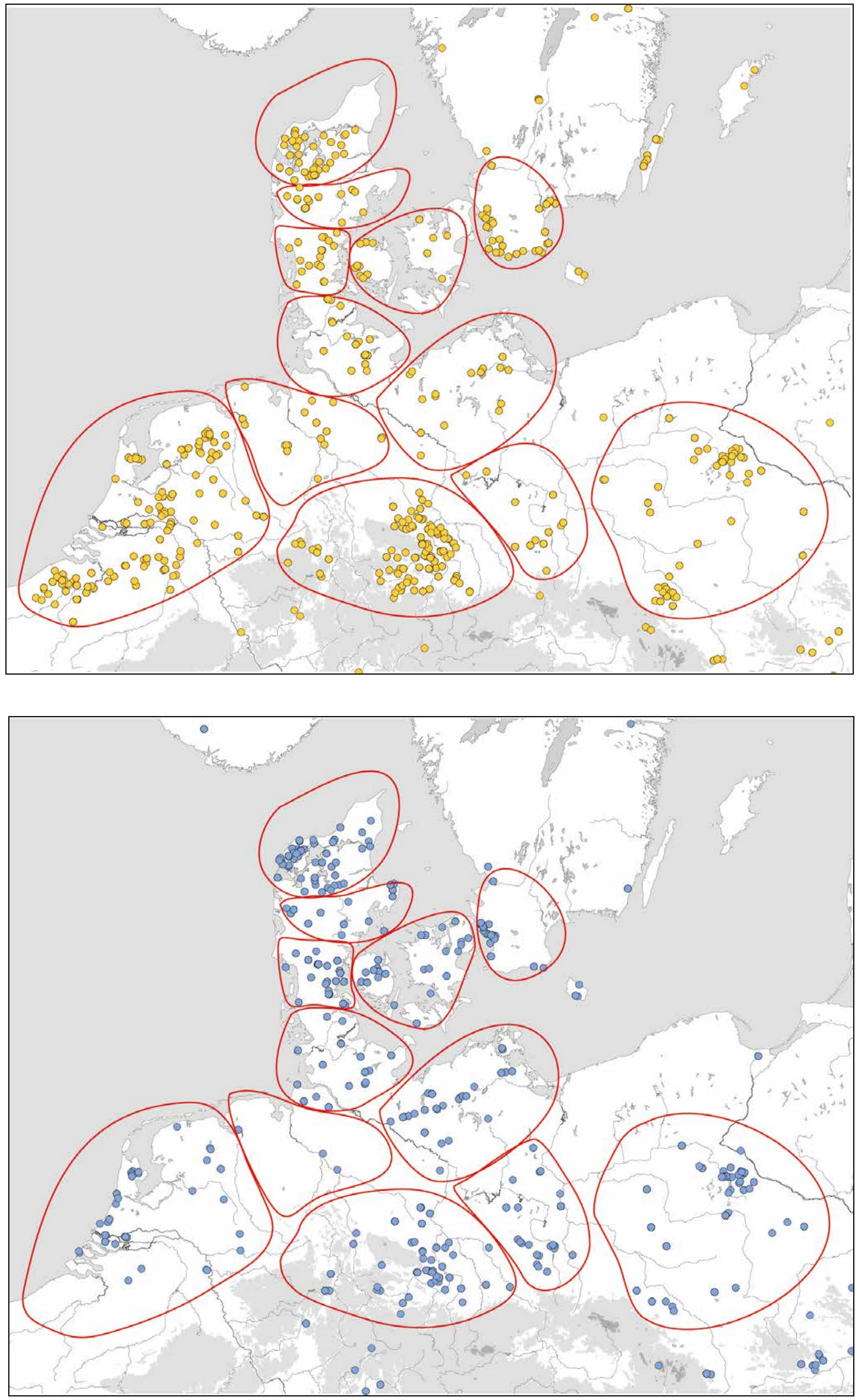


Figure 5. Map of the ^{14}C-dated graves (yellow) and settlements (blue) and the regional subdivision according the Radon database (Hinz *et al*. 2012; Kneisel *et al*. 2013).

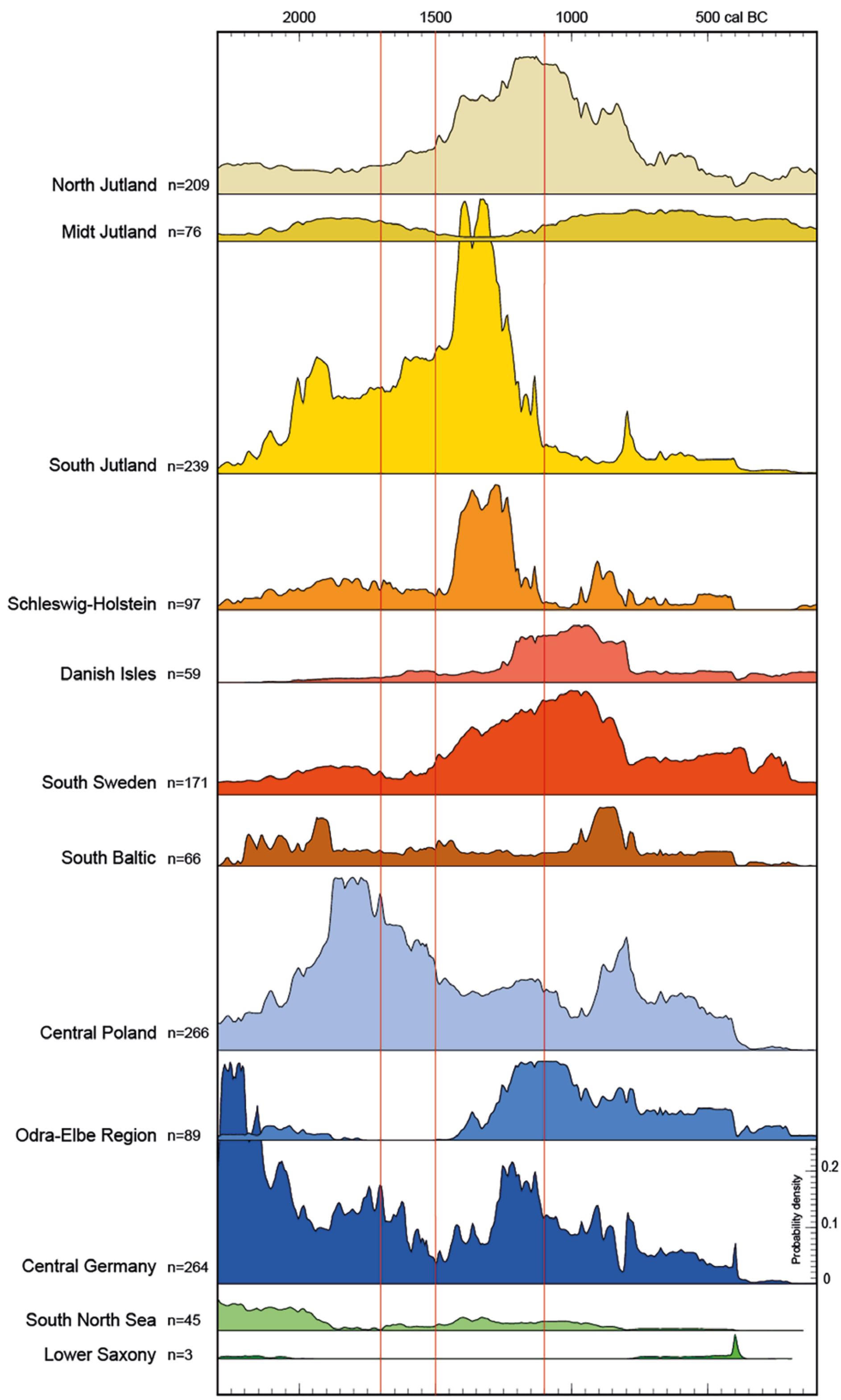


Figure 6. Sum calibration of the ^{14}C dates from settlements by region for northern Europe. The y-axis is standardised for all curves (made using OxCAL 4.3.2).

In contrast to the two previous sites, the intensive settlement activities at Gönnebek date to the Younger Bronze Age. Single older dates from pits probably reflect redeposited material connected to previous human activities at the numerous barrows in the vicinity (Effenberger 2018a; Schwerin von Krosigk 1976). The settlement lies in a landscape characterised by a high density of burials (see also Figure 9).

Supra-regional comparison of settlement data in the western Baltic and northern Europe

In the following, a comparison with settlement data of the other northern European countries is carried out, bearing in mind the rather scarce absolute chronological data for Schleswig-Holstein. Currently, about 9000 records for the Bronze and Iron Age of Europe are accessible online in the Radon-B and Radon databases (Hinz *et al.* 2012; Kneisel *et al.* 2013). About 2000 records relate to northern Europe, providing ideal conditions for a comparison. The available data for northern Europe, the North Sea and Baltic were divided regionally (Figure 5). For each region a single sum calibration was calculated for uncalibrated dates in the age range of 3999-2000 BP (Figure 6). Even though this procedure is often critically discussed in the literature (e.g. Meadows and Contreras 2014), and various statistical calculations such as "binning" and the comparison with simulated data distributions are recommended in order to identify meaningful patterns (Feeser *et al.* 2019; Hinz *et al.* 2019), the main focus here lies on the comparison of the data for Schleswig-Holstein with the better data basis in the neighbouring countries. The authors are aware that different sampling strategies and projects influence the data. This can be seen, for example, in the sum calibration of the graves (Figure 7), as more graves of the Younger Bronze Age in Schleswig-Holstein were dated during the current SFB project "Scales of Transformations" (Schaefer-Di Maida 2020). This can also be observed in Early Bronze Age graves in central Germany, for which several projects have initiated extensive date series (e.g. Hubensack 2018). It should also be noted that the sum curves for Late Bronze Age graves cannot be considered representative for all regions. Only in recent years, due to the possibility of dating cremations, have extensive dating projects been carried out in some regions, such as in Belgium (De Mulder *et al.* 2013), and the first published ^{14}C-data for Middle and Late Bronze Age graves are now also available for Brandenburg (Bönisch 2011; Tiedtke 2020, 341-44). Therefore, in regions with a high frequency of dates, there is also more data for the Early Bronze Age. While the Early Bronze Age is mainly dominated by inhumation graves, which can be dated well, the reliability of dating evidence for the Late Bronze Age is not equally high in all regions, as it has only recently become possible to date cremations. In contrast, for the Danish settlement sites there are generally a comparatively high number of dates for individual houses, which is due to a strategy involving regular and intensive radiocarbon dating of structures independent of research focus and interest. In most cases, a comparison between the dates for settlements and graves shows similar curves, independently of the number of dated sites, as long as sufficient dates are available (Figure 7). Therefore, it seems legitimate to use the sum calibrations of radiocarbon dates from settlements in northern Europe for a comparison of supra-regional settlement activities.

A comparison of the dated settlement sites and houses in northern Europe shows the following picture. The sites from southern Jutland, immediately north of Schleswig-Holstein, show a similar curve as Schleswig-Holstein (Figure 6). Although many more settlements from the eighteenth to sixteenth centuries cal BC are present here, a massive increase in the course of Period II can be observed as well. The curves of both regions flatten again markedly in the course of Period III. In north Jutland, however, the peak starts much later and reaches into the Younger Bronze Age. The curves of the dated settlements in the west, on the Danish islands and in southern Sweden, follow a different trajectory and show a main peak rather in the Younger Bronze Age, as can also be observed for Mecklenburg-Vorpommern (Schmidt 2013).

The situation is different in the south. Here, the peaks of settlement in Poland as well as in central Germany are significantly before 1700 cal BC. In the Lusatian core area between Odra and Elbe, dates for settlements are available only with the beginning of the Lusatian groups after 1400 cal BC. These three curves run parallel to the typo-chronologically dated finds distributions over the time horizons. The period between 1700 and 1500 cal BC marks the beginning of a change in central Europe. In this area (central Poland, central Germany and parts of Mecklenburg-Western Pomerania), the number of dated sites decreases. Assuming that dating was

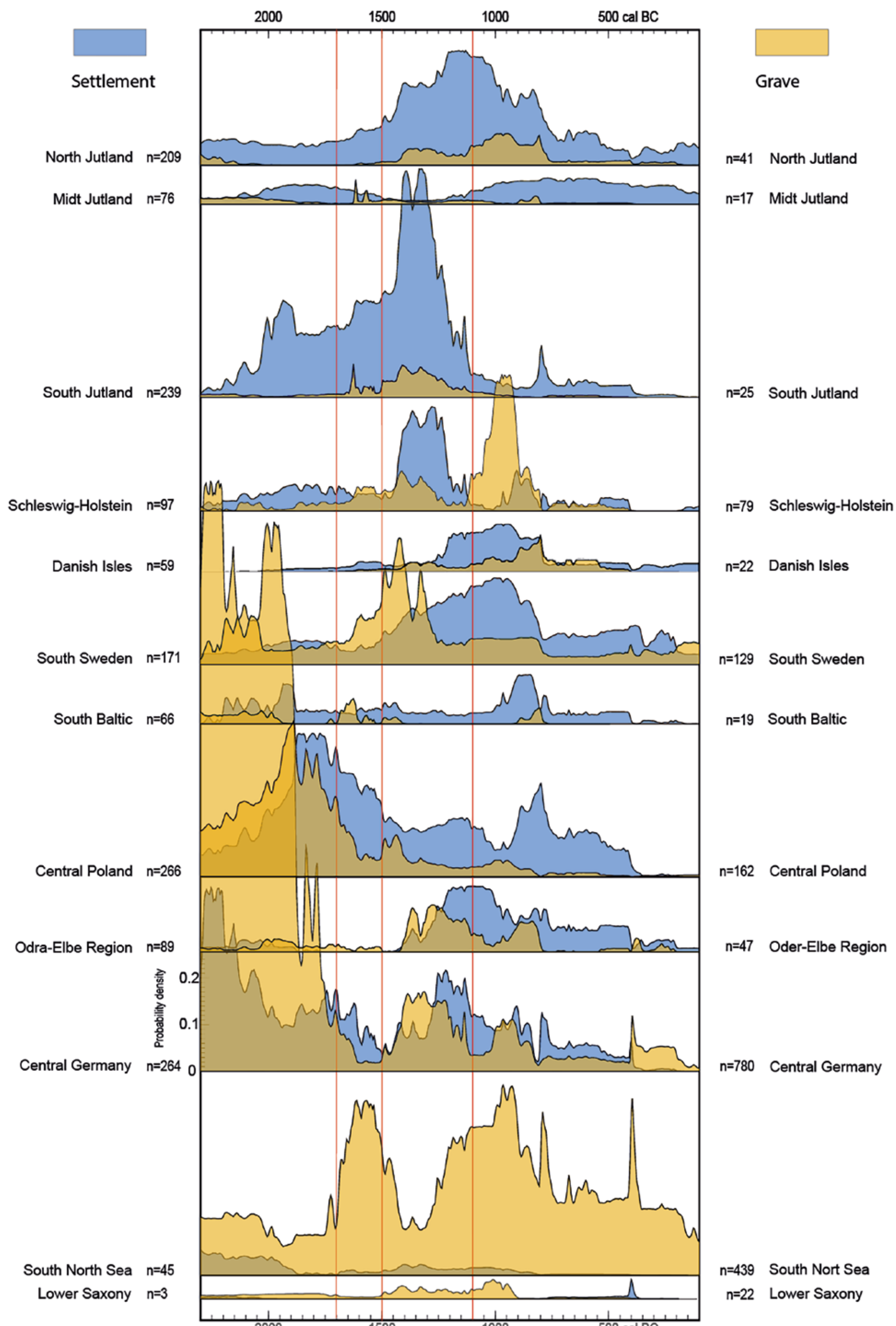


Figure 7. Comparison of the sum calibrations for graves and settlements in northern Europe. The selected data cover the period 3999-2000 cal BP, the y-axis is standardised for all curves (made using OxCAL 4.3.2).

carried out at a representative number of sites, a picture of a decline in sites and thus in visibility of human activities during these time periods emerges, as has been described elsewhere. This is also reflected in proxies for land-use activities, such as pollen profiles and colluvial events (Dreibrodt *et al.* 2010; Feeser *et al.* 2019; Kneisel 2012b; 2013a; 2015). At the same time, from Period I onwards, a steady increase of settlement sites began in the north, but numbers again rose sharply from about 1500 cal BC. Regional differences in the frequency of dated sites from south to north on the Jutland peninsula and different trajectories on the Danish islands and in southern Sweden can be observed. This reveals an asymmetrical settlement pattern, which for the western Baltic (Jutland, Schleswig-Holstein) shows a dynamic situation of progressive settlement expansion towards the north, which only sets in with the collapse of the Únětice groups in the south. The southern Baltic region and Poland, in contrast, seem to be integrated into the central European settlement pattern.

Artefact and grave frequencies in Schleswig-Holstein (macro-level)

In comparison with Jutland, the absolute chronological database for Schleswig-Holstein is very small and the sum calibrations of both the graves and the settlements are based on only a few sites. In order to extend the data base for the few settlements, dated graves were included in the analysis, based on the premise that intensive grave construction or a high find density correlates with high settlement density. The combination of settlement and burial evidence as in Brekendorf (Meier 2013) or in Denmark (Holst

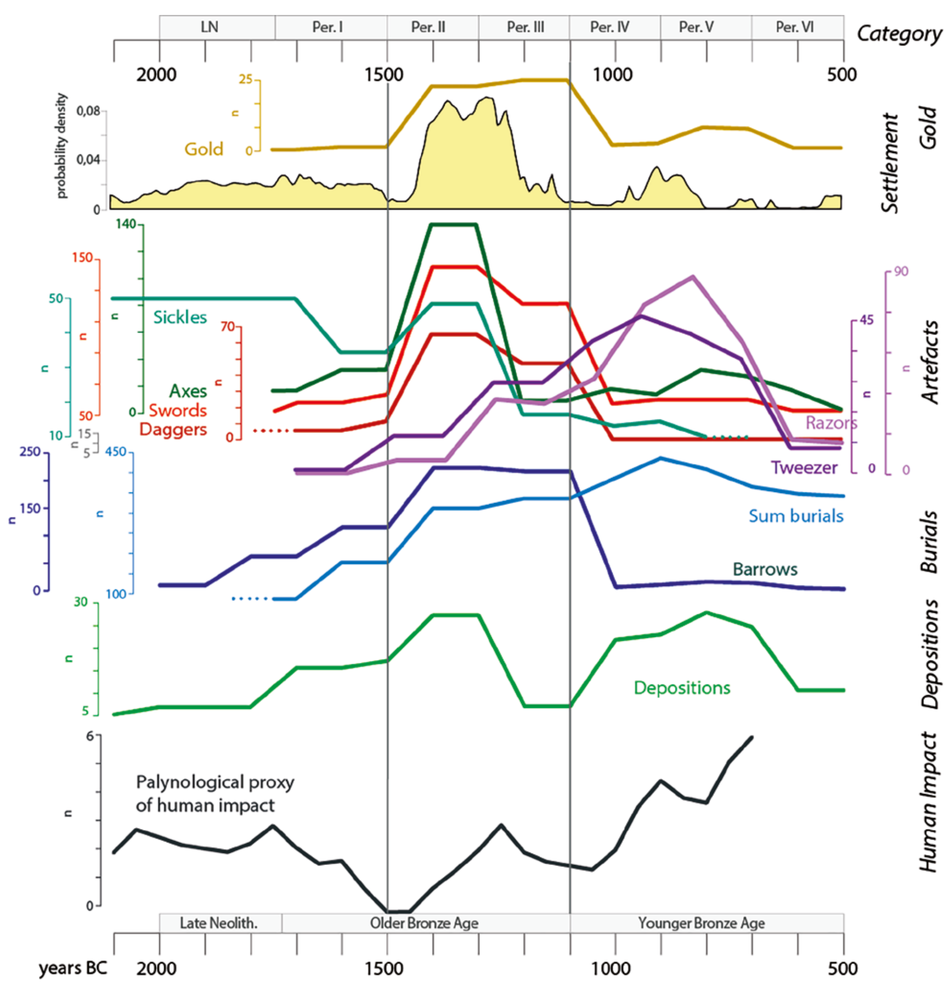


Figure 8. Aoristic distribution of artefact frequencies, number of graves, sum calibration of the ^{14}C-dated settlements (made using OxCAL 4.3.2) and the human impact curve as a palynological proxy for Schleswig-Holstein (sources: Aner and Kersten 1978; 1979; 1981; 1984; 1991; 1993; Aner *et al.* 2005; 2011; 2017; Schaefer-Di Maida 2020; Schmidt 1993; see also Kneisel *et al.* 2019). Image: J. Kneisel/C. Reckweg.

et al. 2013, 4; Runge 2010, 101) shows that settlements are rarely far away from barrows, and that the frequency of construction or reuse of burial sites in fact allows statements about the density and duration the related settlements. Concerning Schleswig-Holstein, the question is whether the evidence suggests a continuous uninterrupted settlement history or whether there are indications for disruptions, as observed in the south. Since absolute dates are missing, the frequency of selected artefact groups and the number of graves per time slice were collated and comparable curves were calculated using the aoristic method. A detailed description of this method and the selection of categories have already been published by Kneisel and colleagues (Kneisel *et al.* 2019), therefore only the results are summarised here (Figure 8). Using this approach, the inaccuracy of the chronological determinations lies between 100 and 200 years, depending on the respective typo-chronological classification of the finds.

With regard to the number of graves, a significant increase can be observed at the beginning of Period II, which continues in Period IV and reaches its peak at the transition to Period V. The number of secondary burials in existing barrows increases in Period III (Kneisel *et al.* 2019, 1613 fig. 4), while mound building is largely given up towards the end of Period III. Artefact groups such as axes, daggers or sickles are documented in large numbers from Period II onwards. Prestigious finds such as daggers, swords or gold are still frequently found in graves until Period III. On the other hand, the frequency of tools such as axes and sickles (all types) declines sharply towards the end of Period II. The hoard find curve shows peaks in Period II and in Period V, around 800 cal BC.

Comparing the data of the artefact frequencies with the sum calibration curve for the settlements reveals coinciding patterns for the Older Bronze Age, while for the Younger Bronze Age the developments seem to be more heterogeneous, not least because new artefact groups such as tweezers and razors gain importance in graves. With the transition from inhumation to cremation burials, however, no abrupt change comparable to that at the beginning of Period II is apparent. Rather, the curves for grave goods indicate a change from finds with a high visual impact (dagger, sword) to grave goods for personal use (tweezers, razors) already in the course of Period II. Similarly, the transition to cremation burials begins during Period II (Kneisel *et al.* 2019, 1613 fig. 4).

In the Older Bronze Age, with the beginning of Period II (bearing in mind the typo-chronological uncertainty), a strong increase in the number of finds, i.e. hoards and burials with grave goods, can be observed. While tools and hoards are already declining after the end of Period II, the frequency of prestige goods such as daggers and swords or gold finds and the use of burial mounds (including graves secondarily added to existing monuments, which mostly reshape or enlarge the original mound) remain high also in Period III. At the same time, secondary burials in mounds increase (Kneisel *et al.* 2019, 1613 fig. 4). The steep rise of the curves after 1500 cal BC is evident in all areas of social life and testifies to a massive increase in activity shown by the artefact curves. In contrast, the transition from the Neolithic to Period I is characterised by very low activity (compare also Brozio *et al.* 2019). The slow increase of settlements evident from 2000 cal BC in southern Jutland can only be observed for Schleswig-Holstein for activities such as hoard deposition and the erection of burial monuments.

In the Younger Bronze Age, the curves do not show uniform peaks. While the number of burials constantly increases, the number of weapons and tools lags far behind the Older Bronze Age, which is mainly explained by the altered burial customs. The new types of grave goods now relate to personal use (toilet utensils) and do not quite reach the high numbers of the Older Bronze Age. With regard to the volume of material (swords versus razors) a significant decrease of metal deposition in graves can be observed. Only the hoard finds reach frequencies comparable to the Older Bronze Age. Especially the transition from Period IV to Period V, as well as Period V itself, are rich in finds. It is a phase with a particularly high number of urn burials. Most of the settlement features also date to the transition from Period IV to Period V and a slight increase in sites mostly attested only by pits can be observed for Period V (Kneisel *et al.* 2019, 1611 fig. 2; Schmidt

1993). This is followed by a phase with only a few graves during Period VI. Also, the number of finds declines markedly with the beginning of Period VI.

Another curve, shown in Figure 8, is based on pollen data. This curve reflects the human impact on the vegetation in the region of Lake Belau and is based on spectra scores on the first axis of a principal component analysis of pollen data (Feeser *et al.* 2019). High values thus indicate high human impact, for instance through higher population densities. Decreasing or low values reflect phases of reduced land use, which are often associated with woodland regeneration. Between 1600 and 1400 cal BC, the curve shows a minimum of land-use activity. Land use then increases again with a short-term maximum between 1300-1200 cal BC. This is followed by declining values leading to a lull at around 1000 cal BC and subsequently increasing values until 900 cal BC. If we compare this proxy with the archaeological record it becomes obvious that the human impact curve is almost parallel to the settlement curve, while the change in the remaining material culture curves took place at the peaks and thus marked the start of the transitions visible in the human impact curve (see also Kneisel *et al.* 2019, 1617 fig. 8). The phase of increasing human impact in the course of the Older Bronze Age, for example, parallels the developments of the settlement and burial activities until the middle of Period III. The following decline towards the transition to the Younger Bronze Age is matched by a decline in the settlement sum curve and a sharp drop in most artefact curves. Similarly, the increasing human impact during Period IV, which reached maximum values at the beginning of Period V, is in agreement with the development of the archaeological settlement and burial curves. Interestingly, the number of hoards seems to increase during phases of declining or low human activity.

If we compare the developments in Schleswig-Holstein with those on the supra-regional scale it becomes obvious that the decline of human activity and settlement activity from 1700 cal BC onwards is not only restricted to central Europe and the Únětice groups but also applies in the north. Here, however, the decline is not followed by a cultural collapse, but the changes visible at the transition from Period I to Period II from the sixteenth century BC onwards can be described as a kind of expansion phase, in which the construction of barrows, the deposition of grave goods and the deposition of metal artefacts intensified. After the collapse of the Únětice groups, access to the copper deposits in the south was unrestricted, as is mirrored in the rich grave equipment of the northern European barrows as well as the development of an independent northern European metal ornamentation style. The transition from Period III to Period IV from the twelfth century BC is mainly reflected in a change in grave goods and the decline of elaborate grave constructions. Instead of barrows, we now see urn or pit graves. The increasing individualisation of grave goods, as well as the start of a cremation custom, began at the end of Period II. Direct influences from the south through the so-called Urnfield cultures must therefore be rejected. Large series of dates from Belgium (De Mulder *et al.* 2013) and eastern central Europe (the Trzciniec area; Makarowicz 1998) show that cremation was already practised more regularly in these regions from the seventeenth century cal BC onwards. In Schleswig-Holstein, too, numerous urn graves date as early as Period III, in some cases even earlier (Schaefer-Di Maida 2020)[3]. Anthropomorphic urns, which provide a container for the body of the deceased, are a development which starts in Period IV in northern Jutland and then spreads across northern Europe in Period V (Kneisel 2012a), again questioning the southern roots of the urn burial custom. The transition to the Younger Bronze Age in the north is slower and already starts in Period II. Only the abandonment of mound building at the end of Period III shows a marked break,

3 Cremation burials occur already at the transition from Period I-II, mainly in Dithmarschen (western Schleswig-Holstein), and become established in the course of Period II-III throughout Schleswig-Holstein. From Period III/transition Period IV onwards, burials in urns can be observed mainly in the western part of the country and occasionally on the Geest, and can thus be attributed to western rather than southern influences (Schaefer-Di Maida 2020; Schmidt 1993).

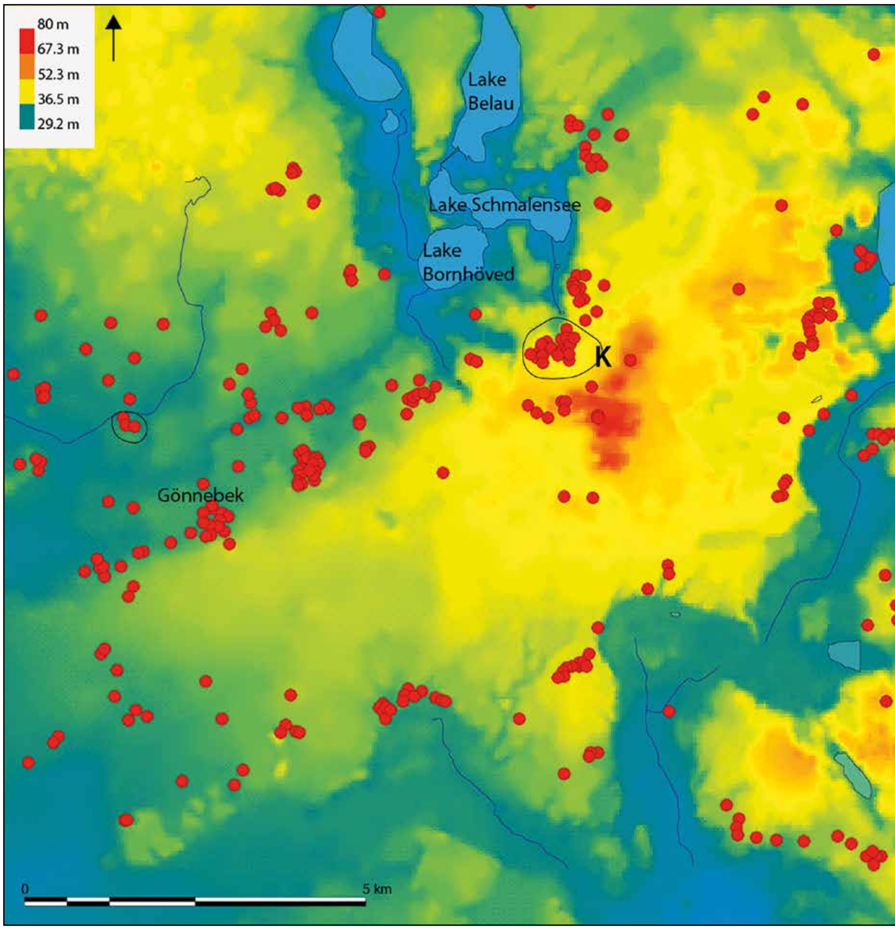


Figure 9. Elevation map of the moraine landscape with the Bronze Age burial mounds (red dots) south of Lake Belau (after Schwerin von Krosigk 1976).

which can also be described as a radical social change. However, it occurred one or two centuries later than the Urnfield period in central Europe, and it was not until Period V that changes became apparent, pointing to renewed intensive exchange relations with the south.

This means that of the two transformations in the Bronze Age of northern Europe described at the beginning of this paper, only the first can be placed in the context of changes in the south, as a reaction to the developments there. Otherwise, events in the Urnfield area do not seem to have caused any direct change in the north. Instead, we observe a slow transition in the death ritual, which begins with the change to cremation burials around 1300 BC and ends with the beginning of urn burials around 1100 BC. This transformation goes hand in hand with a changed expression of social status that requires neither ostentatious graves nor prestige grave goods, but rather focuses on personalised goods and greatly reduces the cost of burial construction. As accurate dates for the start of the cremation custom in the eastern Baltic are still lacking, the impetus for this development is possibly to be found in the west, where cremation graves and urn burials began very early (De Mulder *et al.* 2013). Other early dates are known from the Trzciniec area in Poland (Makarowicz 2001; Makarowicz *et al.* 2013), and research in Brandenburg and Mecklenburg-Western Pomerania has just begun to close the gap between west and east (CRC1266 Scales of Transformation – subproject D3: The Bronze Age in north central Europe).

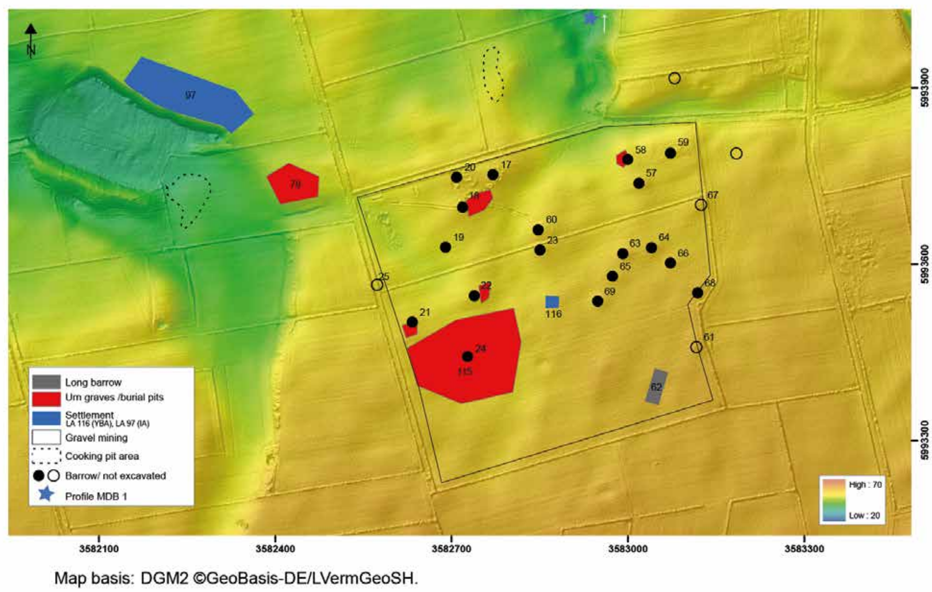


Figure 10. Overview of the Mang de Bargen site near Bornhöved, Kr. Segeberg (after I. Lütjens).

Mang de Bargen site, Segeberg district (meso-level)

While the investigations described above concern the region of Schleswig-Holstein as a whole, extensive investigations of the Bronze Age settlement on a meso-level are available for a site in the Segeberg district. The starting point is a burial group in the area “Mang de Bargen”, whose mounds were at risk due to gravel extraction and were therefore almost completely investigated (Lütjens 2008; Schaefer-Di Maida 2020). The Mang de Bargen area, whose name literally means “between the barrows”, is one of the larger groups of mounds along the edge of an Ice Age moraine range extending between Lake Plön in the north-east and the village of Gönnebek in the south-west (Figure 9).

The excavations in Mang de Bargen were carried out by the State Office for Archaeological Heritage, supplemented by surveys and the excavation of one burial mound by the University of Kiel within the framework of the Collaborative Research Centre 1266 (Kneisel *et al*. in prep.). The site, now analysed as part of a doctoral thesis, makes it possible to reconstruct the development and intensity of occupation on the basis of graves, even if settlements are rare (Schaefer-Di Maida 2020). Pollen analysis of a short peat core (profile MDB 1, Figure 10) from a wet depression immediately to the north of the site (Feeser *et al*. 2020; 2022) allows to compare vegetation and land-use history with the results of archaeological research on a local scale. Additionally, the pollen profile from Lake Belau, only 5 km to the north, allows further comparisons between archaeological and environmental data on a regional scale (Dörfler *et al.* 2012; Wiethold 1998).

In the area of Mang de Bargen, 18 of 20 tumuli still visible above ground were excavated, as well as a destroyed Neolithic long barrow (LA 62). The site also includes an urn cemetery and settlement remains. To the north-west there is another urn cemetery and an Iron Age settlement which have not been further investigated. Intensive prospection and magnetic surveys revealed two additional cooking pit fields north of the barrows and in the lowlands to the west. The latter was investigated with two small sondages (Figure 10). In the following, we reconstruct the settlement processes at the site on the basis of the burials and other features.

Five of the 18 grave mounds examined had been ploughed to the extent that no evidence of any burial remained. However, Younger Bronze Age burials were found near and in of some of the barrows, while the large cemetery LA 115 dates to the Iron Age. Many of the investigated barrow sites revealed additional pits or several postholes, but building structures could generally not be identified. Only a small area (LA 116) with six pits, four

Burials in Older BA barrows	Destroyed / unexcavated barrows	Urn graves and cremation pits in/near barrows	Burials at cemetery LA 115
15	7	58	201
MNI barrows (Late Neolithic and Older BA)		MNI secondary burials in barrows (Younger BA)	MNI cemetery (Iron Age)
23		59	203

Table 1. Distribution of graves in Mang de Bargen. MNI= Minimum number of individuals.

fireplaces and an oven indicated further human activity. Features surrounding the oven indicate that it was used in Period IV-V, but a charcoal sample from the oven returned a Mesolithic date. One possible explanation is that this is redeposited charcoal from an older context. Earlier human activity in the area is indicated by a Mesolithic or Neolithic tanged point-style arrowhead near tumulus LA 57[4]. Furthermore, in a depression east of tumulus LA 57 an agricultural horizon from the beginning of the Younger Neolithic was discovered, overlaid by a Younger Bronze Age colluvium (Period V; Kneisel *et al.* in prep.).

The investigated mounds contained 15 Late Neolithic to Older Bronze Age burials, some with massive stone constructions and features indicating log coffins (Table 1). Nine mounds contained one burial each and two mounds three burials each (LA 23, LA 64). For mound LA 63, two phases of mound stratigraphy indicate at least one further burial. In addition, there are seven destroyed or unexcavated mounds, so that the minimum number of individuals for the phase between the Late Neolithic and Period III is 23. Unfortunately, there was only little datable material for the Older Bronze Age. Bone preservation is poor and archaeobotanical remains were rarely found. Of the five ^{14}C-dates from the barrow graves (Figure 11), three date to the Late Neolithic between 2430-2025 cal BC, and two into Period II, between 1440-1310 cal BC (1 σ values).

It is more difficult to reconstruct the number of Young Bronze Age secondary burials. In contrast to the mounds, which were already recognised in past centuries and are clearly visible in the landscape, urn graves are usually only found by excavation. Since the site was not completely excavated, it seems probable that not all graves have been recorded. Also, some of the burials in the Iron Age cemetery had already been destroyed by gravel mining (Schaefer-Di Maida 2020). In addition, individual finds likely relating to destroyed urn graves show that some urn burials at the edge of the barrow were most likely destroyed by ploughing. Evidence for looting of urn burials, probably in modern times, could be observed for barrow LA 57 (destroyed vessel in a pit with disturbed fill). Also, the regular presence of disturbed stone constructions in the seven mound areas possibly points to further destroyed burials.

The Younger Bronze Age burials are concentrated near two mounds, LA 18 and LA 58. The minimum number of burials is 58, including one double burial (LA 58, feature 19). Thus, at least 59 individuals were buried near the two barrows. As far as possible, all cremations were dated. This resulted in 38 radiocarbon dates for the Younger Bronze Age burials. Based on these, the majority of the burials date between 1190-810 cal BC (1 σ), and two burials date between 755-540 cal BC and thus fall into the Hallstatt Plateau (Figure 11). The Iron Age cemetery has not been extensively investigated, but consists of at least 201 burials (see Schaefer-Di Maida 2020, 346 fig. 86 for further detail).

Two ^{14}C-dates for pits are available, which also date to the Younger Bronze Age. Whether the pits belong to a settlement or were part of burial activities is unclear, since both possibilities are attested in Schleswig-Holstein. The dates fall into the range 920-555 cal BC (1 σ). In contrast, the cooking pits from the surrounding area date to the most recent phase of tumulus construction, between 1430-1220 cal BC (1 σ). However, since only two of over 100 cooking pits have been dated, it is likely that the pits continued

4 It is unclear whether this find is an Ahrensburgian tanged point or a Pitted Ware culture point of type A (pers. comm. K. Winkler).

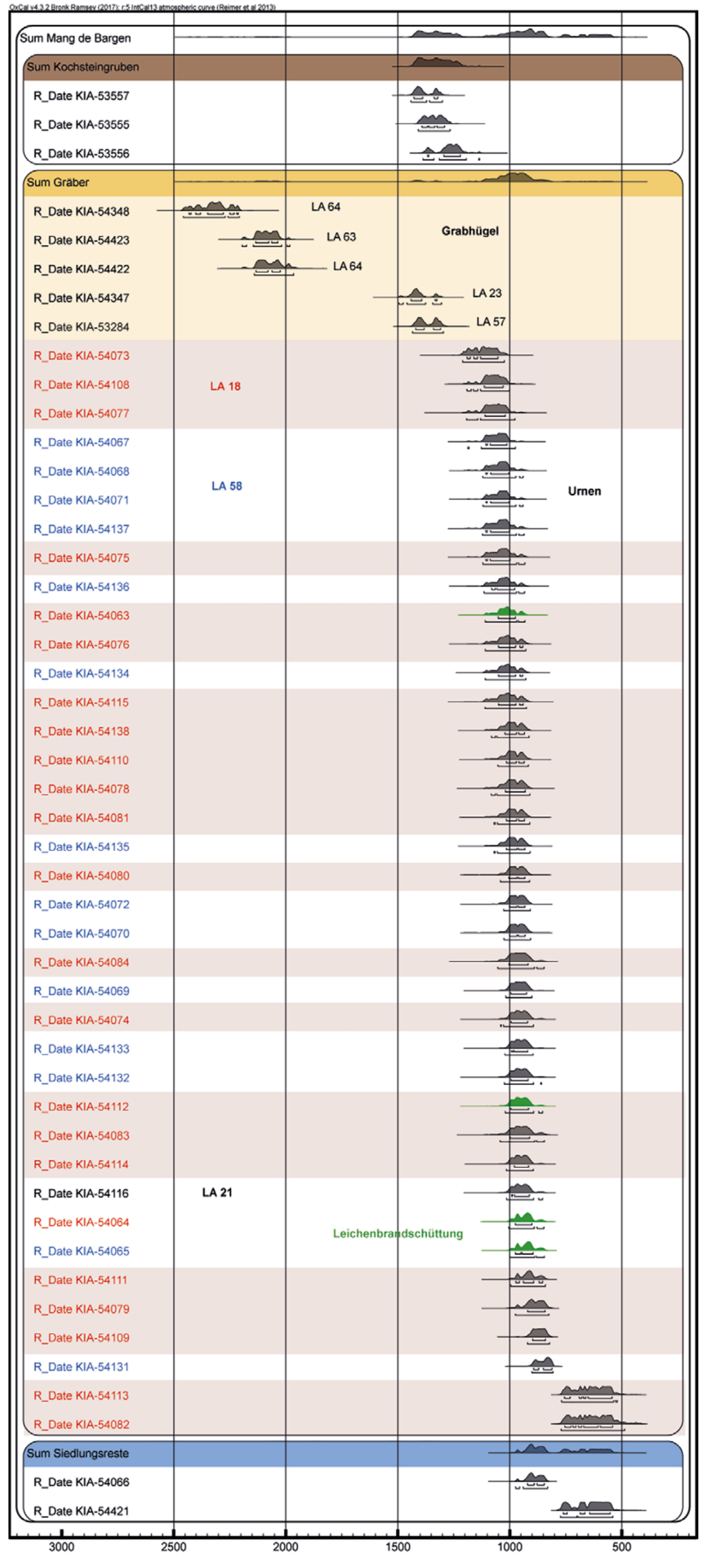


Figure 11. Multiplot of ^{14}C-dates from the site of Mang de Bargen (made using OxCAL 4.3.2).

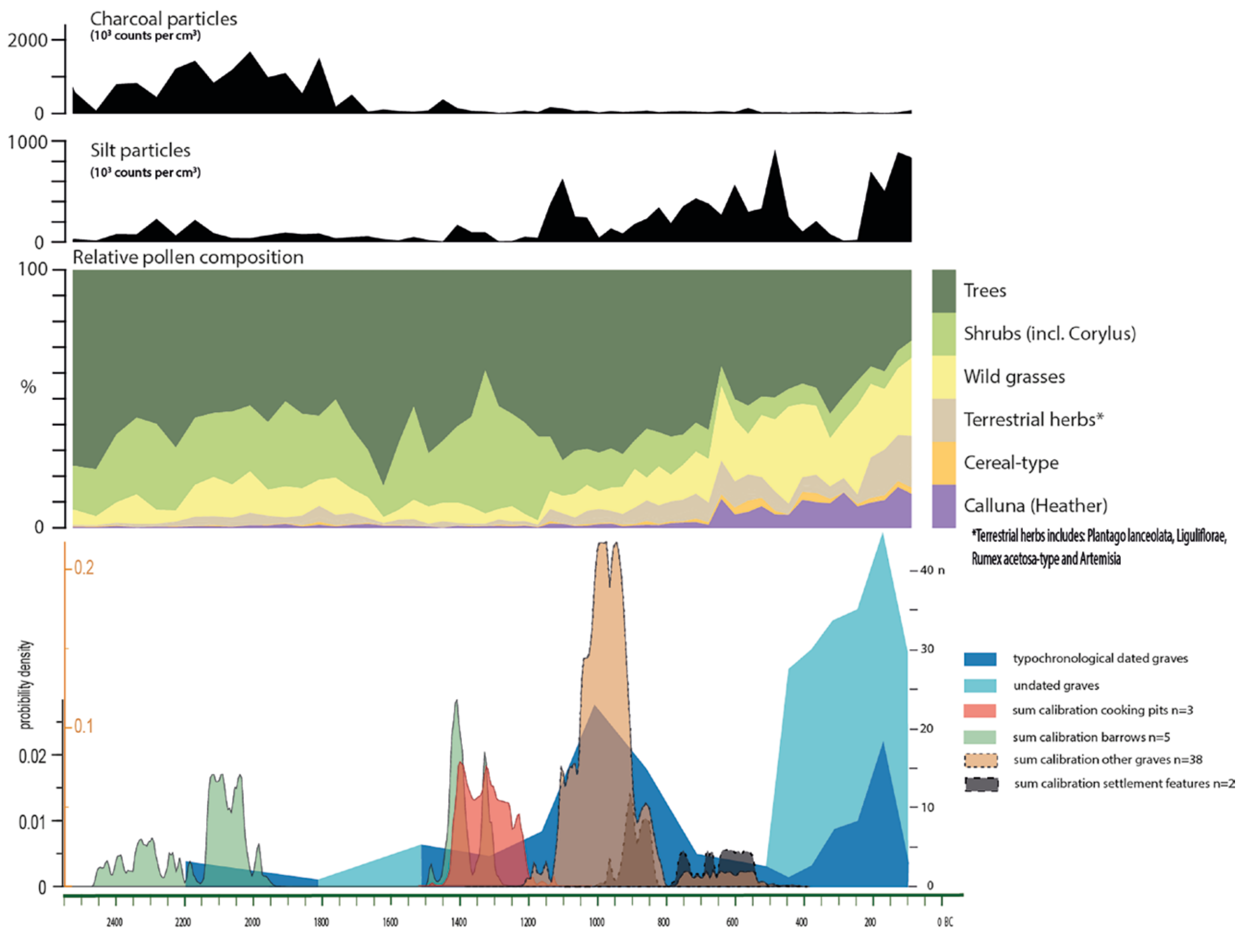


Figure 12. Comparison of archaeological data (aoristic distribution), sum calibrations and environmental data from the Mang de Bargen site, Kr. Segeberg.

into the Younger Bronze Age, as cooking pit areas were often used over longer periods (Kruse and Matthes 2019; May and Hauptmann 2011, 134; Schmidt 2012).

To sum up, based on the results of the archaeological excavations the activities at Mang de Bargen can be traced back to Young Neolithic arable farming and Late Neolithic grave construction. From 2500 BC onwards, burial mounds were built on the hilltops of the moraine landscape. The number of graves at the site indicates an increase in burial activity during the Younger Bronze Age, with a sharp rise in the pre-Roman Iron Age. Contemporaneous settlements were probably located on the flat plains to the west or east of the site, as known elsewhere (Meier 2013; Runge 2010). An intensive use of the area can be reconstructed from about 1450 cal BC onwards and until approximately Period V (Figure 12).

Based on the analysis of pollen profile MDB 1, the local human activity can be characterised. Between c. 2200-1700 cal BC an increase in land-use and settlement indicators (the cereal-type pollen, wild grasses and terrestrial herbs in Figure 12) reflects a local phase of human activity. Thereafter, the values decrease slightly and do not rise again until 1300 cal BC, i.e. at around the time of the last construction of a burial mound, when the palynological and sedimentological data suggest a fundamental change of land-use practices.

During the first half of the investigated segment, until about 1400 cal BC, increased settlement and land-use indicators are generally associated with higher levels of hazel (*Corylus*), bracken (*Pteridium*) and charcoal particles. This suggests that during land-use phases characterised by agriculture in open landscapes (cf. cereal-type pollen), the surrounding woodlands were also intensively used for pasture (Feeser *et al.* 2020). It is assumed that the quality of the woodland pasture was improved by regular burning of the undergrowth, which promoted the light-demanding hazel and the disturbance-tolerant bracken.

From about 1200 cal BC onwards, the *Corylus* values remain at a rather constant and comparatively low level, despite a general trend of increasing settlement and land-use indicators. Micro-charcoal values also decline sharply. However, dung-indicating fungal spores are also regularily recorded from the upper part of the pollen diagram and show that local animal husbandry remained important after 1200 cal BC. This suggests that animal management changed fundamentally at around this time. In contrast to woodland pasture, grazing in open grassland pasture probably gained importance. Besides increased levels of open land indicators (terrestrial herbs), this could also be reflected in the spread of broom heather (*Calluna*) in the pollen diagram. At around the same time, the concentration of minerogenic particles (silt particles) in the peat profile increases sharply, pointing to increased soil erosion or a more intensive use of the local environment. This intensification, however, need not only relate to the change in livestock farming. Archaeobotanical studies have shown an increase in the range of cultivated plants over the same period (Effenberger 2018b; Filipović *et al.* 2018), and this probably also involved changes in land-use practices. Interestingly, Younger Bronze Age cremation burials or the use of the cooking pits are not reflected in an increase in charcoal particles in the pollen diagram.

From Period V onwards, with the end of the Younger Bronze Age burial phase, the palynological results indicate a strong increase of land-use activity associated with the beginning spread of heathland. It is therefore assumed that the barrow sites were used for pasture. The colluvial layers from Period V east of barrow LA 57 also indicate an intensive use of the area and could reflect erosion of the mound due to intensive on-site grazing activities. Heathland vegetation also spreads in Denmark in the Younger Bronze Age (Søgaard *et al.* 2018, 217). The coinciding increase in cereal-type pollen in our core, however, suggests a generally more intensive land use, including pastoral and arable farming, at around the time when the Iron Age cemeteries were in use.

From c. 200 cal BC onwards, at around the time of maximum heathland expansion, the onset of rye cultivation can be inferred from the palynological record. The start of rye cultivation, a crop generally better adapted to poorer soil conditions, was therefore probably a reaction to the increasing soil depletion. This change is further associated with a phase of maximum values for land-use activity and soil erosion between c. 200 cal BC and cal AD 200.

A comparison of the results from profile MDB 1 with the more regional Lake Belau pollen record reveals a generally good agreement of local and regional land-use developments. The decrease of human influence on the landscape between 1700 and 1500 cal BC (Figure 8) is recorded in both profiles. The fundamental change in land-use strategies inferred at Mang de Bargen at around 1300 cal BC is also associated with a phase of increasing human activity on a regional scale. This was the time of the last construction of mounds at Mang de Bargen. The use of barrows LA 18 and LA 58 as Younger Bronze Age burial sites (see below) coincides with a strong local increase of settlement and land-use indicators in profile MDB1 from 1150 cal BC onwards. This increase is not equally reflected in the regional record, where human activity increases only after c. 1000 cal BC. This is also true for the phase of maximum local activity between c. 200 cal BC and cal AD 200, which is only recorded at MDB 1 and points to a more local phenomenon.

Two burial grounds in Mang de Bargen (micro-level)

As a last aspect of the Bronze Age occupation at Mang de Bargen, we attempt to narrow down the period of Younger Bronze Age burials in order to obtain information on possible settlement patterns. The example of extensively investigated settlement areas such as Kildehuse II on Funen, Denmark, shows that settlements and burial sites often shifted within a small local area during the Bronze Age and that individual house communities chose barrows as burial sites (Hornstrup 1999; Runge 2010; 2013).

Mang de Bargen has two groups of graves, one each at barrows LA 18 and LA 58, of which as far as possible all graves have been dated. Both mounds contained a central burial, dating from the Late Neolithic to the Older Bronze Age (Schaefer-Di Maida 2020). In addition, mound LA 58 contained 15 cremations, of which all but one are radiocarbon

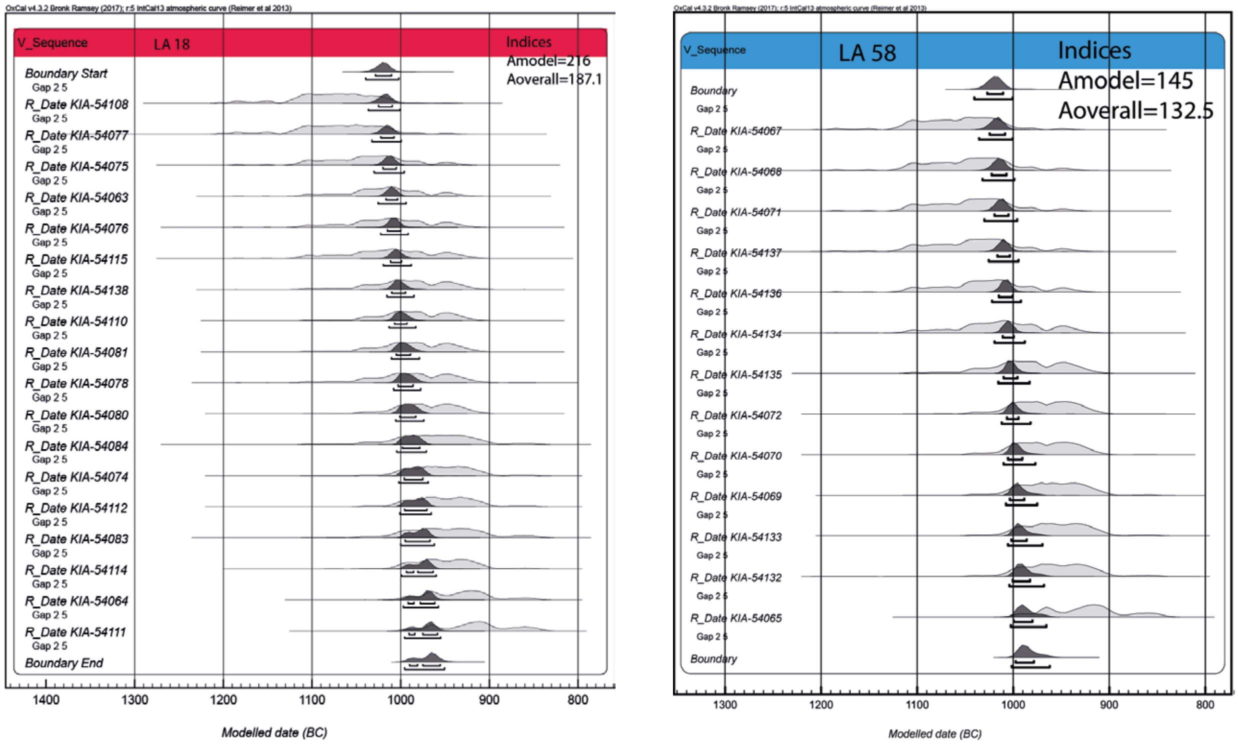


Figure 13. Mang de Bargen, district of Segeberg, modelled data of Younger Bronze Age graves from LA 18 and 58 (made using OxCAL 4.3.2).

dated. Mound LA 18 also contained a central burial. To the east of the mound 29 urn graves and six cremation graves were found, 23 of which are dated (all dates are on cremated bone). Anthropological analyses are only available for ten graves (Storch 2020), but further work is in progress. Due to the small number of anthropologically studied graves, this information was not considered in the following analysis.

The 23 dates for the burial area at mound LA 18 show a more or less regular sequence in the multiplot. Except for two dates which fall into the Hallstatt Plateau, the remaining 21 fall into a 350-year range from 1190-840 cal BC (1 σ). If the two younger dates are left out, a burial would have taken place on average every 17 years. The Oxcal program allows various models to be tested. The following calculation is based on a V-sequence, as used for deposition models (Bronk Ramsey 2008), assuming that burial would take place at more or less regular intervals. The V-sequence has the advantage over the normal D-sequence that uncertainties in the intervals between events are allowed. In the following, two hypotheses are tested: is it possible that regular burials took place over the entire period of 350 years; and is it possible that all burials took place in a relatively short period of time within the 350 years range, for example, a burial every 2-7 years?

The first model distributes the burials at LA 18 over the entire period of 350 years at intervals of 17±5 years. Here the value of ^{A}model is 165 for all 21 dates. According to this model, it is therefore possible that people were buried at the site repeatedly over a longer period of time or at longer intervals within these 350 years.

The second model for LA 18 was calculated to allow 2±5 years between burials, excluding the two which lie on the Hallstatt plateau. As a result, the oldest and two of the most recent dates showed a "poor agreement" (KIA-54079; KIA-54073; KIA-154109). However, the model works with the remaining 18 dates and the value for ^{A}model is 216 (Figure 13). Thus, these 18 burials could fall into the period between 1025-960 cal BC, within 75 years and at intervals of 2±5 years. The excluded graves do not show any peculiarities, except that they are situated between the graves directly at the edge of the mound (n=8) and in the group a little further to the east (n=5). Further modelling on the basis of groups makes little sense without anthropological data (which could, for example, suggest family groups).

The 14 graves around LA 58 date between 1100-800 cal BC (1 σ), which means the burials are distributed over a maximum of 300 years in two groups, one to the west and one to the east of the mound (Schaefer-Di Maida 2020, appendix IV). The multiplot shows a division of the dates into three groups. One group contains only a late single date (KIA-54131), while the remaining groups comprise six or seven dates each. However, the spatial distribution of these two "time groups" is mixed, as both are scattered over the eastern and western area. Also, the most recent grave is not in a separate position relative to the mound. 300 years is a very long time for the small number of graves, and it is unlikely that burials at this site only took place approximately every 21 years.

The first model distributes the burials on mound LA 58 evenly over the whole period of 300 years at intervals of 21±5 years. The model returns a value of ^{A}model 155 for all 14 dated graves. The second model assumes intervals of about 2±5 years between burials (Figure 13). The value of ^{A}model is 145 for 12 dates (with "poor agreement" for KIA-54065 and without KIA-54131). Twelve of the graves could therefore have been laid out between 1025-980 cal BC (1 σ), over a period of 45 years.

Models that calculate a chronological sequence of burials from LA 18 to LA 58 or vice versa do not work, so we are either dealing with a long burial phase on different mounds, or two burial communities overlapping in time on different barrows. The choice of 2±5 years is the smallest temporal distance between individual burial events that resulted in a successful OxCal model. Larger intervals or irregular intervals, however, are equally likely and would furthermore allow to include the other dates with "poor agreement". The authors are aware that such models cannot be used to reconstruct burial activities, but only allow statements to be made about the probabilities of different scenarios.

With the help of modelling, the period of use in Mang de Bargen could be considerably shortened, even if slightly different scenarios are possible and the value of 2±5 years between burials can only be considered approximate. If the number of burials is spread over 45-70 years, this corresponds approximately to the usual lifetime of a longhouse (Holst *et al.* 2013). Theoretically, the burials on the two mounds could have belonged to a house community with a maximum of four generations each. One burial would be a little older and four a little younger. In addition, there are the two graves that date to the Hallstatt plateau. That such a scenario is likely is supported by investigations at the Kildehuse II site in Denmark. The extensive excavations there revealed two burial communities on two neighbouring mounds whose settlement sites were about 700 m away (Runge 2010). Other sites in Denmark have small burial communities on or around Older Bronze Age mounds, with a similar number of 13 to 25 burials, which probably reflect house communities burying their dead on that older mound over several generations (Hornstrup 1999; Runge 2013, 11 fig. 3). Therefore, a similar settlement structure, supported by the modelling results, can probably also be assumed for Mang de Bargen. The calculated use phase of the site for secondary burial (1025-980/940 cal BC) is not reflected in the local pollen diagram, but dates to the beginning of a longer-lasting phase of increasing land use in the local area starting from 1100 cal BC and rising slightly around 900 cal BC.

Discussion and conclusions

In conclusion, different settlement processes can be reconstructed for the south-western Baltic area. Comparing the settlement data of the western Baltic region and the Danish islands shows an increase in settlement intensity on the Jutland Peninsula with an offset from south to north, while the islands and southern Sweden show a different pattern of settlement intensity that is more in line with central Europe. Based on the published settlement data, two phases of increased settlement activity in Schleswig-Holstein can be described, one around 1450-1100 cal BC, which is supported by data from south Jutland, and a second possible one between 950-800 cal BC. In contrast to central Germany and central Poland, where settlement activity seems interrupted for a longer time after a strong decrease in land-use activity around 1600/1500 cal BC, settlement activity in the north

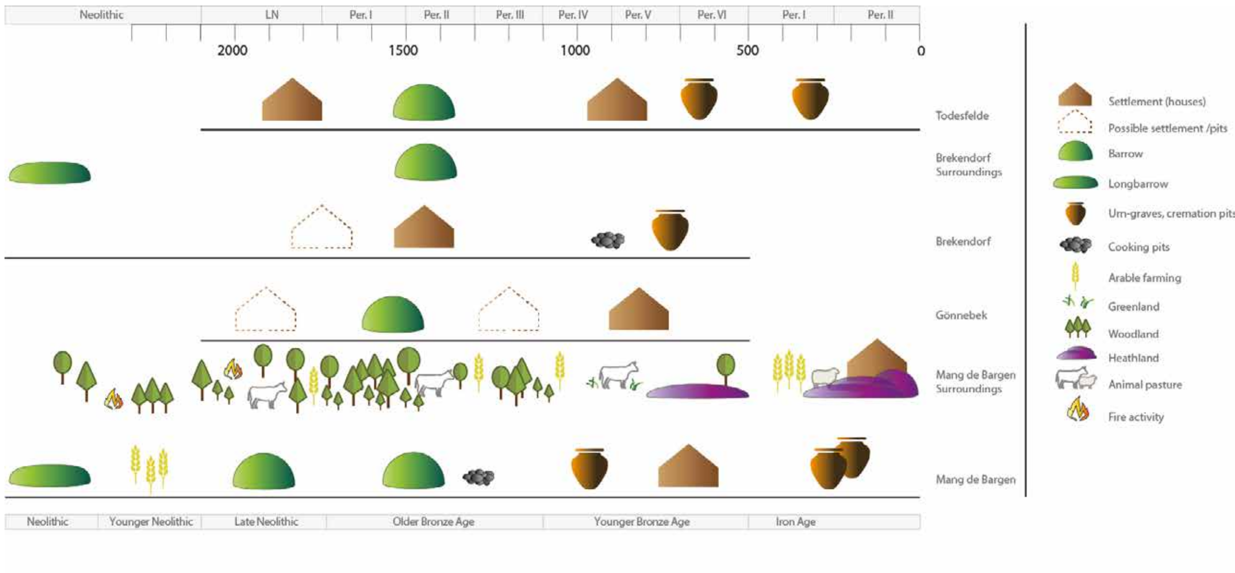


Figure 14. A schematic overview of the settlement and usage phases of mentioned Bronze Age sites in Schleswig-Holstein.

increases markedly. Due to the low number of settlements, graves and artefact frequencies were included in the study. Starting in the Late Neolithic, there is a slow increase of burial mounds and selected artefacts in the study area. These indicators increase strongly between 1500 and 1300 cal BC in Period II. The only significant change at the transition to the Younger Bronze Age around 1150 cal BC is the abandonment of large mounds and elaborate secondary burials in log coffins. The transition to cremation burials and the change in grave goods from "prestige" items to personalised items are gradual changes which already began around 1400 cal BC with Period II and were completed with the beginning of Period IV. At the transition of Period IV/V and in Period V, approximately between 900 and 800 cal BC, there is a peak in both the number of burials and in individual grave good categories.

At the meso-level of the site Mang de Bargen, different occupation phases can be determined. Barrows were erected until c. 1300 cal BC and between 1050-950 cal BC individual mounds were reused as small Younger Bronze Age cemeteries, without direct continuity from the older burials (Figure 14). However, most burials date to the Iron Age. Nevertheless, the different finds and the pollen analyses show that Mang de Bargen was used repeatedly since the Neolithic. The dated cooking pits fall into the period between the last burial mounds and the beginning of the urn burials. Only around 1600/1500 cal BC and around 1200/1100 cal BC is there a decrease in land use and settlement indicators as well as an increase in tree pollen, indicating low activity at the site. This is supported by the regional pollen data from Lake Belau, which also show evidence for lower human activity and associated reforestation in both periods.

On the basis of our investigations, the settlement history of Schleswig-Holstein during the Bronze Age can be described as an independent development which, although it reacts to changes in the south, nevertheless has its own patterns of social change. On the "rough scale" of the macro-level, the collapse of the Únětice groups and the access to metal can be associated with a peak in Bronze Age finds. Yet, on the meso-level, be it in the case of the settlement of Brekendorf or Mang de Bargen, an increase in the intensity of finds and features can only be observed in Period II. This increase in finds at the local level is not contemporary with the change in the south, but runs parallel to the arrival of the tumulus culture in the northern part of central Europe from 1400/1450 cal BC (Innerhofer 2010, 126). These may be regional developments, but as long as only typo-chronological dates for Period I and II are available and other settlement sites are missing, this is the current picture of settlement development in the Older Bronze Age. In the Younger Bronze Age, however, we see a general increase in graves and in settlement intensity, based on the number of features and on human impact visible in pollen diagrams. However, the transition to a new burial and grave good practice is slower, starting already in the course of Period II and extending into Period IV. Social change is therefore not abrupt, but asserts itself slowly. Still, the decision to stop building new barrows from Period III onwards must be seen as a profound change that influenced the entire social structure, as it considerably reduces the amount of work invested in funerary activities, their organisation and the resulting division of labour, as well as the use and shaping of the landscape.

At the micro-level, and with the help of Bayesian modelling, it could be shown that the small cemeteries of the Younger Bronze Age were probably not in use continuously. At a minimum, 100-200 years could have passed between the construction of the first barrow and the first Younger Bronze Age graves. Nevertheless, the burial mounds were visited again and used as a cemetery by individual house communities. The settlement pattern of small communities in the vicinity of the barrows remains unchanged from the Older to the Younger Bronze Age. The sites each show their own dynamics, but what they have in common is that they always choose older burial sites or orient their settlement structure and the layout of their burials according to older grave monuments. At Mang de Bargen, two neighbouring communities probably used the site contemporaneously for burial.

A fundamental change in land use began around 1300 cal BC and is reflected in pollen profiles at both the macro- and meso-level. In principle, two lulls in the curve of regional human impact, around 1500 and 1100 cal BC, are also reflected in the local near-site pollen profile of Mang de Bargen. In this context, the increase in finds deposition in Period II, a phase with little human impact, is interesting. If one interprets hoarding as an action that is carried out more frequently in times of crisis, it can be taken as an indicator for problematic changes at the beginning of the Older and the Younger Bronze Age.

While the beginning of the Nordic Bronze Age can be clearly identified, the development of the Younger Bronze Age in Schleswig-Holstein is much more diffuse. In the south, early influences from the neighbouring regions are already noticeable, while individual centres of wealth, for example in Dithmarschen and the district of Segeberg, develop in Period V (900-700 BC). The construction of singular large burial mounds, such as in Albersdorf, Dithmarschen (Schmidt 1993), Lusehøj on Funen (Thrane 1984) or the Seddin burial mound in Brandenburg (May 2002; Wüstemann 1974), attest to prosperity in Period V with its extensive supra-regional networks. At the end of the period, this leads to a completely new development in Period VI, ushering in the beginning of the Iron Age in the north.

Of the two phases of transformation, the transition from the Late Neolithic to the Older Bronze Age presents itself as a clear break and distinct change, which can be explained above all by access to the new metal. It brought far-reaching social changes, expressed in rich grave assemblages and the erection of large burial mounds and indicating a strongly stratified society. The transition to the Younger Bronze Age, on the other hand, took place as a slow change, which was in contrast to the marked changes in the south and did not run parallel to them. When comparing archaeological data with environmental data on the meso-level, we see a change in land use between heavily used burial grounds and arable land, a division that only became blurred in the Iron Age. Even if breaks in the way the sites were used can be observed at the micro-level, the spatial reference point for human activities remains the same throughout the Bronze Age.

Acknowledgements

This article is based on close cooperation between the subclusters D3, F2, F3 and C1 of CRC 1266, funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation, project number 2901391021-SFB 1266) and under Germany's Excellence Strategy (EXC-2150 – 390870439). We would like to thank all participants most sincerely for their intensive and constructive collaboration and discussion. Special thanks go to Carsten Reckweg for graphics support. Jan Piet Brozio also deserves our gratitude for providing the sickle and hoard frequency for the Late Neolithic.

Bibliography

Aner, E. and Kersten, K. 1978. *Südschleswig-Ost: die Kreise Schleswig-Flensburg und Rendsburg-Eckernförde (nördlich des Nord-Ostsee-Kanals).* Neumünster: Wachholtz.

Aner, E. and Kersten, K. 1979. *Südschleswig-West. Nordfriesland.* Neumünster: Wachholtz.

Aner, E. and Kersten, K. 1981. *Nordslesvig – Syd. Tønder, Åbenrå und Sønderborg Amter.* Neumünster: Wachholtz.

Aner, E. and Kersten, K. 1984. *Nordslesvig – Nord. Haderslev Amt.* Neumünster: Wachholtz.

Aner, E. and Kersten, K. 1991. *Dithmarschen.* Neumünster: Wachholtz.

Aner, E. and Kersten, K. 1993. *Kreis Steinburg.* Neumünster: Wachholtz.

Aner, E., Kersten, K. and Willroth, K.-H. 2005. *Kreis Rendsburg-Eckernförde (südlich des Nord-Ostsee-Kanals) und die kreisfreien Städte Kiel und Neumünster.* Neumünster: Wachholtz.

Aner, E., Kersten, K. and Willroth, K.-H. 2017. *Kreise Plön und Ostholstein und die kreisfreie Hansestadt Lübeck.* Neumünster: Wachholtz.

Aner, E., Kersten, K., Willroth, K.-H. and Lütjens, I. 2011. *Kreis Segeberg.* Neumünster: Wachholtz.

Bech, J.-H., Eriksen, B.V. and Kristiansen, K. 2018. *Bronze Age settlement and land-use in Thy, northwest Denmark.* Aarhus: Jutland Archaeological Society.

Bo Henriksen, M. 2005. Danske kogegruber og kogegrubefelter fra yngre bronzealder og ældre jernalder. In L. Gustafson, T. Heibreen and J. Martens (eds), *De gåtefulle kokegroper*, 77-102. Oslo: Kulturhistorisk museum.

Bokelmann, K. 1977. Ein bronzezeitlicher Hausgrundgriß bei Handewitt, Kr. Schleswig-Rendsburg. *Offa* 34, 82-89.

Bönisch, E. 2011. Kausche 6, Lkr. Spree-Neiße, Familien-Bestattungsplatz der Buckelkeramik. Mit Beiträgen von Bärbel Heußner, Doris Jansen, Jutta Kneisel. *Veröffentlichungen zur Brandenburgischen Landesarchäologie* 45, 61-129.

Bronk Ramsey, C. 2008. Deposition models for chronological records. *Quaternary Science Reviews* 27, 42-60.

Brozio, J.P., Müller, J., Furholt, M., Kirleis, W., Dreibrodt, S., Feeser, I., Dörfler, W., Weinelt, M., Raese, H. and Bock, A. 2019. Monuments and economies: what drove their variability in the middle-Holocene Neolithic? *The Holocene* 29, 1558-71.

Czebreszuk, J. 1998. "Trzciniec". An alternative view. In J. Czebreszuk [+ 12 others] and H. Taras (eds), *The Trzciniec area of the Early Bronze Age civilization: 1950-1200 BC*, 165-89. Poznań: Adam Mickiewicz University Press.

Czebreszuk, J. and Müller, J. (eds) 2015. *Bruszczewo III. The settlement and fortification in the mineral zone of the site.* Bonn: Rudolf Habelt.

De Mulder, G., Van Strydonck, M. and Boudin, M. 2009. The impact of cremated bone dating on the archaeological chronology of the low countries. *Radiocarbon* 51, 579-600.

De Mulder, G., Van Strydonck, M. and De Clercq, W. 2013. ^{14}C dating of "Brandgrubengräber" from the Bronze Age to the Roman Period in western Flanders (Belgium). *Radiocarbon* 55, 1233-45.

Donat, P. 2018. *Häuser der Bronze- und Eisenzeit im mittleren Europa. Eine vergleichende Untersuchung.* Langenweißbach: Beier & Beran.

Dörfler, W., Feeser, I., Van den Bogaard, C., Dreibrodt, S., Erlenkeuser, H., Kleinmann, A., Merkt, J. and Wiethold, J. 2012. A high-quality annually laminated sequence from Lake Belau, northern Germany: revised chronology and its implications for palynological and tephrochronological studies. *The Holocene* 22, 1413-26.

Dräger, J. 2014. Jungbronze- und früheisenzeitliche Burgwälle in Mecklenburg-Vorpommern. In D. Jantzen, J. Orschiedt, J. Piek and T. Terberger (eds), *Tod im Tollensetal. Forschungen zu den Hinterlassenschaften eines bronzezeitlichen Gewaltkonfliktes in Mecklenburg-Vorpommern 1*, 253-72. Schwerin: Landesamt für Kultur und Denkmalpflege Mecklenburg-Vorpommern.

Dreibrodt, S., Lubos, C., Terhorst, B., Damm, B. and Bork, H.-R. 2010. Historical soil erosion by water in Germany: scales and archives, chronology, research perspectives. *Quaternary International* 222, 80-95.

Effenberger, H. 2018a. *Pflanzennutzung und Ausbreitungswege von Innovationen im Pflanzenbau der Nordischen Bronzezeit und angrenzender Regionen.* Neumünster: Wachholtz.

Effenberger, H. 2018b. The plant economy of the northern European Bronze Age – more diversity through increased trade with southern regions. *Vegetation History and Archaeobotany* 27, 65-74.

Feeser, I., Dörfler, W., Kneisel, J., Hinz, M. and Dreibrodt, S. 2019. Human impact and population dynamics in the Neolithic and Bronze Age: multi-proxy evidence from north-western central Europe. *The Holocene* 29, 1596-1606.

Feeser, I., Van den Bogaard, C. and Dörfler, W. 2020. Palaeoecological investigations at the archaeological site Mang de Bargen, Bornhöved, Kreis Segeberg: new insights into local to over-regional land-use changes during the Bronze Age. Contribution in S. Schaefer-Di Maida, *Bronzezeitliche Transformationsprozesse in Schleswig-Holstein am Beispiel vom Fundplatz von Mang de Bargen, Bornhöved (Kr. Segeberg)*, Appendix VII.3. PhD dissertation, Christian-Albrechts-Universität zu Kiel.

Feeser, I., Schaefer-Di Maida, S., Dreibrodt, S., Kneisel, J. and Filipović, D. 2022. Onsite to offsite: a multidisciplinary and multiscale consideration of the 13th to 11th century BCE transformation in northern Germany. In D. Filipović, M. Dal Corso and W. Kirleis (eds), *Millet and what else? The wider context of the adoption of millet cultivation in Europe*, 185-215. Leiden: Sidestone.

Filipović, D., Meadows, J., Wiethold, J., Jahns, S., Bittmann, F. and Kirleis, W. 2018. Before and after: millet cultivation and the transformation of prehistoric crop production in northern Germany. *Antiquity* 92, 1-6.

Fokkens, H. 1997. The genesis of urnfields: economic crisis or ideological change? *Antiquity* 71, 360-73.

Halbwidl, E. 2013. Landschaftsarchäologische Studien zum älterbronzezeitlichen Siedlungsplatz Brekendorf, Kreis Rendsburg-Eckernförde. In K.-H. Willroth (ed.), S*iedlungen der älteren Bronzezeit. Beiträge zur Siedlungsarchäologie und Paläoökologie des zweiten vorchristlichen Jahrtausends in Südskandinavien, Norddeutschland und den Niederlanden. Workshop vom 7. bis 9. April 2011 in Sankelmark*, 261-74. Neumünster: Wachholtz.

Hinz, M., Furholt, M., Müller, J., Raetzel-Fabian, D., Rinne, C., Sjörgen, K.-G. and Wotzka, H.-P. 2012. RADON – Radiocarbon dates online 2012. Central European database of ^{14}C dates for the Neolithic and Early Bronze Age. *Journal of Neolithic Archaeology* 14, doi: 10.12766/jna.2012.65.

Hinz, M., Schirrmacher, J., Kneisel, J., Rinne, C. and Weinelt, M. 2019. The Chalcolithic-Bronze Age transition in southern Iberia under the influence of the 4.2 kyr event? A correlation of climatological and demographic proxies. *Journal of Neolithic Archaeology* 21, 1-26.

Holst, M.K., Rasmussen, M., Kristiansen, K. and Bech, J.H. 2013. Bronze Age "Herostrats": ritual, political, and domestic economies in Early Bronze Age Denmark. *Proceedings of the Prehistoric Society* 79, 1-32.

Honeck, M. 2009. *Nichts als heiße Steine? Zur Deutung der Brenngruben der späten Bronzezeit und frühen Eisenzeit in Deutschland.* Bonn: Rudolf Habelt.

Hornstrup, K.M. 1999. Brandgrave fra yngre bronzealder. Muligheter og perspektiver. *Kuml* 13, 99-146.

Hubensack, V. 2018. *Das Bestattungsverhalten in Gräberfeldern und Siedlungen der Aunjetitzer Kultur in Mitteldeutschland.* Halle: Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt, Landesmuseum für Vorgeschichte.

Innerhofer, F. 2010. Zwischen Frühbronzezeit und Hügelgräberkultur – Zum zeitlichen Umfeld der Himmelsscheibe von Nebra in Mitteldeutschland. In H. Meller and F. Bertemes (eds), *Der Griff nach den Sternen. Internationales Symposium in Halle (Saale) 16.-21. Februar 2005*, 120-29. Halle: Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt, Landesmuseum für Vorgeschichte.

Jantzen, D., Orschiedt, J., Piek, J. and Terberger, T. (eds) 2014. *Tod im Tollensetal. Forschungen zu den Hinterlassenschaften eines bronzezeitlichen Gewaltkonfliktes in Mecklenburg-Vorpommern 1*. Schwerin: Landesamt für Kultur und Denkmalpflege Mecklenburg-Vorpommern.

Klems, V. 2020. Die jungbronzezeitlichen Siedlungsstellen in Schleswig-Holstein. Presentation given at the Bronze Age Round Table in Kiel, 18.02.2020.

Klems, V. and Müller, E. 2020. Der Siedlungsplatz Schashagen. *Archäologische Nachrichten aus Schleswig-Holstein* 2020**,** 100-01.

Kneisel, J. 2012a. *Anthropomorphe Gefäße in Nord- und Mitteleuropa während der Bronze- und Eisenzeit. Studien zu den Gesichtsurnen – Kontaktzonen, Chronologie und sozialer Kontext.* Bonn: Rudolf Habelt.

Kneisel, J. 2012b. The problem of the Middle Bronze Age inception in northeast Europe – or: did the Únětice society collapse? In J. Kneisel, W. Kirleis, M. Dal Corso, N. Taylor and V. Tiedtke (eds), *Collapse or continuity? Environment and development of Bronze Age human landscapes. Proceedings of the international workshop "Socio-environmental dynamics over the last 12,000 years: The creation of landscapes II (14th-18th March 2011)" in Kiel*, 209-33. Bonn: Rudolf Habelt.

Kneisel, J. 2013a. Der Übergang von der Frühbronzezeit zur Mittelbronzezeit im nordöstlichen Mitteleuropa. Lücke oder Forschungsdesiderat? In J. Kneisel, H.J. Behnke and A. Schopper (eds), *Frühbronzezeit – Mittelbronzezeit. Neue Erkenntnisse zur Besiedlung zwischen Elbe und Warthe und angrenzender Regionen (2000-1400 v. Chr.). Symposium von 24.-25. Sept. 2011 in Welzow/Brandenburg*, 95-120. Bonn: Rudolf Habelt.

Kneisel, J. 2013b. Raumordnungen in der frühen und späten Bronzezeit am Beispiel Bruszczewos (Großpolen) und Umgebung. In S. Hansen and M. Meyer (eds), *Parallele Raumkonzepte. Tagung des DAI 15.-17. März 2010 in Berlin*, 175-200. Berlin: Topoi.

Kneisel, J. 2015. Bronze Age settlements reflected in the material culture of the surroundings of Lake Sacrow. In J. Kneisel, M. Dal Corso, W. Kirleis, H. Scholz, N. Taylor and V. Tiedtke (eds), *The third food revolution? Setting the Bronze Age table: common trends in economic and subsistence strategies in Bronze Age Europe. Proceedings of the international workshop "Socio-environmental dynamics over the last 12,000 years: the creation of landscapes III (15th-18th April 2013)" in Kiel*, 255-70. Bonn: Rudolf Habelt.

Kneisel, J. and Rode, S. 2010/11. Ein bronzezeitlicher Grabhügel: LA 29 in Kronsburg-Glinde, Bredenbek, Kr. Rendsburg-Eckernförde. *Offa* 67/68, 129-84.

Kneisel, J. [+ 10 others] and Ważny, T. 2008. Bruszczewo – Early Bronze Age defensive settlement in Wielkopolska. Metallurgy, peat zone finds and changes in the environment. In J. Czebreszuk, S. Kadrow and J. Müller (eds), *Defensive structures from central Europe to the Aegean in the 3rd and 2nd millennia BC*, 155-70. Poznań, Bonn: Wydawnictwo Poznańskie, Rudolf Habelt.

Kneisel, J., Kirleis, W., Dal Corso, M. and Taylor, N. 2012. Collapse or continuity? Concluding remarks on the environment and development of Bronze Age human landscapes. In J. Kneisel, W. Kirleis, M. Dal Corso, N. Taylor and V. Tiedtke (eds), *Collapse or continuity? Environment and development of Bronze Age human landscapes. Proceedings of the international workshop "Socio-environmental dynamics over the last 12,000 years: The creation of landscapes II (14th-18th March 2011)" in Kiel*, 267-79. Bonn: Rudolf Habelt.

Kneisel, J., Hinz, M. and Rinne, C. 2013. Radon-B. Database accessible at: http://radon-b.ufg.uni-kiel.de

Kneisel, J., Dal Corso, M., Kirleis, W., Scholz, H., Taylor, N. and Tiedtke, V. (eds) 2015. *The third food revolution? Setting the Bronze Age table: common trends in economic and subsistence strategies in Bronze Age Europe. Proceedings of the international workshop "Socio-environmental dynamics over the last 12,000 years: the creation of landscapes III (15th-18th April 2013)" in Kiel*. Bonn: Rudolf Habelt.

Kneisel, J., Dörfler, W., Dreibrodt, S., Schaefer-Di Maida, S. and Feeser, I. 2019. Cultural change and population dynamics during the Bronze Age: integrating archaeological and palaeoenvironmental evidence for Schleswig-Holstein, northern Germany. *The Holocene* 29, 1607-21.

Kneisel, J., Schaefer-Di Maida, S., Feeser, I., Dreibrodt, S. and Filipović, D. In prep. *Leben und Ansichten von LA 117 und LA 57, Grabhügel. Vorbericht über die Ausgrabungen bronzezeitlicher Grabhügel bei Bornhöved, Kr. Segeberg.*

Kruse, P. and Matthes, L. 2019. Vieh, Laub und Versammlungsplatz: Soziale Organisation in der Bronzezeit, Beispiel Brunde/Egelund. *Acta Archaeologica* 90, 204-51.

Lütjens, I. 2008. Grabhügel und Kiesabbau. Die Ausgrabungen in Bornhöved und Groß Rönnau. *Archäologische Nachrichten aus Schleswig-Holstein* 14, 27-29.

Lütjens, I. 2013. Frühe Häuser und Gräber bei Todesfelde, Kr. Segeberg. *Archäologische Nachrichten aus Schleswig-Holstein* 19, 39-43.

Makarowicz, P. 1998. Absolute chronology of the Trzciniec complex in the Vistula drainage in the light of ^{14}C datings. In J. Czebreszuk [+ 12 others] and H. Taras (eds), *The Trzciniec area of the Early Bronze Age civilization: 1950-1200 BC*, 141-55. Poznań: Adam Mickiewicz University Press.

Makarowicz, P. 2001. The second half of the third and second millennium BC in Kujawy, northern Poland, in the light of 14C determinations. In J. Czebreszuk and J. Müller (eds), *Die absolute Chronologie in Mitteleuropa 3000-2000 v.Chr.*, 209-70. Rahden: Marie Leidorf.

Makarowicz, P. 2010. *Trzciniecki krąg kulturowy – wspólnota pogranicza Wschodu i Zachodu Europy.* Poznań: Wydawnictwo Poznańskie.

Makarowicz, P., Lysenko, S.D., and Kočkin, I.T. 2013. Kurhany z epoki brązu nad górnym Dniestrem – polsko-ukraińskie projekty badawcze. *Folia Praehistoria Posnaniensia* 18, 151-76.

May, J. 2002. Das Königsgrab von Seddin. *Archäologie in Deutschland* 3/2002**,** 8-15.

May, J. and Hauptmann, T. 2011. Warum befindet sich das „Königsgrab“ von Seddin am Mittellauf der Stepenitz? Wasserwege und archäologische Sachkultur der jüngeren Bronzezeit in der Prignitz. In F. Bittmann, J. Ey, M. Karle, H. Jöns, E. Strahl and S. Wolters (eds), *Flüsse als Kommunikations- und Handelswege. Marschenratskolloquium 5.-7. November 2009*, 129-50. Rahden: Marie Leidorf.

Meadows, J. and Contreras, D.A. 2014. Summed radiocarbon calibrations as a population proxy: a critical evaluation using a realistic simulation approach. *Journal of Archaeological Science* 52, 591-608.

Meier, D. 2013. Eine Siedlung der älteren Bronzezeit in Schleswig-Holstein. In K.-H. Willroth (ed.), *Siedlungen der älteren Bronzezeit. Beiträge zur Siedlungsarchäologie und Paläoökologie des zweiten vorchristlichen Jahrtausends in Südskandinavien, Norddeutschland und den Niederlanden. Workshop vom 7. bis 9. April 2011 in Sankelmark*, 91-118. Neumünster: Wachholtz.

Meller, H. 2010. Nebra: Vom Logos zum Mythos – Biographie eines Himmelsbildes. In H. Meller and F. Bertemes (eds), *Der Griff nach den Sternen. Internationales Symposium in Halle 16.-21.2. 2005*, 23-73. Halle: Landesmuseum für Vorgeschichte Halle.

Meller, H. and Schunke, T. 2016. Die Wiederentdeckung des Bornhöck – Ein neuer frühbronzezeitlicher “Fürstengrabhügel” bei Raßnitz, Saalekreis. Erster Vorbericht. In H. Meller, H.-P. Hahn, R. Jung and R. Risch (eds), *Arm und Reich. Zur Ressourcenverteilung in prähistorischen Gesellschaften. 8. Mitteldeutscher Archäologentag vom 22. bis 24. Oktober 2015 in Halle (Saale),* 427-65. Halle: Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt, Landesmuseum für Vorgeschichte.

Mikkelsen, M. 2013. The topographical placing of the Late Neolithic and Bronze Age settlements and an introduction to a new interpretation of the layout of the individual farms in the Bronze Age. In K.-H. Willroth (ed.), *Siedlungen der älteren Bronzezeit. Beiträge zur Siedlungsarchäologie und Paläoökologie des zweiten vorchristlichen Jahrtausends in Südskandinavien, Norddeutschland und den*

Niederlanden. Workshop vom 7. bis 9. April 2011 in Sankelmark, 33-66. Neumünster: Wachholtz.
Müller, J. and Czebreszuk, J. 2003. Bruszczewo – eine frühbronzezeitliche Siedlung mit Feuchtbodenerhaltung in Großpolen. Vorbericht zu den Ausgrabungen 1999-2001. *Germania* 81, 443-80.
Müller, J. and Kneisel, J. 2010. Bruszczewo: production, distribution, consumption and the formation of social differences. In J. Kneisel, J. Müller and H. Czebreszuk (eds), *Bruszczewo II. Ausgrabungen und Forschungen in einer prähistorischen Siedlungskammer Großpolens*, 756-82. Bonn: Rudolf Habelt.
Nakoinz, O., Kneisel, J., Beilke-Voigt, I. and Dräger, J. 2017. Befestigungen der Bronze- und Eisenzeit zwischen Marburg und Uppsala. In I. Beilke-Voigt and O. Nakoinz (eds), *Enge Nachbarn. Doppel- und Mehrfachburgen in der Bronzezeit und im Mittelalter, mittelalterliche Doppelstädte*, 21-88. Berlin: Topoi.
Runge, M. 2010. *Kildehuse II. Gravpladser fra yngre bronzealder og vikingetid i Odense Sydøst*. Odense: Odense Bys Museer.
Runge, M. 2013. Yngre bronzealders dødekult indenfor et 350 hektar stort undersøgelsesområde sydøst for Odense. In S. Boddum, M. Mikkelsen and N. Terkildsen (eds), *Dødekulten i yngre bronzealders lokale kulturlandskab. Seminarrapport fra seminaret "Dødekulten i yngre bronzealders lokale kulturlandskab" 8. marts 2012*, 9-23. Viborg, Holstebro: Viborg Museum, Holstebro Museum.
Schaefer-Di Maida, S. 2018. Bronzezeitliche Transformationen zwischen den Hügeln (Mang de Bargen, Bornhöved, Kr. Segeberg). *Archäologie in Schleswig* 17, 27-44.
Schaefer-Di Maida, S. 2020. *Bronzezeitliche Transformationsprozesse in Schleswig-Holstein am Beispiel vom Fundplatz von Mang de Bargen, Bornhöved (Kr. Segeberg).* PhD dissertation, Christian-Albrechts-Universität zu Kiel.
Schäfer, G. 1980a. Archäologische Ausgrabungen 1979 in Borgdorf-Seedorf und Österrönnefeld. *Rendsburger Jahrbuch* 30, 208-19.
Schäfer, G. 1980b. Ein Wohnplatz der jüngeren Bronzezeit mit Spuren einer Bronzegießerei bei Borgdorf-Seedorf, Krs. Rendsburg-Eckernförde. *Die Heimat* 87, 337-43.
Schenk, T. and Goldmann, T. 2004. Die Seddiner Kultfeuerreihe. Geomagnetische Prospektion am Königsgrab in der Prignitz. *Archäologie in Berlin und Brandenburg* 2003, 57-59.
Schmidt, J.-P. 1993. *Studien zur jüngeren Bronzezeit in Schleswig-Holstein und dem nordelbischen Hamburg*. Bonn: Rudolf Habelt.
Schmidt, J.-P. 2005. Grillfest oder Opferkult? Der Feuerstellenplatz von Jarmen, Lkr. Demmin. In U.M. Meier (ed.), *Die Autobahn A20 – Norddeutschlands längste Ausgrabung. Archäologische Forschungen auf der Trasse zwischen Lübeck und Stettin*, 71-76. Schwerin: Landesamt für Bodendenkmalpflege Mecklenburg-Vorpommern.
Schmidt, J.-P. 2012. Kein Ende in Sicht? Neue Untersuchungen auf dem Feuerstellenplatz von Naschendorf, Lkr. Nordwestmecklenburg. *Archäologische Berichte aus Mecklenburg-Vorpommern* 19, 26-46.
Schmidt, J.-P. 2013. Bronzezeitliche Hausbefunde und Siedlungen in Mecklenburg-Vorpommern. In K.-H. Willroth (ed.), *Siedlungen der älteren Bronzezeit. Beiträge zur Siedlungsarchäologie und Paläoökologie des zweiten vorchristlichen Jahrtausends in Südskandinavien, Norddeutschland und den Niederlanden. Workshop vom 7. bis 9. April 2011 in Sankelmark*, 119-36. Neumünster: Wachholtz.
Schunke, T. 2016. Die Wiederentdeckung des Bornhöck – Ein neuer frühbronzezeitlicher Fürstengrabhügel bei Raßnitz, Saalekreis. Erster Vorbericht. In H. Meller, H.P. Hahn, R. Jung and R. Risch (eds), *Arm und Reich. Zur Ressourcenverteilung in prähistorischen Gesellschaften. 8. Mitteldeutscher Archäologentag vom 22. bis 24. Oktober 2015 in Halle (Saale)*, 427-65. Halle: Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt, Landesmuseum für Vorgeschichte.
Schwerin von Krosigk, H. 1976. *Untersuchungen zum vor- und frühgeschichtlichen Siedlungsablauf am Fundbild der Gemarkungen Bornhöved – Gönnebek – Groß-*

Kummerfeld – Schmalensee, Kreis Segeberg/Holstein. Schleswig: Schleswig-Holsteinisches Landesmuseum für Vor- und Frühgeschichte.

Søgaard, K., Christensen, C. and Mortensen, M.F. 2018. Pollen analyses from lake, field and beach-ridge deposits in the vicinity of the Bronze Age settlement at Bjerre Enge, Thy. In J.-H. Bech, B.V. Eriksen and K. Kristiansen (eds), *Bronze Age settlement and land-use in Thy, northwest Denmark*, 193-222. Aarhus: Jutland Archaeological Society.

Steinmetz, W.-D. 2003. Zur ur- und frühgeschichtlichen Besiedlung des Braunschweiger Landes. Ein Vergleich der archäologischen Quellen mit den vegetationsgeschichtlichen Ergebnissen aus dem Bullenteich bei Braunschweig. *Neue Ausgrabungen und Forschungen in Niedersachsen* 24, 325-76.

Storch, A. 2020. Anthropologisches Gutachten zu den Leichenbränden/Skelettresten für SFB 1266 Projekt D3. Contribution in S. Schaefer-Di Maida, *Bronzezeitliche Transformationsprozesse in Schleswig-Holstein am Beispiel vom Fundplatz von Mang de Bargen, Bornhöved (Kr. Segeberg)*, Appendix VII.1. PhD dissertation, Christian-Albrechts-Universität zu Kiel.

Thrane, H. 1984. *Lusehøj ved Voldtofte – en sydvestfynsk storhøj fra yngre broncealder.* Odense: Odense Bys Museer.

Thrane, H. 2013. Scandinavia. In H. Fokkens and A. Harding (eds), *The Oxford handbook of the European Bronze Age*, 746-66. Oxford: Oxford University Press.

Tiedtke, V. 2020. *Grab und Raum. Ressourcenteilung in der Rituallandschaft um den Bestattungsplatz Müllrose Fundplatz 2 (Brandenburg).* PhD dissertation, Christian-Albrechts-Universität zu Kiel.

Vandkilde, H. 1996. *From stone to bronze. The metalwork of the Late Neolithic and earliest Bronze Age in Denmark*. Højbjerg: Jutland Archaeological Society.

Vandkilde, H. 2017. *The metal hoard from Pile in Scania, Sweden. Place, things, time, metals, and worlds around 2000 BCE.* Aarhus: Aarhus University Press.

Wiethold, J. 1998. *Studien zur jüngeren postglazialen Vegetations- und Siedlungsgeschichte im östlichen Schleswig-Holstein.* Bonn: Rudolf Habelt.

Wirth, K. 1994. *Archsum/Melenknop. Ein Fundplatz des Spätneolithikums und der älteren Bronzezeit.* PhD dissertation, Christian-Albrechts-Universität zu Kiel.

Wüstemann, H. 1974. Zur Sozialstruktur im Seddiner Kulturgebiet. *Zeitschrift für Archäologie* 8, 67-107.

Zich, B. 1993/94. "In Flintbek stand ein Steinzeithaus …". Ein Hausfund von der Wende des Neolithikums zur Bronzezeit aus Flintbek, Kreis Rendsburg-Eckernförde. *Archäologische Nachrichten aus Schleswig-Holstein* 29, 18-46.

Zich, B. 2005. Flintbek. In K.-H. Willroth, K. Kersten and E. Aner (eds), *Kreis Rendsburg-Eckernförde (südlich des Nord-Ostsee-Kanals) und die kreisfreien Städte Kiel und Neumünster*, 31-84. Neumünster: Wachholtz.

Zich, B. 2016. Aunjetitzer Herrschaften in Mitteldeutschland – "Fürsten" der Frühbronzezeit und ihre Territorien ("Domänen"). In H. Meller, H.-P. Hahn, R. Jung and R. Risch (eds), *Arm und Reich. Zur Ressourcenverteilung in prähistorischen Gesellschaften. 8. Mitteldeutscher Archäologentag vom 22. bis 24. Oktober 2015 in Halle (Saale)*, 371-406. Halle: Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt, Landesmuseum für Vorgeschichte.

The emergence of fortified settlements in Bronze Age Lithuania

A new model

Algimantas Merkevičius

"Over the years archaeologists have concentrated on origin problems: farming, political complexity, or this or that culture" (Milisauskas and Kruk 2011, 293).

Introduction

For thousands of years from the Late Palaeolithic until the Bronze Age, people in Lithuania (which is the southern part of the east Baltic region), like in many other European regions, lived in small open (unfortified) settlement sites established on slightly elevated or flat ground close to water bodies, mainly rivers and lakes. However, something happened in the Bronze Age that made people start to erect a radically new type of settlement sites, fortified ones, called hillforts in Lithuania as well as in many other European regions.

Hillforts as prehistoric and early historic fortified settlement sites are not only prominent marks in the modern landscape, but also one of the most important archaeological sources for the investigation and reconstruction of the military, social, political, economic and even religious organisation of the societies which built them. Currently the number of recorded hillforts in Lithuania has reached almost 1,000 (Baubonis *et al.* 2017; Grigalavičienė 1995, 27; Zabiela 2005, 7). These sites are dated to different prehistoric and early historic periods, spanning from the Late Bronze Age until the fifteenth century AD (Grigalavičienė 1981, 5-18; 1995, 27; Zabiela, 2005, 19). One can calculate that fortified settlement sites (hillforts) in Lithuania were used for more than 2,500 years and are divided into three chronological stages: early, later and latest hillforts. The majority are later and latest hillforts, dated roughly to the first millennium AD and to the first half of the second millennium AD.

The early hillforts can be attributed to the Early Metal Period in Lithuania, which lasts from 2000 BC-50 AD and comprises the Bronze Age and Early Iron Age. The Bronze Age is divided into two sub-periods, the Early and Late Bronze Age, dated respectively to c. 2000-1200 and 1200-500 BC, while the Early Iron Age is dated c. 500 BC-50 AD (Merkevičius 2016, 130). The total number of hillforts attributed to the Early Metal Period in Lithuania is still not known, because some late hillforts may possess earlier culture layers and were founded in the Late Bronze or in the Early Iron Age, but are not excavated. A quarter of a century ago, Elena Grigalavičienė listed 46 early hillforts located in Lithuania (Grigalavičienė 1995, 46 fig. 3). However, at the end of the last decade, due to different kinds of investigations in the last twenty years, the number of early hillforts has increased drastically and reached 223 (Merkevičius 2018) (Figure 1).

Despite the numerous and long-lasting archaeological investigations of Lithuanian hillforts, which started in the nineteenth century (Grigalavičienė 1995, 8-9; Zabiela 2005, 7), and the huge amount of archaeological data they obtained, we still lack satisfactory explanations to a number of questions concerning different aspects of fortified settlements (especially the earliest ones), such as *why*, *when*, *where* and *how* fortified

In D. Hofmann, F. Nikulka and R. Schumann (eds) 2022. *The Baltic in the Bronze Age. Regional patterns, interactions and boundaries*, Leiden: Sidestone Press, pp. 219-230.

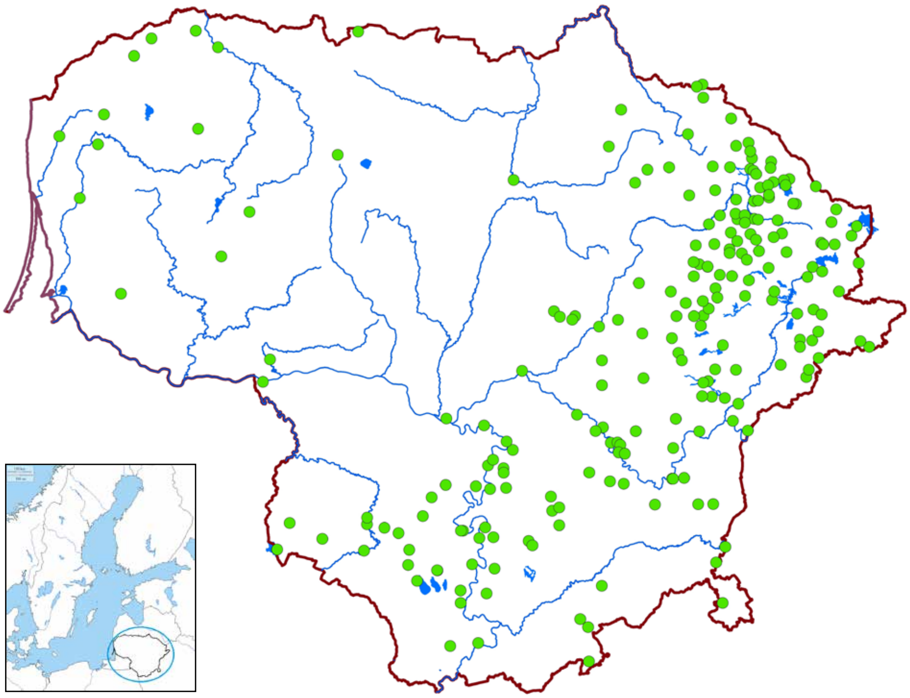


Figure 1. Left: Lithuania in the Baltic region; right: distribution of early hillforts in Lithuania (after Merkevičius 2018).

settlements emerged in the region under consideration. This article tries to answer these questions by using available (old and new, published and unpublished) archaeological data and ideas obtained by studying settlement sites in the region over the last decade (see Merkevičius 2018 for a more in depth analysis of the underlying data). In this article, the emergence of fortified settlements in Lithuania is analysed in the context of settlement development, not as a separate, isolated phenomenon. The article presents a new model for the emergence of fortified settlements in Lithuania using sites with a sufficient level of information to illustrate the overall pattern.

Classification of Early Metal Period settlement sites in Lithuania

In the Early Metal Period, researchers have traditionally distinguished two main types of settlement sites in Lithuania. These are open (the term “unfortified” is also used) settlement sites and fortified ones, called hillforts (Grigalavičienė 1995, 17-40). The main difference between them is the presence or absence of human-made fortifications. However this classification is too simplistic and does not cover all main types of settlement sites which were used in the period under discussion. In this article we offer a new classification of Early Metal Period settlements in Lithuania. With regards to their nature and location, all settlements are divided into three main types: open settlements, hilltop settlements and fortified settlements. Fortified settlements can be divided into two sub-types: fortified hilltop settlements (hillforts) and lake dwellings or palafitic settlements.

The first type of settlement sites, which were used from the Stone Age, are open settlements, erected on flat or slightly elevated ground. Sites of this type were established close to water bodies (lakes and rivers) and are not protected either by anthropogenic or natural defences.

The second type of settlements were “naturally protected” sites, set up in difficult to access locations in the landscape on natural rises, such as hills, higher river or lake banks, promontories, islands, and so on. Water bodies and slopes, sometimes steep, were the natural protection of these sites. However these settlements had no human-made fortifications. This type of sites are called hilltop settlements.

The third type of settlement sites are fortified settlements. Both sub-types, the fortified hilltop settlements (hillforts) and the lake dwellings or palafitic settlements, were erected in naturally protected places. Lake dwellings or palafitic settlements were erected on shallow lakes and were reinforced by human-made timber stockades. Fortified settlements (hillforts) were erected on hills, higher river or lake banks, promontories, islands or peninsulas, and were reinforced by human-made fortifications such as timber stockades or earthen fortifications like ramparts and/or ditches. Stone walls were sometimes erected as well. It is these latter that are the main focus of this contribution.

Why did fortified settlement sites emerge in Lithuania in the Bronze Age

One of the most important scientific questions associated with the change in settlement patterns is *why* communities so radically changed the type of settlement sites and shifted from open (unfortified) to fortified ones. Also, why did these changes occur in the Bronze Age, but not earlier or later in prehistory? The answer can be found by examining the archaeological data and context within and outside of the east Baltic region in the Bronze Age. The Bronze Age, according to many researchers, was a time of radical changes in different fields of society (Harding 2000; Kristiansen 2000; Kristiansen and Larsson 2005). Anthony Harding even characterised the European Late Bronze Age as a period of revolutions: military, social, industrial, religious, and also a period of migrations (Harding 1994, 304). An important trend in the development of the Bronze Age "was the establishment of close contacts between different regions and societies" (Lang 2007, 11). Also, it was a time of intensive movement of people. New materials, technological innovations, and also a certain lifestyle, ideology, religion, customs and so on spread widely through Europe (Lang 2007, 11-12). However, these movements and intensive contacts were not always peaceful. War raids, aggression and danger were a part of this process. According to Harding, for European societies in the Bronze Age, warfare was a frequently undertaken and important element of life (Harding 1994, 331). Huge amounts and different kinds of weapons, such as swords, spearheads, daggers, arrowheads and more were used at that time. Due to this situation the warrior ideology spread widely from Mycenaean Greece through all of Europe. A clear example of the unsafe and dangerous situation in Europe at that time was the destruction of the Mycenaean palaces and the Hittite civilisation in the eastern Mediterranean around 1200 BC by "Peoples of the Sea" (Harding 1994, 304; Popham 1994, 277-88). Due to this unsafe and dangerous situation, societies in various parts of Europe began to systematically protect themselves by erecting different kind of fortifications, mostly from the Middle or Late Bronze Age onwards. According to Timothy Darvill, the appearance of fortified settlements, or hillforts, reflects the need for defence, and this process was "approximately coincident with the development of a greater range of weapons" (Darvill 1998, 128). Not only in Britain, but also in the eastern Baltic and elsewhere, researchers have traditionally interpreted the emergence of fortified settlements as the response to these conflicts (see Lang 2018, 19-21). Another aspect, according to Harding, is that "placing settlements on hills could act as a deterrent in itself" (Harding 2000, 292).

However, external threats were only one, albeit possibly the most important factor for the emergence of this radically new type of settlement sites at that time. The internal organisation of society was also an important aspect in the appearance of this new type of settlements. For the construction of fortified settlements, first of all enormous communal labour and new skills were required. Also a certain level of societal development was needed. According to earlier social studies, the Bronze Age societies in the eastern Baltic, especially from the second part of the second millennium BC, were stratified, low-level centralised and hierarchical (see Merkevičius 2005b, 50). It is clear from available data that after the appearance of fortified settlements, the number of open settlement sites decreased markedly, especially in the north-eastern part of Lithuania. However, given the current state of research one can only speculate on the nature and extent of mutual relationship between these two types of sites. Judging from other types of data (such as burial sites and artefacts), some interdependence and a relationship of subordination seem likely.

For example, while the main type of houses in open and in fortified settlements remained very similar, production of metal artefacts was practiced only in fortified settlements (Grigalavičienė 1995; examples in Merkevičius 2018). An elite group of people also demonstrated their high status and wealth in different ways. They were buried in 1-4 metre high burial mounds of earth or stone, sometimes also with stone structures around and between the graves, and they used imported and locally made bronze artefacts, so rare in this region. Overall, the settlement sites of this group of people, as well as burial sites, weapons and ornaments, were markedly different from the group of commoners (Merkevičius 2005b, 43-50; 2007, 96-103; 2014).

Religion and ideology were also very important aspects of life for the people of these societies, and landscape forms were frequently used for this purpose in different ways (see Merkevičius 2007, 102; 2015, 223-24; Merkevičius and Remeikaitė 2012, 116). The divergent establishment of settlement sites, in higher and more visible locations in the landscape, can be interpreted as the demonstration of an exceptional, higher status of the social elite not only in the Baltic region but also in other European regions (Merkevičius 2007, 102-03; Wardle 1994, 228-35).

After the examination of various kinds of archaeological evidence at fortified and unfortified settlements, one can state that in the Late Bronze Age, fortified settlement sites became multi-functional central places of power and wealth for the whole micro-region, with specific functions: defence-related, political-administrative, economic and even religious (see Merkevičius 2005b, 46). Evidence of bronze casting has only been found in fortified hilltop settlement sites. It has been stated that fortified settlements were inhabited by the chief and elite families (see Merkevičius 2005b, 46).

To sum up, one can claim that the emergence of hilltop settlements and later of fortified sites indicates not only the existence of external threats, the need for protection of people and property, but also radical changes of a different kind within societies: population growth, differentiation and centralisation in society, a certain economic capacity, production and exchange of bronze artefacts, and so on. These above-mentioned processes forced people to establish safer and more prestigious places for living and for other different kinds of activity (Merkevičius 2005b, 45-50).

Adaption

The emergence of a new type of settlement site resulted in a radical shift in the settlement pattern. For this shift, the concept of adaptation can be used. Adaptation is a process in which different factors are involved, and stimulate one or another type and rate of change. According to Ian Hodder (1995, 93), a “society can only continue to exist if it is internally and externally well adjusted”. Unadjusted socio-cultural units degenerate and break down (Merkevičius 2005b, 43).

In my view, changes in society and culture are determined by both the external influences on and internal developments of a socio-cultural unit (Merkevičius 2005b, 43). The essence for all societies and cultures is the pursuit to survive and evolve. For this reason all societies strive to adopt novelties, and to improve or embellish their life (Merkevičius 2009, 59).

For the possibility to survive and evolve, societies and cultures have to *adapt* to the changing circumstances in the world around them. Two main, fundamental types of adaptation can be distinguished. The first one concerns the adaptation of socio-cultural groups to the physical environment, the ecological adaptation. The second one is the arrangement and adjustment of the individuals, components of society, and the societies themselves in relation to each other, i.e. the socio-cultural adaptation. Through those two types of adaptation societies and cultures can survive and evolve (Merkevičius in press). The latter could be divided into two more types, namely internal and external adjustments. Individuals and human groups have to adjust within their own socio-cultural group and to find their place in their own unit; this is referred to as internal adjustment. The other type is external adjustment, when individuals and groups have to adjust to other socio-cultural entities, outside their own unit. Thus humans, individuals and groups, have to adapt both to the ecological and to the socio-cultural milieus. Or, as noted by Clive Gamble (2004, 179), “much change is an unintended consequence of the complex interaction of biology and culture with which we are all involved“.

In sum, the processes of adaptation to the socio-cultural and natural environments for the purpose to survive and evolve are the main, fundamental cause of change in every society and culture (Merkevičius in press). In the case of a shift in the settlement pattern (from open to hilltop and later to fortified settlement sites), one can characterise this process as the adaptation to a new socio-political situation through an adjustment in the natural environment.

The first relocation of settlement sites

It was noticed, after examining the archaeological material, that the first relocation from the densely populated lowlands to the higher locations in the landscape in some areas of the east Baltic region started already in the Early Bronze Age. Some open settlements were abandoned and new settlements in the higher locations were established.

A good example of such a shift is the Lake Lubāna micro-region in east Latvia. This area had been densely populated in the Neolithic, but beginning in the Early Bronze Age was gradually depopulated and the majority of people moved to adjacent higher locations in this area (Lang 2007, 23; Vasks 1994, 65, 113). According to Andrejs Vasks, in this area “of 23 Neolithic/Early Bronze Age settlements only 10 continued on their existence in the Late Bronze Age” (Vasks 1994, 113). New settlements were also established on the Daugava river banks (Vasks 1994, 67). In this period, the same tendencies, i.e. the movement from open sites on low lake shores to higher locations, can also be traced in the Kretuonas lake area of east Lithuania (Girininkas 2011, 167) and in the Biržulis lake basin of west Lithuania (Butrimas 2019).

However, this relocation of settlement sites in some areas from lower to higher ground was only a first movement of people, with the purpose to settle areas apparently more suitable for farming (Lang 2007, 23). The fundamental changes in the settlement pattern and the establishment of a radically new type of settlement sites occurred a little bit later.

From open to fortified settlement sites

According to our model, two stages are distinguished in the formation of fortified settlements in Lithuania. The first stage was a shift from open to hilltop settlement sites, and the second stage was the establishment of human-made fortifications on the majority of hilltop settlement sites.

Stage I: From open to hilltop settlement sites

As external threats intensified in the course of the Bronze Age, and the internal situation changed, communities began to look for new ways to protect themselves and their property and to demonstrate the exceptional status of an elite group of people. As the region lacked non-ferrous metal ore, was far from the main trade routes and did not have large quantities of metal weapons or large communities, the well-known natural environment was the best solution to solve this problem.

The easiest way to adapt to the new situation, to protect people and property and to demonstrate exceptional status, was to change the location in the landscape from low and unsafe, to higher and safer and thus the type of settlement site from open to hilltop. For this, people started to search for new, different and difficult to access, but also easily defensible, “naturally protected” places in the landscape. Natural rises close to water bodies, such as hills, high river and lake banks, promontories, peninsulae and islands, amongst others, were appropriate places to cater to these new needs. These places possessed specific physical characteristics, appropriate to a new situation. Natural features, such as high hill slopes and water (rivers, lakes), became the main elements of protection.

Hilltop settlements were an initial stage, the first step towards the establishment of fortified settlements (Merkevičius 2005a, 19-22). However this type of settlement site was a new and separate stage, with its own features in the course of the development of settlements. As mentioned above, until now hilltop settlement sites have not been included into the settlement development model. The roles of hilltop sites were little analysed and poorly understood.

When did hilltop settlements emerge?

To answer the question of when the first hilltop settlement sites emerged in Lithuania is not so easy, because we still lack data from the earliest occupations of hilltop sites. The available important information was obtained during quite old excavations, with no radiometric dating. Therefore we still have to rely only on artefacts found at the time of excavation, or survey of some exceptionally early hillforts. A new and modern investigation and radiocarbon dating of this type of sites is needed.

According to data from excavated earliest hillforts one can calculate around six to seven earliest hilltop settlements with early archaeological material (Merkevičius 2018). All of them are located in the north-eastern part of Lithuania, which is rich in lakes and hills. For the purpose of chronology of the earliest hilltop settlement, the four most important sites with exceptional early archaeological material were selected. Two of them, Velikuškės and Vosgėliai, were excavated in 1933 by Petras Tarasenka (Tarasenka 1956, 23-27, 29-30). The other two, Nevieriškė and Sokiškiai, were excavated in the Soviet period by Elena Grigalavičienė, respectively in 1976-1978 and in 1980-1983 (Grigalavičienė 1986a, 52-88; 1986b, 89-138). Unfortunately, as all these sites were excavated quite a long time ago, no radiocarbon dates are available. Only a relative chronology built on artefact typology and site stratigraphies can be used to answer chronological questions. This provides a useful, though not very exact dating.

All the mentioned sites were established on separate hills of medium size and located on the high banks of rivers or lakes (Figures 2 and 3). Almost all the earliest artefacts, such as axes, arrowheads, knives and boat-shaped battle axes, were made of stone or flint and have been found at the bottom of the culture layers. Some pieces of early pottery were also reported.

As pointed out by Elena Grigalavičienė, who excavated a number of early hillforts in Lithuania, it was usually not possible to distinguish the culture layers of the earliest occupations from the later ones. Most probably, they were thin and have been destroyed by the later inhabitants (Grigalavičienė 1981, 9). Just small numbers of artefacts were left by the people of the earliest occupation phases. In Lithuania at the end of the Early Bronze Age, one can notice a considerable decrease in the use of flint artefacts. Flint axes were replaced by stone axes. However, on some early hilltop sites flint axes were found. At the Nevieriškė hilltop site a flint axe was found at the base of the culture layer, as well as two flint arrowheads and a flint knife (Grigalavičienė 1981, 6-7 fig. 1:3; 1986a, 53 fig. 3:1). Flint axes were also found in Vosgėliai hillfort (Grigalavičienė 1981, 7) and in Klangiukalns hillfort in Latvia (Grigalavičienė 1981, 7). In the other Lithuanian and Latvian hillforts, despite large-scale excavations and although hundreds of stone artefacts were discovered, no more flint axes were reported. At the beginning of the Bronze Age, the use of flint artefacts decreased considerably not only in Lithuania, but also in Finland (Lang 2007, 23). This fact, among others, testifies to the early occupation of these sites, at the very end of the usage period of flint artefacts. The typological dating of flint axes is quite complicated (Bogušienė and Rimantienė 1974, 84-86; Brazaitis and Piličiauskas 2005, 71-118). However, to sum up all available material and context, one can attribute these flint axes to around the middle of the second millennium BC.

The other exceptional and rare artefacts found in some early hillforts are boat-shaped battle axes. Late types of these axes were discovered in Velikuškės hillfort (Tarasenka 1956, 26) (Figure 4), in Nevieriškės hillfort (two; Grigalavičienė 1986a, 53 fig. 10:1,2), in

Figure 2. Velikuškės hillfort from the south-east (from Merkevičius and Remeikaitė 2018a, fig. 2).

Figure 3. Sokiškiai hillfort (from Merkevičius and Remeikaitė 2018b, fig. 5).

Sokiškiai hillfort (Grigalavičienė 1986b, 92) and in Degėsiai hillfort (Zabiela 2018, 240). In Velikuškės hillfort a stone flat axe, a "copy" of a bronze flanged axe and a pottery sherd decorated with cord impressions were also found (Grigalavičienė 1981, 8; Merkevičius and Remeikaitė 2018a, 1192 fig. 5).

All these materials remain difficult to date with any accuracy. The chronology of boat-shaped battle axes, for example, is not entirely clear, as there are many different variants of them. These axes are generally attributed to the Late Neolithic and the beginning or even the first part of the Bronze Age, and dated to the third millennium BC and to the first part of the second millennium BC (Bogušienė and Rimantienė 1974, 91-96). The latest specimens of these axes, found at the Nida settlement in west Lithuania, could be dated to approximately the seventeenth century BC (Rimantienė 1989, 54). As for the flanged axes of the kind "copied" at Velikuškės, as far as we know they were replaced by socketed axes

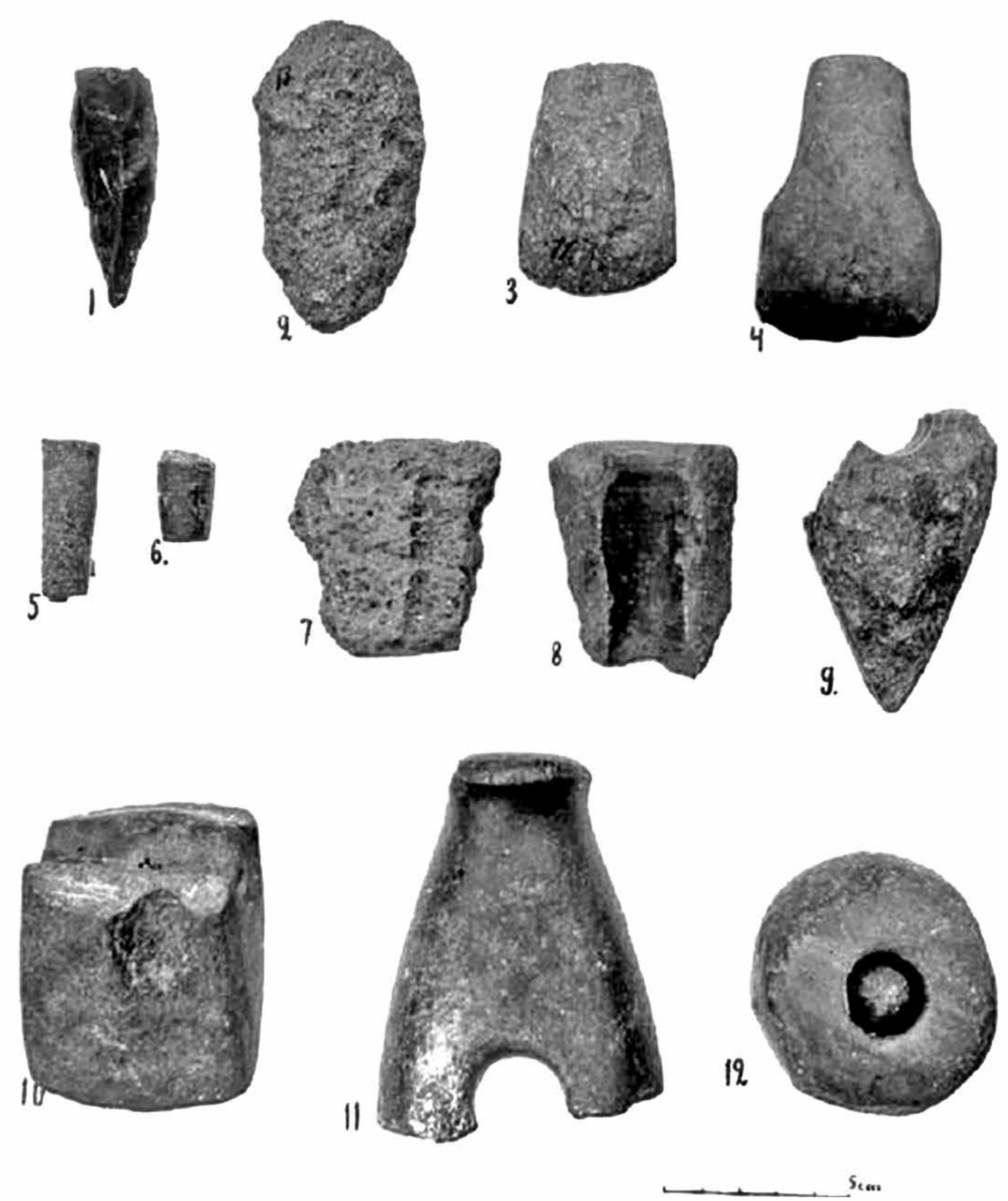


Figure 4. Stone artefacts from Velikuškės hilltop and fortified settlement, excavated in 1933 (from Tarasenka 1933, fig. 1).

before the last quarter of the second millennium BC, so the stone copies of flanged axes were most likely produced between around the middle to the last quarter of the second millennium BC.

Judging from this and other available archaeological material one can agree with Grigalavičienė's opinion that these early hilltop settlements were established between around the middle to the very beginning of the last quarter of the second millennium BC (Grigalavičienė 1981, 8-9).

Stage II: From hilltop settlement sites to fortified settlements

As mentioned above, fortified settlement sites are associated with human-made fortifications. As the security situation in the region was getting worse in the course of the Bronze Age, people started to improve "naturally protected" hilltop settlement sites by erecting built fortifications. One can agree with Lang's "probable scenario" that some hilltops “a few centuries later became gradually fortified” (Lang 2018, 23). With our current level of knowledge, it is difficult to determine how much time was needed to start building fortifications on hilltops, a few decades or some centuries. Different scenarios are possible.

Two main types of earliest fortifications in Lithuania can be distinguished: timber constructions (usually two rows of vertical timber posts) and earthen constructions, namely ramparts and ditches. According to our data, the gradual establishment of human-made fortifications on the majority of hilltop settlement sites started first in the north-eastern part of Lithuania. In this area the biggest number of early hillforts are known and the earliest hilltop settlement sites were established (Grigalavičienė 1995, 22-64; Merkevičius 2018).

When did human-made fortifications and also at the same time fortified settlements emerge in the region, and what type of fortifications were built first? The answer can be found by examining data from large-scale excavations of the earliest hillforts. In one of the earliest fortified settlements in Lithuania, Narkūnai hillfort, two types of early fortifications have been found: timber constructions, which consisted of double rows of vertical timber posts, and earthen constructions comprising a rampart and ditch. Postholes of such double timber constructions were found at the western part of the hillfort at the edge of the hill. The diameter of the postholes was 8-18 cm and the distance between the rows was 40-45 cm (Volkaitė-Kulikauskienė 1986, 16). According to the excavator, the erection of timber posts preceded the earthen construction recovered at the same hillfort. The later earthen structures consisted of a small rampart and ditch (Volkaitė-Kulikauskienė 1986, 16). Based on stratigraphy, on the recovered artefact types and on comparisons with other hillforts in the wider region, the very beginning of fortification (and of the fortified settlement at the site itself) was dated to the end of the second millennium BC (Volkaitė-Kulikauskienė 1986, 41). Almost the same situation was documented in the other excavated earliest hillforts in Lithuania. The construction of a double row of timber posts at the edge of the hill was revealed also in what according to the excavated material is the earliest hillfort in Lithuania, Nevieriškės hillfort (Grigalavičienė 1986a, 54). The diameter of postholes was 8-10 cm. This fortified settlement site was also dated to the end of the second millennium BC, again based on the artefacts found here and on analogies with other sites (Grigalavičienė 1986a, 59). It seems the same situation also applied in Sokiškiai hillfort (Grigalavičienė 1986b, 92). Two rows of postholes of 8-10 cm in diameter and set 2.5-3 m distance apart were located at the edge of the hill (Grigalavičienė 1986b, 92).

In summing up, one can conclude that according to the excavated earliest fortified settlements in the region, timber constructions (usually a double row of timber posts) were the earliest human-made fortifications in Lithuania, built earlier than the earthen structures of ditches and ramparts (Grigalavičienė 1995, 56-61; Kulikauskienė 1986, 16). Some researchers date the earliest fortified settlements in Lithuania back to the last quarter of the second millennium BC or to the very beginning of the first millennium BC (Grigalavičienė 1981, 17; 1995, 27, 56-60; Kulikauskienė 1986, 41). At almost the same time, such sites also emerged in Latvia and Estonia (Lang 2007, 67; see Lang 2018, 23-24, for a discussion on chronology).

In the second stage of settlement fortification, single lines of small ramparts and ditches were constructed on the edges of the hills. The chronology of the emergence of earthen defence structures is still a problematic question. According to Kulikauskienė (based also on some Latvian early fortified settlements), the earliest rampart (about 1 m high) and a small ditch in Narkūnai were constructed around the middle or in the second part of the first millennium BC (Kulikauskienė 1986, 18). At the Sokiškiai fortified settlement, according to Grigalavičienė, a ditch (3-5 m wide and 1.1-2 m deep) and rampart (0.5-0.7 m high) were possibly constructed at the very end of the second millennium BC, or at the beginning of the first millennium BC (Grialavičienė 1986, 131). It is obvious that an improvement of our chronology of defence structures is needed.

Excavations of early hillfort interiors provide evidence that the zone behind the defensive structures was occupied by houses build close to the timber posts or rampart (Grigalavičienė 1995, 42-55).

Conclusions

The Bronze Age in the east Baltic region, as well as in some other European regions, was marked by large changes in different fields of society. The newly established fortified settlement sites were one of the signs of these radical changes. The emergence of fortified settlements in Lithuania was a result of a long-lasting and complicated process, which started around the middle and the second part of the second millennium BC in a hilly area of north-east Lithuania and was completed after the establishment of the earliest human-made fortifications: wooden stockades of double rows of timber posts at the edge of hills, and later earthen constructions comprising a small rampart and ditch. The shift from open to hilltop settlement sites, after open settlements had been used for several millennia, was a turning point in the lifestyle of the societies in east Baltic region.

External threats and internal development were two main factors for the radical change of the settlement pattern. Almost at the same time, around the middle of the second millennium BC and a little bit later, impressive barrows started to appear in the coastal area of the south-eastern Baltic region, attesting to the formation of the stratum of elite families in society, whereas commoners were buried in simple pit graves, without above-ground barrow constructions. A hierarchical, stratified, partly centralised society had been formed (Merkevičius 2005, 47-50; 2016, 131-42).

According to our model, two stages leading from open to fortified settlements can be distinguished. In the first stage, some communities gradually changed the location of their settlements and moved from open sites in the lowlands to “naturally protected”, difficult to access places in the landscape. Natural rises, such as hills, higher river and lake banks, promontories, islands and so on were appropriate kinds of places, which provided good natural protection and catered to these new needs. In the second stage, the majority of hilltop settlements became gradually fortified after some time. One can stress that the fundamental change in the settlement pattern was a shift from one type of settlement location in the landscape to the other. Location in this case is very important.

Changes in settlement location happened not only by “free choice”. Communities were forced to adapt to the newly changed situation in the region. The possibility to live safely in comfortable open (unfortified) settlement sites was coming to an end. The process of socio-political adaptation through the adjustment in the natural environment had started.

To sum up, the emergence of fortified settlements, a radical new type of sites, is the reflection not only of external threats, but also of radical internal changes within society. We need more data, for example on changes in community size or more detailed chronologies, to further disentangle whether these processes were driven mainly by communal decision making, by the rise of elites itself, or by a combination between the two.

Acknowledgements

I would like to thank Dr Daniela Hofmann for her kind help and valuable comments and two anonymous reviewers for their valuable comments, which helped to improve the article.

Biblography

Baubonis, Z., Stončius, D., Šatavičius, E. and Zabiela, G. (eds) 2017. *Lietuvos piliakalniai. Atlasas* 4. Vilnius: Lietuvos archeologijos draugija.

Bogušienė, O. and Rimantienė, R. 1974. Akmeniniai gludinti kirviai. In R. Rimantienė (ed.), *Lietuvos TSR archeologijos atlasas* 1. *Akmens ir žalvario amžiaus paminklai,* 84-205. Vilnius: Mintis.

Brazaitis, D. and Piličiauskas, G. 2005. Gludinti titnaginiai kirviai Lietuvoje. *Lietuvos archeologija* 29, 71-118.

Butrimas, A. 2019. *Biržulis. Medžiotojai, žvejai ir senieji žemdirbiai X-II tūkstantmetyje pr. Kr. 1. Paminklų tyrinėjimai. Summary: Biržulis: hunters, fishermen and ancient farmers 10 000-1000 BC. Site research*. Vilnius: Vilniaus dailės akademijos leidykla.

Darvill, T. 1998. *Prehistoric Britain*. London: Routledge.

Gamble, C. 2004. *Archaeology: the basics*. London: Routledge.

Girininkas, A. 2011. *Baltų kultūros ištakos 2*. Klaipėda: Klaipėdos universiteto leidykla.

Grigalavičienė, E. 1981. Kada buvo apgyvendinti piliakalniai. *Lietuvos istorijos metraštis* 1981, 5-18.

Grigalavičienė, E. 1986a. Nevieriškės piliakalnis. Švenčionių apyl. ir raj. *Lietuvos archeologija* 5, 52-88.

Grigalavičienė, E. 1986b. Sokiškių piliakalnis. Ignalinos raj., Sokiškių apy. *Lietuvos archeologija* 5, 89-138.

Grigalavičienė, E. 1995. *Žalvario ir ankstyvasis geležies amžius Lietuvoje.* Vilnius: Mokslo ir enciklopedijų leidykla.

Harding, A. 1994. Reformation in Barbarian Europe, 1300-600 BC. In B. Cunliffe (ed.), *The Oxford illustrated history of prehistoric Europe*, 304-35. Oxford: Oxford University Press.

Harding, A. 2000. *European societies in the Bronze Age*. Cambridge: Cambridge University Press.

Hodder, I. 1995. *Theory and practice in archaeology*. London: Routledge.

Kristiansen, K. 2000. *Europe before history*. Cambridge: Cambridge University Press.

Kristiansen, K. and Larsson, T.B. 2005. *The rise of Bronze Age society. Travels, transmissions and transformations.* Cambridge: Cambridge University Press.

Lang, V. 2007. *The Bronze and Early Iron Ages in Estonia.* Tartu: Tartu University Press.

Lang, V. 2018. Fortified settlements in the eastern Baltic: from earlier research to new interpretations. *Archaeologia Lituana* 19, 13-33.

Merkevičius, A. 2005a. Karyba Lietuvos teritorijoje žalvario amžiuje. *Karo archyvas* 20, 8-49.

Merkevičius, A. 2005b. Material culture and the east Baltic Bronze Age society. In V. Lang (ed.), *Culture and material culture. Papers from the first theoretical seminar of the Baltic archaeologists (BASE) held at the University of Tartu, Estonia, October 17th-19th, 2003,* 39-52. Tartu, Riga, Vilnius: University of Tartu, University of Latvia, University of Vilnius.

Merkevičius, A. 2007. Material culture and the Bronze Age society in Lithuania. In A. Merkevičius (ed.), *Colours of archaeology. Material culture and the society. Papers from the second theoretical seminar of the Baltic Archaeologists (BASE) held at the University of Vilnius, Lithuania, October 21st-22nd, 2005*, 93-107. Vilnius, Helsinki, Riga, Tartu: University of Vilnius, University of Helsinki, University of Latvia, University of Tartu.

Merkevičius, A. 2009. Material culture and social memory in the east Baltic societies during the Bronze Age and Pre-Roman Iron Age. In A. Šnē and A. Vasks (eds), *Memory, society, and material culture. Papers from the third theoretical seminar of the Baltic Archaeologists (BASE) held at the University of Latvia, October 5-6, 2007*, 59-69. Riga, Helsinki, Tartu, Vilnius: University of Latvia, University of Helsinki, University of Tartu, University of Vilnius.

Merkevičius, A. 2014. *Ankstyvojo metalų laikotarpio laidojimo paminklai Lietuvoje.* Vilnius: Vilniaus universiteto leidykla.

Merkevičius A. 2015. Archaeology of late prehistoric religion in Lithuania: new reconstruction possibilities. In A. Haak, V. Lang and M. Lavento (eds), *Today I am not the one I was yesterday: archaeology, identity, and change. Papers from the fourth theoretical seminar of the Baltic Archaeologists (BASE), Archaeology and identity, held at the University of Helsinki, Finland, October 8th-10th, 2009, and the fifth theoretical seminar, Archaeology today: things to be Changed, held at the University of Tartu, October 27th-29th, 2011*, 219-30. Tartu, Helsinki, Riga, Vilnius: University of Tartu, University of Helsinki, University of Latvia, University of Vilnius.

Merkevičius, A. 2016. West Lithuania during the Early Metal Age. In. G. Zabiela, Z. Baubonis and E. Marcinkevičiūtė (eds), *A hundred years of archaeological discoveries in Lithuania*, 130-47. Vilnius: Lietuvos archeologijos draugija.

Merkevičius, A. (ed.) 2018. *Ankstyvojo metalų laikotarpio gyvenvietės Lietuvoje*. Vilnius: Vilniaus universiteto leidykla.

Merkevičius, A. in press. The dynamics of sociocultural system. Stability, continuity and change in archaeological past. *Interarchaeologia* 5.

Merkevičius, A. and Remeikaitė, L. 2012. Kurmaičių mikroregionas ankstyvajame ir senajame geležies amžiuje. *Lietuvos archeologija* 38, 107-20.

Merkevičius, A. and Remeikaitė, L. 2018a. Velikuškės 1, piliakalnis, Zarasų r. sav., Antazavės sen. In A. Merkevičius (ed.), *Ankstyvojo metalų laikotarpio gyvenvietės Lietuvoje*, 1191-93. Vilnius: Vilniaus universiteto leidykla.

Merkevičius, A. and Remeikaitė, L. 2018b. Sokiškiai, piliakalnis, Ignalinos r. sav., Dūkšto sen. In A. Merkevičius (ed.), *Ankstyvojo metalų laikotarpio gyvenvietės Lietuvoje,* 1053-59. Vilnius: Vilniaus universiteto leidykla.

Milisauskas, S. and Kruk, J. 2011. Late Neolithic/Late Copper Age 3500-2200 BC. In S. Milisauskas (ed.), *European prehistory. A survey*. 2nd edition, 293-325. New York: Springer.

Popham, M. 1994. The collapse of Aegean civilization at the end of the Late Bronze Age. In B. Cunliffe (ed.), *The Oxford illustrated history of prehistoric Europe*, 277-303. Oxford: Oxford University Press.

Rimantienė, R. 1989. *Nida. Senųjų baltų gyvenvietė.* Vilnius: Mokslas.

Tarasenka, P. 1933. *Velykuškių piliakalnis*. Manuscript stored at the Library Manuscript Department of the Lithuanian Institute of History, no. 1598.

Tarasenka, P. 1956. *Lietuvos piliakalniai.* Vilnius: Valstybinė politinės ir mokslinės literatūros leidykla.

Vasks, A. 1994. *Brikuļu nocietinātā apmetne. Lubāna zemiene vēlajā bronzasun dzelzs laikmetā (1000. g. pr. Kr. – 1000. g. pec Kr.).* Riga: University of Latvia.

Volkaitė-Kulikauskienė, R. 1986. Narkūnų didžiojo piliakalnio tyrinėjimų rezultatai (Apatinis kultūrinis sluoksnis). *Lietuvos archeologija* 5, 5-49.

Wardle, K.A. 1994. The Palace Civilization of Minoan Crete and Mycenaen Greece, 2000-1200 BC. In B. Cunliffe (ed.), *The Oxford illustrated history of prehistoric Europe*, 202-43. Oxford: Oxford University Press.

Zabiela, G. 2005. Piliakalniai – seniausieji Lietuvos gyvybiniai įtvirtinimai. In Z. Baubonis and G. Zabiela (eds), *Lietuvos piliakalniai atlasas. Akmenės Kupiškio rajonai 1*, 4-21. Vilnius: LR Krašto apsaugos ministerija.

Zabiela, G. 2018. Degėsiai, piliakalnis, Utenos r. sav., Užpalių sen. In A. Merkevičius (ed.), *Ankstyvojo metalų laikotarpio gyvenvietės Lietuvoje,* 240-41.Vilnius: Vilniaus universiteto leidykla.

Interpreting Bronze and Iron Age enclosed spaces, fortifications and boundaries in the western Baltic

Jutta Kneisel, Ines Beilke-Voigt, Oliver Nakoinz

Introduction

Fortified complexes of the Bronze and Iron Age are a broad topic that goes back a long way in the history of central European research. Already W. Unverzagt and C. Schuchhardt recognised the potential of fortified sites and initiated the "Arbeitsgemeinschaft zur Erfassung der nord- und ostdeutschen vor- und frühgeschichtlichen Wall- und Wehranlagen" (Working group for the registration of north and east German pre- and protohistoric fortifications) in Kiel in 1927 with the objective of a diachronic study (Grunwald 2009). The aim was to record all fortifications between the Elbe and the Vistula in order to assess their status from the point of view of monument conservation. The c. 1000 index cards that have been preserved contain general information about each monument, such as the name of the field, district, short description, state of preservation and location sketch, as well as detailed plans of the exact location and form of the fortifications. The approximately 3,600 sites mentioned in the project application encompassed all the fortifications from the Bronze Age to the Early Middle Ages inventoried by the state heritage management offices in what were then the German border regions. However, only part of the fortifications could be recorded and parts of the archives were lost. After the working group was dissolved, what remained was transferred to the "Arbeitsgemeinschaft für die Erforschung der Vor- und Frühgeschichte des deutschen Ostens" (Working group for the study of pre- and proto-history of the German east) in 1932, whose aim now included clear political motives in search on the demarcation of the border in the east between "Slavs" and "Germanic tribes". A detailed account of the history of research can be found in S. Grunwald (2009), who concludes that fortification research dominated in this region in the first half of the twentieth century.

This research on the fortifications from both the Polish and the German side forms the basis of Bronze and Iron Age settlement studies, as is still reflected in publications today. In recent decades, individual investigations stand out due to new and comprehensive excavations, such as the Hünenburg near Watenstedt (Heske 2006) or Duhnen near Cuxhaven (Lower Saxony; Mennenga 2019; Spohn 2008), the publication of the excavations in Lossow, Brandenburg (Beilke-Voigt 2014; Griesa 2013) or investigations in Sobiejuchy, Greater Poland (Harding *et al.* 2004) and the use of scientific analyses. The University of Frankfurt's LOEWE project on prehistoric conflict research deals with fortified sites between the Taunus and Carpathians (e.g. Krause 2019, 24) and has so far presented distribution maps in time slices for this region (Hansen 2019, 96 figs 1-4). In addition, numerous investigations on newly discovered fortified sites have been carried out (e.g. Gogâltan *et al.* 2019; Szentmiklosi *et al.* 2011). Within the framework of the Excellence Cluster ROOTS and the subcluster "Conflict and conciliation", a group of researchers is studying fortified sites from the Late Neolithic to the Early Middle Ages in northern Europe. The authors focus on the period between the Early Bronze Age, from about 2000 BC, to the end of the Pre-Roman Iron Age in the region between Marburg and Uppsala, between the German low mountain ranges and northern Scandinavia (Nakoinz *et al.* 2017 and Figure 1).

In D. Hofmann, F. Nikulka and R. Schumann (eds) 2022. *The Baltic in the Bronze Age. Regional patterns, interactions and boundaries*, Leiden: Sidestone Press, pp. 231-250.

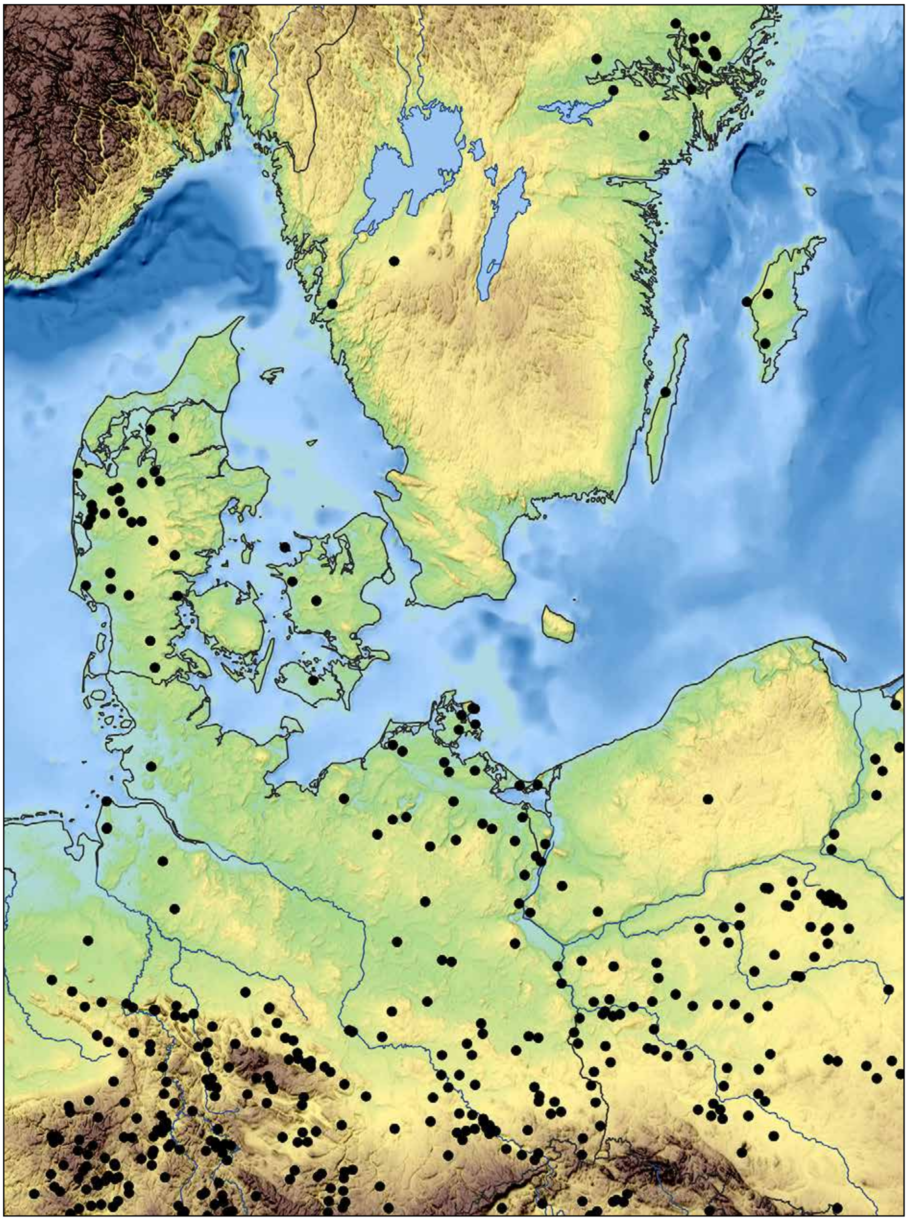


Figure 1. Distribution map of boundaries and fortified structures from the Bronze and Iron Age in the area under study (Nakoinz *et al.* 2017 with catalogue).

With this site collection, the project extends the distribution maps of fortified sites created in the LOEWE project (Hansen 2019, 96 figs 1-4) further towards the north.

The aim of the article is to provide an overview of the different fortifications and boundaries in the Bronze and Iron Age of northern Europe. Two types of boundaries can be distinguished. First, there are enclosing structures in the landscape which surround an area and thus form an “inside” and an “outside”. Second, linear boundaries in the landscape form a border separating an “in front” and a “behind”. The function and temporal position of both types of structures are described and discussed in terms of their possible function. In a case study, an attempt is made to understand the fortifications of the Early Bronze Age in northern Europe as territorial boundaries, alongside other functions.

Definition

Fortification is a very wide term. Therefore, we will here foreground spatial, and not functional aspects. We understand fortification as demarcation in general (Delfino *et al.* 2020; Hesse 2009; Kneisel 2018; Menne and Brunner 2020). This includes both the Lusatian ramparts with settlement traces and ritual structures, such as the site of Duhnen-Cuxhaven (Spohn 2010), as well as linear structures that run through the landscape, for instance pit alignments, land boundaries or sea barrages. Anything that emphasises an area through delimitation or demarcation is included.

A fortification is a structure which surrounds or delimits a certain area or region using permanent means such as ditches, ramparts, banks, palisades, henges and pit zones. It is thus a physically manifested boundary, whether it is linear in appearance or encloses space. A boundary hence includes the confrontation or understanding of self/us and other/them and consequently leads to inclusion and exclusion (Hofmann 2009, 68). At the same time, it strengthens internal social cohesion. In contrast to the extent of culture groups (as e.g. illustrated on distribution maps), which can imply a demarcation from others, but whose utility or applicability has been critically discussed (e.g. Müller 2000; Sangmeister 1967), fortifications are physically manifested constructions whose intention of exclusion and/or containment cannot be denied. Depending on their construction, chronology, use and location in the landscape, different interpretations can be suggested.

Over the long history of research, different readings for example of prehistoric forts have indeed been proposed. They have been regarded as protective banks against "enemies" and thus as indicators of conflicts and violence. An increase in such sites can therefore indicate a crisis or an increase in conflicts (e.g. Jaeger 2018, 149; Jockenhövel 1990, 220, 228). For example, at some Early Iron Age fortified sites in eastern central Europe, the scattered skeletal material and Scythian arrowheads were interpreted as signs of attacks by eastern horseback nomads (Bukowski 1977). Shaft pits on some of these sites were discussed as ritual places and thus the sites interpreted as ritual sites (Beilke-Voigt 2013). An interpretation as central places is also frequently found, as import finds, rare raw materials and signs of production cluster there (Nakoinz 2012; e.g. Gackowski 2015; Müller *et al.* submitted). Fortified sites could thus have an organisational function and control trade (Beilke-Voigt 2017). Another interpretation that can be found in the older literature is that of border or refuge forts (Fernández-Götz 2018, 127; Koch-Heinrichs 2017; Schulze-Forster 2007), which are often built close to the edge of one's territory or at places which are difficult to access (e.g. mountaintops; see e.g. Fernández-Götz 2018; Schulze-Forster 2007). Fortified settlements are supposed to demarcate territory against other groups and at the same time ensure a stronger internal cohesion. However, it can be assumed that in many cases the interpretation must be rather more complex and poly-functional. Table 1 gives an approximate overview of the different kinds of fortifications and their date in our research area. The chronological classification in the text is based on Reinecke's central European chronological system. The table shows the wide range of delimiting and enclosing structures. The two basic types are structures that completely enclose an area or delimit it by incorporating natural features, and linear structures in the landscape. In the following sections, the two types of boundaries will be described in chronological order.

Enclosures

Enclosed sites are those completely surrounded by ramparts, palisades, ditches and/or fences. In addition, segmented ramparts or ditches which form a closed area in conjunction with a natural feature such as a lake or hilltop are included. Enclosed sites are more frequent than linear structures. They can differ strongly in terms of their function, significance and also in their interpretation.

Fortification	EBA	MBA	LBA	EIA	LIA
	2000-1500 BC	1500-1300 BC	1300-800 BC	800-500 BC	500-1 BC
Hilltop	•			•	•
Lowland	•			•	•
Circular fort		•	•	•	
Segmented rampart	•		•	•	•
Linear earthwork			•?		
Multi-part ramparts			•	•	•
Rampart	•	•	•	•	•
Ditch	•	•	•	•	•
Palisade	•		•	•	
Pit fields / zones			•	•	•
Pit alignments			•	•	
Cooking pit rows		•	•	•	•
Wave breaker	•			•	
Sea barrage					•
Henge-like	•				
Cemetery enclosure					•
Fence (house)			•		
Fence (settlement)			•	•	•
Celtic fields			•	•	•

Table 1. Overview of the different structures and their chronological distribution. Abbreviations: EBA – Early Bronze Age, MBA – Middle Bronze Age, LBA – Late Bronze Age, EIA – Early Iron Age, LIA – Late Iron Age.

Early Bronze Age

For the Early Bronze Age only a few fortified sites exist in the study area. One type comprises the henge-like structures from Saxony-Anhalt (Pömmelte-Zackmünde, Schönebeck), which consist of several palisade circles and are surrounded by graves. The structures date to the transition from the Late Neolithic to the Early Bronze Age and are interpreted as ritual places on the basis of the relation to funerary behaviour (Spatzier 2017; 2018). Otherwise, fortified settlements are so far only known from Poland. These include the Bruszczewo settlement and Radłowice (Lasak and Furmanek 2008; Müller and Czebreszuk 2003), as well as the settlements of Jędrychowice and Nowa Cerekwia, which are situated on higher ground at the transition zone to the low mountain ranges. Another three sites are known from southern Poland, but they do not fall within the study area (Jaeger 2018, 266 fig. 1). The northern four settlements can be assigned to the Únětice groups based on the recovered finds. Large grave mounds are known in the vicinity of Bruszczewo and Radłowice. The settlements are situated at the eastern edge of the distribution of Únětice sites and form a border between metal-rich and metal-poor regions. In addition, they are regularly distributed 110 km apart from each other as the crow flies. A further 110 km on lies the Moravian Gate, the access to the Carpathian Basin and eastern Alps (see case study below).

Middle Bronze Age

For the Middle Bronze Age, or Period II-III, only the enclosed site of Duhnen (Lower Saxony) can be listed, whose main rampart dates from 1550-1250 cal BC (Wendowski-Schünemann and Veit 2013, 205). The exposed position towards the North Sea, the presence of a burial mound inside the enclosure, a number of cooking pits and the lack of settlement traces indicate a ritual character beyond the Older Bronze Age (Mennenga 2019).

Late Bronze Age and Early Iron Age

It was not until the Late Bronze Age that fortified places were increasingly built in Saxony, Brandenburg and Poland, some of which continued into the Iron Age. These fortifications run along the large river systems up to the coast. The island of Rügen alone has several possible sites. A number of fortifications have also been identified in Mecklenburg-Western Pomerania. They are situated like beads on a string at a similar distance to the Baltic (Dräger 2014, 224 fig. 1). Also, the fortified site of Horst, Brandenburg was established close to the well-known Late Bronze Age barrow at Seddin (May and Hauptmann 2011, 137).

A few of these sites start from Hallstatt B (Ha B; c. 1000-800/700 BC) at the latest, if not a little earlier. However, most date to Ha C. They are primarily oriented along river systems. While Mecklenburg has only a few well-researched complexes, the Lusatian forts have been intensively studied for centuries (e.g. Beilke-Voigt 2010; Bérenger 1999; Buck 1982; Coblenz 1963; Gediga 2017; Grimm 1958; Harding *et al.* 2004; Heine 1999; 2000; Jockenhövel 1990; 1999; Kobyliński and Nebelsick 2008; Malinowski 1955; Nakoinz *et al.* 2017; Niesiołowska-Wędzka 1974; Peschel 1999). The Hünenburg near Watenstedt, Lower Saxony also dates to this early phase (Heske 2006). The comprehensive investigations have revealed it as a central site with an outside settlement, which is closely integrated into a far-reaching exchange network (Heske 2010; Heske *et al*. 2010). The same is true for many of the Lusatian settlements, whose exchange network is documented by exceptional finds (e.g. a ram figurine from Lossow, Beilke-Voigt 2018), amber processing (Komorowo: Malinowski 2006) and the metalworking frequently attested at such sites (Czarnowo: Gackowski 2015). In recent times, the centrality aspect and trade have often been cited as arguments for the establishment of fortified sites, in contrast to an earlier reading based on protection from enemies and "*Fluchtburgen*" (refuge forts) (Beilke-Voigt 2017).

In the Polish region, very special fortified settlements emerge during the Ha C period. The fortified lake shore settlements of the Biskupin type show a dense and mostly regular layout of houses, but are abandoned after a short period of time. The interpretation of these sites ranges from military camps via proto-urban settlement structures to economic centres. The first reading seems unlikely given the absence of indications for warrior bands in the Lusatian area, which are not visible before Ha D, i.e. from around 600 BC (Kneisel 2012, 295-313). In contrast, these first signs of an impressive settlement agglomeration cannot be dismissed and the evidence of varied production activities supports the interpretation of settlement centres (e.g. Harding *et al.* 2004, 194-200). An essential function of the fortifications was also to protect against rising water or ice. Some sites, such as Komorowo, also served as trade centres between the Baltic and the Hallstatt region (Malinowski 2006), in this case also supported by the nearby cemetery of Gorszewice with its numerous Ha C import finds, which here reach their northernmost point in Poland (Narożna-Szamałek and Szamałek 2007).

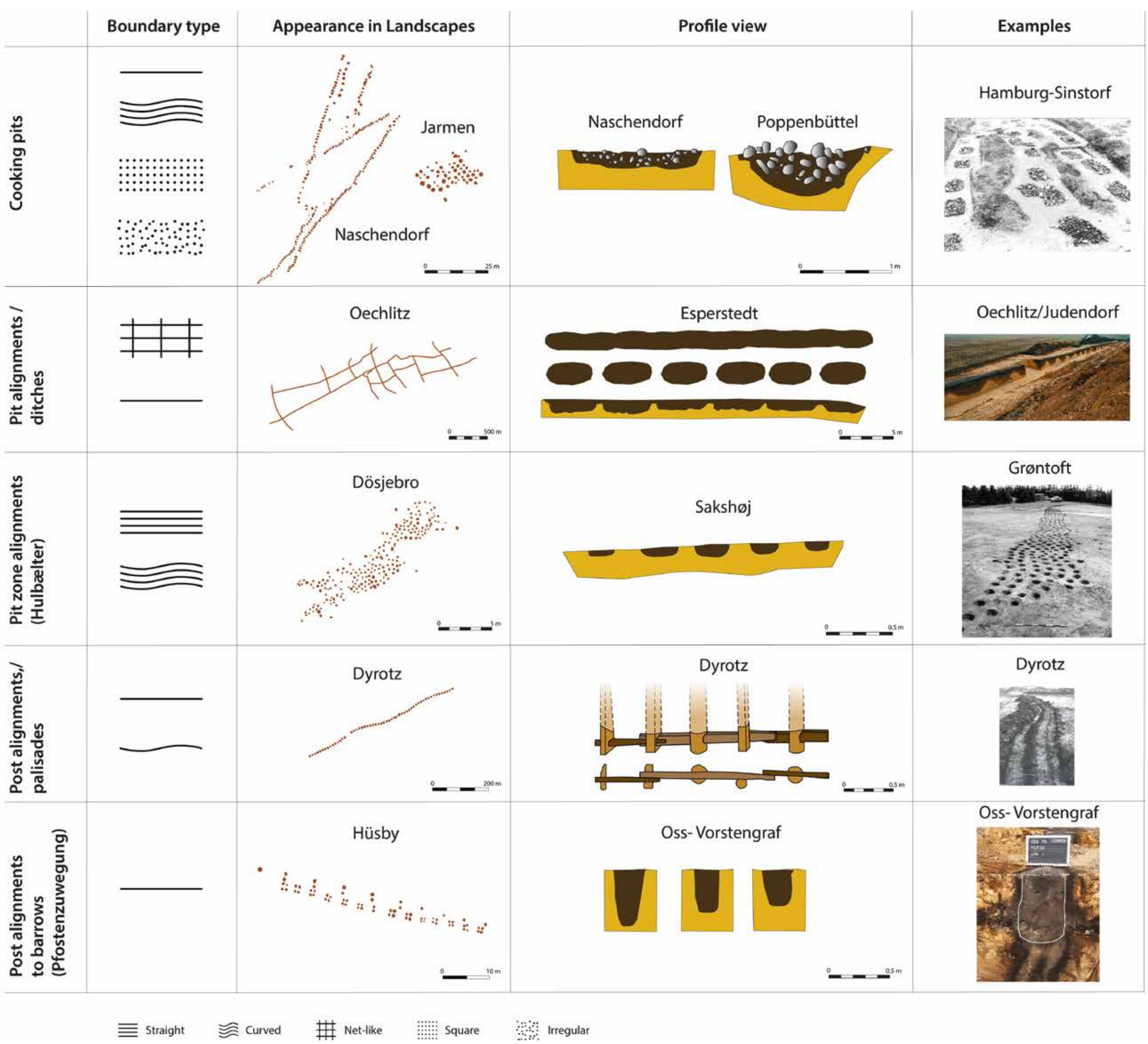
In addition to ramparts, ditches and complex palisade enclosures, which are interpreted as fortifications and defensive structures, we also know of simple ditch-and-bank structures, which had less of a fortification character and rather served to delimit settlement units. Late Bronze Age examples are known from Zwenkau, Saxony (Huth and Stäuble 1998) or Løgstrup, Denmark. While in Zwenkau the entire settlement is enclosed, in Løgstrup different houses are separated from each other by several ditches. Bronze casting was also carried out at this settlement (Mikkelsen 2012, 48 fig. 9).

The so-called Celtic fields represent enclosures of cultivated land dating from the Bronze Age onwards, and are more strongly represented in northern Europe from the Iron Age (e.g. Arnold 2011; Helt Nielsen *et al.* 2018). As they have a clear function that is related to agricultural practice rather than fortification, they will not be discussed further here.

Later Iron Age

In the period after 500 BC many of the fortified sites in Poland and along the Oder river were abandoned. In some cases, horizons of destruction testify to their violent end (Słupca: Bukowski 1977; Wokroj 1958). In Lower Saxony, Schleswig-Holstein and Scandinavia, new fortified sites were built (Martens 2007; Nakoinz *et al.* 2017, 34). For a long time, Borremose in Jutland was considered the only fortified settlement, well-known not least because of the Gundestrup cauldron found nearby (e.g. Martens 1988). Modern large-scale excavations have uncovered other sites in Denmark with elaborate fortifications, such as Lyngmose, Grøntoft (Becker 1971; Eriksen *et al.* 2003) or Kjelst/Tarp (Martens 2007, 95). But also fencing in of settlements is repeatedly documented, for instance in Hodde and Galsted, Denmark (Hvass 1985; Løvschal 2015; Rindel 2010). In Sweden, the so-called *fornborgar* are a long-known site type, dating largely to the Roman Iron Age and later, but there is occasional evidence of settlements dating to the Bronze and Pre-Roman Iron Ages (Nakoinz *et al.* 2017, 39).

Figure 2. Examples of linear structures in northern Europe (from top left: Mewis and Schmidt 2011; Hüser 2011; Schunke 2017; Glaser and Glaser 2006; Eriksen and Rindel 2018; May 2009; Freudenberg 2012; Jansen and Fokkens 2007). Image: Kneisel/Reckweg.



Linear structures

In addition to the fortified enclosures, the Bronze and Iron Ages have also yielded numerous linear structures that subdivide the landscape. We know ritual linear post structures that are related to burial mounds, for example from the Older Bronze Age (1500-1100 BC) burial mound in Hüsby near Schleswig (Freudenberg 2012b). Other so-called processional paths have recently been uncovered in Boest Mose in connection with an axe deposit; here, too, there are grave mounds nearby (pers. comm. C. Rassmann). According to M. Freudenberg, Older Bronze Age access paths to graves and individual rows of posts related to grave sites are found mainly in western Lower Saxony, the Netherlands and England (Fokkens 2013; Freudenberg 2012a, 7 fig. 3; Wilhelmi 1986).

Linear fences or palisades were found at Neu Pansow, Mecklenburg-Western Pomerania (Segschneider 2005) or Dyrotz, Brandenburg, where the posts are related to a row of pits with a complex wooden foundation for the posts (Figure 2; May 2009). While the site at Neu Pansow dates to the Pre-Roman Iron Age (fourth to third centuries BC) and thus coincides with the beginning of fortified settlements in northern Europe, Dyrotz dates to the thirteenth century BC and, due to its length of almost 900 m, is not interpreted as a settlement demarcation but as a linear system. The combination of the palisade with pits relates this site more to the pit alignments described below.

A relatively recent phenomenon are so-called pit alignments or *Landgräben* which have so far been observed mainly in central Germany (Duchniewski and Kretschmer 2019; Glaser and Glaser 2006; Nebelsick 2007; Stäuble 2002). They extend over long distances (up to 2 km) through the landscape and partly consist of pits excavated several times, some of which are up to two metres deep. They mainly date to the Bronze and Early Iron Age 1300-500 BC (Schunke 2017). In small-scale excavations, they normally appear as a single row of pits or ditches, but where larger areas have been opened they can form grid-like structures. T. Schunke divides these pit alignments into two kinds. First, the reticulated structures in the landscape seem to delineate rectangular areas of unclear function. Since there are no openings in the pit alignments, access to these areas is difficult or only possible via bridging constructions. These kinds of site primarily functioned as landscape divisions. Second, as for instance at Oechlitz (Saxony-Anhalt), parallel arrangements of these grid-like structures correspond to the terrain morphology on slight ridges above rivers or dry valleys. This naturally enhanced border can also be seen as a border between different population groups and thus as territorial boundary at a larger scale (Schunke 2017). The above-mentioned example of Dyrotz in Brandenburg is likewise laid out parallel to a humid lowland, but in contrast to the pit alignments is additionally provided with a row of posts (May 2009).

Research is also increasingly focusing on the rows of firepits or cooking pits, which have been documented in northern Germany and Scandinavia from the middle of Period II. The pits are filled with fire-cracked cobble stones, discoloured from the heat, and varied amounts of charcoal. There are no other finds. One site of three parallel rows of such pits meandering through the landscape was found in the area of the burial mound of Hüsby, Schleswig-Holstein (Meier 2013). A straight row was found close to the burial mound of Seddin, Brandenburg (Schenk and Goldmann 2004). As they are frequently observed in relation to mounds, a connection with the burial rite is assumed (Schmidt 2005). However, the situation is somewhat different with the firepit rows than with the pit alignments. The multiple, criss-crossing and intersecting rows, or the more than ten parallel rows in Naschendorf, Mecklenburg-Western Pomerania (Schmidt 2012), do not fit the picture of a linear boundary. Similarly, firepits have been documented in a semi-circular arrangement at the burial place of Mang de Bargen, Schleswig-Holstein (Schaefer-Di Maida 2018), in parallel rows arranged into squares in Watenstedt near the Hünenburg, Lower Saxony, or at Jarmen, Mecklenburg-Western Pomerania (Heske *et al.* 2012, 316 fig. 6; Schmidt 2005, 71 fig. 2), or in irregular clusters, sometimes near settlements (Schmidt 2005, 74). In contrast to the pit alignments, their layout is therefore not necessarily linear, but also does not enclose areas in the way the pit alignments in Saxony-Anhalt do (Schunke 2017, 87 fig. 13). The earliest evidence dates this phenomenon from Period II until well into the Late Iron Age, when they also occur in Sweden (e.g. Röekillorna; Stjernquist 1997). Around Hamburg, a series of firepit rows are documented from about 1100 BC onwards up to the second century BC (Hüser 2011, 119 fig. 16). On the basis of the ^{14}C dates available for pit alignments and cooking pits, it seems that the pit alignments begin earlier, but run parallel with the cooking pits for a long time (Kneisel *et al.* 2013; Schunke 2017, 88 fig. 14). Spatially, the phenomena are separate, with pit alignments found in central Germany; Dyrotz is certainly one of the most northerly sites. In contrast, firepits seem to be restricted to southern parts of northern Europe, with Egeln, Saxony-Anhalt probably the southernmost point (Mewis and Schmidt 2011, 68; see also Løvschal and Fontijn 2019, 144 fig. 2).

Another kind of linear demarcation, which has been observed more and more frequently in recent years, are multiple pit alignments (*hulbælter*) forming pit fields. In contrast to single pit alignments, they consist of several rows of parallel smaller pits (Eriksen and Rindel 2018). Sometimes there are small pointed stakes between the pits (Schlosser Mauritsen 2010, 267). These structures are also called "Caesar's lilies" and are interpreted exclusively as defensive structures. They all date back to the Late Iron Age and, with a few exceptions, are concentrated in central Jutland, particularly in the western area around Ringkøbing. Their distribution seems to almost bisect the Jutland peninsula (Eriksen 2018, 14 fig. 4).

The first sea barrages and land boundaries are documented in Denmark from the Late Iron Age onwards (Martens 2007, 88 fig. 1; Nakoinz *et al.* 2017, 37). Their interpretation as defensive structures is unquestionable.

Boundaries and enclosed spaces

The boundary structures presented here can be divided into enclosing and linear structures. While the enclosing constructions usually demarcate or surround settlements and, in a few cases, also ritual sites, the linear constructions offer a much more differentiated picture. Large-scale excavations can reveal alignments of pits which surround delimited areas, but the use of these inner areas is still unclear and goes beyond the dimensions of common settlements. Despite their grid-like structure, in smaller-scale excavations such sites can look like linear alignments (e.g. for central Germany: Schunke 2017, 86 figs 12-13). *Hulbælter* and firepit rows, on the other hand, run as more or less linear alignments through the landscape. Firepit clusters are also found in non-linear form and although the relation to burial mounds is not always given, they are often associated with the ritual sphere (Heidelk-Schacht 1989; Henriksen 2005; Honeck 2009; Schmidt 2005). *Hulbælter*, on the contrary, have been interpreted as land boundaries with a demarcating function, while M. Løvschal mainly sees them as communication lines and borders between different kinds of landscapes (Løvschal 2015, 12; 2018).

In conflict research, the need to set limits or to set boundaries is often understood as an indication of an increased potential for conflict (e.g. Løvschal 2015, 16; Nakoinz *et al.* 2019, 4). Weapons, fortifications or even pictorial representations of fighting individuals are used to address an increased potential for conflict, violence and war. For the authors, who grew up during the Cold War period, partly in a walled-in city behind the Iron Curtain, no time was more peaceful in Europe than this. Armament and the demonstration of power with weapons were common and although there were many victims of this conflict, open war and direct combative confrontations by larger groups were far less frequent (e.g. Schwank 2012; 2018; Statista 2021). This modern example certainly has no universal validity, it is merely intended to illustrate that demarcation and weapons may not necessarily indicate exclusively violent conflict, but also conflict avoidance strategies, as in the case of the state governments during the Cold War (MAD-Doctrine[1]). The construction of borders, deterrence through fortifications and the designation of mutually recognised demarcated areas or the formation of territories can be an indication of conflict prevention (e.g. Løvschal 2015, 17; Veit 2018, 127).

1 MAD stands for "mutual assured destruction" and describes the logic behind nuclear armament.

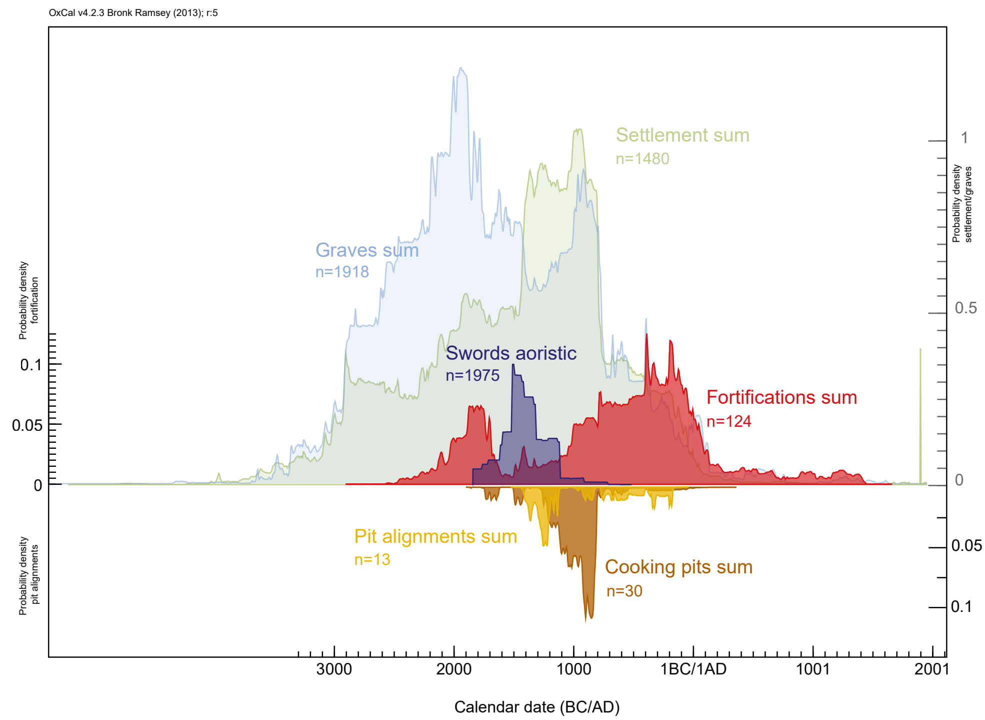


Figure 3. The chronological sequence of fortifications, swords and pit alignments. Swords according to aoristic calculation, remainder based on sum calibration of ^{14}C-dates (created using OxCal). Image: Kneisel/Reckweg.

Therefore, the ROOTS project not only researches conflicts in prehistory, but also records indications of conciliatory actions or states of affairs. Borders need not indicate conflict and crisis, but could also point to the possibility to resolve or at least avoid escalation by drawing boundaries. Here the concept of territoriality plays an important role. The demarcation of territories can also include a mutual agreement on a border. In the original sense of the word, a territory refers to a piece of arable land or an urban area belonging to a city, but it can also be used politically as the area of control or territory of a state. In this text it is referred to as "a kind of regulation of spatial organisation. Territoriality appears to have the capacity of preventing conflict escalations under certain circumstances, while territoriality also emerges as conflict potential under other circumstances" (Nakoinz *et al.* 2019, 8). In this sense, borders serve above all as long-range regulators within a landscape and can thus be used to form territories, i.e. enclosed spaces. A heavily fortified border is more likely to indicate conflict, which necessitates a fortification-based demarcation, while slight ditches or fences would certainly indicate demarcation without violence and thus a joint agreement between two parties. The situation is different in the case of fortified settlements, which, although they represent a territory or a delimited area, can only be understood at the local scale. A territorial reading would only be appropriate for several fortifications and their location in the landscape. While the latter will be discussed in the Early Bronze Age case study at the end of this article, we first provide a compilation of the various fortifications to give an overview of their temporal coexistence and the resulting congruence. We also draw on the occurrence of swords in the Bronze Age, as this is the first implement exclusively usable as a weapon.

In Figure 3, the different types of fortifications are contrasted, alongside overall settlement and grave sites. As far as possible, sum calibrations of enclosing structures and linear boundaries were performed (based on data in Kneisel *et al.* 2013). There is considerable discussion surrounding sum calibrations, but at this stage it is only intended as an overview and stimulation for further discussions[2]. They are supplemented by an

2 The dataset has limitations. On the one hand, the database contains mostly Bronze Age and some Iron Age data, on the other hand, some few sites have provided a lot of dates, which influence the curves. In addition, the number of dated firepits and pit alignments is quite small. Nevertheless, this presentation was chosen to obtain a first comparison. Further dates are being collected as part of the ROOTS project.

aoristic calculation of the swords as a frequency curve. The aoristic method originates from crime statistics and makes it possible to display events of different duration together in one graph (Mischka 2004). Thus, it is possible to display artefact types with different chronological lifetimes quantitatively on a common curve (as in Figure 3)[3].

The distribution of fortified settlements is very irregular, both chronologically and spatially. While we observe a marked increase of fortified settlements from the Late Bronze Age onwards, i.e. at the same time as the battle in the Tollense valley, such settlements are rather an exception in the Early Bronze Age, at least north of the low mountain ranges. The sum calibration of all fortified settlements for northern Europe shows a gap between 1600 and 1000 BC, followed by a second increase of fortifications which reaches into the Late Iron Age. Into this gap of fortifications falls the increase in swords (1600-1100 BC), which subsides with the renewed increase of fortified settlements. A similar sequence has been observed by S. Hansen for southern and south-eastern Europe and he attributes this to the introduction of iron swords, which have not been preserved (Hansen 2019, 99 fig. 6). However, it could also be argued that swords were no longer deposited in archaeologically retrievable contexts (graves, hoards), which would allow a statement about their significance in the Bronze Age. In the same temporal gap, we observe an increase of pit alignments and the beginning of linear boundaries in central Europe. The firepits, on the other hand, date later and coincide with the renewed rise of fortified sites[4]. However, the spatial distribution of pit alignments and firepits hardly overlaps with that of fortified settlements (only in Saxony are both types of sites found together).

If we equate swords with increased conflict potential, the curve seems to run more parallel to the construction of the linear boundaries than to fortified settlements. Moreover, the increase of fortified settlements appears to be accompanied by a decrease of the Bronze Age settlement curve, so that it can probably be regarded as a complementary form of settlement, as discussed for the Lusatian fortified sites (Beilke-Voigt 2017; Gediga 2017; Harding *et al.* 2004). Of course, the picture remains incomplete. Arrows and lances are also weapons, but have not yet been added. Concerning arrows, R. Krause (2019) could show for southern Germany that they are often found in connection with fortifications, mostly also in the rampart area. Furthermore, the weapon of choice of the Early Iron Age is the spear or the lance, rather than the sword (Kneisel 2005). On the other hand, fortified settlements can also be interpreted as central places, as indicated by bronze casting, amber processing or import finds. They can be located at fords and control trade. Their alignment along the river systems speaks for an intensive integration into supra-regional exchange systems.

Are there territorial boundaries in the Bronze Age?

This final section presents a case study of the Early Bronze Age fortifications in Poland to show how different spheres of influence that can be understood as a territory may be connected to each other. The boundary is not physically formed in the sense of a surrounding fortification, but rather as a protection of internal power (wealth) and separation from the exterior and its influence.

The Early Bronze Age (2200-1500 BC) Únětice (Aunjetitz) groups and their material remains can be found in an area between the Harz mountains and the Vistula river in the north, the Warta river in the east and the zone of low mountain ranges to the south. The material has been presented in detail by B. Zich (1996). The Únětice groups belong to the earliest societies in central Europe to work bronze at a large scale. For the western part of this region, B. Zich defined domains controlling metal distribution and where the dead were buried in richly furnished princely graves (Zich 2016). This is also the region where

3 The aoristic distribution of dated swords is based on the catalogues in Bunnefeld 2016, Vogt 2004 and Wüstemann 2004. For the aoristic method see Kneisel *et al.* 2019, 1609.

4 The sum calibration includes all kinds of firepits, but the majority of the dates comes from firepit alignments.

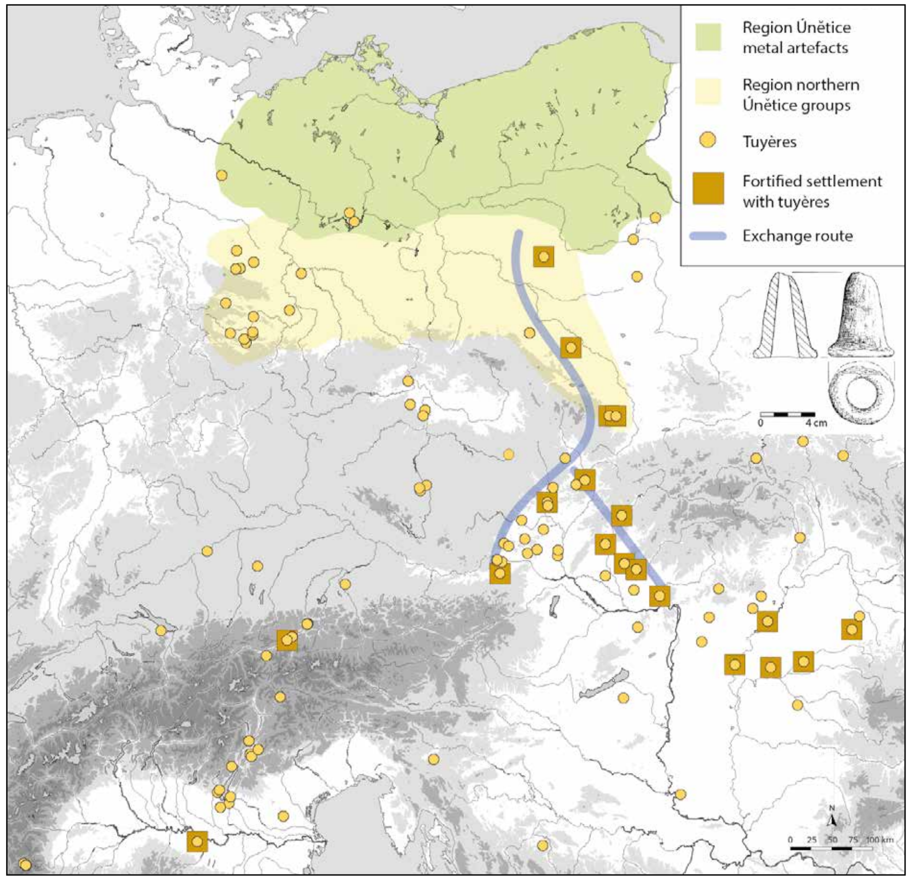


Figure 4. The distribution of Early Bronze Age fortified settlements and metalworking tools (tuyères) in the Early Bronze Age (after Kneisel 2013a, 104 fig. 5). Image: Kneisel/ Reckweg.

the Nebra sky disk was found, an artefact indicating institutionalised power and knowledge (Meller 2010). The distribution of Únětice material culture in the whole northern region can be recorded by mapping bronze artefacts of Únětice type, graves and settlements with typical Únětice inventory (yellow on the map in Figure 4). Further north, in Mecklenburg-Western Pomerania and northern Poland, only bronze finds are preserved, mostly from hoards. Graves are rare and settlements absent. The distribution of tuyères, sometimes up to 300 pieces from one grave (Sachsenburg, Saxony-Anhalt; Overbeck 2018, 303), stretches from the Carpathian Basin to the Warta river and west to the Harz mountains. To the north, there is no evidence of tuyères. This distribution supports the idea that the Únětice groups were metalworking groups. The metal and thus certainly also the technical know-how of metal processing originates from the Alpine region and Carpathian Basin, which can be reached through the Moravian Gate to the south. The further north (green), on the other hand, does not produce any metal, the first evidence of bronze processing in this region dates to Period II (after 1500 BC; Jantzen 2008).

It seems that the Únětice groups were blocking direct access to technical knowledge or the raw material copper, and instead "traded" the artefacts to the north themselves. In modern terms, they monopolised material and know-how. A second possible explanation would be that the north rejects metalworking, but rather exchanges finished bronze items instead. The distribution of Early Bronze Age amber, whose richest and most easily accessible deposits lie in the Baltic coastal area, makes this explanation plausible (Czebreszuk 2012; Müller and Kneisel 2010, 758 fig. 1), since the locations of amber artefacts form a linear pattern (shown in blue on the map) from the Kashubian Lake District to the Moravian Gate and are situated at distances of less than 50 km from each other (for details see Müller and Kneisel 2010, 758 fig. 1). West towards the Harz mountains there are few amber finds (Zich 1996). East of this line they are missing, just as bronze artefacts east of this line are rare. This is the area of the Trzciniec groups, who obviously did not have or want access to either metal or amber. And exactly along this line one finds the only four Early Bronze Age fortifications north of the low mountain range. As mentioned above, these are located 110 km from each other as the crow flies and another 110 km from the Moravian Gate, which leads to the ore deposits, to the purchasers of amber and to numerous other fortified settlements.

Certainly, Bruszczewo, Radłowice or Nowa Cerekwia and Jędrychowice can be understood as an adoption of the custom of fortified settlements from the south, as we already have several of these sites in the Early Bronze Age Carpathian Basin (Bátora *et al*. 2012; Hansen 2019, 96), while further west, in the interior of the Únětice area, fortified sites were apparently deliberately not built. The connection to the south proved by intensive exchange may have provided the idea for the construction of fortifications. It can be assumed that these fortifications secured the trade routes from north to south, but mainly to the east (Kneisel 2013b, 191 fig. 10). Their location at regular intervals in connection with the amber distribution and the eastern "metal-poor" neighbours indicates a border or demarcation function. Trade or exchange with important goods, such as copper or amber, may support the construction of fortified settlements as central trading places. Therefore, in our opinion, the fortified settlements of the Early Bronze Age north of the low mountain ranges can be described as "territorial boundary" in the sense of the above definition. The area of influence of each settlement may have been locally limited, but these sites secured trade with the Únětice core area as well as to areas with natural resources to the south, north and west and protected metalworking. As the Bruszczewo settlements, for example, existed for several hundred years, this type of demarcation apparently worked for a long time. The burning horizon at the end of the settlement, the numerous human bones (Kneisel and Jaeger in press) and the many arrowheads may indicate a violent end. Whether attacks from outside or internal social turmoil were the decisive factors is not clear at this point. Around 1650/1550 BC, this "iron curtain" also fell.

Summary

This contribution has provided an overview of the different fortifications in central and northern Europe and described their development from the Bronze Age to the Later Iron Age. Apart from ritual complexes, which occur sporadically during the Bronze and Iron Ages, fortified settlements form the largest part of enclosure sites. The main focus of these complexes is in the Late Bronze Age and Iron Age of central Europe. Only in the Iron Age can fortified or enclosed settlements be observed in northern Europe. Linear complexes which separate spaces from each other, such as alignments of pits, rows of palisades or rows of firepits, occur from the middle of the second millennium onwards and show different spatial distributions. Pit alignments are limited to central Germany, rows of firepits to northern Europe and pit fields are a Danish regional phenomenon. Larger land boundaries or sea barrages can only be observed from the Late Iron Age onwards. An exception is the pit alignment with post construction from Dyrotz, Brandenburg, dated to the thirteenth century BC.

According to the dating available so far, linear boundaries begin in the Middle Bronze Age, a period from which we do not know any fortifications, although the two kinds of site existed in parallel for a long time during the Iron Age. Also, a comparison with the frequency of swords did not show any correspondence with fortified settlements; rather, sword finds seem to dominate in a period when fortified structures are missing. Obviously, the sword does not necessarily function well as an attacking weapon on fortifications (for a comprehensive discussion on Bronze Age warfare see Krause 2019, 15 note 20; and e.g. Bunnefeld 2014; Kristiansen 1984; Kristiansen and Larsson 2005; Vandkilde 2006). Further research will show whether the same can be assumed for arrowheads and lances. Finally, the example of the Early Bronze Age fortifications of the Únětice groups could show that these are more than just local fortified settlements, but can be integrated into a wider exchange network, which allows a clear demarcation to the east and thus the delimitation of a territory.

Acknowledgements

This article is based on close cooperation between the subclusters D3 of CRC 1266, funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation; project number 2901391021-SFB 1266) and Germany's Excellence Strategy ROOTS subcluster 6 "Conflict and conciliation" (EXC-2150 – 390870439). We would like to thank all participants for their intensive and constructive collaboration and discussion. Special thanks go to Michael Bilger for collecting the swords in a database and the editors of this volume and two anonymous referees for their intensive discussion about this topic.

Bibliography

Arnold, V. 2011. Celtic fields und andere urgeschichtliche Ackersysteme in historisch alten Waldstandorten Schleswig-Holsteins aus Laserscan-Daten. *Archäologisches Korrespondenzblatt* 41, 439-55.

Bátora, J., Behrens, A., Gresky, J., Ivanova, M., Rassmann, K., Toth, P. and Winkelmann, W. 2012. The rise and decline of the Early Bronze Age settlement Fidvár near Vráble. In J. Kneisel, W. Kirleis, M. Dal Corso, N. Taylor and V. Tiedtke (eds), *Collapse or continuity? Environment and development of Bronze Age human landscapes. Proceedings of the international workshop "Socio-environmental dynamics over the last 12,000 years: the creation of landscapes II" (14th-18th March 2011) in Kiel*, 111-29. Bonn: Rudolf Habelt.

Becker, C.J. 1971. Früheisenzeitliche Dörfer bei Grøntoft, Westjütland. *Acta Archaeologica Kopenhagen* 42, 79-110.

Beilke-Voigt, I. 2010. Methodische Überlegungen zu bronze-/früheisenzeitlichen Zentralorten mit Bezug auf den Burgwall von Lossow bei Frankfurt (Oder). In C. Theune, F. Biermann, R. Struwe and G.H. Jeute (eds), *Zwischen Fjorden und Steppe. Festschrift für Johan Callmer zum 65. Geburtstag*, 41-56. Rahden: Marie Leidorf.

Beilke-Voigt, I. 2013. Die früheisenzeitlichen Opferschächte von Lossow. Zum Forschungsstand, den Befunden und deren Deutung. In I. Heske, H.-J. Nüsse and J. Schneeweiß (eds), *Landschaft, Besiedlung und Siedlung. Archäologische Studien im nordeuropäischen Kontext. Festschrift für Karl-Heinz Willroth zu seinem 65. Geburtstag*, 139-54. Neumünster, Hamburg: Wachholtz.

Beilke-Voigt, I. 2014. *Das jungbronze- und früheisenzeitliche Burgzentrum von Lossow. Ergebnisse der Ausgrabungen 2008 und 2009.* Rahden: Marie Leidorf.

Beilke-Voigt, I. 2017. Lossow und Lebus. Ein Burgenpaar an der Oder. In I. Beilke-Voigt and O. Nakoinz (eds), *Enge Nachbarn. Das Problem von Doppelburgen und Mehrfachburgen in der Bronzezeit und im Mittelalter*, 91-123. Berlin: Topoi.

Beilke-Voigt, I. 2018. Lossow, Olympia und der Vordere Orient. Zum Fund einer spätgeometrischen Widderfigur im östlichen Brandenburg. In S. Wefers, M. Augstein, I. Balzer, J. Fries-Knoblach, C. Later, K. Ludwig, C. Tappert, P. Trebsche and J. Wiethold (eds), *KunstHandWerk. Beiträge der 26. Tagung der AG Eisenzeit gemeinsam mit der Keltenwelt am Glauberg und der hessenARCHÄOLOGIE im Landesamt für Denkmalpflege Hessen in Bad Salzhausen, 3.-6. Oktober 2013*, 51-68. Langenweißbach: Beier & Beran.

Bérenger, D. 1999. Ältereisenzeitliche Burgen in Westfalen. In A. Jockenhövel (ed.), *Ältereisenzeitliches Befestigungswesen zwischen Maas/Mosel und Elbe. Internationales Kolloquium am 8. November 1997 in Münster anlässlich des hundertjährigen Bestehens der Altertumskommission für Westfalen,* 99-110. Münster: Aschendorff.

Buck, D.-W. 1982. Befestigte Siedlungen der Lausitzer Kultur im Norden der DDR. In B. Chropovský and J. Hermann (eds), *Beiträge zum bronzezeitlichen Burgenbau in Mitteleuropa*, 97-118. Berlin: Zentralinstitut für Alte Geschichte und Archäologie.

Bukowski, Z. 1977. *The Scythian influence in the area of Lusatian culture*. Wrocław: National Ossoliński Institute.

Bunnefeld, J.-H. 2014. Der Häuptling und sein Schwert? Anmerkungen zur sozialen Stellung des Schwertträgers in der älteren nordischen Bronzezeit. In T. Link and

H. Peter-Röcher (eds), *Gewalt und Gesellschaft. Dimensionen der Gewalt in ur- und frühgeschichtlicher Zeit. Internationale Tagung vom 14.-16. März 2013 an der Julius-Maximilians-Universität Würzburg*, 133-43. Bonn: Rudolf Habelt.

Bunnefeld, J.-H. 2016. *Älterbronzezeitliche Vollgriffschwerter in Dänemark und Schleswig-Holstein. Studien zu Form, Verzierung, Technik und Funktion.* Kiel, Mainz: Wachholtz.

Coblenz, W. 1963. Bemerkungen zur Funktion der Lausitzer Burgen Sachsens. In W. Kocka (ed.), *Munera archaeologica Iosepho Kostrzewski quinquagesimum annum optimarum artium studiis deditum peragenti ab amicis, collegis, discipulis oblata*, 193-200. Poznań: Polska Akademia Nauk.

Czebreszuk, J. 2012. *Bursztyn w kulturze mykeńskiej. Zarys problematyki badawczej*. Poznań: Wydawnictwo Poznańskie.

Delfino, D., Coimbra, F., Cruz, G. and Cardoso, D. (eds) 2020. *Late prehistoric fortifications in Europe. Defensive, symbolic and territorial aspects from the Chalcolithic to the Iron Age. Proceedings of the International Colloquium "FortMetalAges", Guimarães, Portugal.* Oxford: Archaeopress.

Dräger, J. 2014. Jungbronze- und früheisenzeitliche Burgwälle in Mecklenburg-Vorpommern. In D. Jantzen, J. Orschiedt, J. Piek and T. Terberger (eds), *Tod im Tollensetal. Forschungen zu den Hinterlassenschaften eines bronzezeitlichen Gewaltkonfliktes in Mecklenburg-Vorpommern 1,* 253-72. Schwerin: Landesamt für Kultur und Denkmalpflege Mecklenburg-Vorpommern.

Duchniewski, B. and Kretschmer, S. 2019. Jungbronzezeitliche Grubenreihen. In H. Meller and S. Friedrich (eds), *Salzmünde-Schiepzig – ein Ort, zwei Kulturen. Ausgrabungen an der Westumfahrung Halle (A 143) Teil II*, 193-96. Halle: Landesmuseum für Vorgeschichte Halle.

Eriksen, P. 2018. Hulbælter. In P. Eriksen and P.O. Rindel (eds), *Lange linjer i landskabet. Hulbælter fra jernalderen*, 11-20. Højbjerg: Jysk Arkæologisk Selskab.

Eriksen, P. and Rindel, P.O. (eds) 2018. *Lange linjer i landskabet. Hulbælter fra jernalderen,* Højbjerg: Jysk Arkæologisk Selskab.

Eriksen, P., Rindel, P.O., Robinson, D.E. and Pedersen, L.H. 2003. Eine befestigte Siedlung der jüngeren vorrömischen Eisenzeit bei Lyngsmose. Eine neuentdeckte Anlage vom Typ Borremose in Jütland, Dänemark. *Archäologisches Korrespondenzblatt* 33, 123-43.

Fernández-Götz, M. 2018. Urbanization in Iron Age Europe: trajectories, patterns, and social dynamics. *Journal of Archaeological Research* 26, 117-62.

Fokkens, H. 2013. Post alignments in the barrow cemeteries of Oss-Vorstengraf and Oss-Zevenbergen. In D. Fontijn, A.J. Louwen, S. van der Vaart and K. Wentink (eds), *Beyond barrows. Current research on the structuration and perception of the prehistoric landscape through monuments*, 141-54. Leiden: Sidestone.

Freudenberg, M. 2012a. Eliten in der Provinz – Überlegungen zu einigen reich ausgestatteten Gräbern der älteren Bronzezeit in Schleswig-Holstein. In T. Kienlin and A. Zimmermann (eds), *Beyond elites. Alternatives to hierarchical systems in modelling social formations. International conference at the Ruhr-Universität Bochum, Germany October 22-24, 2009*, 403-11. Bonn: Rudolf Habelt.

Freudenberg, M. 2012b. Grab und Kultanlage der älteren Bronzezeit von Hüsby, Kreis Schleswig-Flensburg – rituelle Landschaft oder eine Demonstration der Macht am Verbindungsweg zwischen Jütischer Halbinsel und Norddeutschland? In D. Bérenger, J. Bourgeois, M. Talon and S. Wirth (eds), *Gräberlandschaften der Bronzezeit. Internationales Kolloquium zur Bronzezeit Herne, 15.-18. Oktober 2008*, 619-39. Darmstadt: Philipp von Zabern.

Gackowski, J. 2015. Pozostałości warsztatu brązowniczego z osiedla obronnego ludności kultury łużyckiej w Czarnowie (stan. 46, d. Kamieniec), pow. Toruń. *Pomerania Antiqua* 24, 131-44.

Gediga, B. 2017. Einige Bemerkungen über das Problem der "Lausitzer" Doppelburgen in Polen. In O. Nakoinz and I. Beilke-Voigt (eds), *Enge Nachbarn. Das Problem von Doppelburgen und Mehrfachburgen in der Bronzezeit und im Mittelalter*, 145-63. Berlin: Topoi.

Glaser, H.-U. and Glaser, G. 2006. Pit alignments – Rätselhafte Grubenreihen? In H. Meller (ed.), *Archäologie auf der Überholspur. Ausgrabungen an der A 38*, 195-98. Halle: Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt.

Gogâltan, F., Sava, V. and Krause, R. 2019. Sântana-Cetatea Veche. A Late Bronze Age mega-fort in the lower Mureş Basin in southwestern Romania. In S. Hansen and R. Krause (eds), *Materialisation of conflicts. Proceedings of the third international LOEWE conference, 24-27 September 2018 in Fulda*, 191-221. Bonn: Rudolf Habelt.

Griesa, S. 2013. *Der Burgwall von Lossow: Forschungen von 1909 bis 1984. Lossow II.* Rahden: Marie Leidorf.

Grimm, P. 1958. *Die vor- und frühgeschichtlichen Burgwälle der Bezirke Halle und Magdeburg*. Berlin: Akademie-Verlag.

Grunwald, S. 2009. Potentiale der Burgwallforschung. Sächsische Archäologie in der ersten Hälfe des 20. Jahrhunderts. In J. Schachtmann, M. Strobel and T. Widera (eds), *Politik und Wissenschaft in der prähistorischen Archäologie. Perspektiven aus Sachsen, Böhmen und Schlesien*, 149-68. Göttingen: V&R unipress.

Hansen, S. 2019. Hillforts and weaponry in the Early and Middle Bronze Age. In S. Hansen and R. Krause (eds), *Materialisation of conflicts. Proceedings of the third international LOEWE conference, 24-27 September 2018 in Fulda*, 93-132. Bonn: Rudolf Habelt.

Harding, A., Ostoja-Zagórski, J., Palmer, C. and Rackham, J. 2004. *Sobiejuchy. A fortified site of the Early Iron Age in Poland*. Warsaw: Polish Academy of Sciences.

Heidelk-Schacht, S. 1989. Jungbronzezeitliche und früheisenzeitliche Kultfeuerplätze im Norden der DDR. In F. Schlette and D. Kaufmann (eds), *Religion und Kult in ur- und frühgeschichtlicher Zeit. 13. Tagung der Fachgruppe Ur- und Frühgeschichte vom 4. bis 6. November 1985 in Halle (Saale)*, 225-40. Berlin: Akademie-Verlag.

Heine, H.-W. 1999. Ältereisenzeitliche Burgen und Befestigungen in Niedersachsen – Stand der Forschungen und Perspektiven. In A. Jockenhövel (ed.), *Ältereisenzeitliches Befestigungswesen zwischen Maas/Mosel und Elbe. Internationales Kolloquium am 8. November 1997 in Münster anlässlich des hundertjährigen Bestehens der Altertumskommission für Westfalen*, 111-24. Münster: Aschendorff.

Heine, H.-W. 2000. *Die ur- und frühgeschichtlichen Burgwälle im Regierungsbezirk Hannover*. Hannover: Hahn.

Helt Nielsen, N., Holst, M.K., Gadd, A.C. and Holst, K.K. 2018. The layout and internal development of Celtic fields: structural and relative chronological analyses of three Danish field systems. *European Journal of Archaeology* 21, 385-410.

Henriksen, M.B. 2005. Danske kogegruber og kogegrubefelter fra yngre bronzealder og ældre jernalder. In L. Gustafson, T. Heibreen and J. Martens (eds), *De gåtefulle kokegroper*, 77-102. Oslo: University of Oslo.

Heske, I. 2006. *Die Hünenburg bei Watenstedt, Ldkr. Helmstedt – Eine ur- und frühgeschichtliche Befestigung und ihr Umfeld (mit einem Beitrag von Julian Wiethold).* Neumünster: Wachholtz.

Heske, I. 2010. Herrschaftssitz oder Elitenort? Zum Nachweis einer jungbronzezeitlichen Außensiedlung an der Hünenburg bei Watenstedt, Kr. Helmstedt, und ihre Bedeutung im überregionalen Vergleich. In B. Horejs and T. Kienlin (eds), *Siedlung und Handwerk. Studien zu sozialen Kontexten in der Bronzezeit. Beiträge zur Sitzung der Arbeitsgemeinschaft Bronzezeit 2007 und 2008*, 285-300. Bonn: Rudolf Habelt.

Heske, I., Grefen-Peters, S., Posselt, M. and Wiethold, J. 2010. Die jungbronzezeitliche Außensiedlung der "Hünenburg" bei Watenstedt, Lkr. Helmstedt. Vorbericht über die Ausgrabungen 2005-2007. *Prähistorische Zeitschrift* 85, 159-90.

Heske, I., Lüth, P. and Posselt, M. 2012. Deponierungen, Gargruben und ein verfüllter Wasserlauf. Zur Infrastruktur der Hünenburg-Außensiedlung bei Watenstedt, Lkr. Helmstedt. Vorbericht über die Grabung 2011. *Prähistorische Zeitschrift* 87, 308-37.

Hesse, S. (ed.) 2009. *Grenzen in der Archäologie und Geschichte. Beiträge zur Jahrestagung der Archäologischen Kommission für Niedersachsen e.V. in Rotenburg (Wümme), 14.-16. Juni 2007.* Oldenburg: Isensee.

Hofmann, K.P. 2009. Grenzen in der Bronzezeit am Beispiel des Elbe-Weser-Dreiecks. In S. Hesse (ed.), *Grenzen in der Archäologie und Geschichte. Beiträge zur Jahrestagung der Archäologischen Kommission für Niedersachsen e.V. in Rotenburg (Wümme), 14.-16. Juni 2007*, 67-108. Oldenburg: Isensee.

Honeck, M. 2009. *Nichts als heiße Steine? Zur Deutung der Brenngruben der späten Bronzezeit und frühen Eisenzeit in Deutschland*. Bonn: Rudolf Habelt.

Hüser, A. 2011. Kultische Feuer? Gar- oder Herdgruben im Großraum Hamburg. *Hammaburg N.F.* 16, 95-121.

Huth, C. and Stäuble, H. 1998. Ländliche Siedlungen der Bronzezeit und älteren Eisenzeit. Ein Zwischenbericht aus Zwenkau. In H. Küster, A. Lang and P. Schauer (eds), *Archäologische Forschungen in urgeschichtlichen Siedlungslandschaften. Festschrift für Georg Kossack zum 75. Geburtstag*, 185-230. Regensburg: Universitätsverlag Regensburg.

Hvass, S. 1985. *Hodde. Et vestjysk landsbysamfund fra ældre jernalder*. Copenhagen: Akademisk Forlag.

Jaeger, M. 2018. Fortified settlements of the Early Bronze Age in Poland. In S. Hansen and R. Krause (eds), *Bronze Age hillforts between Taunus and Carpathian mountains. Proceedings of the first international LOEWE conference, 7-9 December 2016 in Frankfurt/M.*, 265-96. Bonn: Rudolf Habelt.

Jansen, R. and Fokkens, H. 2007. Het vorstengraf van Oss re-reconsidered. Archeologisch onderzoek Oss-Vorstengrafdonk 1997-2005. *Archol rapporten* 49, 1-115.

Jantzen, D. 2008. *Quellen zur Metallverarbeitung im Nordischen Kreis der Bronzezeit*. Stuttgart: Steiner.

Jockenhövel, A. 1990. Bronzezeitlicher Burgenbau in Mitteleuropa. Untersuchungen zur Struktur frühmetallzeitlicher Gesellschaften. In T. Bader (ed.), *Orientalisch-ägäische Einflüsse in der europäischen Bronzezeit. Ergebnisse eines Kolloquiums vom 16.-19.10.1985 in Mainz*, 209-28. Bonn: Rudolf Habelt.

Jockenhövel, A. (ed.) 1999. *Ältereisenzeitliches Befestigungswesen zwischen Maas/Mosel und Elbe. Internationales Kolloquium am 8. November 1997 in Münster anlässlich des hundertjährigen Bestehens der Altertumskommission für Westfalen.* Münster: Aschendorff.

Kneisel, J. 2005. Krigeren og præstinden? Den pommerske kulturs gravskikke. In J. Goldhahn (ed.), *Mellan sten och järn. Rapport från det 9:e nordiska bronsålders-symposiet, Göteborg 2003-10-09/12*, 637-58. Gothenburg: Intellecta Docusys.

Kneisel, J. 2012. *Anthropomorphe Gefäße in Nord- und Mitteleuropa während der Bronze- und Eisenzeit. Studien zu den Gesichtsurnen – Kontaktzonen, Chronologie und sozialer Kontext.* Bonn: Rudolf Habelt.

Kneisel, J. 2013a. Der Übergang von der Frühbronzezeit zur Mittelbronzezeit im nordöstlichen Mitteleuropa. Lücke oder Forschungsdesiderat? In J. Kneisel, H.J. Behnke and A. Schopper (eds), *Frühbronzezeit – Mittelbronzezeit. Neue Erkenntnisse zur Besiedlung zwischen Elbe und Warthe und angrenzender Regionen (2000-1400 v. Chr.). Symposium vom 24.-25. Sept. 2011 in Welzow/Brandenburg,* 95-120. Bonn: Rudolf Habelt.

Kneisel, J. 2013b. Raumordnungen in der frühen und späten Bronzezeit am Beispiel Bruszczewos (Großpolen) und Umgebung. In S. Hansen and M. Meyer (eds), *Parallele Raumkonzepte. Tagung des DAI 15.-17. März 2010 in Berlin,* 175-200. Berlin: Topoi.

Kneisel, J. 2018. Borders. Developments of society and landscape during the Bronze Age and the Iron Age – face urns as a case study. In A. Haug, L. Käppel and J. Müller (eds), *Past landscapes. The dynamics of interaction between society, landscape, and culture,* 235-57. Leiden: Sidestone.

Kneisel, J. and Jaeger, M. in press. Space not only for the living. Graves in settlements of Poland and the Bronze Age site Bruszczewo. In E. Kaiser and N. Berseneva (eds), *Space not only for the living: human remains at Bronze Age settlements in Eurasia.* Berlin: Topoi.

Kneisel, J., Hinz, M. and Rinne, C. 2013. Radon-B. Radiocarbon dates online. Accessible at: http://radon-b.ufg.uni-kiel.de; last accessed 28.05.2021.

Kneisel, J., Dörfler, W., Dreibrodt, S., Schaefer-Di Maida, S. and Feeser, I. 2019. Cultural change and population dynamics during the Bronze Age: integrating archaeological and palaeoenvironmental evidence for Schleswig-Holstein, northern Germany. *The Holocene* 29, 1607-21.

Kobyliński, Z. and Nebelsick, L.D. 2008. Bronze and Early Iron Age strongholds between the Elbe and the Vistula – seen from the perspective of the Polish-German excavations in the Upper Lusatian stronghold "Sumpfwall Biehla". In F. Falkenstein, M. Schönfelder and H. Stäuble (eds), *Langfristige Erscheinungen und Brüche von der Bronze- zur Eisenzeit*, 37-40. Langenweißbach: Beier & Beran.

Koch-Heinrichs, F. 2017. Oberlausitz. Die Lausitzer Kultur und ihre Burgen. *Veröffentlichungen des Museums der Westlausitz Kamenz* 34**,** 3-60.

Krause, R. 2019. Zur Professionalisierung des Krieges in der Bronzezeit. In S. Hansen and R. Krause (eds), *Materialisation of conflicts. Proceedings of the third international LOEWE conference, 24-27 September 2018 in Fulda*, 13-43. Bonn: Rudolf Habelt.

Kristiansen, K. 1984. Krieger und Häuptlinge in der Bronzezeit Dänemarks. Ein Beitrag zur Geschichte des bronzezeitlichen Schwertes. *Jahrbuch des Römisch-Germanischen Zentralmuseums* 31, 187-208.

Kristiansen, K. and Larsson, T.B. 2005. *The rise of Bronze Age society. Travels, transmissions and transformations*. Cambridge: Cambridge University Press.

Lasak, I. and Furmanek, M. 2008. Bemerkungen zum vermutlichen Wehrobjekt der Aunjetitzer Kultur in Radłowice in Schlesien. In J. Czebreszuk, S. Kadrow and J. Müller (eds), *Defensive structures from central Europe to the Aegean in the 3rd and 2nd millennia BC*, 123-34. Poznań, Bonn: Wydawnictwo Poznańskie.

Løvschal, M. 2015. Repeating boundaries: repertoires of landscape regulations in southern Scandinavia in the Late Bronze Age and Pre-Roman Iron Age. *Danish Journal of Archaeology* 3, 95-118.

Løvschal, M. 2018. De lineære hulbælter og de hollandske "landweer": (For)historiske fænomener? In P. Eriksen and P.O Rindesl (eds), *Lange linjer i landskabet. Hulbælter fra jernalderen* 377-82. Højbjerg: Jysk Arkæologisk Selskab.

Løvschal, M. and Fontijn, D. 2019. Directionality and axiality in the Bronze Age: cross-regional landscape perspectives on 'fire pit lines' and other pitted connections. *World Archaeology* 51, 140-56.

Malinowski, T. 1955. Grodziska kultury łużyckiej w Wielkopolsce. *Fontes Archaeologici Posnanienses* 5, 1-48.

Malinowski, T. 2006. *Komorowo, stanowisko 1: Grodzisko kultury Łużyckiej – faktoria na szlaku bursztynowym.* Rzeszów: Instytut Archeologii Uniwersytetu Rzeszowskiego.

Martens, J. 1988. Borremose reconsidered. The date and development of a fortified settlement of the Early Iron Age. *Journal of Danish Archaeology* 7, 159-81.

Martens, J. 2007. Fortified places in low-land northern Europe and Scandinavia during the Pre-Roman Iron Age. In S. Möllers, W. Schlüter and S. Sievers (eds), *Keltische Einflüsse im nördlichen Mitteleuropa während der mittleren und jüngeren vorrömischen Eisenzeit. Akten des internationalen Kolloquiums in Osnabrück vom 29. März bis 1. April 2006*, 87-105. Bonn: Rudolf Habelt.

May, J. 2009. Zaun mit Graben. Lineare Struktur aus dem 13. Jahrhundert v. Chr. im Havelland. *Archäologie in Berlin und Brandenburg* 2007, 72-76.

May, J. and Hauptmann, T. 2011. Warum befindet sich das "Königsgrab" von Seddin am Mittellauf der Stepenitz? Wasserwege und archäologische Sachkultur der jüngeren Bronzezeit in der Prignitz. In F. Bittmann, J. Ey, M. Karle, H. Jöns,

E. Strahl and S. Wolters (eds), *Flüsse als Kommunikations- und Handelswege. Marschenratskolloquium 5.-7. November 2009*, 129-50. Rahden: Marie Leidorf.
Meier, D. 2013. Bronzezeitliche Feuergruben in ungewöhnlicher Anordnung. In I. Heske, H.-J. Nüsse and J. Schneeweiß (eds), *"Landschaft, Besiedlung und Siedlung". Archäologische Studien im nordeuropäischen Kontext. Festschrift für Karl-Heinz Willroth zu seinem 65. Geburtstag*, 319-30. Neumünster: Wachholtz.
Meller, H. 2010. Nebra: Vom Logos zum Mythos – Biographie eines Himmelbildes. In H. Meller and F. Bertemes (eds), *Der Griff nach den Sternen. Internationales Symposium in Halle 16.-21.2. 2005,* 23-73. Halle: Landesmuseum für Vorgeschichte Halle.
Menne, J. and Brunner, M. (eds) 2020. *Grenzräume in der Archäologie.* Darmstadt: WBG/Theiss.
Mennenga, M. 2019. Die rituelle Landschaft von Cuxhaven-Duhnen, Ldkr. Cuxhaven – neue Ergebnisse aus dem Umfeld des Ringwalles. *Siedlungs- und Küstenforschung im südlichen Nordseegebiet* 42, 23-41.
Mewis, F. and Schmidt, J.-P. 2011. Die Feuerstellenreihen von Naschendorf, Lkr. Nordwestmecklenburg. *Archäologische Berichte aus Mecklenburg-Vorpommern* 18, 62-75.
Mikkelsen, M. 2012. „Dobbeltgårde" i yngre bronzealder. In S. Boddum, M. Mikkelsen and N. Terkildsen (eds), *Bebyggelsen i yngre bronzealders lokale kulturlandskab. Seminarrapport fra seminariet „Bebyggelsen i yngre bronzealders lokale kulturlandskab" afholdt i Holstebro, 10. marts 2011*, 41-65. Viborg, Holstebro: Viborg Museum, Holstebro Museum.
Mischka, D. 2004. Aoristische Analyse in der Archäologie. *Archäologische Informationen* 27, 233-43.
Müller, J. 2000. Soziale Grenzen – ein Exkurs zur Frage räumlicher Identitätsgruppen in der Prähistorie. In S. Kadrow (ed.), *A turning of ages. Jubilee book dedicated to Professor Jan Machnik on his 70th anniversary*, 415-27. Kraków: Polish Academy of Sciences.
Müller, J. and Czebreszuk, J. 2003. Bruszczewo – eine frühbronzezeitliche Siedlung mit Feuchtbodenerhaltung in Großpolen. Vorbericht zu den Ausgrabungen 1999-2001. *Germania* 81, 443-80.
Müller, J. and Kneisel, J. 2010. Bruszczewo: production, distribution, consumption and the formation of social differences. In J. Kneisel, J. Müller and H. Czebreszuk (eds), *Bruszczewo II. Ausgrabungen und Forschungen in einer prähistorischen Siedlungskammer Großpolens*, 756-82. Bonn: Rudolf Habelt.
Müller, J., Delgado-Raack, S., Escanilla, N., Kienle, L., Kneisel, J., Czebreszuk, J., Jaeger, M., Szmyt, M. and Schürmann, U. submitted. First evidence for the forging of gold in an Early Bronze Age site of central Europe (2200-1800 BCE). *Journal of Archaeological Science: Reports.*
Nakoinz, O. 2012. Models of centrality. In W. Bebermeier, R. Hebenstreit, E. Kaiser and J. Krause (eds), *Landscape archaeology. Proceedings of the international conference held in Berlin, 6th-8th June 2012*, 217-23. Berlin: Topoi.
Nakoinz, O., Kneisel, J., Beilke-Voigt, I. and Dräger, J. 2017. Befestigungen der Bronze- und Eisenzeit zwischen Marburg und Uppsala. In I. Beilke-Voigt and O. Nakoinz (eds), *Enge Nachbarn. Doppel- und Mehrfachburgen in der Bronzezeit und im Mittelalter, mittelalterliche Doppelstädte*, 21-88. Berlin: Topoi.
Nakoinz, O., Kneisel, J. and Gorbahn, H. 2019. Competition and conciliation: Modelling and indicating prehistoric conflicts. In S. Hansen and R. Krause (eds), *Materialisation of conflicts. Proceedings of the third international LOEWE conference, 24-27 September 2018 in Fulda*, 1-12. Bonn: Rudolf Habelt.
Narożna-Szamałek, U. and Szamałek, K. 2007. Cmentarzysko halsztackie w Gorszewicach w świetle nowych badań. *Fontes Archaeologici Posnanienses* 43, 113-227.
Nebelsick, L.D. 2007. Die Grenze. Rituell denotierte Grabenstrukturen der späten Bronzezeit im Mittelelbe-Saale-Gebiet. In M. Blečić, M. Črešnar, B. Hänsel, A. Hellmuth, E. Kaiser and C. Metzner-Nebelsick (eds), *Scripta praehistorica in honorem Biba Teržan*, 267-300. Ljubljana: Narodni muzej Slovenije.

Niesiołowska-Wędzka, A. 1974. *Poczatki i rozwój grodów kultury łuzyckiej*. Wrocław: Zakład Narodowy immienia Ossolińskich.
Overbeck, M. 2018. *Die Gießformen in West- und Süddeutschland (Saarland, Rheinland-Pfalz, Hessen, Baden-Württemberg, Bayern).* Stuttgart: Franz Steiner.
Peschel, K. 1999. Höhensiedlungen der älteren vorrömischen Eisenzeit nördlich des Thüringer Waldes. In A. Jockenhövel (ed.), *Ältereisenzeitliches Befestigungswesen zwischen Maas/Mosel und Elbe. Internationales Kolloquium am 8. November 1997 in Münster anlässlich des hundertjährigen Bestehens der Altertumskommission für Westfalen*, 125-58. Münster: Aschendorff.
Rindel, P.O. 2010. Grøntoft revisited. New interpretations of the Iron Age settlement. In M. Meyer (ed.), *Haus – Gehöft – Weiler – Dorf. Siedlungen der vorrömischen Eisenzeit im nördlichen Mitteleuropa. Internationale Tagung an der Freien Universität Berlin vom 20.-22. März 2009*, 251-62. Rahden: Marie Leidorf.
Sangmeister, E. 1967. Methoden der Urgeschichtswissenschaft. *Saeculum* 18, 199-244.
Schaefer-Di Maida, S. 2018. Bronzezeitliche Transformationen zwischen den Hügeln (Mang de Bargen, Bornhöved, Kr. Segeberg). *Archäologie in Schleswig* 17, 27-44.
Schenk, T. and Goldmann, T. 2004. Die Seddiner Kultfeuerreihe. Geomagnetische Prospektion am Königsgrab in der Prignitz. *Archäologie in Berlin und Brandenburg 2003*, 57-59.
Schlosser Mauritsen, E. 2010. Brændgaards Hede. A settlement surrounded by pit zone fortifications from the early Pre-Roman Iron Age in Denmark. In M. Meyer (ed.) *Haus – Gehöft – Weiler – Dorf. Siedlungen der vorrömischen Eisenzeit im nördlichen Mitteleuropa. Internationale Tagung an der Freien Universität Berlin vom 20.-22. März 2009*, 262-80. Rahden: Marie Leidorf.
Schmidt, J.-P. 2005. Grillfest oder Opferkult? Der Feuerstellenplatz von Jarmen, Lkr. Demmin. In H. Jöns and F. Lüth (eds), *Die Autobahn A20 – Norddeutschlands längste Ausgrabung. Archäologische Forschungen auf der Trasse zwischen Lübeck und Stettin*, 71-76. Schwerin: Archäologisches Landesmuseum und Landesamt für Bodendenkmalpflege Mecklenburg-Vorpommern.
Schmidt, J.-P. 2012. Kein Ende in Sicht? Neue Untersuchungen auf dem Feuerstellenplatz von Naschendorf, Lkr. Nordwestmecklenburg. *Archäologische Berichte aus Mecklenburg-Vorpommern* 19, 26-46.
Schulze-Forster, J. 2007. Die Burgen der Mittelgebirgszone. Eisenzeitliche Fluchtburgen, befestigte Siedlungen, Zentralorte oder Kultplätze? In S. Möllers and B. Zehm (eds), *Rätsel Schnippenburg. Sagenhafte Funde aus der Keltenzeit*, 109-44. Bonn: Rudolf Habelt.
Schunke, T. 2017. Netze auf der Landschaft. Das Rätsel der bronze- bis eisenzeitlichen Grubenreihen (pit alignments) und Landgräben. In H. Meller and M. Becker (eds), *Neue Gleise auf alten Wegen II. Jüdendorf bis Gröbers*, 79-94. Halle: Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt, Landesmuseum für Vorgeschichte.
Schwank, N. 2012. *Konflikte, Krisen, Kriege. Die Entwicklungsdynamiken politischer Konflikte seit 1945.* Baden-Baden: Nomos.
Schwank, N. 2018. Entwicklung inner- und zwischenstaatliche Krisen und Kriege 1945-2017. https://www.bpb.de/internationales/weltweit/innerstaatliche-konflikte/54520/entwicklung-innerstaatlicher-kriege-seit-dem-ende-des-ost-west-konfliktes, 31.12.2018; last accessed 5.2.2021.
Segschneider, M. 2005. Pfahl an Pfahl an Pfahl… Eine Palisade der vorrömischen Eisenzeit bei Neu Pansow, Lkr. Ostvorpommern. In H. Jöns and F. Lüth (eds), *Die Autobahn A20 – Norddeutschlands längste Ausgrabung. Archäologische Forschungen auf der Trasse zwischen Lübeck und Stettin*, 83-84. Schwerin: Archäologisches Landesmuseum und Landesamt für Bodendenkmalpflege Mecklenburg-Vorpommern.
Spatzier, A. 2017. *Das endneolithisch-frühbronzezeitliche Rondell von Pömmelte-Zackmünde, Salzlandkreis, und das Rondell-Phänomen des 4.-1. Jt. v. Chr. in Mitteleuropa*. Halle: Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt, Landesmuseum für Vorgeschichte.

Spatzier, A. 2018. Detecting deliberate fragmentation at a circular enclosure from the late 3rd millennium BC. Calculating fragmentation and refitting analysis of ceramic finds from Pömmelte-Zackmünde, Saxony-Anhalt, Germany. *Praehistorische Zeitschrift* 92, 370-86.
Spohn, J. 2008. Bronzezeitliche Ringwallanlage in Cuxhaven-Duhnen. *Archäologie in Deutschland* 4/2008, 44-45.
Spohn, J. 2010. Mehr als "nur" ein altbekanntes Erdwerk. *Archäologie in Deutschland* 1/2010, 68-69.
Statista 2021. Vergleich der Verteidigungsausgaben der USA und der UdSSR in den Jahren von 1950 bis 1990. Accessible at https://de.statista.com/statistik/daten/studie/935886/umfrage/verteidigungsausgaben-der-usa-und-der-udssr/, last accessed 5.2.2021.
Stäuble, H. 2002. Lineare Gräben und Grubenreihen in Nordwestsachsen. Eine Übersicht. *Arbeits- und Forschungsberichte zur sächsischen Bodendenkmalpflege* 44, 9-49.
Stjernquist, B. 1997. *The Röekillorna spring. Spring cults in Scandinavian prehistory.* Stockholm: Almqvist & Wiksell.
Szentmiklosi, A., Heeb, B.S., Heeb, J., Harding, A., Krause, R. and Becker, H. 2011. Corneşti-Iarcuri – a Bronze Age town in the Romanian Banat? *Antiquity* 85, 819-38.
Vandkilde, H. 2006. Warfare, weaponry, and material culture. An introduction. In T. Otto, H. Thrane and H. Vandkilde (eds), *Warfare and society. Archaeological and social anthropological perspectives*, 483-90. Aarhus: Aarhus Universitetsforlag.
Veit, U. 2018. Gewalt – Konflikt – Theorie: Überlegungen zur theoretischen Grundlegung einer prähistorischen Konfliktforschung unter Mitberücksichtigung der Burgenforschung. In S. Hansen and R. Krause (eds), *Bronzezeitliche Burgen zwischen Taunus und Karpaten: Beiträge der ersten internationalen LOEWE-Konferenz vom 7. bis 9. Dezember 2016 in Frankfurt*, 125-38. Bonn: Rudolf Habelt.
Vogt, I. 2004. *Der Übergang von der frühen zur mittleren Bronzezeit in Mittel- und Nordeuropa unter besonderer Berücksichtigung der Griffplattenklingen*. Bonn: Rudolf Habelt.
Wendowski-Schünemann, A. and Veit, U. 2013. Eine bronzezeitliche Ringwallanlage bei Cuxhaven im südlichen Elbemündungsgebiet. *Siedlungs- und Küstenforschung im südlichen Nordseegebiet* 36, 199-208.
Wilhelmi, K. 1986. Älterbronzezeitliche Grabanlage mit Pfostenzuwegung in Westniedersachsen und ihre englischen Muster. *Helinium* 26, 58-66.
Wokroj, F. 1958. Szczątki ludzkie z grodziska kultury łużyckiej w Słupcy. *Fontes Archaeologici Posnanienses* 8-9, 137-43.
Wüstemann, H. 2004. *Die Schwerter in Ostdeutschland.* Stuttgart: Franz Steiner.
Zich, B. 1996. *Studien zur regionalen und chronologischen Gliederung der nördlichen Aunjetitzer Kultur.* Berlin: de Gruyter.
Zich, B. 2016. Aunjetitzer Herrschaften in Mitteldeutschland. "Fürsten" der Frühbronzezeit und ihre Territorien ("Domänen"). In H. Meller, H.-P. Hahn, R. Jung and R. Risch (eds), *Arm und Reich. Zur Ressourcenverteilung in prähistorischen Gesellschaften. 8. Mitteldeutscher Archäologentag vom 22. bis 24. Oktober 2015 in Halle (Saale)*, 371-406. Halle: Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt, Landesmuseum für Vorgeschichte.

Stone Age-Early Metal Period transition in the southern Finnish lake district

Incipient forest grazing and temporary burning practices

Kerkko Nordqvist, Teija Alenius, Chiara Molinari

Introduction

In the mid-third millennium BC, coastal areas of southern Finland were occupied by Corded Ware groups and the inland was inhabited by local hunter-fisher-gatherers generally identified through Pöljä Ware. A few centuries later, the Kiukainen culture appeared on the coast, whereas much of the inland lake district is archaeologically poorly defined at this time. Only centuries later do archaeological materials become visible again, but in an altered form and scarcer than before.

The decrease in the number of archaeological sites and finds in the Finnish inland areas during the late third millennium BC occurred simultaneously with deteriorating climatic conditions (see Heikkilä and Seppä 2003; Helama and Oinonen 2019; Salonen *et al.* 2014). This scarcity is explained either by diminishing population sizes, even depopulation (Lavento 2001, 141-42; see also Sundell 2014; Tallavaara *et al.* 2010), or by a shift to a more mobile lifestyle and archaeologically less visible material culture (Lavento 2001, 183-84; 2015, 125; Mökkönen 2011, 65). At the same time, palaeoecological records evidence an increasing anthropogenic impact on the environment. This contrast between palaeoecological and archaeological data has been pointed out in studies of land use and settlement history in inland areas (e.g. Alenius and Laakso 2006, 146; Alenius *et al.* 2009, 152; 2013, 15; 2020, 1632), and it forms the starting point for this study. Our goal is to combine palaeoecological and archaeological results from the southern lake district of Finland (Figure 1, Table 1) in order to discuss vegetation and land use changes during the transition from the Late or Final Stone Age to the Early Metal Period (i.e. the Bronze and Early Iron Ages; for terminology, see Nordqvist 2018, 53-54). In absolute years, the focus is roughly between 2500 and 1500 BC (see Table 2).

Long and continuous cores from lake sediments serve as rich archives for palaeoenvironmental reconstructions. They preserve records of past environmental changes and can provide information about the development of anthropogenic activities

Table 1. Lakes with analysed sediment pollen and/or charcoal* sequences discussed in this article (in cases where samples were obtained from a bay, the area of the bay is indicated in parenthesis; archaeological materials include the following categories: settlement/cairn/rock art site. † two of the sites overlap).

	Lake Kirkkolampi*	Lake Orijärvi*	Lake Nautajärvi	Lake Katajajärvi	Lake Huhdasjärvi*	Lake Ahvenainen*
Location	61°47’N 30°00’E	61°40’N 27°14’E	61°48’N 24°41’E	61°90’N 26°50’E	61°10’N 26°35’E	61°02’N 25°07’E
Area (ha)	72 (4)	29	19	17	107 (27)	7
Reference	Alenius and Laakso 2006	Alenius *et al.* 2008	Ojala and Alenius 2005	Alenius *et al.* 2009	Alenius *et al.* 2013; 2017a	Tolonen 1978
Number of archaeological sites at different radiuses	<1 km 0 (0/0/0) <2 km 0 (0/0/0) <5 km 1 (1/0/0) <10 km 3 (1/0/2) *Total 4 (2/0/2)*	<1 km 0 (0/0/0) <2 km 0 (0/0/0) <5 km 2 (2/0/0) <10 km 6 (5/0/1) *Total 8 (7/0/1)*	<1 km 0 (0/0/0) <2 km 0 (0/0/0) <5 km 0 (0/0/0) <10 km 6 (3/3/0) *Total 6 (3/3/0)*	<1 km 3 (3/0/0) <2 km 6 (4/1/1) <5 km 5 (3/1/1) <10 km 6 (5†/1/0) *Total 20 (15/3/2)*	<1 km 1 (1/0/0) <2 km 0 (0/0/0) <5 km 1 (1/0/0) <10 km 12 (6†/2/4) *Total 14 (8/2/4)*	Not studied

In D. Hofmann, F. Nikulka and R. Schumann (eds) 2022. *The Baltic in the Bronze Age. Regional patterns, interactions and boundaries*, Leiden: Sidestone Press, pp. 251-268.

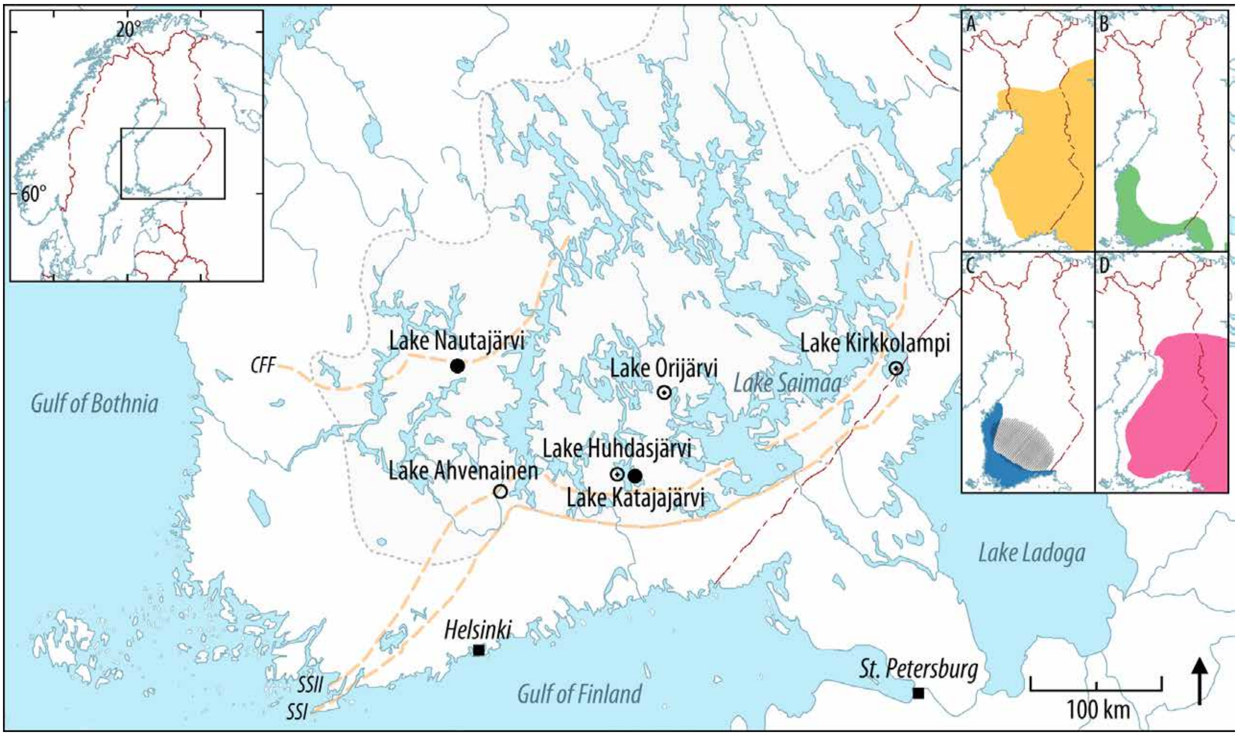


Figure 1. Locations of lakes with pollen (filled symbols) and charcoal (open symbols) data discussed in this article. The smaller maps show the main archaeological areas mentioned in the text: A – Pöljä Ware, B – Corded Ware, C – Kiukainen Ware and the "Middle Zone" (hatched), D – Textile Ware. The approximate border of the inland lake district (dotted line) and the major ice-marginal formations are also marked (SSI and SSII – Salpausselkä I and II, CFF – central Finland formation) (map by K. Nordqvist based on public domain data from Natural Earth (https://www.naturalearthdata.com/)).

through time. We analysed palaeoecological data from five previously published case studies using CONISS cluster analysis (Grimm 1987; 1991) with the aim to identify and date different vegetation phases (clusters) in the pollen sequences. To assess the impact of fire as a possible indicator of land use, we collected charcoal data from four previously published sites and reconstructed the main fire dynamics in the studied region. Finally, we combined the data with archaeological material from the surroundings in order to explore land use during the period that marks the change from the Stone Age to the metal periods.

Changes in social and economic conditions during the period under review are also more widely reflected in land use patterns in the northern and eastern Baltic Sea region (see for example Lang 2007 for Estonia). It is noteworthy, however, that despite indications of food-producing livelihoods found in various parts of the area (e.g. Cramp *et al.* 2014; Piličiauskas *et al.* 2017; Vanhanen 2019), the hunter-gatherer lifestyle in no way disappeared, and nowhere did societies emerge that relied solely on food production; the latter developed in the area only starting from the Bronze Age, or even much later. Development is typically slow in pace and, above all, highly variable. The area, disguised by such terms as "eastern Baltic region" or "north-east Europe", is geographically huge and includes a patchwork of cultural and natural environments, each of which provided local populations with particular resources and restrictions. In this context, our article presents one view based on a specific dataset from a particular area in the southern lake district of Finland.

Materials and methods

Five well-dated, high-resolution pollen records and four charcoal records obtained from sediments of lakes Kirkkolampi, Orijärvi, Nautajärvi, Katajajärvi, Huhdasjärvi and Ahvenainen (Figure 1) were selected for this study. Fieldwork, laboratory analyses and dating of the sediment sequences are described in the respective previous publications (see Table 1).

These records were chosen because they belong to the same geo-cultural context of the southern Finnish lake district. All lakes are situated between 61°20' and 61°90' latitude in the southern boreal vegetation zone. The bedrock of southern Finland belongs to the Svecokarelic unit, where microcline granite dominates. The studied lakes are located in

Figure 2. The rugged and steep shorelines of lake Katajajärvi, covered by bedrock and moraine, are not at first glance the preferred habitat for hunter-fisher-gatherers – nor the later farmers. The dominance of moraine soils is often seen as making the lake district less suited for cultivation. View from the southern end of the lake, from where the sediment core was obtained (photo: K. Nordqvist).

the vicinity of major ice-marginal formations (the Salpausselkä I-II and central Finland formations), and the rolling topography is often covered with Quaternary till, sand, silt, clay and organic deposits, which commonly fill the depressions of crystalline bedrock (Figure 2).

The lakes or basins (bays) selected for sampling vary between 4 and 29 ha in size and, therefore, also in the relevant source area of pollen (RSAP; Sugita 1994). In general, large sedimentary basins collect pollen from larger areas than small basins (Jacobson and Bradshaw 1981; Prentice 1985) and reflect a more regional vegetation cover (and human impact on vegetation). According to computer simulations (Sugita 1994), the RSAP in a fully forested environment is c. 300-400 m from the lake edge for small lakes (radius c. 50 m, lake Katajajärvi has a radius of 80 m) and 600-800 m for medium-sized lakes (radius c. 250 m, the other studied lakes).

To best identify periods of similar vegetation composition and ultimately observe possible changes in land use, a stratigraphically constrained cluster analysis (CONISS; Grimm 1987; 1991) was conducted for each site except lake Ahvenainen (due to the unavailability of raw pollen data) using land taxa. Cluster analysis helps to group pollen samples that differ from each other. *Picea, Pinus, Betula* and *Alnus* were omitted from the analyses to avoid the dominance of the major tree species. For each site, four major clusters were identified (Figure 4). To understand the main variations in vegetation composition and explore whether the vegetation actually changed during the Early Metal Period, the CONISS analyses were extended beyond this temporal interval, to between 3000 BC and AD 800. The lower limit was selected because, from this time onwards, all species typical of modern boreal forests (including *Picea*) are present. In contrast, the upper limit was chosen because until c. AD 800, no large-scale human impact on the landscape profoundly changed the forest structure.

For the study of fire dynamics at the regional level, charcoal data (microcharcoal concentrations, i.e. number of fragments/cm^3) from lakes Kirkkolampi, Orijärvi, Ahvenainen and Huhdasjärvi were transformed and standardised according to a protocol described by Power *et al.* (2008). The smooth composite curve (Figures 5 and 6) was produced by determining fitted values at 100-year intervals, and the data were expressed as transformed charcoal influx (hereafter referred to as tCHAR) Z-scores around the long-term mean, using the method implemented in the R (R Core Team 2016) package "paleofire" version 1.2.4 (Blarquez *et al.* 2014).

Figure 3. The cairn of Piikinperse A (southern lake Saimaa area) is a picturesque example of the "Lapp cairns", often described as rounded and low settings of unworked stones, located in the interior of Finland and built on bedrock in a prominent position along a lakeshore or on an island. Still, despite a long research history, there is no unambiguous definition for them, and the extremely few finds keep their dating and function open to interpretation (photo: K. Nordqvist).

Pöljä Ware	3300-2600/1900 BC
Corded Ware	*2900-2200/2000 BC*
("Middle Zone ceramics"	third millennium BC)
Kiukainen Ware	*2300-1800/1500 BC*
Textile Ware	1900-100 BC
Coastal Bronze Age Wares	*1500-500 BC*

Table 2. Dating of pottery types which, in the Finnish scholarly tradition, define the archaeological phases used in this paper. Coastal phenomena are in italics (the traditional dualistic coast-inland division of the Bronze Age in Finland associates the inland areas with the so-called eastern (i.e. non-Scandinavian) Bronze Age or Early Metal Period (c. 1900 BC-AD 400)).

To understand the archaeological micro-environment around the five lakes studied for pollen, information about all the surrounding material was collected and plotted on a map. This was done radially, first at a distance of less than 1000 m from the coring location. Keeping in mind the small size of the basins and their small RSAP, this distance should register relevant local human activity. To provide a broader context, finds at distances of 2000, 5000 and 10,000 m were also included (Table 1 and Figure 7). Information was extracted from the register of ancient monuments, maintained by the Finnish Heritage Agency (www.kyppi.fi), and amended using published literature (e.g. Alenius *et al.* 2013; Lavento and Lahelma 2007; Miettinen 1998). The register is primarily a tool for cultural resource management, and therefore its classifications are not accurate enough for research purposes (generic find categories and approximate dates). For example, "Settlement sites" (Table 1) include all find locations that are dated to the "Early Metal Period", but also to the "Stone Age" and "Prehistory". Almost all of them are locations identified based on only a handful of survey finds (mostly chipped quartz) without any datable attributes, and thus their potential age covers several millennia (dating based on shore displacement cannot be effectively used

Cluster	Lake Kirkkolampi	Lake Orijärvi	Lake Nautajärvi	Lake Katajajärvi	Lake Huhdasjärvi
1	**3000 -2120 BC** Trees: 93 % Thermophilous Deciduous trees: 3.5 % Herbs: 3.1 % *Juniperus:* 0.1 %	**3000-1860 BC** Trees: 93 % Thermophilous Deciduous trees: 4.5 % Herbs: 1.8 % *Juniperus:* 0.6 %	**3000-1520 BC** Trees: 92.4 % Thermophilous Deciduous trees: 4.8 % Herbs: 2.1 % *Juniperus:* 0.6 %	**3000-2560 BC** Trees: 91.7 % Thermophilous Deciduous trees: 5 % Herbs: 2.7 % *Juniperus:* 0.6 %	**3000-2060 BC** Trees: 91.4 % Thermophilous Deciduous trees: 5.4 % Herbs: 1.5 % *Juniperus:* 0,7 % Cereals: single 2160 BC
2	**2120-985 BC** Trees: 94.9 % Thermophilous Deciduous trees: 2 % Herbs: 2.4 % *Juniperus:* 0.5 %	**1860-90 BC** Trees: 94.4 % Thermophilous Deciduous trees: 2.9 % Herbs: 1.7 % *Juniperus:* 1 %	**1520-1180 BC** Trees: 93.6 % Thermophilous Deciduous trees: 3.7 % Herbs: 1.5 % *Juniperus:* 1.2 %	**2560-1950 BC** Trees: 92.3 % Thermophilous Deciduous trees: 4.4 % Herbs: 3 % *Juniperus:* 0.4 % Cereals: single 2220 BC	**2060-730 BC** Trees: 92.9 % Thermophilous Deciduous trees: 3.3 % Herbs: 1.6 % *Juniperus:* 1.3 %
3	**985 BC-AD 540** Trees: 96 % Thermophilous Deciduous trees: 1.3 % Herbs: 2.1 % *Juniperus:* 0.6 % Cereals: sporadically from AD 335 onwards	**90 BC-AD 720** Trees: 95.5 % Thermophilous Deciduous trees: 1.9 % Herbs: 1.8 % *Juniperus:* 0.8 % Cereals: single AD 620	**1180-30 BC** Trees: 94.2 % Thermophilous Deciduous trees: 2.5 % Herbs: 2.2 % *Juniperus:* 1.1 %	**1950-1660 BC** Trees: 92.3 % Thermophilous Deciduous trees: 3.5 % Herbs: 2.4 % *Juniperus:* 1.8 %	**730 BC-AD 660** Trees: 94.4 % Thermophilous Deciduous trees: 1.9 % Herbs: 1.9 % *Juniperus:* 0.9 % Cereals: 280 BC, AD 270, AD 620
4	**AD 540-800** Trees: 92 % Thermophilous Deciduous trees: 0.6 % Herbs: 6.4 % *Juniperus:* 1 % Cereals: continuously, 0.5 %	**AD 720-800** Trees: 95 % Thermophilous Deciduous trees: 2.4 % Herbs: 1.7 % Cereals: continuously from AD 740 onwards	**30 BC-AD 800** Trees: 94.8 % Thermophilous Deciduous trees: 1.9 % Herbs: 2.5 % *Juniperus:* 0.7 %	**1660 BC-AD 800** Trees: 94 % Thermophilous Deciduous trees: 1.7 % Herbs: 2.9 % *Juniperus:* 1.4 % Cereals: continuously between AD 280-670	**AD 660-800** Trees: 93.9 % Thermophilous Deciduous trees: 1.3 % Herbs: 2.7 % *Juniperus:* 1.5 % Cereals: AD 660, AD 775

Table 3. The four major clusters (3000 BC-AD 800) defined by the CONISS analysis, with a description of the main vegetation.

in most cases either). Only sites with typologically characteristic finds (pottery) from other periods, as well as sites with the remains of pithouses (housepits), which generally become less common from c. 2500 BC onwards (see Mökkönen 2011, 41-44; Okkonen 2003, 172), are excluded. "Cairns" include both the cairns directly dated to the Early Metal Period in the register and all "Undated" stone settings that, based on their description, meet the common criteria for Early Metal Period "Lapp cairns" (the building of which began at the very end of the third millennium BC; Saipio 2015, 126; Taavitsainen 2003, 29) (Figure 3). Finally, although mostly affiliated with the preceding Stone Age (starting c. 5000 BC), rock art sites are included here, as there are indications of their prolonged use or recontextualisation during the Early Metal Period (Lahelma 2008, 37-41; Saipio 2015, 129).

Results

The descriptions of the four major clusters identified by CONISS are presented in Table 3 and in Figure 4.

The regional reconstruction of fire dynamics oscillated during the period 3000 BC to AD 800 (Figure 5). Despite uncertainties, the composite charcoal curve shows values above the long-term mean (i.e. positive tCHAR Z-scores compared to the base period, i.e. the Early Metal Period, 1900 BC-AD 400) at 2800 BC, during the periods 2400-2200 BC, 2000-1800 BC, 1300-1000 BC, 700-400 BC, around 0 and 200 AD, and between AD 500 and 700. The maximum value is registered at 600 BC. Values below the long-term mean are instead recorded between 3000 and 2900 BC, 2700 and 2500 BC, around 2100 BC, during the periods 1700-1400 BC, 900-800 BC, 300 BC-AD 400 (peak in negative tCHAR Z-scores at AD 400) and around AD 800.

The number of archaeological sites located close to the sampling locations, while acknowledging the possible research biases, is quite low (Table 1 and Figure 7). Sites within the RSAP are only found at lakes Katajajärvi and Huhdasjärvi. When the radius increases (5 km or more), sites are found also around the other coring locations. Still, basically none of the nearby (small and short-term) settlement or camp sites can be securely associated with the time horizon discussed in this paper. The same applies to the unexcavated stone cairns. Rock art sites are found in the vicinity of all locations, excluding lake Nautajärvi, which already lies outside the main distribution area of rock paintings.

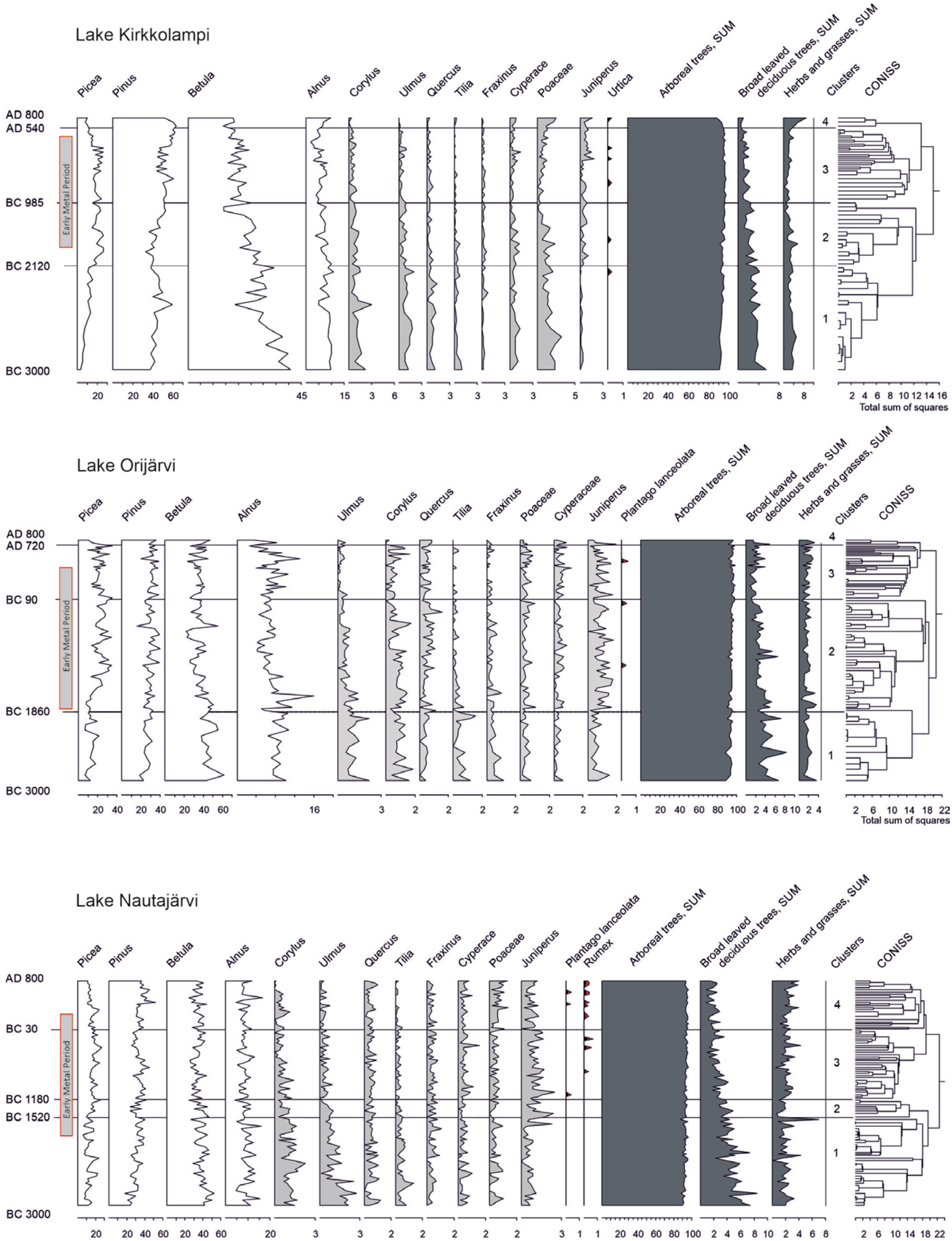


Figure 4. Pollen percentage diagrams with selected taxa plotted for the time interval 3000 BC-AD 800. The CONISS zonation and main clusters (defined by CONISS) are shown on the right.

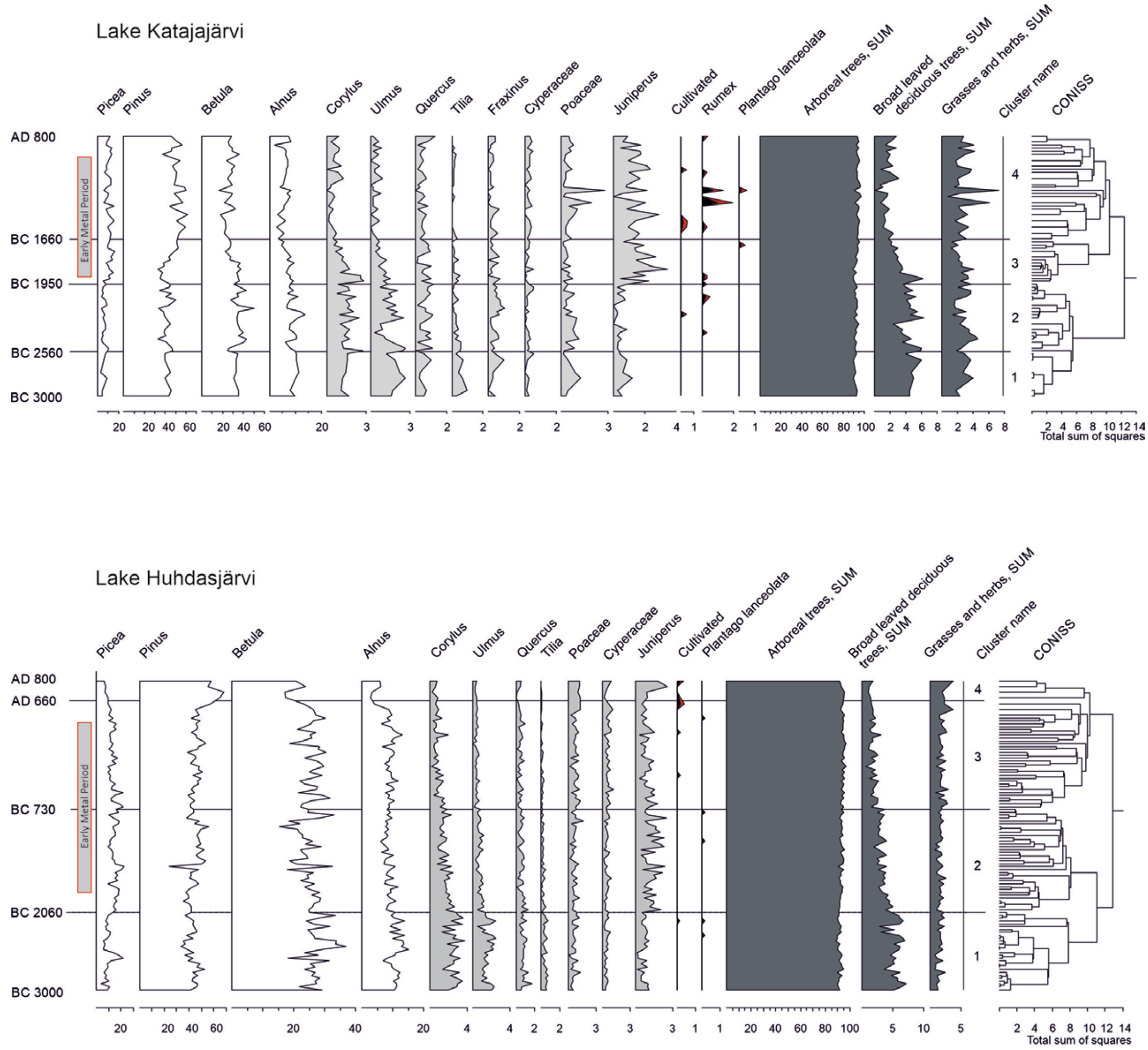


Figure 4 (continued).

Discussion

Incipient forest grazing and slash-and-burn cultivation

At lakes Kirkkolampi, Orijärvi, Nautajärvi and Huhdasjärvi, the analysed transition period coincides with the beginning of cluster 2 and at lake Katajajärvi with the start of cluster 3. In all five lakes, this period begins at c. 2120-1520 BC, and it is characterised by a variation in forest structure. The most distinct change in each place is a slight increase in *Juniperus* (juniper) pollen values. At the same time, a clear decrease in *Betula* (birch), *Alnus* (alder) and other broadleaved deciduous trees (*Ulmus, Corylus, Quercus, Tilia, Fraxinus*) is recorded. *Rumex*, *Urtica* and *Plantago lanceolata* are present sporadically, and even some *Hordeum*-type pollen grains have been dated to c. 2160 BC in lake Huhdasjärvi (at the end of cluster 1) and c. 2220 BC in lake Katajajärvi (in cluster 2).

The decrease in broadleaved trees and the simultaneous increase in *Juniperus* (a species with special light requirements and generally connected to forest disturbances) indicate grazing pressure (e.g. Behre 1981; Hæggström 1990; Pykälä 2001). During the era of traditional animal husbandry, livestock grazed and trampled freely in the forests (Soininen 1974) and helped preserve heterogeneous habitat mosaics and plant diversity

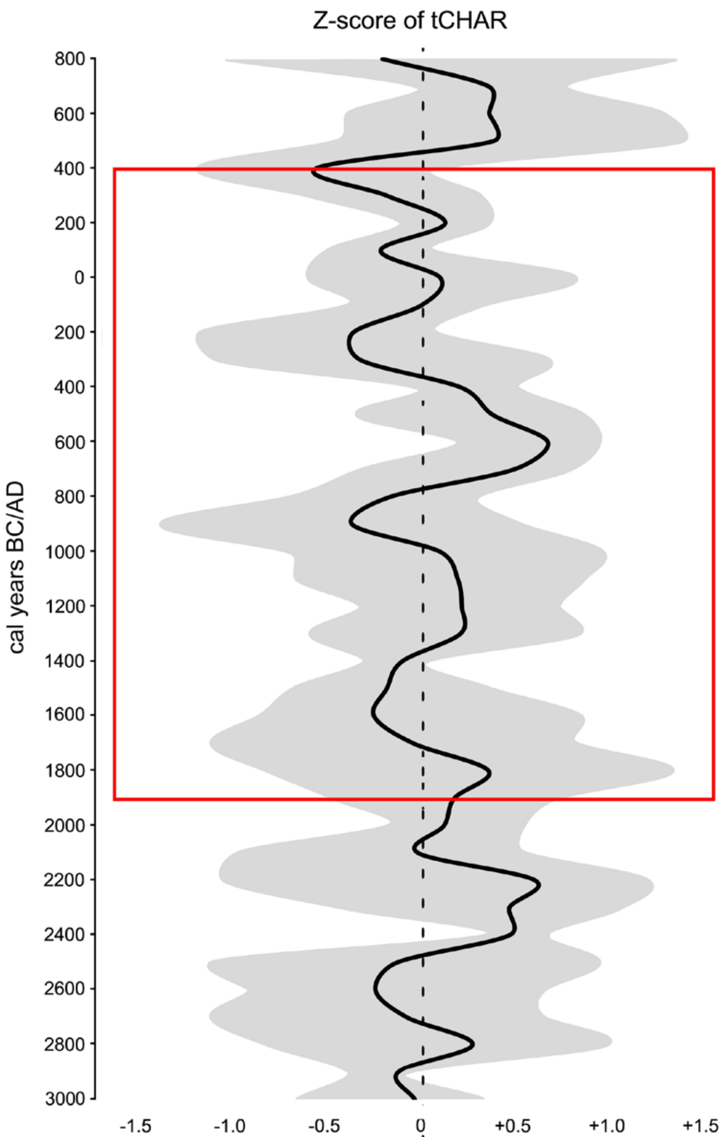


Figure 5. Reconstruction of regional fire activity (tCHAR Z-scores) for the time interval 3000 BC-AD 800 based on charcoal data from lakes Ahvenainen, Huhdasjärvi, Kirkkolampi and Orijärvi. The composite charcoal curve has a base period between 1900 BC and AD 400 and has been smoothed using a 150-year window half width. Grey shading represents the 95 % CI calculated using the bootstrap procedure. The Early Metal Period is marked with a red rectangle.

in the landscape (Luoto *et al.* 2003). The medieval shieling system in Dalarna (central Sweden) can be used to demonstrate the pre-industrial influence of animal husbandry on forest structure (Emanuelsson and Segerström 1998; Segerström and Emanuelsson 2002). Shieling areas that were established in the forests at some distance from the permanent settlements and used to pasture domesticated animals had a strong impact on local vegetation development: broadleaved trees like *Quercus*, *Tilia* and *Ulmus* disappeared locally, and *Betula* and *Picea* diminished. *Juniperus*, *Pinus*, Poaceae and other herbs (such as Caryophyllaceae, *Rumex* and *Urtica*) increased and cereals were introduced (Segerström and Emanuelsson 2002). Changes in vegetation in Dalarna correspond closely to what we see in the pollen data from the southern Finnish lake district.

Thus, it can be hypothesised that the vegetation dynamics observed at our studied sites are mostly the result of the introduction of incipient animal husbandry in the forests. However, the variations in pollen data are quite discreet. Starting from 2120-1520 BC onwards, *Juniperus* percentages increase but still remain low (c. 1.2 %). In previous pollen analyses carried out at lake Hannusjärvi, near Helsinki, *Juniperus* proportions accounted for close to 10 % of vegetation between AD 1550 and 1750, at a time when animal husbandry was already a widely established part of subsistence. According to cadastral and tithes records from AD 1571, lake Hannusjärvi was surrounded by ten farms, with a total of 12 horses, 39 cattle, 44 sheep and one pig (Alenius *et al.* 2017b). Based on these previous results, it can be speculated that only a few sheep would have been enough to cause the slight change in *Juniperus* proportions recorded by our data.

Archaeological and osteological evidence of domesticated animals for this time period is meagre (all material is burnt, as unburnt bone does not generally preserve in the soil conditions of Finland). The earliest sheep/goat bone comes from the context of the coastal Kiukainen culture (end of the third millennium BC), while cattle and horses are found only later in the Bronze Age in south-western Finland (Bläuer and Kantanen 2013, 1651-53). Lipid biomarker analyses of pottery are few, and no material dating to the studied period has been published from the inland parts of Finland. On the coast, the presence of dairy lipids has been established from the Corded Ware period onwards (Cramp *et al.* 2014, 3-4; Pääkkönen *et al.* 2020, 9-11). Despite this evidence, animal husbandry did not yet alter the basic subsistence, and the fragmentary osteological assemblages show that hunting and fishing also retained their importance during the transition to the Early Metal Period in southern Finland (Bläuer and Kantanen 2013, 1655; Mökkönen 2001; Seitsonen *et al.* 2017; Ukkonen 1996). The rapid expansion of animal husbandry in northern Europe has recently been genetically dated to the Middle and Late Iron Age (AD 400-1000; Niemi 2018).

The earliest macrofossil evidence of a domesticated plant from the Finnish mainland is a barley grain from a Kiukainen culture context, coastal south-western Finland, dated to the second half of the third millennium BC (Vuorela and Lempiäinen 1988, 40-41). In the southern lake district, the oldest macrofossil identification (barley) comes from a Textile Ware context dated to the second half of the second millennium BC (Lavento 1998, 50). However, archaeobotanical studies are quite limited in Finland (Vanhanen 2019, 15-20). No artefacts undisputedly related to cultivation exist from these early contexts.

Pollen data from different parts of the country testify to the incipient growing of domesticated species from c. 2300 BC onwards, but signs of cultivation remain scarce throughout the Early Metal Period (see Vuorela 1999; Vuorela and Hicks 1996 for reviews). Judging by the sporadic and low occurrence of cereal pollen, cultivation during this time must have been an episodic, small-scale activity, with no major subsistence value. Pollen data indicate that cultivation started to gain importance in many places in the Middle and Late Iron Age. Even then, farming often remained a subsidiary subsistence strategy.

We are aware of the fact that variations in vegetation composition in our study region could have been driven by purely environmental factors, including climate (Marquer *et al.* 2014; 2017). Recent research shows that the greatest proportion of variation in vegetation composition in Finland is explained by climate during the pre-agricultural period (c. 8000 BC-AD 1000; Kuosmanen *et al.* 2018). Furthermore, other studies support the hypothesis that land use became a primary driver of vegetation dynamics in northern Europe and Fennoscandia only during the last 2500 years (Kuosmanen *et al.* 2018; Marquer *et al.* 2017; Reitalu *et al.* 2013). Nonetheless, changes in the five pollen diagrams analysed here are abrupt (yet small-scale), while climate-driven alterations in vegetation are usually more gradual over a long time period and probably would affect a larger area. The assumption of human-driven change in vegetation composition is further supported by the sporadic occurrence of apophytes (i.e. *Rumex, Plantago lanceolata* and *Hordeum*), which are normally favoured by anthropogenic activities.

Incipient farming, particularly slash-and-burn cultivation, is an element associated in archaeological narratives with the Early Metal Period (Carpelan 1982; 1999, 268; Lavento 2001, 139-41; 2012a, 9-11). The regional charcoal curve from south-east Finland (Figure 5) seems to partially support the idea of the introduction of slash-and-burn cultivation during this time. In fact, even if the trend oscillates throughout the recorded time period (3000 BC-AD 800), with respect to the Early Metal Period the

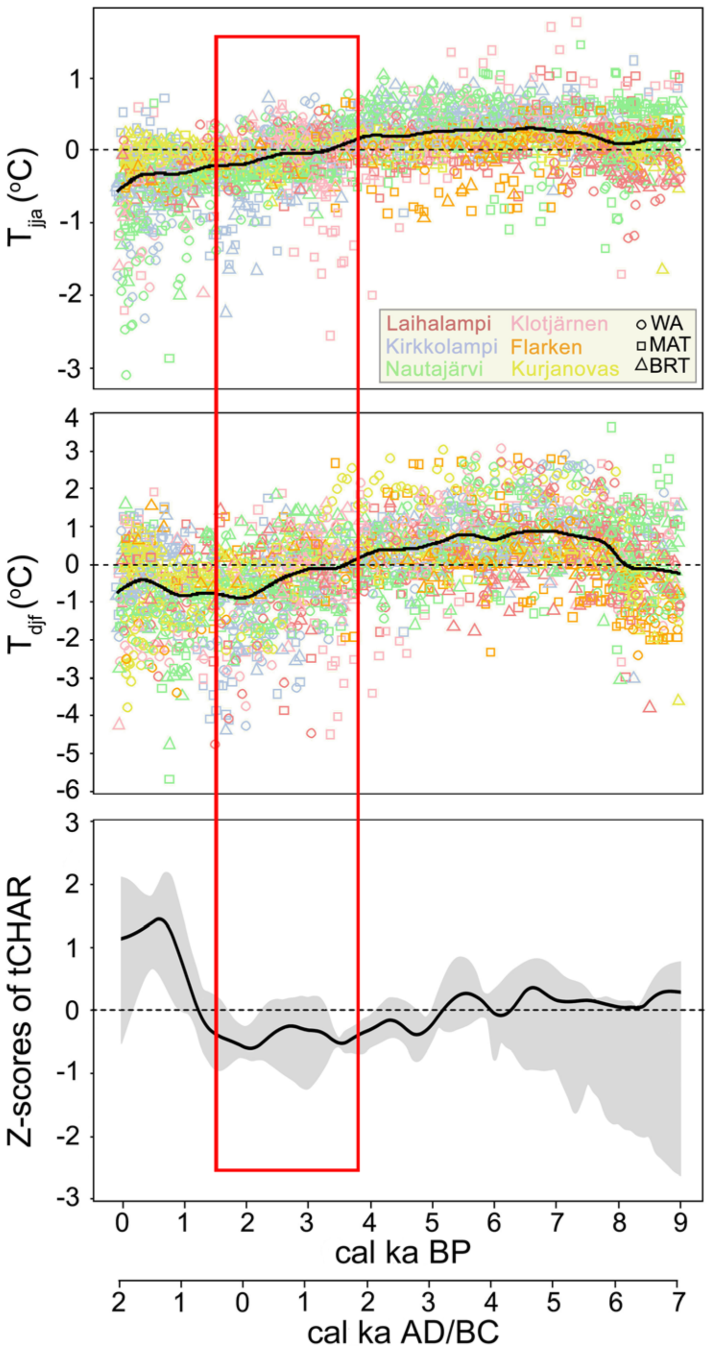


Figure 6. Comparison between pollen-based palaeoclimatic reconstructions for Tjja (June-to-August mean temperature) and Tdjf (December-to-February mean temperature), based on work by Salonen *et al.* (2014), and regional fire activity over the past 9 ka. A total of 18 reconstructions are included for each climatic parameter, prepared from six lakes with three methods: weighted averaging regression and calibration (WA), the modern analogue technique (MAT) and boosted regression trees (BRT). For details, see Salonen *et al.* (2014). For this comparison, both paleoclimate and biomass burning trends were expressed as deviations from the reconstruction-specific 9-ka mean, and the composite charcoal curve was smoothed using a 500-year window half width. Grey shading represents the 95 % CI calculated using the bootstrap procedure. The Early Metal Period is marked with a red rectangle.

intervals 1900-1800 BC, 1300-1000 BC, 700-400 BC and approximately AD 0 and AD 200 are characterised by charcoal values above the long-term mean (in this case, charcoal data have been expressed as deviations from the base period of 1900 BC-AD 400; Figure 5). The comparison of regional fire dynamics with reconstructions of Holocene summer and winter temperatures in northern Europe (taken from Salonen *et al.* 2014) indicates a rise in forest fires during the intervals 1500-700 BC and AD 0-400, two periods characterised by a general decrease in temperatures, especially mean summer values (Figure 6). Despite values below the long-term mean for both temperature and charcoal Z-scores (to be comparable with palaeoclimate reconstructions, in this case charcoal data have been expressed as deviations from the base period 0-9000 BP), these opposite trends during the Early Metal Period could suggest the occurrence of human-induced fires more than variations driven by natural disturbances (unlike the ones characterising earlier periods when the palaeoclimate and charcoal trends were synchronous).

Effects and scale of past human disturbance and modern research activities

Studies searching for the beginning of food-producing economies are often tuned to identifying the phases when cultivation and/or animal husbandry are already more or less established, providing a certain level of subsistence and transforming the structure and socio-demographic development of societies. However, this can be preceded by a lengthy introductory – or “trial-and-error” – period when the signs of new livelihood(s) may be weak and sporadic (Smith 2001). These incipient phases have usually received less scholarly attention (see also Alenius and Laakso 2006, 146; Alenius *et al.* 2021; Mökkönen 2010).

Inconsistencies between the archaeological and palaeoecological material are also not unknown in Finnish inland areas during the later phases of prehistory, and in several cases signs of cultivation or grazing are not backed up by archaeological finds (Alenius *et al.* 2004; 2008, 180; 2009, 141; 2013, 15; 2020, 1632). Lake Kirkkolampi can serve as an example here: despite indications of human activities and food production dated from the Bronze Age and Early Iron Age onwards, archaeological signals appear only in the Middle Ages (Alenius and Laakso 2006, 160). In this particular case, the lack of finds is not related to a lack of fieldwork: due to the adjacent and well-studied Papinniemi Orthodox village and cemetery (Laakso 2014), the lake shore and other surrounding areas have been thoroughly surveyed for Iron Age and later sites. These studies have not produced Stone Age or Early Metal Period finds. However, part of the adjacent area (radius >3 km) is located on the Russian side of the present-day border, and thus remains completely unstudied (Figure 7:4).

Of the other analysed locations, the area surrounding lake Nautajärvi remains practically unexplored, while in the area around lake Orijärvi numerous Iron Age excavations, but no basic surveys, have been conducted (Figure 7:2 and 7:3). The sites next to the coring locations in the lake Huhdasjärvi and lake Katajajärvi area (the two lakes are situated less than 14 km apart; Figure 7:1) were largely identified during targeted intensive archaeological surveys conducted in connection with palynological studies (Alenius *et al.* 2013, 7-8; Lavento and Lahelma 2007). Furthermore, the rather small number of finds in relation to the research efforts highlights the scarcity of sites and the sparse nature of land use. They also illustrate the problems connected to finding sites that are often (especially around lake Katajajärvi) situated in settings that diverge markedly not only from the stereotypical positions expected for Stone Age hunter-fisher-gatherer locations, but also from later agropastoral settlements (Alenius *et al.* 2009, 150; Nordqvist 2007, 107) (Figure 2). The absence of typologically diagnostic finds and radiocarbon dates prevents proper dating and emphasises the unclassifiable nature of the material.

The implications of limited research on and the potentially reduced archaeological visibility of such sites must be acknowledged. The changes suggested for settlement patterns and material culture in general (Ikäheimo 2005, 773-76; Lavento 2001, 137-39; Mökkönen 2011, 65) would markedly weaken the archaeological signals. However, since

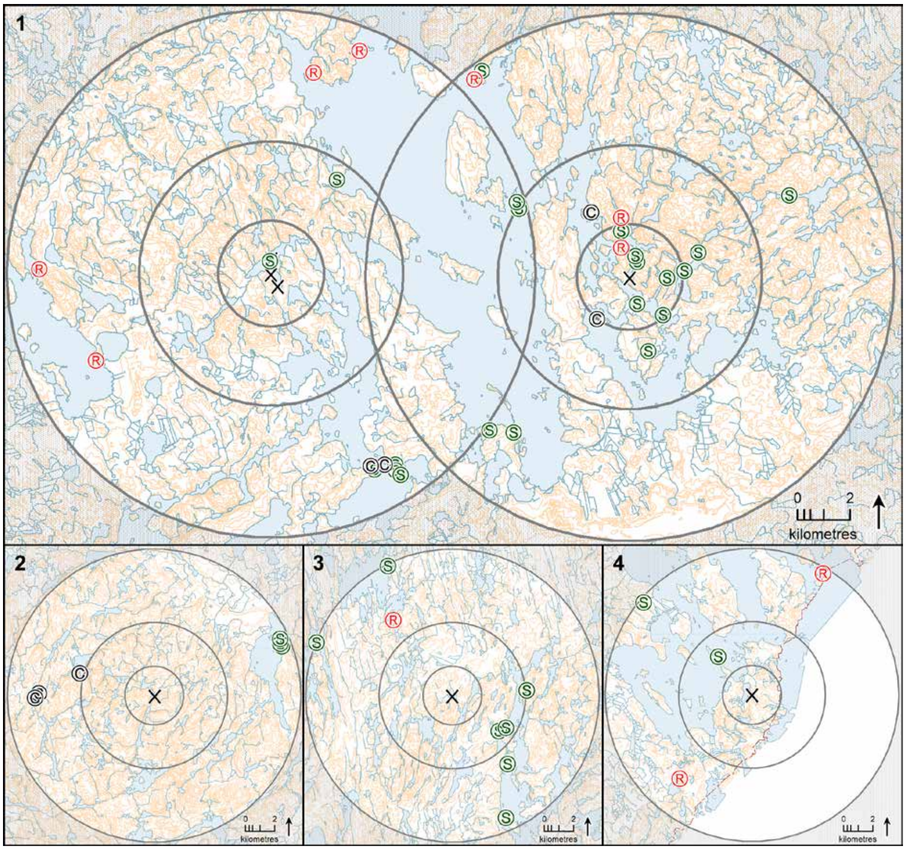


Figure 7. Archaeological sites located in the vicinity of the sampling locations (x): 1 – lake Huhdasjärvi (left) and lake Katajajärvi (right), 2 – lake Nautajärvi, 3 – lake Orijärvi, 4 – lake Kirkkolampi (white uncharted area is in the territory of the Russian Federation); C – cairn; R – rock art, S – settlement. Concentric circles mark 2-, 5- and 10-km buffer zones around the coring sites (map by K. Nordqvist, based on CC-BY data from the National Land Survey of Finland Topographic Database 10/2020).

only a handful of properly studied Early Metal Period sites and micro-areas are known (*cf.* Lavento 2001, 135-37; 2012b, 159-61), this must remain just one of several hypotheses. Even if we noted a contradiction between the archaeological and palaeoecological data, both sets of data still show a change in land use and settlement patterns and indicate the limited magnitude of anthropogenic activities during the last centuries of the Stone Age and the beginning of the Early Metal Period.

It has been demonstrated (Broström *et al.* 2004; Sugita 1994) that small vegetation patches cannot be recorded in pollen data from very large lakes because substantially large amounts of pollen come from more distant sources. Vegetation appears homogeneous in the pollen record, and therefore very large lakes are well suited for reconstructing regional vegetation, but less for studying small-scale (local) forest composition and human activities. At the same time, *Juniperus communis* and *Plantago lanceolata* have high pollen productivity estimates (Broström *et al.* 2004; Hjelle 1998), accounting for the significant influence of background pollen coming from an area beyond the immediate RSAP. This suggests that the light increase in *Juniperus* in all studied sites from 2120-1520 BC onwards does not necessarily indicate local pastoral activity, but might instead, given the lack of archaeological finds near most sampling locations, represent human activities (i.e. grazing) on a regional scale; alternatively, if grazing did take place beside these lake basins, it was not connected with the settlements.

The low human presence close to the sampled sites could be explained through sparse habitation and the (also historically documented) practice of clearing cultivated plots further away from the settlements (Alenius *et al.* 2009, 150; 2013, 15; Lavento 2012a, 15, 32; see also Taavitsainen *et al.* 1998). The earliest cultivated plant pollen originate from autogamous and insect-pollinated species (such as *Hordeum, Avena* and *Triticum*), which release very little pollen into the air (Fægri and Iversen 1989). *Hordeum* pollen are poorly represented even in the immediate vicinity of the fields (Bakels 2000; Hall 1989;

Vuorela 1973), and therefore, the picture provided by cultivated plant pollen types is likely distorted. Wind-pollinated *Secale*, on the other hand, produces substantial amounts of pollen, and as a result the onset of slash-and-burn cultivation with rye as the main species is more clearly visible in the sediments relative to the cultivation of barley even in small permanent fields.

Farewell to the Stone Age

The palaeoecological data summarised here suggest changes in land use in the southern Finnish lake district during the Stone Age-Early Metal Period transition, including incipient forest grazing and even sporadic cultivation attempts in some areas (Figure 4). Still, the overall changes in the forest structure remain quite small (yet visible) and indicate that the human-driven activities causing these changes must have been of limited magnitude. The question is how to contextualise these observations in archaeological terms.

Much of the material related to the inland hunter-fisher-gatherers, generally epitomised by Pöljä Ware (see Meinander 1954, 161-67; Nordqvist and Mökkönen 2021), disappears during this time. Even if some continuity is often assumed between the Stone Age and the Early Metal Period, actually very little material has been reliably dated to later than 2500 BC (including Pöljä pottery/food crusts; see Nordqvist and Mökkönen 2021, 34; Pesonen 2004, 92), and the few dated contexts evidence changes in settlements, dwellings and other material culture (Mökkönen 2011, 64). Levels in sediment cores containing *Cerealia* pollen dating to the third millennium BC have previously been connected with groups living in the so-called Middle Zone (Carpelan 1982, 268; 1999, 268), which is seen as a contact area in southern Finland where hybridisation of the coastal and inland populations took place (Carpelan 1979, 15; 1999, 267). However, the "Middle Zone" remains a vaguely defined concept with similarly unclear dating (*cf.* Mökkönen 2011, 53; Nordqvist 2016, 59-61; see also Lavento 2012b, 153-54) and lacking full explanatory value. Thus, in the presence of only insufficiently recognised archaeological materials, these early indications of cultivation remain rather "stray pollen finds" without clear origins and context.

Changes in forest structure, visible from 2120-1520 BC onwards and likely caused by forest grazing, partially pre-date but largely overlap with the occurrence of Textile Ware. Characterising the inland Bronze Age, its appearance most likely resulted from external influences from the (south-)east, possibly with some local inputs (Lavento 2001, 176; see also Carpelan 1999, 268-70; Meinander 1954, 180-95). Textile Ware populations were probably familiar with slash-and-burn cultivation (Lavento 2001, 139-41; 2015, 132; also Carpelan 1999, 268) and, although their main subsistence still came from foraging (Lavento 2001, 141), they may also have engaged in animal husbandry on a quite limited scale (Lavento 2015, 133). Although some caution is warranted with our data interpretation, both temporary burning practices and forest grazing are supported by the present results. In conclusion, the change in land use does not indicate a large-scale spread of agriculture during this time. Both cultivation and animal husbandry were known, but they only had, at best, a minor subsidiary role in subsistence. The transition to fully productive livelihoods was a gradual process in Finland, and their introduction did not lead to an immediate population increase or obvious increase in social complexity. Finally, the present data do not indicate a total break (long-lasting hiatus) or depopulation in the studied area as a whole, but, at the same time, they do not support full-scale continuity either.

The duration of the Stone Age has intrigued Finnish archaeologists for over a century (e.g. Ailio 1913; Äyräpää 1935; Tallgren 1914). Even if the Stone Age-like nature of settlements and subsistence during the Early Metal Period has been repeatedly stressed (cf. the Arctic Bronze Age; Tallgren 1937, 12-14), the period of time discussed in this article covers the disappearance of many populations following a hunter-fisher-gatherer way of life in the traditional Stone Age sense of the word (see also Lang 2007, 33). The character of the archaeological data changes in many fields of life (settlements and settlement patterns, material culture, belief systems), indicating the alteration of society in general. Nevertheless, we are forced to conclude that, at present, we can neither sufficiently identify the role of local communities behind such developments nor name all the populations or directions of impact responsible for particular changes in archaeological terms. This gap in our knowledge regarding the cultural and demographic developments of the late third and the early second millennium BC still requires heavy interdisciplinary research input, not only in Finland but also on a north-east European scale.

Acknowledgements

The writing of this paper was funded by the Helsinki University Humanities project (HUH) (KN), the Turku Institute for Advanced Studies (TIAS) (TA) and the Lund University Strategic Research Area on ModElling the Regional and Global Earth system (MERGE) (CM). The authors would also like to thank the editors for the invitation to contribute to this collection and the two reviewers for their helpful comments.

Bibligraphy

Ailio, J. 1913. Die Dauer der Steinzeitkultur im Norden. In O. Almgren (ed.), *Opuscula archœologica Oscari Montelio: septuangenario dicata D. IX M. Sept. A. MCMXIII*, 9-18. Stockholm: Häggström.

Alenius, T. and Laakso, V. 2006. Palaeoecology and archaeology of the village of Uukuniemi, eastern Finland. *Acta Borealia* 23, 145-65.

Alenius, T., Grönlund, E., Simola, H. and Saksa, A. 2004. Land-use history of Riekkalansaari Island on the northern archipelago of Lake Ladoga, Karelian Republic, Russia. *Vegetation History and Archaeobotany* 13, 23-31.

Alenius, T., Mikkola, E. and Ojala, A.E.K. 2008. History of agriculture in Mikkeli Orijärvi, eastern Finland as reflected by palynological and archaeological data. *Vegetation History and Archaeobotany* 17, 171-83.

Alenius, T., Lavento, M. and Saarnisto, M. 2009. Pollen-analytical results from Lake Katajajärvi: aspects of the history of settlement in the Finnish inland regions. *Acta Borealia* 26, 136-55.

Alenius, T., Mökkönen, T. and Lahelma, A. 2013. Early farming in the northern Boreal zone: reassessing the history of land use in south eastern Finland through high-resolution pollen analysis. *Geoarchaeology* 28, 1-24.

Alenius, T., Mökkönen, T., Holmqvist, E. and Ojala, A.E.K. 2017a. Neolithic land use in the northern Boreal zone: high-resolution multiproxy analyses from Lake Huhdasjärvi, south-eastern Finland. *Vegetation History and Archaeobotany* 26, 469-86.

Alenius, T., Haggrén, G., Koivisto, S., Vanhanen, S. and Sugita, S. 2017b. Landscape dynamics in southern Finland during the Iron Age and the Early Modern Era – pollen-based landscape reconstruction (LRA), macrofossil and historical data from Western Uusimaa. *Journal of Archaeological Science: Reports* 12, 12-24.

Alenius, T., Gerasimov, D., Sapelko, T., Ludikova, A., Kuznetsov, D., Golyeva, A. and Nordqvist, K. 2020. Human-environment interaction during the Holocene along the shoreline of the ancient Lake Ladoga: a case study based on palaeoecological and archaeological material from the Karelian Isthmus, Russia. *The Holocene* 30, 1622-36.

Alenius, T., Marquer, L., Moliniari, C., Heikkilä, M. and Ojala, A. 2021. The environment they lived in: anthropogenic changes in local and regional vegetation composition in eastern Fennoscandia during the Neolithic. *Vegetation History and Archaeobotany* 30, 489-506.

Äyräpää, A. 1935. Muutama sana Parikkalan Kaunissaaren asuinpaikkalöydöstä. *Suomen Museo* 41, 49-51.

Bakels, C.C. 2000. Pollen diagrams and prehistoric fields: the case of Bronze Age Haarlem, the Netherlands. *Review of Palaeobotany and Palynology* 109, 205-18.

Behre, K.-E., 1981. The interpretation of anthropogenic indicators in pollen diagrams. *Pollen et Spores* 23, 225-45.

Blarquez, O., Vannière, B., Marlon, J.R., Daniau, A.-L., Power, M.J., Brewer, S. and Bartlein, P.J. 2014. Paleofire: an R package to analyse sedimentary charcoal records from the Global Charcoal Database to reconstruct past biomass burning. *Computers & Geosciences* 72, 255-61.

Bläuer, A. and Kantanen, J. 2013. Transition from hunting to animal husbandry in southern, western and eastern Finland: new dated osteological evidence. *Journal of Archaeological Science* 40, 1646-66.

Broström, A., Sugita, S. and Gaillard, M.-J. 2004. Pollen productivity estimates for the reconstruction of past vegetation cover in the cultural landscape of southern Sweden. *The Holocene* 14, 368-81.

Carpelan, C. 1979. Om asbestkeramikens historia i Fennoskandien. *Finskt Museum* 85, 5-25.

Carpelan, C. 1982. Om bronsålderns jordbrukssamhälle i Finland. In T. Sjøvold (ed.), *Introduksjonen av jordbruk i Norden. Foredrag holdt ved fellesnordisk symposium i Oslo april 1980*, 267-78. Oslo: Universitetsforlaget.

Carpelan, C. 1999. Käännekohtia Suomen esihistoriassa aikavälillä 5100…1000 eKr. In P. Fågelberg (ed.), *Pohjan poluilla: suomalaisten juuret nykytutkimuksen mukaan*, 249-80. Helsinki: The Finnish Society of Sciences and Letters.

Cramp, L.J.E., Evershed, R.P., Lavento, M., Halinen, P., Mannermaa, K., Oinonen, M., Kettunen, J., Perola, M., Onkamo, P. and Heyd, V. 2014. Neolithic dairy farming at the extreme of agriculture in northern Europe. *Proceedings of the Royal Society B* 281, 20140819.

Emanuelsson, M. and Segerström, U. 1998. Forest grazing and outland exploitation during the Middle Ages in Dalarna, central Sweden. A study based on pollen analysis. In H. Andersson, L. Ersgård and E. Svensson (eds), *Outland use in preindustrial Europe*, 80-94. Lund: Institute of Archaeology, Lund University.

Fægri, K. and Iversen, J. 1989. *Textbook of pollen analysis*. Chichester: John Wiley and Sons.

Grimm, E.C. 1987. CONISS: A Fortran 77 program for stratigraphically constrained cluster analysis by the method of incremental sum of squares. *Computers & Geosciences* 13, 13-35.

Grimm, E.C. 1991. *TILIA and TILIA-GRAPH*. Springfield: Illinois State Museum.

Hæggström, C.A. 1990. The influence of sheep and cattle grazing on wooded meadows in Åland, SW Finland. *Acta Botanica Fennica* 141, 1-28.

Hall, V.A. 1989. A study of the modern pollen rain from a reconstructed 19th century farm. *The Irish Naturalists' Journal* 23, 82-92.

Heikkilä, M. and Seppä, H. 2003. A 11,000 yr palaeotemperature reconstruction from the southern boreal zone in Finland. *Quaternary Science Reviews* 22, 541-54.

Helama, S. and Oinonen, M. 2019. Exact dating of the Meghalayan lower boundary based on high-latitude tree-ring isotope chronology. *Quaternary Science Reviews* 214, 178-84.

Hjelle, K.L. 1998. Herb pollen representation in surface moss samples from mown meadows and pastures in western Norway. *Vegetation History and Archaeobotany* 7, 79-96.

Ikäheimo, J. 2005. Re-assessing the Bronze Age of coastal northern Ostrobothnia – the lower Oulujoki river valley. In J. Goldhahn (ed.), *Mellan sten och järn. Rapport från det 9:e nordiska bronsålders-symposiet, Göteborg 2003-10-09/12*, 771-84. Göteborg: University of Göteborg.

Jacobson, G.L. Jr and Bradshaw, R.H.W. 1981. The selection of sites for paleovegetational studies. *Quaternary Research* 16, 80-96.

Kuosmanen, N. [+ 10 others] and Seppä, H. 2018. The role of climate, forest fires and human population size in Holocene vegetation dynamics in Fennoscandia (JVS-S-04131). *Journal of Vegetation Science* 29, 382-92.

Laakso, V. 2014. *Papinniemi in Uukuniemi and related archaeological sites of the eastern Orthodox cultural area in Finland*. Turku: Suomen keskiajan arkeologian seura.

Lahelma, A. 2008. *A touch of red. Archaeological and ethnographic approaches to interpreting Finnish rock paintings*. Helsinki: Finnish Antiquarian Society.

Lang, V. 2007. *The Bronze and Early Iron Ages in Estonia*. Tartu: Tartu University Press.

Lavento, M. 1998. Sisämaan vanhemman metallikauden väestö tutkimusongelmana. *Muinaistutkija* 4, 46-55.
Lavento, M. 2001. *Textile ceramics in Finland and on the Karelian Isthmus. Nine variations and a fugue on a theme of C.F. Meinander*. Helsinki: Finnish Antiquarian Society.
Lavento, M. 2012a. Cultivation among hunter-gatherers in Finland – evidence of activated connections? In R. Grünthal and P. Kallio (eds), *A linguistic map of prehistoric northern Europe*, 1-40. Helsinki: Finno-Ugrian Society.
Lavento, M. 2012b. Local centres in the periphery: the Late Neolithic, Bronze Age and Early Metal Age in Finland. In N. Anfinset and M. Wrigglesworth (eds), *Local societies in Bronze Age northern Europe*, 148-68. London: Routledge.
Lavento, M. 2015. Pronssi- ja varhaismetallikausi. In G. Haggrén, P. Halinen, M. Lavento, S. Raninen and A. Wessman, *Muinaisuutemme jäljet. Suomen esi- ja varhaishistoria kivikaudelta keskiajalle*, 123-212. Helsinki: Gaudeamus.
Lavento, M. and Lahelma, A. (eds) 2007. *Sama maisema, eri kulkijat – Repoveden kansallispuisto kivikaudelta 1900-luvulle*. Helsinki: Metsähallitus.
Luoto, M., Pykälä, J. and Kuusisaari, M. 2003. Decline of landscape-scale habitat and species diversity after the end of cattle grazing. *Journal for Nature Conservation* 11, 171-78.
Marquer, L. [+ 19 others] and Seppä, H. 2014. Holocene changes in vegetation composition in northern Europe: why quantitative pollen-based vegetation reconstructions matter. *Quaternary Science Reviews* 90, 199-216.
Marquer, L. [+ 24 others] and Seppä, H. 2017. Quantifying the effects of land use and climate on Holocene vegetation in Europe. *Quaternary Science Reviews* 171, 20-37.
Meinander, C.F. 1954. Die Bronzezeit in Finnland. *Finska fornminnesföreningens tidskrift* 54, 5-242.
Miettinen, T. 1998. *Kymenlaakson esihistoriaa.* Kotka: Kymenlaakson maakuntamuseo.
Mökkönen, T. 2001. Hauki on kala – Saimaan vesistöalueen kivi- ja varhaismetallikauden osteologinen aineisto. *Muinaistutkija* 3, 2-13.
Mökkönen, T. 2010. Kivikautinen maanviljely Suomessa. *Suomen Museo* 116, 5-38.
Mökkönen, T. 2011. *Studies on Stone Age housepits in Fennoscandia (4000-2000 cal BC). Changes in ground plan, site location and degree of sedentism*. Helsinki: University of Helsinki.
Niemi, M. 2018. *Genetic reconstruction of ancient northern European cattle and sheep populations*. Helsinki: University of Helsinki.
Nordqvist, K. 2007. Repoveden alueen arkeologiset tutkimukset vuonna 2006. In M. Lavento and A. Lahelma (eds), *Sama maisema, eri kulkijat – Repoveden kansallispuisto kivikaudelta 1900-luvulle*, 105-08. Helsinki: Metsähallitus.
Nordqvist, K. 2016. From separation to interaction. Corded Ware in the eastern Gulf of Finland. *Acta Archaeologica* 87, 49-84.
Nordqvist, K. 2018. *The Stone Age of north-eastern Europe 5500-1800 calBC. Bridging the gap between the East and the West*. Oulu: University of Oulu.
Nordqvist K. and Mökkönen, T. 2021. Pöljä Ware: properties, dating and regional variation. *Fennoscandia archaeologica* XXXVIII, 29-58.
Ojala, A.E.K. and Alenius, T. 2005. 10000 years of interannual sedimentation recorded in the Lake Nautajärvi (Finland) clastic-organic varves. *Palaeogeography, Palaeoclimatology, Palaeoecology* 219, 285-302.
Okkonen, J. 2003. *Jättiläisen hautoja ja hirveitä kiviröykkiöitä – Pohjanmaan muinaisten kivirakennelmien arkeologiaa*. Oulu: University of Oulu.
Pääkkönen, M., Holmqvist, E., Bläuer, A., Evershed, R.P. and Asplund, H. 2020. Diverse economic patterns in the north Baltic Sea region in the Late Neolithic and Early Metal Periods. *European Journal of Archaeology* 23, 4-21.
Pesonen, P. 2004. Neolithic pots and ceramics chronology – AMS-datings of Middle and Late Neolithic ceramics in Finland. In P. Uino (ed.), *Fenno-ugri et slavi 2002. Dating and chronology*, 87-97. Helsinki: National Board of Antiquities.

Piličiauskas, G., Jankauskas, R., Piličiauskienė, G., Craig, O.E., Charlton, S. and Dupras, T. 2017. The transition from foraging to farming (7000-500 cal BC) in the SE Baltic: a re-evaluation of chronological and palaeodietary evidence from human remains. *Journal of Archaeological Science: Reports* 14, 530-42.

Power, M.J., [+ 82 others] and Zhang, J.H. 2008. Changes in fire regimes since the Last Glacial Maximum: an assessment based on a global synthesis and analysis of charcoal data. *Climate Dynamics* 30, 887-907.

Prentice, I.C. 1985. Pollen representation, source area, and basin size: toward a unified theory of pollen analysis. *Quaternary Research* 23, 76-86.

Pykälä, J. 2001. *Maintaining biodiversity through traditional animal husbandry*. Helsinki: Finnish Environment Institute.

R Core Team 2016. *R: a language and environment for statistical computing*. Vienna: R Foundation for Statistical Computing.

Reitalu, T. [+ 12 others] and Veski, S. 2013. Long-term drivers of forest composition in a boreonemoral region: the relative importance of climate and human impact. *Journal of Biogeography* 40, 1524-34.

Saipio, J. 2015. Bronze Age cairns in the Finnish lake district: cultural contacts, creative translations and local traditions. In P. Suchowska-Ducke, S. Scott Reiter and H. Vandkilde (eds), *Forging identities. The mobility of culture in Bronze Age Europe 2*, 123-31. Oxford: Archaeopress.

Salonen, J.S., Luoto, M., Alenius, T., Heikkilä, M., Seppä, H., Telford, R.J. and Birks, H.J.B. 2014. Reconstructing palaeoclimatic variables from fossil pollen using boosted regression trees: comparison and synthesis with other quantitative reconstruction methods. *Quaternary Science Reviews* 88, 69-81.

Segerström, U. and Emanuelsson, M. 2002. Extensive forest grazing and hay-making on mires – vegetation changes in south-central Sweden due to land use since Medieval times. *Vegetation History and Archaeobotany* 11, 181-90.

Seitsonen, O., Seitsonen, S. Broderick, L.G. and Gerasimov, D.V. 2017. Burnt bones by Europe's largest lake: zooarchaeology of the Stone Age and Early Metal period hunter-gatherers at Lake Ladoga, NW Russia. *Journal of Archaeological Science: Reports* 11, 131-46.

Smith, B.D. 2001. Low-level food production. *Journal of Archaeological Research* 9, 1-43.

Soininen, A.M. 1974. Vanha maataloutemme. Maatalous ja maatalousväestö Suomessa perinnäisen maatalouden loppukaudella 1720-luvulta 1870-luvulle. *Journal of the Scientific Agricultural Society of Finland* 46, 1-459.

Sugita, S. 1994. Pollen representation of vegetation in Quaternary sediments: theory and method in patchy vegetation. *Journal of Ecology* 82, 881-97.

Sundell, T. 2014. *The past hidden in our genes. Combining archaeological and genetic methodology: prehistoric population bottlenecks in Finland*. Helsinki: University of Helsinki.

Taavitsainen, J.-P. 2003. Lapp cairns as a source on metal period settlement in the inland regions of Finland. *Acta Borealia* 20, 21-47.

Taavitsainen, J.-P., Simola, H. and Grönlund, E. 1998. Cultivation history beyond the periphery: early agriculture in the north European Boreal forest. *Journal of World Prehistory* 12, 199-253.

Tallavaara, M., Pesonen, P. and Oinonen, M. 2010. Prehistoric population history in eastern Fennoscandia. *Journal of Archaeological Science* 37, 251-60.

Tallgren, A.M. 1914. Den östeuropeiska bronsålderskulturen i Finland. *Finskt Museum* 21, 11-22.

Tallgren, A.M. 1937. The Arctic Bronze Age in Europe. *Eurasia Septentrionalis Antiqua* 11, 1-46.

Tolonen, M. 1978. Palaeoecology of annually laminated sediments in Lake Ahvenainen, S. Finland. I. Pollen and charcoal analyses and their relation to human impact. *Annales Botanici Fennici* 15, 177-208.

Ukkonen, P. 1996. Osteological analysis of the refuse fauna in the Lake Saimaa area. In T. Kirkinen (ed.), *Environmental studies in eastern Finland. Reports of the Ancient Lake Saimaa Project*, 63-91. Helsinki: University of Helsinki.
Vanhanen, S. 2019. *Prehistoric cultivation and plant gathering in Finland. An archaeobotanical study*. Helsinki: University of Helsinki.
Vuorela, I. 1973. Relative pollen rain around cultivated fields. *Acta Botanica Fennica* 102, 1-27.
Vuorela, I. 1999. The beginnings of agricultural land use in Finland: an assessment based on palynological data. In U. Miller, T. Hackens, V. Lang, A. Raukas and S. Hicks (eds), *Environmental and cultural history of the eastern Baltic region*, 339-51. Rixensart: Conseil de l'Europe.
Vuorela, I. and Hicks, S. 1996. Human impact on the natural landscape in Finland. A review of the pollen evidence. In A.M. Robertsson, A. Åkerlund and S. Hicks (eds), *Landscapes and life. Studies in honour of Urve Miller*, 245-57. Rixensart: Conseil de l'Europe.
Vuorela, I. and Lempiäinen, T. 1988. Archaeobotany of the site of the oldest cereal grain find in Finland. *Annales Botanici Fennici* 25, 33-45.

The Bronze Age culture in Finland from the perspective of the 2020s

Mika Lavento

Introduction

The Bronze Age is a period of the past that is both evident but also problematic to define in Finland. While the appearance of the new period is relatively easy to observe on the basis of archaeological remains in the coastal zone of the country, it is not that easy to separate from the Late Neolithic in inland areas or particularly in the northern part of the country. The same problem is apparent in the northern part of Scandinavia, the Baltic countries as well as in the Kola peninsula. The many changes observed in the archaeological material, as well as in the populations and their structure, make this period complicated and challenging.

Research on the Bronze Age has a great deal of possibilities despite the fact that the availability of archaeological material is variable and opens only some parts of the past cultures to analysis. This means that questions can be posed to the material and the material can be researched using varying methods. Although the Bronze Age has already been studied from many perspectives in Finland, much still remains to be researched; what I can do here is to give a general overview of the situation right now.

The aim of the article is to describe the Bronze Age and the Early Metal Period in Finland. As a period, the Bronze Age has been dated between c. 1700-500 BC, while the Early Metal Age began c. 1900 BC (Figure 1) and continues as late as c. AD 300/400. The Early Metal Age has been defined as a period in eastern and northern Finland, Karelia and the northern part of European Russia. Already during the late decades of the nineteenth century, archaeologists in Finland saw the Bronze Age in the country divided into two areas. The coastal zone was connected to the Scandinavian Bronze Age, but inland culture had its roots in the east. This was important, because the origin of the language of Finland lay to the east and archaeologists focused on locating the origins of material culture in Russia. As a result, the western Bronze Age was separated from the eastern Bronze Age, which later was given the name Early Metal Period.

Questions and material

First, I will briefly examine the research situation and the most essential issues that indicate how and why the settlement pattern and population of these Early Metal Age cultures changed. It will be questioned which archaeological characteristics indicate new influences in the area. I will then discuss which characteristics are essential and how they differ from the neighbouring countries during the second millennium BC and slightly later, focusing on settlement, economy and material culture to reconstruct patterns of interaction and boundary creation, thereby tracing the different influences which were active in what is now Finland during this period. Here, I will first give a brief introduction to the kinds of data available.

The most numerous and evident new Bronze Age structures are the stone cairns. Most of them are known in the coastal zone of south-west and western Finland. In total, the number of cairns is larger than c. 10,000. They have been built on the bedrock shore cliffs. The building of cairns in southern Scandinavia began largely at the beginning of

In D. Hofmann, F. Nikulka and R. Schumann (eds) 2022. *The Baltic in the Bronze Age. Regional patterns, interactions and boundaries*, Leiden: Sidestone Press, pp. 269-288.

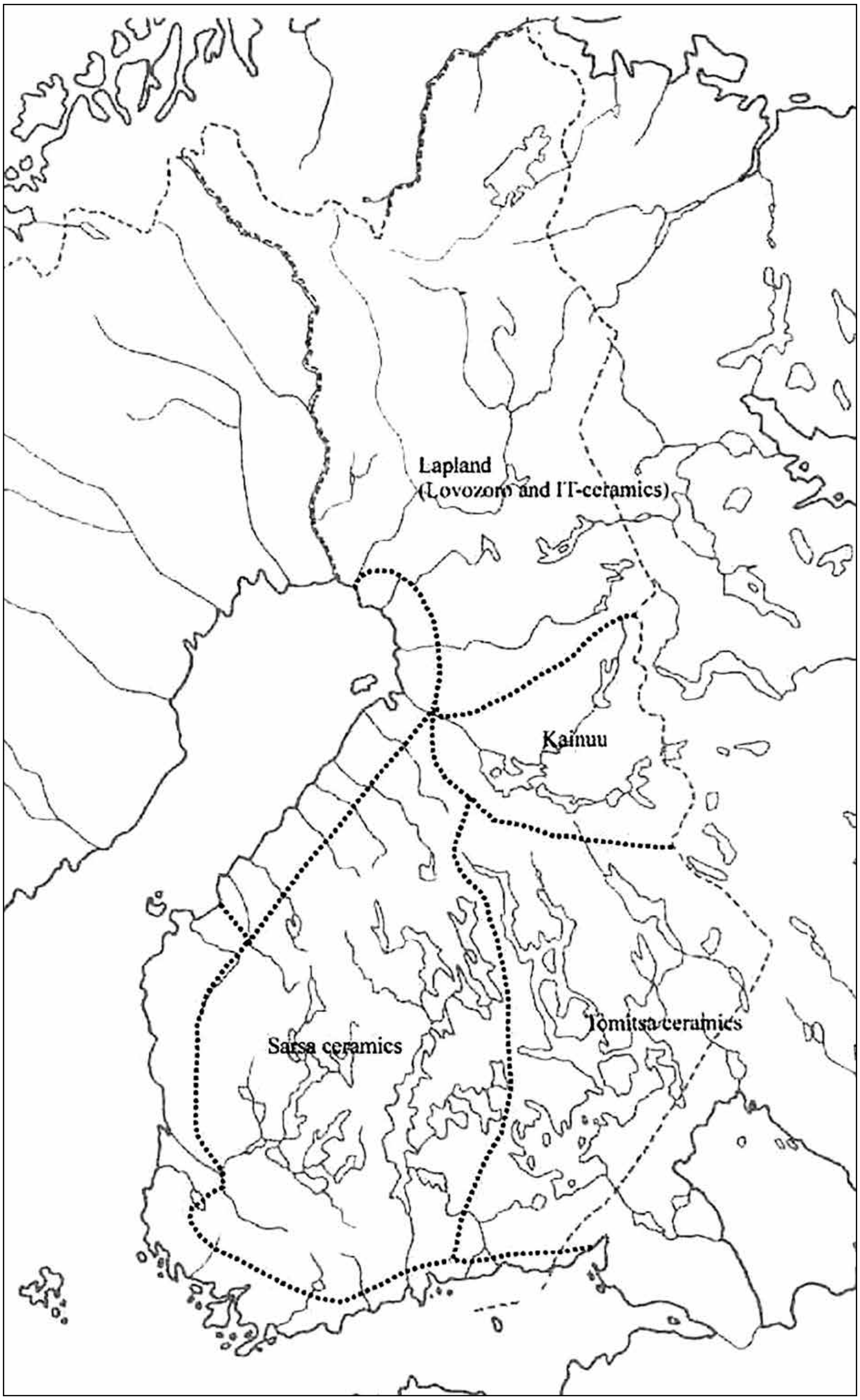


Figure 1. Bronze Age and Early Metal Period in Finland. Distribution of textile ceramic types during the early part of the second millennium BC in Finland (figure: M. Lavento).

the second millennium BC. Although the Bronze Age in Finland began in the coastal zone c. 1700 BC, the earliest cairns may have been built on the western coast of the Baltic Sea, on the north-west coast of Finland, in the late third millennium BC (Okkonen 2003) or even at the end of the fourth millennium BC (Mökkönen 2013). Nevertheless, cairns were mostly built after the first Scandinavian Bronze Age period.

The cairns were also built inland, where they have been called “Lapp cairns”. The reason for the name are the populations that lived in a large part of Finland during the Bronze Age and during the Early Metal Age. The name “Lapp cairns” refers to the hunter-gatherer populations that lived in the region during the Neolithic and Bronze Age. In the coastal zone, the last part of the third millennium BC saw the development of the local Kiukainen culture, an amalgamation of populations from southern Scandinavia and local groups (Meinander 1954a; 1954b). This means that the new Bronze Age culture mostly developed in the coastal area. When looking at the social system in more detail, we can observe several essential changes in the area – these will be discussed in later sections.

A first general point is that the number of dwelling sites during the Bronze Age-Early Metal Period is considerably smaller than during the Stone Age. It is also smaller than the number of dwelling sites during the Iron Age. In Finland, “dwelling site” is defined as any place where humans have stayed for a time. This can include house remains, but depending on the case, even two or three artefacts can be enough. Bronze Age sites have been difficult to find so far. These observations can be connected with the variation in the population in the study area. Basically, the population decreased in the Final Neolithic, but began to increase at the beginning of the second millennium.

Archaeological research methods in Finland have been based on fieldwork, but have tried to use new methods where possible. As is normal in archaeology, the methods used in other sciences have been borrowed extensively because they can bring important information to archaeological research.

In Finland, every municipality has generally been surveyed, but practically, almost all areas would require more detailed fieldwork, such as the survey of Bronze Age cairns carried out during a project by Turku University in south-western Finland in 1980-90s (Salo *et al.* 1992). There have also been excavations, but the number of sites has not been considerable and as a result the amount of material of the Bronze Age and Early Metal Age is not as large as what is known from the Stone Age, Iron Age and even from the Middle Ages and Historical Period.

In spite of this, some material groups dating to the study period have been studied relatively comprehensively (Carpelan 2003; Lavento 2001). This is possible with those materials found in many areas and phases of the Bronze Age, namely ceramics, some metal object types and even some stone items. More interest has recently been directed to the scientific analysis of archaeological material. For example, thin section microscopy or scanning electron microscopy (SEM) have been applied, as have other forms of spectroscopy such as EDS/WDS, XRF or AAS analyses, in cases were machines were available (Ikäheimo 2014; Lavento and Hornytzkyj 1996; Pääkkönen *et al.* 2020).

A considerable part of research is based on analysing bioarchaeological materials from dwelling sites or cemeteries. This means in practice taking into consideration the results of macro-fossil and osteological analysis of the bones of humans and animals when reconstructing the economy and its changes in the Bronze Age. Among these analyses we can also number pollen analysis, which has had an important role in dating the appearance of agriculture (Alenius *et al.* 2008; Vanhanen 2019; Vuorela and Hicks 1996).

Research history

The first archaeological research on the Bronze Age in Finland was carried out already in the 1870s and in particular in south-western Finland and Åland. The interest concentrated on areas where the Finnish language, carried by Finno-Ugrian groups, may have migrated to northern parts of the Baltic Sea. Already the linguist M.A. Castrén carried out field research in Siberia in the 1840s, which he published beginning in the 1850s. Soon after this, the first Finnish archaeologist J.R. Aspelin visited Altai, in the western part of Siberia, and suggested after his fieldwork in the 1870s that the origin of the Finns was there and that a migration to the eastern part of the Baltic Sea had taken place during the Bronze Age (Aspelin 1877-84).

In Finland, the first large-scale collecting of Bronze Age material began during research for *Die Bronzezeit Finnlands* by Alfred Hackman (1897). Hackman had a central role in Finnish archaeology, because he presented the hypothesis that the Finns migrated to the southern coast of the country from Estonia at the beginning of the Iron Age, during the period 1-200 AD (Hackman 1917). The idea was based on the assumption that the populations that used Fenno-Ugric languages migrated to the northern part of the Baltic countries – and first of all to Estonia – already during the Bronze Age.

From then on, the Bronze Age played an essential role in Finnish archaeology as the new period of interest. A.M. Tallgren was instrumental in its investigation. His research argued that the Fenno-Ugrian cultures had formed in the river Volga area and even in the western part of Siberia. Tallgren wrote his PhD thesis on the Copper and Bronze Age in 1911, but he continued his archaeological research in this area until the revolution (Tallgren 1916) and indeed long after, as for instance evidenced in the early publication *Eurasia Septentrionalis Antiqua* (ESA), which was published by Tallgren until 1938. In contrast, his successor Professor Ella Kivikoski focused on the Iron Age, which was then seen as the most important period in Finnish archaeology at Helsinki University. Nevertheless, the young archaeologist C.F. Meinander wrote his seminal PhD thesis on *Die Bronzezeit in Finnland* (1954b) and the same year published a book about the Final Neolithic in the coastal area of Finland, *Die Kiukaiskultur* (1954a). In his books, Meinander presents an overview of the period in Finland and Åland between c. 2500-500 BC.

At Turku University, Unto Salo organised much practical fieldwork on Bronze Age sites and cairns along the south-west and west coast of Finland. Salo himself knew the region of Satakunta best, where the river Kokemäenjoki is running from the province of Häme to the Baltic Sea. He worked as a head of the Satakunta museum in the 1970s but became the professor of archaeology at Turku University in 1971. He had earlier carried out some archaeological excavations at the Bronze Age sites in Rieskaronmäki in Nakkila district (Salo 1981). In Turku, archaeological research under Salo invested much energy into the Bronze Age but in particular the Iron Age. The idea was to survey the south-west of Finland, find new sites and carry out field research at the most interesting of them. As a result, Tapani Tuovinen (2002) wrote a PhD dissertation concentrating on the Turku archipelago. Central in his PhD are the Bronze Age cairns. Henrik Asplund (2008) wrote his dissertation about the island of Kemiönsaari in the Baltic Sea, in southern Finland. This work goes through all the prehistoric periods in the area, but the important role is played by the Bronze Age and Iron Age.

One viewpoint on the Bronze Age in eastern and northern Finland defines this as the Early Metal Age between c. 1900 BC-AD 400 (see above). Investigations began by locating dwelling sites with both ceramics and some bronze material of this period. Christian Carpelan (1965) wrote his licentiate thesis about the Säräisniemi 2 (or Sär 2) ceramics and he divided the material found in Finland first into three and later into four subgroups. He continued his studies on the river Kemijoki, northern Finland, and excavated at Sirnihta in Kesälahti, on the eastern shore of lake Saimaa, in 1971. Carpelan investigated large areas and dated many ceramic types by AMS-dating (Carpelan 2003). This had a considerable value where researching contact with Russia, making use of linguistic research (Carpelan and Parpola 2001). During the Early Metal Age, the languages in the north and Russia were based on Fenno-Ugrian languages. His work was also important for the archaeology of Saami groups and their development during the Early Metal Age, the Iron Age and the Historical Period.

Recent research on the Early Metal Age and Bronze Age has concerned dwelling sites and cairns. It has been carried out by the Universities of Turku and Oulu and mostly in the coastal area. Research in Turku has concentrated on the coastal zone of south-west Finland. At Oulu University, PhD dissertations on the Early Metal Age and Iron Age have mostly focused on the lower part of the river Oulujoki, but also on the northern coast of the Bothnian Bay (Kuusela 2013; Kuusela *et al*. 2017). Fieldwork was carried out in Oulujoki and the coastal area (e.g. Okkonen 2003; Ikäheimo 2005), but studies in the wider environment were based on the material collected by the Finnish Heritage Agency (Muinaisjäännösrekisteri).

In northern Ostrobothnia and Lapland, inland areas have been researched since the 1960s because of water engineering works along the large rivers in the north. The water rationing caused a considerable fluctuation of the water level and made it possible to find new sites and large quantities of prehistoric material. When the surveys began in the Kainuu region in the 1960s, a large number of new sites were found by Matti Huurre (1959; 1982; Huurre and Keränen 1986). The survey along the river Kemijoki was begun in 1955 and continued as late as 1980; many rescue excavations were carried out in the area (Huurre 1983, 42-46). Among the archaeologists involved were M. Huurre, A. Kopisto, C. Carpelan, A. Siiriäinen and P. and A. Sarvas.

At Helsinki University, fieldwork with the purpose of locating new Early Metal Age sites was carried out in the lake Saimaa area and afterwards in the Karelian Isthmus in the framework of several projects. One result was a PhD dissertation on Textile ceramics in Finland (Lavento 2001). Dwelling sites have proven problematic to identify during rescue excavations, while inland cairns have been researched through excavations, normally with financial help from local foundations (Saipio 2011; 2017). Work with these questions is continuing.

Settlement and economy

An essential feature of the Bronze Age has for a long time been the small number of dwelling sites when compared to the Neolithic and Iron Age. This has been the case particularly in the coastal zone of the Baltic Sea in Finland. Inland, the number of dwelling sites is larger during the Early Metal Age. Recently, new dwelling sites have also been found on the coast, largely due to several surveys (Asplund 2008; Lavento 2001; Okkonen 2003; Tuovinen 2002).

The prehistoric material database of the Finnish Heritage Agency (Muinaisjäännösrekisteri) lists 414 Bronze Age dwelling sites in Finland. The number of Early Metal Age dwelling sites is so far 391. We should not consider this as a reliable starting point, however, because much information is missing and the classification system is problematic – several relevant sites may have been assigned to a period other than the Bronze Age or Early Iron Age.

A considerable number of Bronze Age dwelling sites on this list are in the northern municipalities of Enontekiö, Inari and even Utsjoki, over 60 altogether. The number of Early Metal Age dwelling sites – which have been used already in the Stone Age – is 59 in total. The numbers of sites are perhaps not very reliable in all municipalities. In Suomussalmi in Kainuu, the number of Early Metal Age dwelling sites is 15 and for the Bronze Age there are four sites. This is evidently a problem, because these figures do not correctly reflect the number of sites dating to these periods. The problem is best illustrated with the results from the municipality of Vaala. The Muinaisjäännösrekisteri list contains neither Bronze Age nor Early Metal Age sites for Vaala, although Säräisniemi 2 ceramics were first observed and defined there (Ailio 1909). The number of dwelling sites dating between 2000 BC and AD 400 was thus evidently larger than the database suggests. If using only the database records, one would get a wrong impression about settlement in the area.

One of the central aims of analysing dwelling sites is to establish differences between types of occupation (Carpelan 2003; Lavento 2001). This shows that earlier sites were used again, but in different ways. While dwelling sites were often large in the Middle Neolithic and included several dwelling depressions, most sites during the Early Metal Age were smaller and dwelling depressions were rarely found (Halinen and Mökkönen 2009). The number of known sites dated through various methods decreases during the Final Neolithic (Lavento 2001; Tallavaara and Seppä 2012). On the basis of current information, several areas in Finland were not inhabited during the Final Neolithic. For this reason, new populations could easily migrate there. In contrast, in other regions there were still people and both new and old groups had to be in contact with each other in some ways. Settlement was then continuous from the Late Neolithic Kiukais group (Asplund 2008; Meinander 1954a) to the Bronze Age in the coastal zone as well as in northern Finland, in Lapland (Halinen 2005).

On the western coast of Finland, one of the most well-known Bronze Age dwelling sites so far is Rieskaronmäki in Nakkila. Unto Salo excavated the site in the 1970s and developed a considerable number of interpretations based on the archaeological observations made during the fieldwork. Although the site included only a few ceramics, according to Salo (1984) it was still possible to assume that the site was used for living in the final part of the Bronze Age, during Period V of the Scandinavian Bronze Age. This dates the site roughly between 800-600 BC. Remains of Bronze Age houses were also observed there. According to Salo, the house was reminiscent of the buildings known in southern Scandinavia. The building had two different parts, one inhabited by people and another reserved for animals. The size of the area for people in Rieskaronmäki was c. 20 m^2, but together with the section for the animals the length of the building was c. 17 m (Salo 1984, 115-17).

The same type of building was excavated in Kaunismäki in Harjavalta. The most notable difference between this and the Rieskaromäki building is the large hearth built of stones. The Kaunismäki building is not as well known as the Rieskaronmäki building and the archaeological finds are fewer there. Different kinds of Bronze Age buildings were also excavated in Otterböte on the island of Kökar in Åland. They were found already in 1947 by Mats Dreijer (1947) but were researched later by Meinander (1954b) and for Kenneth Gustavsson's PhD thesis (1997). The buildings at Otterböte are small, more or less round depressions 2.5 x 3.5 m in size that were used during the spring by the fishers and hunters of grey seals.

Hunting and fishing played a central role at dwelling sites along the western coast of the Baltic Sea in Finland. Examples of these sites are Rieskaronmäki in Nakkila and Peltomaa and Viirikallio 1 in Laihia municipality (Holmblad 2010; Miettinen 1994). The house structure may have evident connections to southern Scandinavia, but at the dwelling sites in Laihia one can also see the cooking pit distribution and some possible pavements which are not known from many other sites in the eastern part of the Baltic. Their location close by the sea made it possible to utilise the area for fishing and hunting in the most favourable seasons. The sites vary in size, with some quite large ones, and

Figure 2. South-west part of the sandbar Kalmosärkkä in northern Suomussalmi (photo: M. Lavento).

they indicate constant settlement from the Neolithic to the Bronze Age also in the coastal zone of western Finland.

Most dwelling sites in inland areas indicate sporadic visits, rather than longer-term habitation. The populations were different than during the Middle Neolithic and site size was smaller than earlier. We know some large Early Metal Age dwelling sites, but they are still not frequent. One of the most considerable dwelling sites is Sarsa in Kangasala. Among the most important large sites are those located in Suomussalmi in Kainuu and in Joensuu in northern Karerlia. In Kainuu, there are several large well-known dwelling sites – Kalmosärkkä and Kellolaisten tuli – and in the northern part of Suomussalmi municipality there are also traces of bronze casting (Figure 2). At all three sites, the main activity phase with Textile ceramics (see below) dates to the Early Metal Age (Huurre 1982; Lavento 2001).

One should still remember that in Lapland and in particular in its northern part, there are dwelling sites which were inhabited for a long time – from the Mesolithic to the Early Metal Age – without a clear break. In the Early Metal Age only some things changed. Although copper was already known during the Middle Neolithic, some bronze items came into use during the Early Metal Age (Nordqvist and Herva 2013). The new item of material culture was ceramics, because during the Middle and Late Neolithic pottery production had ceased in Lapland (Halinen 2005). The economy is based on hunting and fishing during the whole Stone Age and the Early Metal Age. The sizes of the sites did not become larger, site numbers did not increase and the population was smaller in the Early Metal Age than earlier.

Already in the Late Neolithic slash-and-burn cultivation began to play some role in the economy of the hunter-gatherer groups in Finland (Alenius *et al.* 2017). Throughout the country, the economy was based on hunting and fishing, although slash-and-burn cultivation was known by all groups. Cultivation was carried out in small areas over a short period, only two or three years, after which the place was necessarily deserted for at least 25-30 years before it was possible to cultivate again. This meant that the groups had to change their residence often and the same dwelling sites were not inhabited for a long time.

The most typical starting point for trying to understand the beginning of agriculture has been palaeoecology and pollen samples. From them, it is possible to observe when slash-and-burn cultivation begins and what kinds of remains it has left. This work has been carried out in Finland by Irmeli Vuorela and Sheila Hicks (1996) and more recently Teija Alenius (e.g. Alenius *et al.* 2014). Alenius and colleagues have suggested that cultivation began in Finland as early as 4040 cal BC, but the number of available dates is still low (Alenius *et al.* 2017).

The second essential research method has been macrofossil analysis. It has mostly been carried out at excavated Iron Age sites, but in the past ten years interest has expanded to include Bronze Age and Stone Age sites, too. The samples have been taken at sites in all areas of Finland and they have been analysed mostly by Terttu Lempiäinen (1987) and recently by young PhD researchers. Mia Lempiäinen-Avci's 2019 dissertation at Turku University concentrated on the Middle Ages, but the Stone Age and partly the Bronze Age were researched using the same methodology in a University of Helsinki PhD by Santeri Vanhanen (2019). Although the Bronze Age has never played the main role in these macrofossil analyses, there is some research for this period, too. In southern Saimaa, at the dwelling site of Kitulansuo d, Ristiina, Pirjo Jussila found barley that was dated to 2990±60 BP (Hela-167) (Lavento 1998, 50).

For the Bronze Age, the most important plants grown were hulled wheat and naked barley. Einkorn (*Triticum monococcum*), spelt (*Triticum spelta*), oat and millet (*Panicum miliaceum*) also play a central role. Other new plants in south-western Finland were grass pea (*Lathyrus sativus*) and chickpea (*Cicer arietinum*) (Hjelmqvist 1997; Vanhanen 2019, 62-64). These are not clearly visible before the beginning of the Bronze Age in Finland.

During the 2000s, a comprehensive analysis of bone material from excavated dwelling sites and cairns was carried out. Both animal osteology and human osteology have brought much information about the economy of the Bronze Age and Early Metal Age. The first large analysis of archaeological bone material in Finland was carried out by Mikael Fortelius (1981) and after this by Pirkko Ukkonen (1996). The first archaeological doctoral thesis about Stone Age birds was written by Kristiina Mannermaa (2008) at the University of Helsinki. Bronze Age bird remains were also studied in the Baltic area. Now, a PhD thesis will concentrate on fish at Stone Age sites (Koivisto and Nurminen 2015), but such research is still missing for the Bronze Age.

Human remains have been investigated particularly for the Iron Age and the Middle Ages. Recently, the investigation of material from cairns has begun, although the number of individuals preserved there is not very large so far. Analysis of the Bronze Age material by Kati Salo is still actively going on, but information will soon be obtained about for instance age at death, the cause of death and nutrition.

Recently, aDNA analyses have also been carried out on human remains where possible. Some samples came from cairns from the coastal and inland areas. It has emerged that new groups migrated to Finland from the southern Baltic Sea area or southern Scandinavia or from the east, from the Middle Volga area, during the second millennium BC (Saag *et al.* 2019). This was probably because Scandinavian groups wanted to find cultivation areas and spread east during the Bronze Age; the populations from the Middle Volga may have been in search of copper as well as new land to cultivate. Good copper sources were known in Pegrema in eastern Karelia (Žuravlev 1991).

Material culture and knowledge transfer

Material culture, its details and changes hold a central position in archaeological research, because by tracing types of material – their dating and location – in detail, researchers have the possibility to reconstruct how the practical characteristics of a culture changed. Although the number of finds at the various sites is not very large, they have been found in several places and indicate in what way culture has changed during the Bronze Age.

The Early Bronze Age and Early Metal Age were periods when the material culture changed considerably over a large area. The essential issue is that metal, in particular bronze objects, came into use and small groups learnt to make metal objects by casting. The first metal artefacts and metalworking spread to Finland both from southern Scandinavia and from the Volga area (Lavento 2001; Meinander 1954b). The most important metal artefacts are bronze axes, different types of swords, spearheads and bronze ornaments. Although the number of bronze objects is not very large, it is still so considerable that, alongside other transformations, it indicates an evident culture change from the Stone Age to the Bronze Age and the Early Metal Age. They will hence be explored in some detail, before turning to stone items and pottery.

Metal artefacts

The metal axe types in Finland during the Bronze Age were the Seima-Turbino axes, Maaninka axes, Akozino-Mälar axes and Ananino axes. The Seima-Turbino axes appeared in northern Scandinavia at the beginning of the second millennium BC, although their appearance in the river Komi area was some centuries earlier (Yushkova 2012). They were in use in a very large area from eastern Siberia to Scandinavia. In Finland, Seima-Turbino axes appeared around the eighteenth century BC (Carpelan 2003, 54). The appearance of Seima axes indicates the spread of the Seima-Turbino phenomenon across a very large area, with Finland as its western border (Figure 3).

The Maaninka axe is a local type which is more or less circumscribed in its distribution; it has been found in central Finland and in some cases in Norrland in Sweden, too. It came into use during the twelfth to tenth centuries BC and groups in central Finland learnt to cast the axes from local material found in eastern Finland and the Republic of Karelia (Ikäheimo 2014; Lavento 2019, 40-42). The Maaninka type had already been defined by

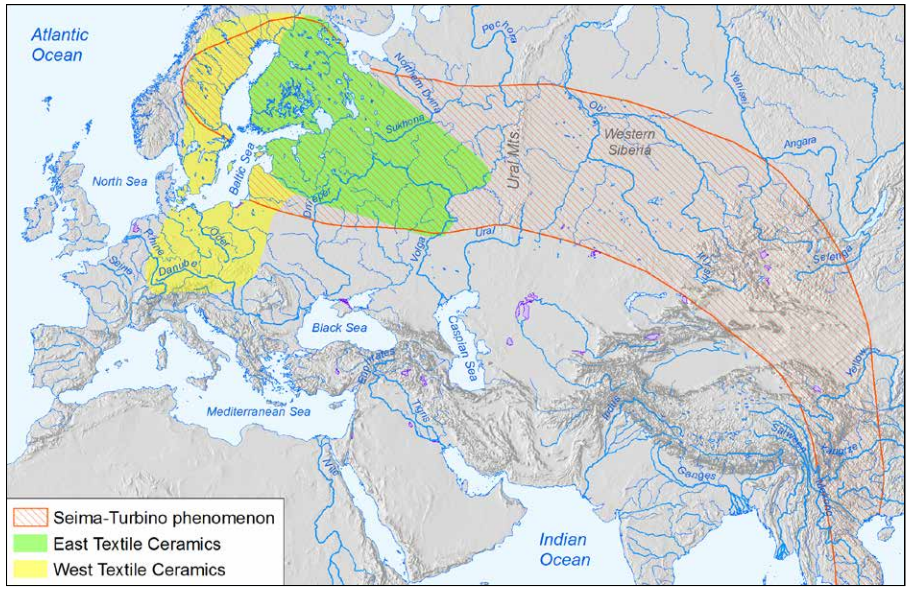


Figure 3. Seima-Turbino phenomenon, the distribution of Textile ceramics in the northern part of Europe and Siberia, and the areas of the western textile impressed ceramics (figure: M. Lavento).

Alfred Hackman (1910, 6-7) and A.M. Tallgren (1911, 190). The Maaninka axe does not belong to any clear local culture, but one problem with the type is that is has not been much researched so far. It evidently forms the beginning of the local casting of bronze axes in Finland (Lavento 2019).

The Akozino-Mälar axes have been found over a large area and the two largest concentrations of the type are in southern Sweden (Mälar) and in the Middle Volga (Akozino cemetery). These areas were researched by Evert Baudou (1960) in Sweden. The Mälar axe was studied recently by Lene Melheim (2011; 2012). V.A. Gorodtsov (1916, 150) discussed Akozino axes in the Middle Volga region. In Finland, the type was first noted by Hackman (1897, 390) but particularly by A.M. Tallgren (1911, 170-83), who also researched it in the Fenno-Ugric area in Russia; he dated the appearance of this axe type to between the thirteenth and eleventh centuries BC, but they stayed in use as late as the ninth to seventh centuries BC (Tallgren 1937, 34-40). V.S. Patrushev (1975) and S.V. Kuz'minykh (1996) continued this research in the 1980s. The question about the relation of the Akozino and Mälar axes remains open today, although the material shares many qualities. Establishing a common culture is not possible using axes alone, but some connections evidently existed.

The last Bronze Age axe type in the northern coniferous zone of Europe is the Ananino axe, which came into use between the eighth and third centuries BC (Forsberg 2012, 41). Only two Ananino axes are known in Finland: one in Haihu in Maria and one in Lusmasaari in Inari (Carpelan 2003, 53-55). The type was moulded actively in settlements in Suomussalmi, in eastern Finland (Huurre 1982; 1992; Lavento 2019). The earliest Ananino axes are found in the Middle Volga area and date to the eighth century BC (Chernykh 1992, 73-76). Although Finland was located on the western border of the distribution area of the Ananino axes, their use was intensive and the bronze axes were needed. Copper and other metals during the Bronze Age were used for moulding new Ananino axes. Thus, some connections from Finland to the Middle Volga area are visible in metal making. In contrast, the ceramic types (see below) were local and indicate production by small groups in Finland and eastern Karelia. It seems that migrations are not essential to explain axe distribution in the second part of the first millennium BC.

Yet not all metal items have eastern inspirations. Flanged and socketed axes are of Scandinavian origin. At least 19 of these types are known in Finland altogether; they came into use in Scandinavia c. 1300 BC (Meinander 1954b, 19-22). These objects were in use only on the south-west coast of Finland (Lavento 2001, 123-24). They have not been found at dwelling sites but mostly as stray finds. The axes were not made in Finland, but they reflect the arrival of new people into the area.

Other important find groups are bronze swords and spearheads. There are 17 examples from 12 sites in Finland. Almost all of them are of different types and come from different areas in Scandinavia and central Europe. The swords were mostly found in the coastal zone of south-west and western Finland. However, the hoard of Petkula in Sodankylä in central Lapland is of particular interest. It consists of four bronze swords. A.M. Tallgren (1906, 79) suggested that their origin was in Britain, but this has not been confirmed. The dating of the swords could be around 900-700 BC.

Almost all swords are stray finds in wetlands or swamps. This is typical for Bronze Age and Early Metal Age metal finds in Finland; later on, the places and environments where items were hidden changed. In Tapaninkylä in Helsinki, two swords dating to Scandinavian Bronze Age period II have been found; they have been interpreted as a hoard (Salo 1984, 142-43). The Nappari sword in Kokemäki can probably be interpreted as a treasure trove. It dates to period V of the Scandinavian Bronze Age and belongs to the Möringen type, the origin of which is in Switzerland.

Most bronze spearheads have come to Finland from southern Scandinavia, from Denmark and southern Sweden. However, the origin of the types may lie in central Europe. Their distribution in Finland concentrates in the south-western and western parts. The earliest find came from Santala near Nakkia and dates to Scandinavian Bronze Age period I. The objects from Ojala near Kokemäki and Panelia in Kiukainen date to Scandinavian Bronze Age period V. There is one example in Anttila in Lestijärvi which may have come to Finland from the southern part of central Europe (Salo 1984, 150-51). This meant that bronze artefacts came to Finland through long-distance trade. Metal was important during the whole Iron Age and Early Metal Age.

The Ananino period was an active period of contacts across the large coniferous zone in north-western Russia and Finland was in its western border. Bronze was still not very much in use in northern Scandinavia, although it was very much used in the river Volga area. The Ananino type of spearhead has been found in Rantsilannummi in Perniö and indicates that the coastal zone also had contacts far to the east as well.

It is of particular interest that so far the earliest Bronze Age weapon in Finland is the dagger that has been found in Hangaskangas in Muhos, on the lower part of the river Oulujoki, a composite between an eastern knife and scraps of a Scandinavian dagger (Ikäheimo 2019). It dates at least to 1900-1800 BC and may have come to Muhos from the east, from the area of the Middle Volga (Lavento 2015, 181). The influence of the spread of eastern bronze artefacts continued during most of the Early Iron Age. Daggers are Bronze Age weapons, but only four are known in Finland. The earliest bronze find comes from Djagsfjärd, Kemiö and dates to Scandinavian Bronze Age period II. Three others were found on the south-west coast and date to Scandinavian Bronze Age periods II or III (Salo 1984, 150).

Several other bronze items are known, but appear to have been less important. They were ornaments, buckles, star-shaped buttons and spiral needles, used between Scandinavian Bronze Age periods III and V. Knives and tweezers have been found particularly in the coastal area of the Baltic Sea in Finland. They were in use from Scandinavian Bronze Age periods III to VI. Among the jewellery are ring-shaped pendants and hand-shaped pendants (Lavento 2015, 181-83; Salo 1984, 144-47).

Stone artefacts

Bronze and copper are not the only materials that were used during the Bronze Age and the Early Metal Age. The making of stone objects continued during the whole period, as in Scandinavia and northern Europe, and their relevance only decreased considerably in the Iron Age, after c. 500 cal BC. People's ability to knap stone axes or other stone objects decreased and the axes were not as good as they were earlier. However, stone artefacts dating to the Bronze Age have not yet been carefully studied, providing a future research opportunity.

Based on earlier research, we have five types of stone axe in Finland in the Bronze Age. They were defined by Meinander (1954b, 67-84). Since then, much new material has been found which would repay renewed study, not yet undertaken.

One important kind of item are straight-based arrowheads. This type has been found in all parts of Finland, but their concentrations are in eastern Kainuu and northernmost Lapland. In the north, the stone used was quartzite, but in southern Finland most were made from quartz and other siliceous rock types. Christian Carpelan (2003, 48-50) has divided the straight-based arrowheads into six subtypes and altogether at least 180 examples were known in Finland at the beginning of the 2000s. Their use in northern Scandinavia began at the start of the second millennium BC and continued to the beginning of the Iron Age. Most examples were quartzite (Lavento 2001, 128-29).

Pottery

Textile ceramics are the first pottery type that came into use at the beginning of the Bronze Age. Textile impressions were already in use during the Late Neolithic and can be found on other ceramic types. However, the ceramic type that is now called Textile ceramics emerged in the Baltic countries and Russia during the third millennium BC; in Finland, its use began at the start of the second millennium BC (Lavento 2001).

Textile ceramics can be separated into subtypes that have local distribution areas and dates. One question is, should we separate the local types from the main type? This is sensible if we are interested in the details; but in this case, we are interested in large areas and long-term change, so it is useful to keep in mind the wider context. In Finland, the Early Bronze Age Textile ceramics were first separated into the Sarsa and Tomitsa groups (Meinander 1954b, 180-95). Later, they were divided into four subtypes by adding Kainuu ceramics and finally the Kalmistonmäki ceramics of the Karelian Isthmus (Lavento 2001, 82-87). The three first-mentioned types date mostly to the second millennium BC, although their use continues to the mid-first millennium BC. The Kalmistomäki ceramics belong to the first millennium BC. Research on Textile ceramics has continued in the region of the Middle Volga in particular (Lavento and Patrushev 2015; Patrushev and Lavento 2019).

In northern Finland and in the western part of the Kola peninsula, Lovozero ceramics came into use at the beginning of the Early Metal Age. Lovozero ceramics were the first ceramic type in Lapland which came into use after the Middle and Late Neolithic. The ceramic type spread into Finland from the east, from Karelia or the Kola peninsula. The other ceramic type in Lapland was the IT (Imitated Textile) type that shows remains of textile impressions which are only vaguely similar to those of Textile ceramics. IT ceramics are also known in Finnmark in Norway and in Norrbotten in Sweden and came into use already c. 1600 BC. Several other ceramic types, such as Sorsele and Vardö, were in use, too (Carpelan 2003, 51-52). Dates are not yet available for all of these types.

Figure 4. Säräisniemi 2 ceramics at Nimisjärvi in Vaala. From left to right: Anttila ceramics (KM 4050: 12); Luukonsaari ceramics (KM 4050: 24, 67); Kjelmøy ceramics (KM 4080: 15, 42).

Soon after 800 BC, new locally made asbestos ceramic types belonging to the Säräisniemi 2 group came into use in Finland. These ceramic types have been found particularly in inland areas of Finland but also in the Karelia Isthmus and eastern Karelia. Subtypes have been defined by C. Carpelan (Carpelan 1965; Carpelan and Parpola 2001). The sequence begins with Anttila ceramics, soon followed by Luukonsaari and Kjelmøy pottery (Figure 4). The last type is Sirnihta pottery. These types are in use in archaeology, but they have not been researched in much detail.

Ceramics have played a key role when archaeologists have tried to separate different cultures in the Bronze Age or Early Metal Age. Other archaeological material has not been found in similar quantities and often has very large distribution areas. Although the changes in bronze artefacts indicate changes of culture, they seem to cross the boundaries of smaller-scale human groups assumed to be reflected in pottery. However, to separate these possible human groups one needs to include many more kinds of archaeological material. Cultures and their definition cannot be based on ceramics only.

Despite these problems, ceramics have in practice been used to define human social groups. Whether this is the case is a question that needs further discussion. Pottery distribution areas are still much smaller than is the case with the metal types. This smaller extent is more indicative for the hunter and fisher groups than the larger distribution patterns of other artefacts, and ceramics are locally easier to differentiate in the archaeological material than metal artefacts, which were exchanged over a large area. These archaeologically defined groups persist for some hundreds of years before pottery types and the extent of their distribution changed.

Boundary creation and patterns of interaction

It is essential in archaeology to interpret several kinds of boundaries using different archaeological material. Archaeology gives the possibility to approach past social structures and the remains of the groups and people who left the material we now study. In this section, I will try to draw together the conclusions reached on the basis of cairns, settlement sites and material culture to interpret patterns of interaction.

Although the number of stone cairns is very large, the number of dwelling sites is relatively small so far in the coastal area. Finding them on the coast is not an easy task for archaeologists and less than 50 sites have been found in the coastal zone. One should still not assume that this is their real number; it evidently indicates that we have not yet found them. This is the case because interest into the Bronze Age only grew after the 1990s (Asplund 2008; Lavento 2001; Okkonen 2003; Tuovinen 2002). The situation has begun to change during the past twenty years.

Inland, the number of dwelling sites is slightly higher than on the coast, even taking into consideration the size of the area. Now we know c. 250 Early Metal Age dwelling sites. In contrast, the number of cairns inland is much smaller than on the coast and they are mostly called Lapp cairns. A new type of cemetery dating to the earlier phase of the Early Metal Age has been found in Ristiina municipality, in the north-western part of lake Saimaa (Saipio 2017).

The dwelling sites that are known inland illustrate some features that were characteristic of the populations of the Early Metal Age. Almost all the sites are smaller in size than during the Neolithic in the same areas. The smaller size indicates smaller groups. It is possible that the number of inhabitants is now 20-30 whereas the larger sites during the Neolithic had 100-150 inhabitants. This number is based on the number of habitations at excavated dwelling sites in the different areas of Finland; the size of dwelling pits was also compared (Halinen 2005; Halinen and Mökkönen 2009; Lavento 2001, app. 1).

What was the reason for the small population during the Early Metal Period? The population was already decreasing during the final phase of the Neolithic. This has been observed since the early 2000s (Lavento 2001; Sundell 2014; Tallavaara 2015) and is reflected in archaeological, DNA and demographic research. One essential factor has been the fluctuation of the temperature, which had an important effect on the number of people.

In the late 1990s, I realised that the number of finds decreased considerably in inland Finland in the second half of third millennium BC, when the Pöljä and Jysmä types of Asbestos ceramics virtually vanished and Textile ceramics spread (Lavento 2001, 176-77). According to the model by Tallavaara (2015, 44-47), which is based on the known AMS-dates, a population bottleneck dates to the period c. 4000-3500 cal BP, and this is possibly connected to the cooling climate. The genetic model suggested by Sundell (2014, 22-23) dates the worst bottleneck between 4100-3800 BP.

As mentioned, in Finland habitation continued in the coastal zone of the Baltic Sea and in the northern part of Lapland. Settlement also continued inland, but only in some places. Yet we see the migration of some new populations that came both from the east and from the south – from the region of the Baltic countries. In the coastal zone, the migration came from southern Scandinavia (Meinander 1954a; 1954b) and to the Ostrobothnian coast from northern Scandinavia. In Ostrobothnia, cairns were built before the beginning of the Bronze Age, between 3500 BC and AD 500 (Okkonen 2003, 146-60). The dating is based on shoreline displacement. Although the archaeology indicates continuation, migration changed the culture in these areas. The Kiukainen culture was amalgamated into the Bronze Age in the south-western coastal zone of Finland at the latest c. 1500 cal BC (Asplund 2008, 55) or 1300 BC (Tuovinen 2002, 52).

Societies defined using archaeological material are small both in coastal and in inland areas. Their small sites do not indicate stable settlements which were used over a long time. In some cases, the sites on the western and south-western part of the coast resemble sites in southern Sweden, but inland the sites are visited only for short periods.

One of the essential features was contact with other populations. This took place in two ways. Because slash-and-burn cultivation was a part of the economy, cultivation was carried out in some places only for a short time and then groups relocated after two or three years. In addition, hunting and fishing caused groups to change places several times per year.

The second essential factor that caused small groups to move was the need for new raw materials and metal implements. They initiated the exchange of material and trade. It is important to realise that the Seima-Turbino axes eventually spread over a very large region in the north, from northern Scandinavia to eastern Siberia or even to coastal areas in China (Linduff and Mei 2009). The appearance of Seima-Turbino axes, daggers and spearheads in the Middle Volga area dates as early as 2200 cal BC, although they began to spread only after the beginning of the second millennium BC (Yushkova 2012, 134).

The Akozino-Mälar axes indicate relations of the same kind between groups that appeared at the beginning of the Middle Early Metal Age / Bronze Age, i.e. the beginning of the second millennium BC, but are distributed in the smaller area with Seima-Turbino axes (Kuzminykh 1996, 6-9). In this situation, the boundaries between the populations did not develop along predictable lines and they are not easy to observe. Groups lived in the areas that belonged to them in a general sense, but populations were so small that ownership of the land did not have to be strongly asserted; this is particularly the situation inland, where agriculture played a secondary role in the economy.

In the later part of the Early Metal Age, more bronze came into use. An important technology was the casting of bronze axes in those areas where it was possible to make moulds from suitable stone. One possibility was soapstone, which can be found in eastern Finland, particularly in the municipality of Suomussalmi. These axes were of Ananino type and they date to the period c. 700-300 cal BC (Lavento 2019, 143). When axes were cast in eastern Finland, they began to be traded over a smaller area – in particular eastern Finland and Karelia (Lavento 2019, 122-23). Though making the bronze axes was important in the area, the population could not have been large.

In the coastal zone, the situation was slightly different. Despite the small number of dwelling sites, some share common features with southern Scandinavia. These

Figure 5. A Lapp cairn inland in Hietaniemi, Ristiina in Mikkeli (photo: M. Lavento).

characteristics are not only visible in the bronze materials, but also the structure of house types known in western Finland. Importantly, these house types consist of a quadrangular building for both humans and animals – mainly sheep and goat (Salo 1984, 115-17). Bronze Age house structures were later also found in Porvoo (Strandberg 2002) and even in Oulu (Alakärppä *et al*. 1998).

Changing populations brought new rituals both to the coast and inland. This involved building a new type of cairns and Lapp cairns. Their aim was to claim the land ownership of these Bronze Age groups. This was needed because agriculture began to play a greater role in the economy. One and the same fields stayed in use for tens of years. However, another essential purpose of building cairns in the coastal zone and Lapp cairns inland was to enable the deceased to continue their life in the otherworld (Figure 5). This was the place for the deceased to remain close to the living.

Scholar of Religion Veikko Anttonen (1996) paid attention to this in his PhD thesis when he researched the cairns and the appearance of a new religion in Finland. This is also reflected in the names of these sites including *pyhä* (or "holy place"). These names may have come into use during the Early Bronze Age and clearly indicate how important the ownership of these areas came to be. Although these *pyhä* place names are more frequent inland, they came into use there later than during the Bronze Age.

The sites which can be classified as *pyhä* are rare in Finland so far, but they indicate culture change. Because the coastal and inland sites were of other kinds and show how different the Bronze Age and Early Metal Age populations were to the Neolithic ones, they indicate how different the inhabitants are, too. The populations moved over a large area, especially inland, while central places were more important in the coastal zone (Lavento 2001, 177-80).

Inland, the Lapp cairns are stone cemeteries that are sometimes so small that they are difficult to observe. In some cases, they are located on cliffs by lakes (Saipio 2011). In addition to Lapp cairns, a new rite of cremation of the dead has been attested in southern Saima (Saipio 2017). The example in Hietaniemi in Mikkeli comes from the Piikinperse D site and it has been excavated by Jarkko Saipio in 2017. The cemetery comprises other Lapp cairns and a pit which is not easy to observe on the surface of the gravel soil. Its find material consists of bones, quartz and ceramics. This new kind of feature dates to the Final Neolithic (Saipio 2018). Lapp cairns and other cremation cairns are not known in south-western Finland and in the northern part of Lapland (Lavento 2015, 160-70).

Bronze axes and spearheads circulate during the first part of the second millennium BC. Also, ceramics had already begun to spread from east to west from the end of the third millennium (Lavento 2019; Lavento and Patrushev 2015). The changing of material culture continued during the whole Bronze Age and Early Metal Age (Patrushev and Lavento 2019).

The use of Textile ceramics continued in a large area over two thousand years, but societies changed at the local level. Groups in each area began to change when some new migrations took place after the beginning of the second millennium BC and new populations influenced many areas. In spite of the different local groups, active trade between them over a large area caused common culture changes.

Some bronze material spread quickly and widely, such as Seima-Turbino axes, Akozino-Mälar axes and Ananino axes. However, despite their local distribution these types reach several different groups in Finland, although they remain on the periphery of them. Despite the development of local groups, some people moved across the north and west in different phases of the Early Metal Age. Members of the different groups thus visited the areas of other groups, because fishing and hunting need different environments and mobility was necessary for that reason.

In the Bronze Age and Early Metal Age, societies changed because of internal and external influence. The reasons for these changes need more research than has been carried out so far. Studies have been focused on separating local ceramic types and comparing them to the larger types (Lavento 2001). The largest ceramic type is the Textile ceramics (Patrushev and Lavento 2019), which is known from the Middle/Upper Volga to northern Fennoscandia, the Baltic countries and eastern Europe. It suggests a change of cultures in the larger Fenno-Ugrian area, but this now needs to be complemented with studies on other materials.

Textile ceramics influenced Finland for over 1500 years, which is an unusually long period for ceramics in the north. Its local types may have lasted for c. 1000 years, but in some cases less than 500 years. The chronology of the types is based on a large number of AMS dates. On the basis of ceramics and metal types, local groups have been preliminarily suggested in these areas (Lavento 2011; 2015, 194-97).

The small populations had their origin in four main sources. One source was the local groups that continued their life in different parts of Finland. These groups are the most visible in south-western Finland and in northernmost Lapland. Some continuity is also evident in the central part of the country, although populations were very small. The dwelling sites with both Textile and Sär 2 ceramic types can be dated by shore displacement and AMS and indicate how long pottery traditions were in use. The making of some of the types belonging to Sär 2 continues into the fourth century AD (Lavento 2001, 99-107).

The second source was a small group spreading to southern Finland from Estonia during the final phase of the Neolithic. This is visible in the Middle Zone ceramics (Carpelan 1979, 9-15) that influenced southern Häme in the middle of the second millennium BC or slightly earlier. After this, the new arrivals mixed with local populations. Although the group declined soon, it maybe influenced the southern part of the Textile ceramics in Finland.

The third origin of the Bronze Age in Finland developed when the Kiukainen culture influenced south-western Finland at the end of the second millennium BC. Small groups from southern Scandinavia migrated to the coastal zone and intermingled with the local population. The Kiukainen population used textile impressions, but does not belong to the Textile ceramics populations. After the appearance of the new population from southern Scandinavia, the textile impression disappeared. The ceramics were of a totally different type – the fine ware is Lausitz-influenced and the coarse types were defined using the material of Toispuolojanummi in Laitila. Meinander (1954b, 176-78) suggested that the Lausitz-influenced ceramics had their origin in the south-east Baltic and although the amount of ceramics has stayed scant in Finland, it indicates long contacts and the arrival of a new population. The coarse, local Toispuoloja ceramic type was investigated by Unto Salo (1984, 155). Still, neither of these two types has been extensively studied.

The fourth origin area lies in central and eastern Finland, which was reached by influences from the south-west and east, from the Middle and Upper Volga. In the archaeological material, Finland is a boundary zone between Textile ceramics and

Scandinavian Bronze Age culture, with the boundary running from the southern part of the Karelian isthmus to Oulu. The population was small before the new migrants arrived and changed material culture in the area, as visible through bronze material, Textile ceramics and straight-based arrowheads. Because the need for sites also changes, the remains of these cultures are more clearly visible. When we come to the end of the Early Metal Age, bronze loses its importance and iron takes its place soon after 500 BC; soon after this the local people learnt to extract iron from the easily available local raw materials (Lavento 2013).

Conclusions

The people living in each group were in contact with other groups and this became much more important when copper and in particular bronze was needed as a new raw material. This new material was brought to Finland by the groups that arrived on the coast from eastern Scandinavia. Because populations were very small before the beginning of the Bronze Age, the arrival and settlement of new people in these areas proceeded without considerable problems which could be visible in the archaeological material. This also applies to the south-west coast of Finland, where the groups using Kiukainen ceramics still lived when the new groups migrated to the area in the second part of the second millennium BC.

What happened was the assimilation of the new arrivals with the Kiukainen culture; the resulting Bronze Age culture has a strong connection to the Scandinavian Bronze Age culture. The economy began to change, so that cultivation and animal husbandry played a more important role than earlier. Although the groups were small, they expanded in area and settlements became more stable than earlier. These changes took place slowly and can be traced at some dwelling sites on the coast.

The changes in the inland area began with the influence of the Seima-Turbino phenomenon and Textile ceramics. They both reflect the arrival of small groups from the east. These connections to the Middle Volga or sometimes even further away continued during the Early Metal Age. These relations brought the Fenno-Ugrian languages to Finland and Estonia, as has been recently discussed in detail by Valter Lang (2018). Many essential changes like the development of original proto-Saami and original Baltic-Finnish took place during the Early Metal Age and this is visible in the archaeological material.

The new arrivals found it easy to introduce new material to this sparsely populated area and start the Metal Age in all parts of Finland. One can observe, too, that DNA evidence indicates where each of these new groups of people came from and how they successively influenced the local groups. Both archaeological material and aDNA data show how people migrated to Finland from as far away as eastern Siberia and central Europe. They initiated the Bronze Age and Early Metal Age in northern Scandinavia and in the coniferous zone of northern Europe.

Bibliography

Ailio, J.E. 1909. *Die Steinzeitlichen Wohnplatzfunde in Finland, I-II*. Helsingfors: Akademische Buchhandlung.

Alakärppä, J., Ikäheimo, J. and Ojanlatva, E. 1998. *Oulun Peurasuo 1997 – myöhäiskivikautisen asuinpainanteen kaivaustutkimus. Meteli, Oulun yliopiston arkeologisen tutkimuslaboratorion tutkimusraportti 15*. Oulu: Oulun yliopisto, arkeologian laboratorio.

Alenius, T., Mikkola, E. and Ojala, A.E.K. 2008. History of agriculture in Mikkeli Orijärvi, eastern Finland as reflected by palynological and archaeological data. *Vegetation History and Archaeobotany* 17, 171-83.

Alenius, T., Haggrèn, G., Oinonen, M., Ojala, A. and Pitkänen, R.-L. 2014. The history of settlement of the coastal mainland in southern Finland. Palaeoecological, archaeological, and etymological evidence from Lohjansaari Island, Western Uusimaa, Finland. *Journal of Archaeological Science* 47, 99-112.

Alenius, T., Mökkönen, T., Holmqvist-Sipilä, E. and Ojala, A. 2017. Neolithic land use in the northern Boreal zone: high-resolution multiproxy analyses from Lake Huhdasjärvi, south-eastern Finland. *Vegetation History and Archaeobotany* 26, 469-86.

Anttonen, V. 1996. *Ihmisen ja maan rajat: 'pyhä' kulttuurisena kategoriana*. Helsinki: Suomalaisen Kirjallisuuden Seura.

Aspelin, J.R. 1877-84. *Muinaisjäännöksiä Suomen suvun asumus-aloilla I-V. Antiquités du Nord Finno-Ougrien*. Helsinki, St. Petersburg, Paris: G. W. Edlund.

Asplund, H. 2008. *Kymittæ. Sites, centrality and long-term settlement change in the Kemiönsaari region in SW Finland*. Turku: University of Turku.

Baudou, E. 1960. *Die regionale und chronologische Einteilung der jüngeren Bronzezeit im Nordischen Kreis*. Stockholm: Almqvist & Wiksell.

Carpelan, C. 1965. *Sär 2. Alustava katsaus erääseen rautakautiseen keramiikkaryhmäänja siihen liittyvään problematiikkaan. Lisensiaatintyö Suomen ja Pohjoismaiden arkeologiassa toukokuussa 1965.* Manuscript at the Institute for Cultural Research, Department of Archaeology, University of Helsinki.

Carpelan, C. 1979. Om asbestkeramikens historia i Fennoskandien. *Finskt museum* 85, 5-25.

Carpelan, C. 2003. Inarilaisten arkeologiset vaiheet. In V.-P. Lehtola (ed.), *Inari – Aanaar. Inarin historia kivikaudesta nykypäivään*, 28-95. Oulu: Inarin kunta.

Carpelan, C. and Parpola, A. 2001. Emergence, contacts and dispersal of Proto-Indo-European, Proto-Uralic and Proto-Aryan in archaeological perspective. In C. Carpelan, A. Parpola and P. Koskikallio (eds), *Early contacts between Uralic and Indo-European: linguistic and archaeological considerations. Papers presented at an international symposium held at the Tvärminne Research Station of the University of Helsinki 8-10 January, 1999,* 55-150. Helsinki: Suomalais-ugrilainen seura.

Chernykh, E.N. 1992. *Ancient metallurgy in the USSR. The Early Metal Age.* Cambridge: Cambridge University Press.

Dreijer, M. 1947. Bronsåldersbyn vid Otterböte. *Åländsk odling* 1947, 3-23.

Forsberg, L. 2012. Asymmetric twins? Some reflections on coastal and inland societies in the Bothnian area during the Epineolithic and Early Metal Age. In N. Anfinset and M. Wrigglesworth (eds), *Local societies in Bronze Age northern Europe,* 31-55. London: Routledge.

Fortelius, M. 1981. *Johdatus arkeologiseen luuanalyysiin*. Helsinki: Museovirasto.

Gorodtsov, V.A. 1916. Культуры бронзовой эпохи в Средней России. *Отчеты Исторического музея* 1914, 121-228.

Gustavsson, K. 1997. *Otterböte: New light on a Bronze Age site in the Baltic*. Doctoral thesis, Stockholm University.

Hackman, A. 1897. Die Bronzezeit Finnlands. *Suomen Muinaisyhdistykesen Aikakauskirja* XVII, 353-408.

Hackman, A. 1910. Förvärv till Historiska Museet år 1909. *Finskt Museum* XVII, 1-15.

Hackman, A. 1917. Förvärv till Nationalmuseet år 1915. Järnåldern. *Finskt Museum* XXIV, 59-61.

Hakonen, A., Hakamäki, V. and Kuusela, J.-M. 2017. Observing social change on the Bothnian Bay coast in the 1st millennium BC: the burials of Tahkokangas and the community of the Oulujoki river estuary. *Assemblage* 2017, 15-27.

Halinen, P. 2005. *Prehistoric hunters of northernmost Lapland. Settlement patterns and subsistence strategies*. Doctoral dissertation, Helsinki: Suomen muinaismuistoyhdistys.

Halinen, P. and Mökkönen, T. 2009. Between lake and sea – Stone Age settlement by ancient lake Ladoga on the Karelian Isthmus. *Fennoscandia archaeologica* 26, 107-32.

Hjelmqvist, H. 1997. Economic plants of the Bronze Age of the Kökar Islands. Contribution in K. Gustavsson, *Otterböte: new light on a Bronze Age site in the Baltic*, 158-66. Doctoral thesis, Stockholm University.

Holmblad, P. 2010. *Coastal communities on the move. House and polity interaction in southern Ostrobothnia 1500 BC – AD 1.* Doctoral thesis, Umeå University.
Huurre, M. 1959. Arkeologiska undersökningar i Suomussalmi. *Finskt Museum* 1958, 52-63.
Huurre, M. 1982. Suomussalmen varhaista metallikautta. *Suomen Museo* 88, 11-30.
Huurre, M. 1983. *Pohjois-Pohjanmaan ja Lapin historia I: Pohjois-Pohjanmaan ja Lapin esihistoria*. Oulu: Pohjois-Pohjanmaan maakuntaliitto.
Huurre, M. and Keränen, J. 1986. *Kainuun historia I. Esihistoria*. Kajaani: Kainuun maakuntaliitto.
Huurre, M. 1992. Suomussalmi esihistoriallisella ajalla. In M. Huurre and O. Turpeinen (eds), *Leipä luonnosta. Suomussalmen historian kymmenen vuosituhatta*, 15-76. Helsinki: Otava.
Ikäheimo, J. 2005. Re-assessing the Bronze Age of coastal northern Ostrobothnia – the lower Oulujoki river valley. In R. J. Goldhahn (ed.), *Mellan sten och järn. Rapport från det 9:e nordiska bronsålderssymposiet, Göteborg 2003-10-09/12*, 771-84. Göteborg: Institutionen för arkeologi och antikens kultur, Göteborg Universitet.
Ikäheimo, J. 2014. Suomen kivikautisten kuparilöytöjen metallin alkuperästä. *Muinaistutkija* 2014/2, 11-26.
Ikäheimo, J. 2019. Taruja herran tikarista – Oulun Hangaskankaan polttohaudan metallilöydöistä. *Muinaistutkija* 2019/4, 30-41.
Koivisto, S. and Nurminen, K. 2015. Go with the flow: stationary wooden fishing structures and the significance of estuary fishing in Subneolithic Finland. *Fennoscandia archaeologica* XXXII, 55-77.
Kuusela, J.-M. 2013. *Political economy of Bronze- and Iron Age societies in the eastern coast of the Bothnian Bay ca. 1500 BC – AD 1300*. Doctoral dissertation, University of Oulu.
Kuz'minykh, S.V. 1996. Osteuropäische und Fennoskandische Tüllenbeile des Mälartyps: ein Rätsel der Archäologie. *Fennoscandia archaeologica* XVIII, 3-27.
Lang, V. 2018. *Läänemeresoome tulemised. Muinaisaja teadus 28*. Tartu: Ülikooli kirjastus.
Lavento, M. 1998. Sisämaan vanhemman metallikauden väestö tutkimusongelmana. *Muinaistutkija* 4/1998, 46-55.
Lavento, M. 2001. *Textile ceramics in Finland and on the Karelian Isthmus. Nine variations and fugue on a theme of C. F. Meinander.* Helsinki: Finnish Antiquarian Society
Lavento, M. 2011. Новые АМС-датировки текстильной керамики Среднего и Верхнего Поволжья. *Тверской археопогический сборник* 8(1), 263-72.
Lavento, M. 2013. Tidig järnproduktion i södra och västra Finland: några aspekter på järnframställning och järnets funktion i samhället. In B. Rundberget, J.H. Larsen and T.H. Borse Haraldsen (eds), *Ovnstypologi og ovnskronologi i den nordiske jernvinna: Jernvinna i Oppland, Symposium på Kittelbu, 16.-18. juni 2009,* 93-103. Oslo: Kulturhistorisk museum, Fornminneseksjonen.
Lavento, M. 2015. Pronssi-ja varhaismetallikausi. In G. Haggrén, P. Halinen, M. Lavento, S. Raninen and A. Wessman (eds), *Muinaisuutemme jäljet. Suomen esi- ja varhaishistoria kivikaudelta keskiajalle*, 123-212. Helsinki: Gaudeamus.
Lavento, M. 2019. Early Metal Age bronze axes in Finland: an overview. In V.A. Lapshin, V.A. Alekshin, S.V. Beletsky, M.Yu. Vakhtina, Yu.A. Vinogradov, L.B. Vishnyatsky, M.T. Kashuba, L.B. Kircho, K. Nordqvist and A.K. Otcherednoi (eds), *Transactions of the institute for the history of material culture* 20, 35-52. St. Petersburg: Institute for the History of Material Culture, Russian Academy of Science.
Lavento, M. and Hornytzkyj, S. 1996. Asbestos types and their distribution in the Neolithic, Early Metal Period and Iron Age pottery in Finland and eastern Karelia. In T. Kirkinen (ed.), *Pithouses and potmakers in eastern Finland. Reports of the Ancient Lake Saimaa Project*, 41-70. Helsinki: University of Helsinki.
Lavento, M. and Patrushev, V.S. 2015. Развитие и хронолология Текстилньной керамики в среднеим и верхнем Поволжье: критичесий взгляд на условно прнятытые 14С-Даты, АмС-датирование и типологическую хронолологию.

Appearance and chronology of Textile ceramics in the Middle and Upper Volga region: critical comparison of conventional 14C-, AMS- and typological chronologies. *ПОВОЛЖСКАЯ АРХЕОЛОГИЯ* 2 (12), 160-88.
Lempiäinen, T. 1987. Kokemäen Ylistaron kylän Leikkimäen rautakautisen kalmiston kasvinjäänteet. *Karhunhammas* 11, 103-12.
Lempiäinen-Avci, M. 2019. *Plant remains in archaeology. A multidisciplinary approach to cultivation, consumption, trade and migration of economic plants in southern Finland AD 1000-1900*. Doctoral dissertation, University of Turku.
Linduff, K.M. and Mei, J. 2009. Metallurgy in ancient Eastern Asia: retrospects and prospects. *Journal of World Prehistory* 22, 265-81.
Mannermaa, K. 2008. *The archaeology of wings. Birds and people in the Baltic Sea region during the Stone Age*. Doctoral dissertation, University of Helsinki.
Meinander, C.F. 1954a. Die Kiukaiskultur. *Finska fornminnesföreningens tidskrift* 53, 1-192.
Meinander, C.F. 1954b. Die Bronzezeit in Finnland. *Finska fornminnesföreningens tidskrift* 54, 5-242.
Melheim, A.L. 2011. Late Bronze Age axe traffic from Volga-Kama to Scandinavia? The riddle of the KAM axes revisited. *Der Anschnitt. Zeitschrift für Kunst und Kultur im Bergbau* 26, 193-202.
Melheim, A.L. 2012. *Recycling ideas. Bronze Age metal production in southern Norway. Doctoral dissertation*. Oslo: University of Oslo.
Miettinen, M. 1994. Viirikallio, an Epineolithic dwelling site in Laihia, southern Ostrobothnia. In P. Purhonen (ed.), Fenno-Ugri et Slavi 1992. *Prehistoric economy and means of livelihood. Papers presented by the participants in the Finnish-Russian Archaeological Symposium "Prehistoric economy and means of livelihood", 11-15 May 1992 in the National Museum of Finland*, 43-51. Helsinki: Museovirasto.
Mökkönen, T. 2013. Stone setting filled with red ochre from the Keelaharju site, northernmost Baltic Sea region: a Stone Age grave in the context of north European burial traditions. *Fennoscandia Archaeologica* XXX, 13-36.
Nordqvist, K. and Herva, V.-P. 2013. Copper use, cultural change and Neolithization in north-eastern Europe (c. 5500-1800 BC). *European Journal of Archaeology* 16, 401-32.
Okkonen, J. 2003. *Jättiläisen hautoja ja hirveitä kiviröykkiöitä – Pohjanmaan muinaisten kivirakennelmien arkeologiaa*. Doctoral dissertation, University of Oulu.
Pääkkönen, M., Holmqvist-Sipilä, E., Bläuer, A., Evershed, R.P. and Asplund, H. 2020. Diverse economic patterns in the north Baltic Sea region in the Late Neolithic and in the Early Metal Period. *European Journal of Archaeology* 23, 4-21.
Patrushev, V.S.1975 Акознско-меларские кельты Марийского Поволжья. *CA* 1975 (3), 28-43.
Patrushev, V. and Lavento, M. 2019. Хозяйство волжских финнов эпохи оздней бронзы и начала железного века. *Economy of the Volga Finns during the Late Bronze Age and Iron Age.* Йошкар-Ола, Helsinki: Академия Наук Республики Татарстан, Институт Археологии им. А.Х. Халикова, Институт Археологии РАН.
Saag, L. [+ 28 others] and Tambets, K. 2019. The arrival of Siberian ancestry connecting the eastern Baltic to Uralic speakers further east. *Current Biology* 29, 1701-11.
Saipio, J. 2011. Lapinrauniotradition kehitys ajoitusten valossa. *Muinaistutkija* 2011, 19-35.
Saipio, J. 2017. The emergence of cremations in eastern Fennoscandia: changing uses of fire in ritual contexts. In J.I. Cerezo-Román, A. Wessman and H. Williams (eds), *Cremation and the archaeology of death*, 201-30. Oxford: Oxford University Press.
Saipio, J. 2018. *Piikinperse d. Muinaisjäännösrekisteri*. Report for the Finnish Heritage Agency, accessible at https://www.kyppi.fi/palveluikkuna/mjhanke/read/asp/r_hanke_det.aspx?HANKE_ID=11564
Salo, U. 1981. *Satakunnan historia I, 2. Satakunnan pronssikausi*. Pori: Satakunnan Maakuntaliitto.
Salo, U. 1984. Pronssikausi ja rautakauden alku. *Suomen historia 1*, 99-249. Helsinki: Weilin+Göös.

Salo, U., Tuovinen, T. and Vuorinen, J.-M. 1992. *Luettelo Suomen rannikon hautaraunioista*. Turku: University of Turku.

Strandberg, N. 2002. Houses by the shore – Early Metal Age and Iron Age houses at Hulkkio in Kaarina and Böle in Porvoo. In H. Ranta (ed.), *Huts and houses. Stone Age and Early Metal Age buildings in Finland*, 211-26. Helsinki: National Board of Antiquities.

Sundell, T. 2014. *The past hidden in our genes. Combining archaeological and genetic methodology: prehistoric population bottlenecks in Finland.* Doctoral dissertation, University of Helsinki.

Tallavaara, M. 2015. *Humans under climate forcing. How climate change shaped hunter-gatherer population dynamics in Europe 30,000-4000 years ago.* Doctoral dissertation, University of Helsinki.

Tallavaara, M. and Seppä, H. 2012. Did the mid-Holocene environmental changes cause the boom and bust of hunter-gatherer population size in eastern Fennoscandia? *The Holocene* 22, 215-25.

Tallgren, A.M. 1906. Tärkeä pronssikauden löytö Sodankylästä. *Finskt Museum* XIII, 73-86.

Tallgren, A.M. 1911. Die Kupfer- und Bronzezeit in Nord- und Ostrussland I. Die Kupfer- und Bronzezeit in Nordwestrussland. Die Ältere Metallzeit in Ostrussland. *Suomen Muinaisyhdistykesen Aikakauskirja* XXV, 1-229.

Tallgren, A.M. 1916. *Collection Zaoussîlov au Musée historique de Finlande à Helsingfors. I. Catalogue raisonné de la collection de l' Âge du Bronze*. Helsingfors: Commission of the Antell Collection.

Tallgren, A.M. 1937. The Arctic Bronze Age in Europe. *Eurasia Septentrionalis Antiqua* XI, 1-46.

Tuovinen, T. 2002. *The burial cairns and the landscape in the archipelago of Åboland, SW Finland, in the Bronze Age and the Iron Age.* Doctoral dissertation, University of Oulu.

Ukkonen, P. 1996. Osteological analysis of the refuse fauna in the Lake Saimaa area. In T. Kirkinen (ed.), *Environmental studies in eastern Finland. Reports of the Ancient Lake Saimaa Project*, 63-91. Helsinki: University of Helsinki.

Vanhanen, S. 2019. *Prehistoric cultivation and plant gathering in Finland. An archaeobotanical study.* Doctoral dissertation, University of Helsinki.

Vuorela, I. and Hicks, S. 1996. Human impact on the natural landscape in Finland. A review of the pollen evidence. In A.M. Robertsson, A. Åkerlund and S. Hicks (eds), *Landscapes and life. Studies in honour of Urve Miller*, 245-57. Rixensart: Conseil de l'Europe.

Yushkova M.A. 2012. Northwestern Russia at the periphery of the north European and Volga-Uralic Bronze Age. In N. Anfinset and M. Wrigglesworth (eds), *Local societies in Bronze Age northern Europe*, 129-47. London: Routledge.

Žuravlev, A.П. 1991. *Пегрема (поселения епохи неолита)*. Петроэаводск: Карелсъкий научнуй сентр АН СССР.

The Late Bronze Age to Early Iron Age transition in the lower Oder and the Oder lagoon region from settlement and environmental perspectives

Katarzyna Ślusarska

Introduction

This article aims primarily to evaluate archaeology and environment perspectives for the Late Bronze and the Early Iron Ages (from the late second millennium until the first half of the first millennium BC). It also contains the results of initial research on the settlement transformations over this period in the Szczecin lowland (also named the Bay of Szczecin and the Oder lagoon)[1]. When attempting to visualise the past, the easiest things to grasp are either a state of the full expression of features, for example, the classical phase of a culture (period), or rapid changes triggered by a small number of interrelated factors. The discussed period, also known as the transition between the Bronze and the Iron Ages, is this kind of period. It is characterised by significant variations in the dynamism and the extent of change, not only across Europe but also at the regional scale.

Modifications in many spheres of human life are evident south of the Baltic Sea. Burial practices underwent the most evident change. The tradition of building kurgans over cremation graves ceases, and flat graves, sometimes collective burials, appear instead. The form of the urn has also changed. A new pear-shaped vessel with various anthropomorphic features replaces the plain, simple vase-like container of the previous tradition.

There is a limited data pool on the dynamics of the changes in settlement structures and economic strategies. The changes pertain to the well-documented climatic variation and consequent environmental modifications during the first half of the first millennium BC. This general picture, however, does not precisely correspond to the situation of the Szczecin lowland. The transformations in burial rites were not as evident and rapid in the Szczecin lowland as in East Pomerania. This situation is particularly apparent in grave architecture; the tradition of raising mounds over burials disappears slowly in phase V of the Bronze Age, giving way to simpler constructions such as stone or earth enclosures surrounding flat graves. Barrows as a form of funeral architecture do not disappear completely; they occurred even into the Hallstatt C period but are much smaller in size (see Bukowski 1998, 198-99; Siuchniński 1956, 7-40). The first half of the first millennium BC continues the earlier "Late Bronze Age" strategies regarding subsistence economy and settlement patterns. However, for the Szczecin lowland region, the term "period VI of the Bronze Age" would be much more appropriate to characterise events and material culture with elements of the Late Bronze Age traditions that survived well into the first half of the first millennium BC.

---

1 This study comprises preliminary results of the project "Man and environment. The Late Bronze and Early Iron Ages in the Stettin lowland".

In D. Hofmann, F. Nikulka and R. Schumann (eds) 2022. *The Baltic in the Bronze Age. Regional patterns, interactions and boundaries*, Leiden: Sidestone Press, pp. 289-308.

The diversification of forms in ceramic and metal production is easily perceptible. Changes that archaeologists notice in the so-called “material culture”, worldview and expression, and the modifications of economic and settlement strategies, are related to different conditions and mechanisms that often do not have equal importance. The dynamics of change vary depending on past reality. Where stylistic features are concerned, especially those conveying symbolic meaning, immeasurable factors such as fashion and subjective opinions regarding attractiveness appear to be the chief factors governing alteration. The worldview expressed, for example, in funeral ceremonialism seems to be more conservative. Here, modifications usually involve reflecting global changes and people’s position in the world and their idea of fate after death. As traditional solutions were no longer effective, people looked for new ways of acting in the environment (new settlement or subsistence strategies). Humans, as biological beings, have a definite number of needs determining their survival. Culture is a mechanism allowing adaptation to conditions that differ from optimal (Binford 1962). However, culture itself cannot fully mitigate the negative impact of an environment that deviates from people’s biological needs. Total cultural system change should be explained in an adaptive context, both social and environmental, not just as the result of “influences,” “stimuli,” or even “migrations” between and among geographically defined units based on material culture similarities. This observation is relevant mainly to the times before the Industrial Revolution. The changes which resulted in lowering the effectivity of traditional subsistence strategies were noticed and often evaluated in mythological terms of “punishment” sent by the gods. People may need to employ unusual activities, such as rituals for the gods, believing them to mitigate the punishment and restore the right and previous order. When both the traditional and extraordinary (ritual) methods failed, a profound restructuring of social strategies may ultimately follow. These strategies of social expression, in turn, can be noticed by archaeologists through inference from the available evidence and provide grounds for understanding “archaeological culture” in a new way. My point is that subsistence patterns, diet, and settlement strategies do not change as long as they are efficient in the given circumstances.

Therefore, this study investigates possible correlations of changes in the economy, settlement, material culture styles and forms of ritual expression, notably burials, with environmental changes. As these will differ in different local circumstances, a micro-regional approach is adopted in which different kinds of habitats are systematically compared.

The chronological and spatial framework

This paper covers the time from the late period IV/early period V of the Bronze Age until the final stage of Hallstatt D. It roughly covers the development of classical traits of the West Pomeranian and Usedom-Uecker and the subsequent Göritzer Group (see Bukowski 1998 for further reading). The study area comprises the Szczecin coastland as defined by J. Kondracki (2001). This includes the regions located around the Szczecin lagoon, the lower Oder, and the areas adjacent to the Bay of Pomerania (Figure 1). The natural western limit of the discussed area is formed by the river Randow, the river Uecker’s estuary, and the course of the river Peene. Ideally, I should therefore have considered regions on both sides of the modern Polish-German frontier. However, the western limit of the area studied is the current border of Poland. The state of archaeological surface survey is of significance here. It is hard to assess the situation between the state border and the valleys of the rivers Randow and Uecker and the German part of Usedom because there has been no programme comparable to the Polish Archaeological Record (PAR; AZP in Polish). Both countries have their unique surface survey programmes that are difficult to compare. Therefore, considering the archaeological materials from the adjacent regions of Germany would result in a distorted picture of the cultural situation. Therefore, this study remains restricted to the Polish part of the area.

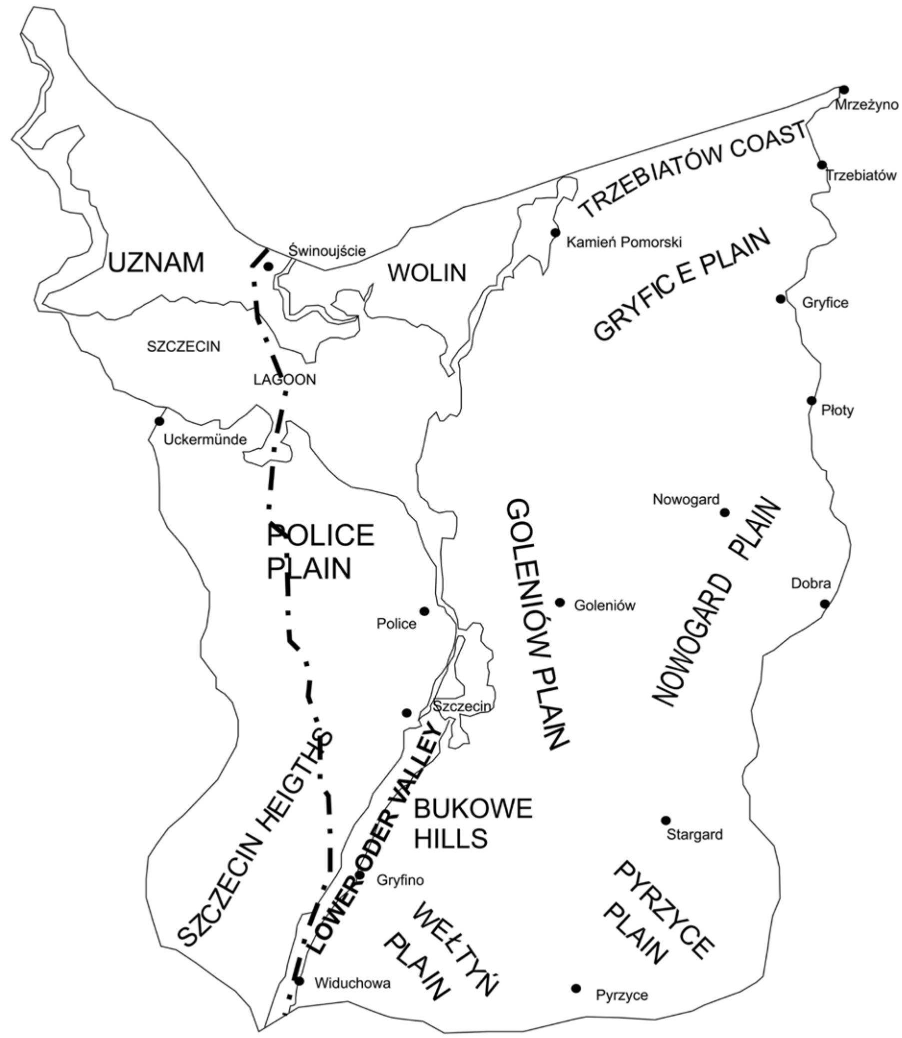


Figure 1. The Szczecin coastland as a study region adopted in the paper.

The western belt of the Trzebiatów coastland up to Rega, including Usedom and Wolin, forms the northernmost part of the area. Further to the south, the upland plain belt stretches to both sides of the Szczecin lagoon and the lower Oder valley. The Uecker plain is the western border, and the limits of the Gryfice and Nowogard plains form the eastern one. The Szczecin uplands and the Bukowe hills stretch on both sides of the lower Oder valley's wetlands, which have been transformed massively over the last two hundred years. The southern limit of the study region is the edge of the Myślibórz lakeland, north of the village Widuchowa and the point where the Oder bifurcates. The southern fringe of the Wełtyń and Pyrzyce plains are also included (Kondracki 2001, 44-53). The eastern limit is not clear. In the south of the region, the boundaries are the margins of the Ińsko lakeland and the Łobez uplands, alongside the north Rega river.

Pottery stylistic dynamics and absolute dating

The majority of data come from the distribution analysis of sites revealed through the PAR surface survey and excavated burial sites. There are also 36 partially excavated settlements and six hillforts (Figure 2). Most of the settlement sites were the subject of rescue excavations preceding significant infrastructure projects in the region, so only parts of them have been excavated, which does not allow for the study of their internal architecture or organisation. Nevertheless, the excavations provided valuable material for establishing a preliminary scheme of change in the stylistic features of pottery.

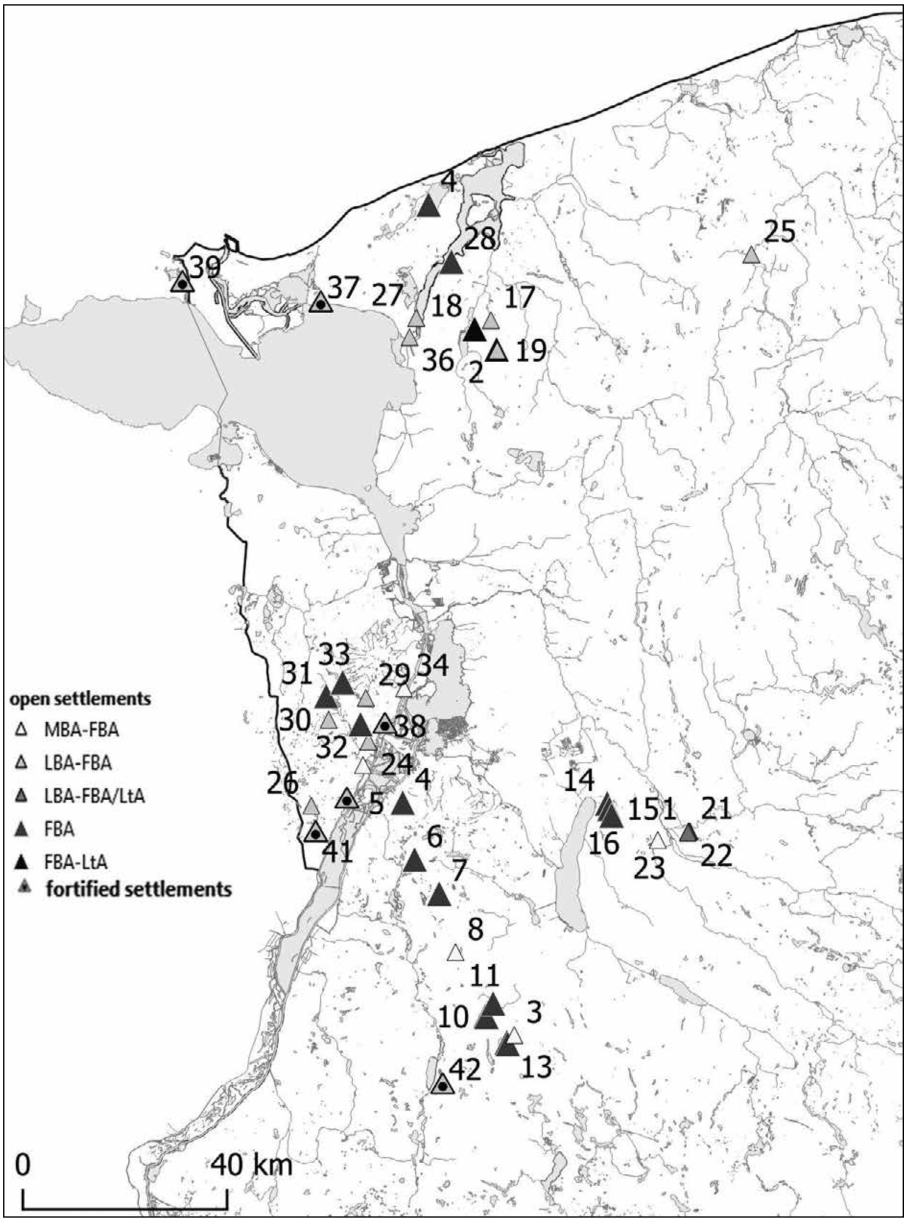


Figure 2. Excavated open and fortified settlements. Numbers according to Table 1. Legend: MBA-FBA (Montelius period IV-Hallstatt C and D), LBA-FBA (Montelius Late Bronze Age-Hallstatt C and D), LBA-FBA/LtA (Montelius period V-Hallstatt D and La Tène A), FBA (Hallstatt C and D), FBA-LtA (Hallstatt D-La Tène A).

The material from four well-studied sites indicates continuous development over the whole period considered (Kozielice, no. 76; Szczecin-Żydowce, no. 14; Sobiemyśl, no. 1 and Witkowo, no. 42). The material from Szczecin-Goszczewo and Szczecin-Ustowo has no signs of occupation at the beginning of the Iron Age. Most open settlements and all hillforts began in period V (Late Bronze Age, LBA) (Table 1). One characteristic trait of period V pottery are clay plates (so-called *Tonscheiben*) and strongly profiled Lower Oder bowls (bowls with everted and obliquely fluted rims). These forms are found both in settlements and in cemeteries, where they serve as a stand for the urn (especially clay plates) or as lids (both clay plates and bowls). The most striking feature of the Early Iron Age is the appearance of the Göritzer Group style: highly profiled forms and ornaments emphasising the vessels' sections in the form of horizontal fluting and twisted necklace imprints (*Ringabrollung* or *ornament pseudosznurowy* in Polish).

No	Site	Type	Period	14C sample material	Laboratory number and date BP
1	Święte 22	Open	LBA–FBA		
2	Ostomice 7	Open	FBA/LtA	charcoal	MKL-517: 2310±50 MKL-518: 2230±50
3	Kozielice 76	Open	MBA–FBA	charcoal	Poz-31792: 2485±35
4	Szczecin-Żydowce 12	Open	FBA		
5	Szczecin-Żydowce 14	Open	MBA–FBA		
6	Wysoka Gryfińska 29	Open	FBA		
7	Drzenin 9	Open	FBA		
8	Sobiemyśl 1	Open	MBA–FBA		
9	Parnica 6	Open	FBA		
10	Parnica 7	Open	FBA		
11	Czarnowo 59	Open	FBA		
12	Mielno Pyrzyckie HD/LtA 18	Open	FBA/LtA		
13	Mielno Pyrzyckie 20	Open	FBA		
14	Kunowo 31	Open	FBA		
15	Kunowo 30	Open	FBA		
16	Kunowo 4	Open	FBA		
17	Parłówko 11	Open	LBA–FBA	charcoal	MKL-515: 2820±80 MKL-516: 2420±60
18	Troszyn 10	Open	FBA/LtA		
19	Ostomice 14	Open	LBA–-FBA		
20	Ostromice 9	Open	LBA-–FBA		
21	Święte 7	Open	LBA	charcoal	MKL-66: 2620±70
22	Święte 8	Open	LBA–FBA/Lt	charcoal	MKL-67: 2710±70 MKL-72: 2370±59 MKL-73: 2390±60
23	Witkowo 42	Open	MBA–FBA		
24	Szczecin -Gumieńc 17	Open	LBA–FBA		
25	Gryfice Stare Miasto	Open	LBA–FBA		
26	Kolbaskowo 1	Open	LBA–FBA		
27	Wolin Wzgórze Młynówka	Open	LBA–FBA		
29	Szczecin-Niemierzyn	Open	LBA–FBA		
28	Sibin 4	Open	FBA		
30	Mierzyn	Open	LBA–FBA		
32	Szczecin Świerszczewo	Open	FBA		
31	Bezrzecze	Open	FBA		
33	Szczecin Głębokie	Open	FBA		
34	Golęcino	Open	MBA–LBA		
35	Ustowo	Open	MBA–LBA		
36	Wolin Wzgórze Wisielców	Open	LBA–FBA		
37	Lubin	Fortified	LBA–FBA		
39	Kamminke	Fortified	LBA–FBA		
38	Szczecin Wzgórze Zamkowe	Fortified	LBA–FBA		
41	Krzemieniec	Fortified	LBA–FBA		
40	Siadlo dolne	Fortified	LBA–FBA		
42	Swobnica	Fortified	LBA–FBA		

Table 1. Excavated open and fortified settlements.

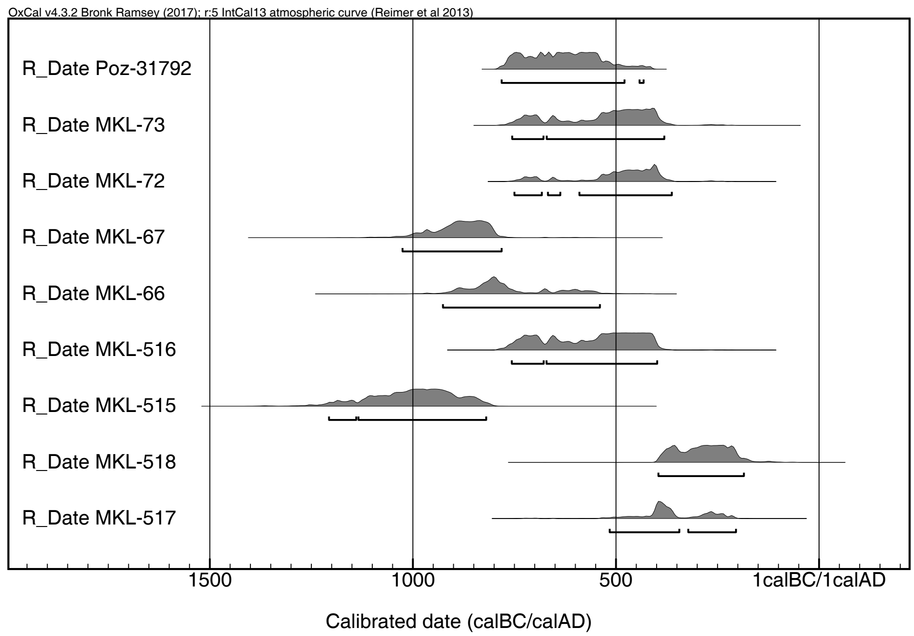


Figure 3. Absolute chronology according to ^{14}C dates. For site attribution, see Table 1.

Absolute dating

The number of available ^{14}C dates is relatively low for the Szczecin plain (Figure 3). All come from excavations preceding major infrastructure projects (see Table 1). However, there are severe difficulties with them. The main problem is that all were charcoal samples. No more extensive series were measured, nor is there a clear relationship of the dates to changes in pottery styles. Three sites (Kozielice no. 76, Święte no. 7 and Parłówko no. 11) are related to the Lusatian culture judging from the stylistic attributes of the pottery. At Kozielice no. 76, it has been possible to distinguish two settlement phases, the Bronze and the Iron Age. However, the archaeological features sampled for ^{14}C dating (charcoal) contained no ceramic material to attribute the single date to either the Bronze Age or the Early Iron Age. Five further ^{14}C dates came from the Early Iron Age settlements. The pottery style made it possible to associate them with the initial phases of the Jastorf culture (the so-called Marianowo phase). This culture defines the end of the Lusatian tradition in West Pomerania. Thus, the ^{14}C dates alone provide no basis for a detailed evaluation of the region's dynamics of change. They also provide no surprises. The Early Iron Age phase of the Lusatian culture (the Göritzer Group phase) overlaps partially with the Early Jastorf culture of the Early Pre-Roman Iron Age. While changes are noticeable in pottery style, bronze artefacts and burial, they are not that evident in the settlement strategies and economy.

Method: archaeological data

All spatial and spatial-statistical analyses were performed using QGIS version 3.16.2 and Past 4.03. To evaluate the dynamics of change in various spheres of human activity in the Szczecin plain at the end of the Bronze and the beginning of the Iron Age, we need to select regions with palaeoenvironmental data. The chosen areas should also have an adequate level of culture chronological information based on different data types (surface survey, excavations). Two spheres of prehistoric human activity, burial and bronze metallurgy, are the best-studied topics in typo-chronology and the composition variability of metal artefact hoards is well established.

This study has two main parts. The first part discusses the state of research on the Late Bronze Age occupation and the Early Iron Age based on field survey and archival information. The second part is a survey of the environmental potential of the Szczecin lowland for settlement development. It includes a reconstruction model of the potential vegetation in the area, with palaeoenvironmental data that allow the evaluation of human impact (anthropopressure) on the environment.

The bulk data collected for the second part come from the field survey programme established in the late 1970s, the so-called Polish Archaeological Record (PAR, in Polish *Archeologiczne Zdjęcie Polski*, AZP). It was primarily a conservation programme that enabled the creation of comparable, unified and upgradable archives of Polish archaeological sites. The basic PAR standard is an archaeological monument record card (in Polish: *Karta Ewidencji Zabytku Archeologicznego*, KEZA) that codes essential data for the site: location, landscape, soil cover, dangers to the site and all identified settlement phases. This recording system is open: it integrates archive data (nineteenth and first half of the twentieth century), field survey and stray finds. It is continuously updated whenever any new archaeological action is performed on the recorded site.

The geographic layout is built on a rectangular mesh covering all of Poland. Each rectangle covers approximately 37.5 km^2 (N-S: 5 km, W-E: 7.5 km) with a number in Arabic numerals in the system: number of a row-number of a column (e.g. 19-02). The mesh is based initially on the map on a scale of 1:25,000 (coordinate system Pulkovo 1942) (Kozioł *et al.* 2012). Each site has a double number; the first part shows the number within the locality and the second number, or PAR (AZP) number, follows the layout "number of rectangle: number of the site within the rectangle". For example, the Urnfield fortified site in Lubin has the double number: Lubin site 8 (AZP 21-04: 8). The list is open, and every new site recorded within the system gets a sequential number both within the location and within the PAR rectangle.

Field surveys are one of the primary methods of the PAR system. They are meant to be periodically repeated in the late autumn (after ploughing) or/and in early spring (before plant growth). Sites recognised during fieldwalking are given numbers and are assigned to one of two groups based on the number of finds (mostly pottery sherds): settlement traces or settlement points. Whenever there are fewer than three finds and no structures, the site is recorded as a settlement trace; if there are more than three finds or some structures, it is identified as a settlement point. The "settlement point" is a group of finds attesting to activity of the same kind (settlement, cemetery) of one cultural and temporal unit. When there are several phases identified in the KEZA, there will be a record: e.g. Modlimowo site 4 (AZP 19-11:10): 1. settlement point, Early Iron Age, 20 pottery sherds, 2. settlement trace, Early Modern, 2 pottery sherds.

There are detailed recording categories like settlement, cemetery, hoard, or single find (mainly metal finds). The record card (KEZA) is supplemented by a map slice at a scale of 1:5000 or 1:10,000, where the precise location and approximate size of the site are recorded. Every PAR rectangle record folder contains record cards and a summary map on a scale of 1:25,000 with all sites marked: crosses for single finds, small dots for settlement traces, bigger dots (5 mm) for settlement points, triangles for archival sites (filled if the location is known, empty if unknown). All these records are kept by the local Regional Historical Monuments Conservation Office or/and local museum with an archaeological collection. The data set presented in this paper comes from the Szczecin National Museum, Archaeological Division Archives and combines pre- and post-WWII information (Museum der Stadt Stettin archives and published data)[2].

The Szczecin lowland area is fairly evenly studied it terms of field surveys under the PAR programme (Figure 4). However, there are some exceptions, notably the woodlands near Goleniów, the forests between Tanowo and Nowe Warpno (Ueckermünde heath) and the wetlands of the Międzyodrze region. The dense forests or marshes of these areas strongly affect the possibility of survey. PAR is a conservation programme, so these data alone are not appropriate for settlement studies. The possibility of finding artefacts is affected by various factors (often independent of human activities), such as access to fields, depth of archaeological features, or the degree of a site's destruction. Of course,

2 I would like to express my deep gratitude to Dorota Kozłowska and Krzysztof Kowalski (National Museum in Szczecin) for their help, hospitality, and all the fruitful discussions we had.

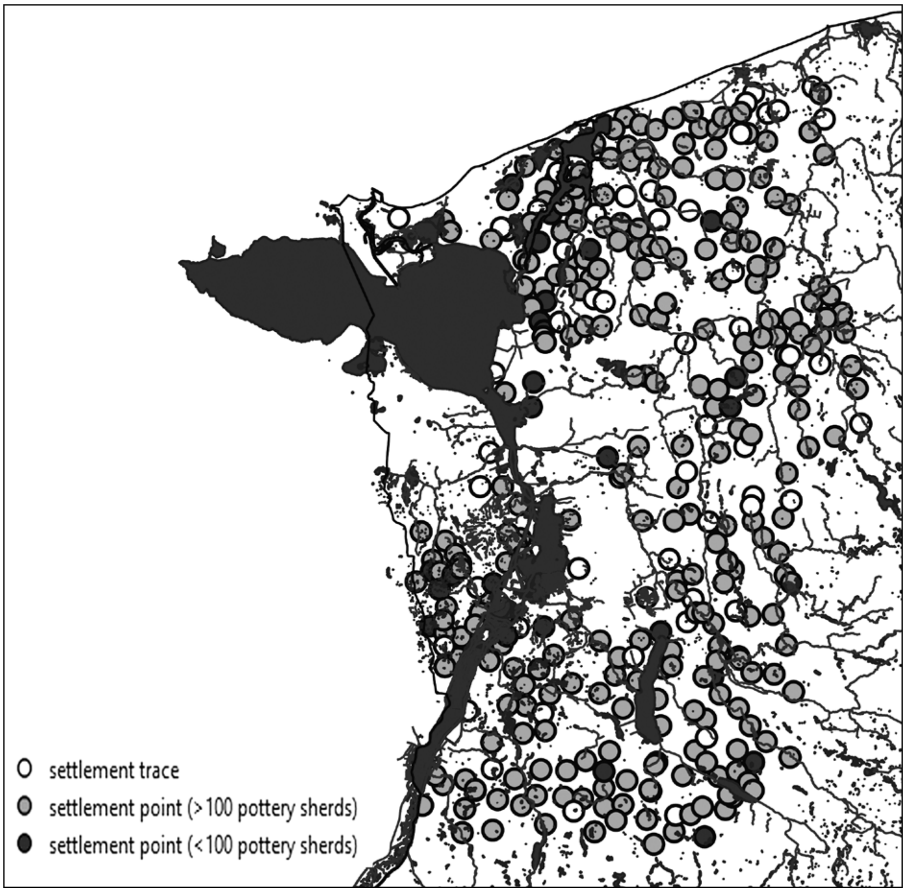


Figure 4. Distribution of sites recorded in the Polish Archaeological Record (PAR) database.

there are also purely human-dependent factors, for example the researcher's interests and skills in surveying the field. The problem working on field survey data is mainly with the preservation of pottery sherds, which can bias chronological assessment. Most surface sherds show considerable taphonomic changes (worn-off surface and edges, small sizes) that obscure distinguishing features. Usually, surface materials provide little opportunity for precise dating. The problem is quite complicated. On the one hand, we have objective obstacles like taphonomic alteration and on the other there are subjective assessments by various scholars with different backgrounds. The lack of a comprehensive chronological scheme for sherds makes this issue quite challenging to solve. Only material with a general culture-historical designation of "Lusatian culture" was included in this study.

The number of documented sites in a specific area depends not solely on the actual settlement activity and its intensity in prehistory. It also depends on the degree and extent of the survey carried out in this region. The so-called field survey coefficient (FSC) was introduced to refine the potential distortions of the picture of past settlement patterns. It is calculated as the sum of sherds collected from the surface, attributed to a definite locality, divided by the number of sites assigned to this locality. Applying this coefficient does not directly answer which mechanism led to the deposition of archaeological material at a specific location. Nevertheless, it helps to reduce the effects of current activity that obscure prehistoric occupation. A low FSC index will indicate that there probably was no extensive and long-term settlement in a specific place. However, it cannot entirely rule out the presence of such a settlement. The sediment layer might be so thick that even ploughing does not drag material from the cultural layer to the surface. At an early stage of settlement studies, applying the FSC index makes it possible to choose regions where dense past occupation seems likely. By this, we gain the opportunity to designate test areas where we can conduct more in-depth studies.

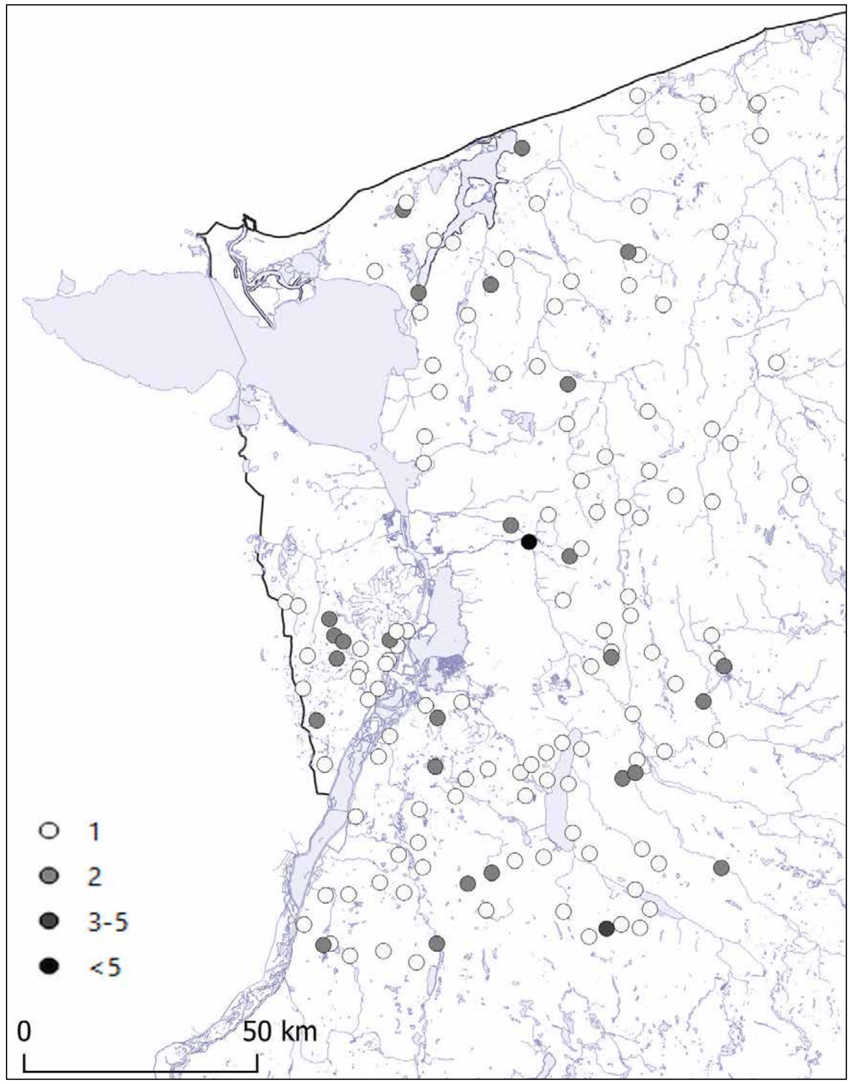


Figure 5. Microregions based on field survey coefficient.

The sites with the lowest FSC value (≤5) include places identified as "settlement trace" (up to five pottery fragments found). There are in total 133 documented localities of this type in the study area. Most of the sites in this group are located in the Nowogard plain. It is hard to interpret this category of sites relying solely on field survey data without other details (cemeteries, burials, or hoards) or excavations. In that case, it is not possible to assess whether a small number of recorded artefacts indicates a lower degree of prehistoric settlement, insufficient recognition by the PAR programme, or the significant depths at which the materials occur.

The next group, characterised by FSC values in the range of 6-11, consists of 107 sites in total. It also contains some individual sites that have been attributed to a given locality and categorised as "settlements" in the classification system accepted by the PAR programme (more than ten sherds collected).

The third category forms a relatively large group with 88 sites and an FSC index between 11 and 30. Here we have sites on both sides of the Oder mouth and between Gryfino in the south and Police in the north. The other area with a relatively high FSC index is the Dziwna river valley between Wolin town in the south, Kamień Pomorski in the north, and Parłówko locality in the east. The third cluster of sites is in the Pyrzyce plain.

There are 20 sites with an FSC index higher than 30. This number also includes five sites with an FSC index higher than 50: Łąka, Stepnica municipality; Olchowo, Nowogard

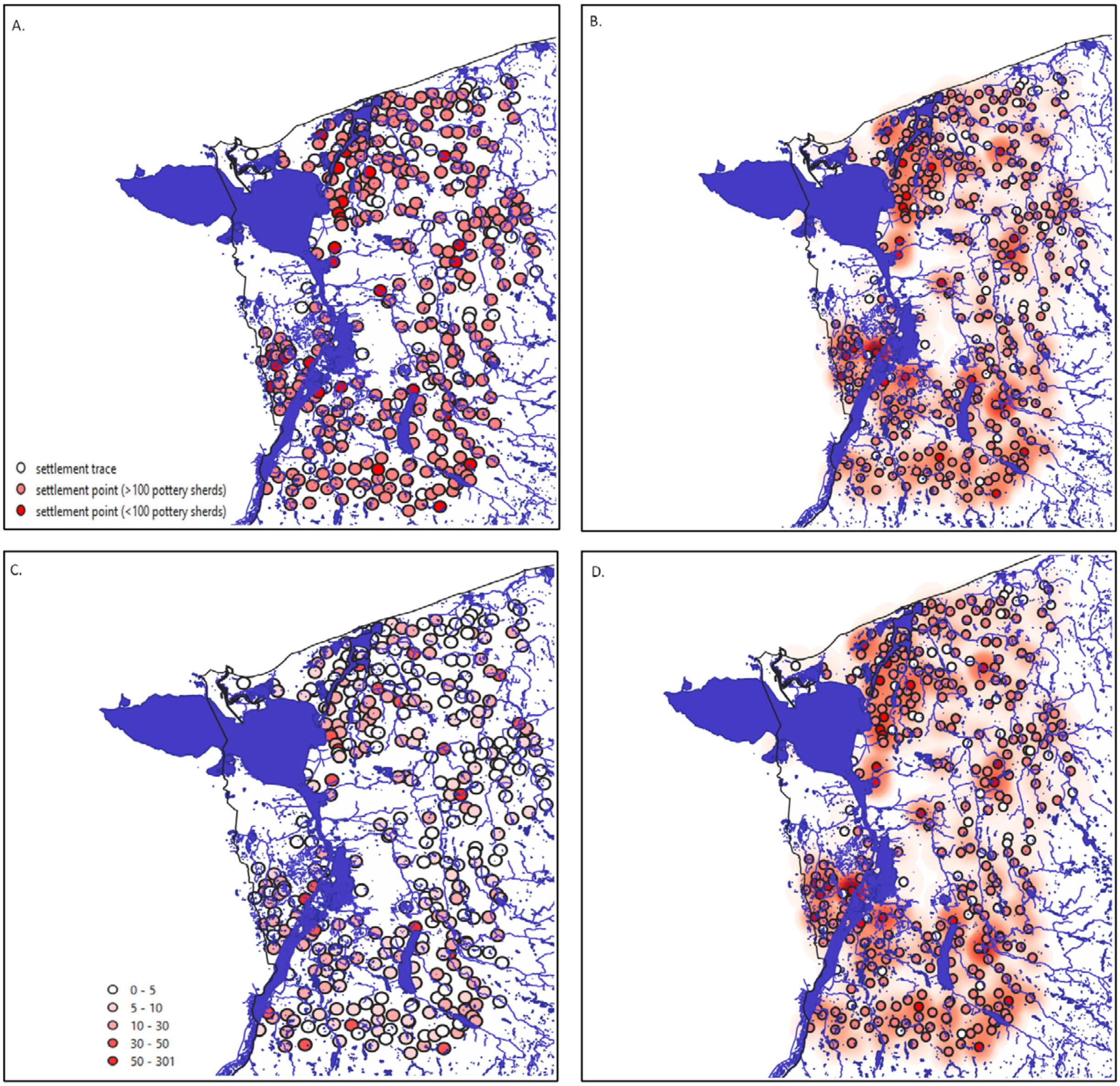


Figure 6. Kernel density estimation. A) raw PAR data point distribution; B) kernel density estimation of raw PAR data; C) field survey coefficient distribution; D) kernel density estimation of FSC correlation with the raw PAR data distribution.

municipality; Szczecin, Szczecin municipality; Morzyczyn, Kobylanka commune and Witkowo, Szczecin municipality. Olchowo is unique as a surface survey recorded a cemetery in the surrounding area of the site. It is, therefore, reasonable to assume that the pottery could belong to destroyed burials.

The raw PAR (field survey) data distribution offers quite a blurred picture. The FSC index helped to identified zones with higher pottery frequencies. Kernel density estimation was performed on raw data to identify potential grouping and then the reversed method was applied for checking the FSC index potential: KDE analysis material grouped within FSC classes (Figure 5). The procedure introduced above allowed for identifying three quite well defined aggregations: one on the western part of Wolin island and west of Szczecin lagoon and Dziwna, the second on both sides of the Oder mouth up to the Szczecin lagoon, and the last on the Pyrzyce plain near lakes Miedwie and Płoń. The situation in the Wełtyń and Nowogard plains was quite challenging to evaluate based solely on surface survey results. A further step was to correlate field survey data with other settlement network elements, such as hoards and cemeteries, as they are also included in the PAR programme (Figure 6).

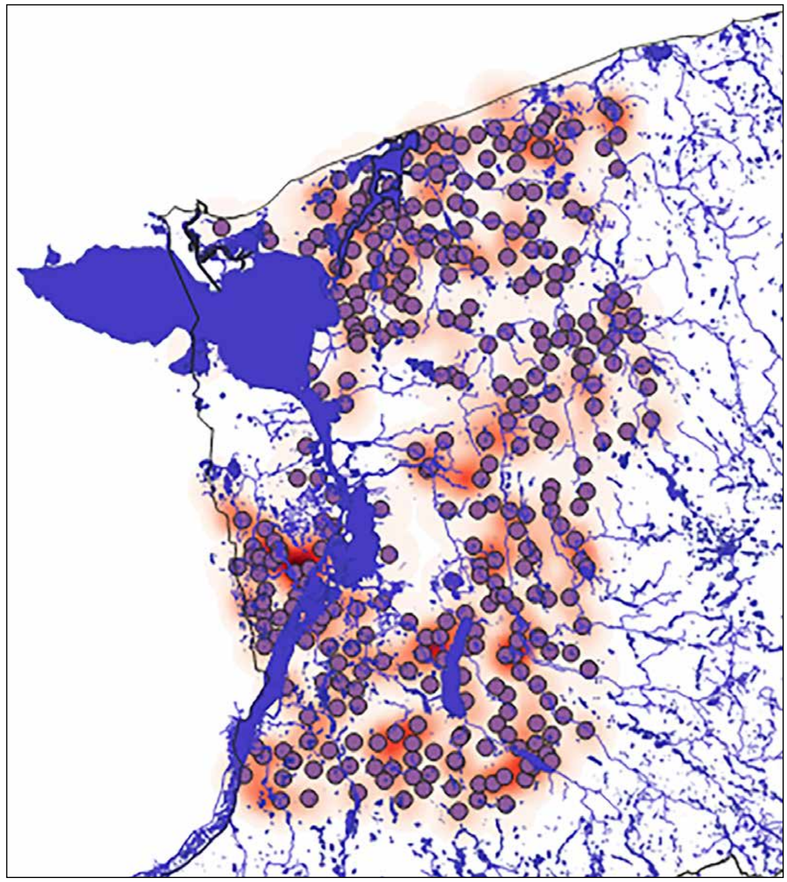


Figure 7. Kernel density estimation for the site type weighed index correlated with PAR raw data distribution.

The analysis also includes burial sites (cemeteries, individual graves and barrows) dated between period IV of the Bronze Age and the end of Hallstatt D. It also encompasses all burial sites attributed to the Lusatian culture without a more detailed chronology. The locality is again considered decisive, in the same way as for sites defined based on pottery. The information regarding sites comes from archival records, so that their exact position will now be challenging to find in the field. In total, 182 burial sites have been analysed and attributed to 142 localities. The largest group comprises locations with only one cemetery (119). Just seven sites of this group have been recorded based on discovering a single grave with no preserved earthen mound or a single barrow discovered or excavated before WWII and not verified later. The funeral customs of the Urnfield circle do not include isolated graves, and the Pomeranian variant of the Lusatian culture is also characterised by groups of barrows forming cemeteries. Therefore, a single grave/barrow indicates the presence of a poorly recognised cemetery. Twenty-five locations have more than one cemetery associated with the Lusatian culture. In just nine cases, the same burial space was used continuously from period IV of the Bronze Age until the end of the Early Iron Age. More than half of all cemeteries studied here began to be used in periods III and IV and ceased existence in period V of the Bronze Age. Some cemeteries (37) were used no earlier than the Iron Age. These are usually located quite close to the Bronze Age cemeteries. This situation has been observed in 17 localities, each having more than one cemetery associated with the Urnfield tradition.

Most hoards do not have precise location information, so it is challenging to compare them to the known location of settlements or cemeteries. Hence, the presence of deposits and even single finds of metal objects shows human activity within an area. There are 68 hoards and 59 single finds attributed to the Late Bronze and Early Iron Age. The positions are weighted based on the type and amount of data. Sites identified solely based on field surveys (pottery) were given the lowest weighting (1). Cemeteries or hoards were assigned a weighted index of 10, the combination PAR data + cemetery or hoard was scored as 15, and cemetery + hoard as 20. The highest index (25) was attributed to localities with all kinds of sites. Kernel density estimation analysis was then performed on those weighed data and correlated with raw PAR data (Figure 7). The picture obtained by this procedure does not differ much from that previously presented.

The Late Bronze Age and the Early Iron Age in the Szczecin lowland – an analysis of the palaeoenvironment evidence

The following section reviews the data on the environment and settlement patterns as recognised by the preliminary investigation of material from surface survey and excavations. The study of palaeoenvironmental data uses available models of the postglacial flora and fauna, historical records (e.g. Great Map of the Duchy of Pomerania) and pollen data.

The Szczecin lowland is a relatively young landform. Its present appearance began to form at the end of the Baltic glaciation c. 16-15 ka. This process culminated in the glacier's retreat towards the north, which coincided with the gradual advance of the newly forming Baltic coast, Szczecin lagoon and Oder river estuary towards the south (Borówka 2002, 51-57). The Szczecin lowland sits at the fringe of the Palaeozoic platforms of west and central Europe. It is a tectonic depression (Cretaceous Szczecin depression) bordered by the Pomeranian anticlinorium in the east. Successive transportation, deposition and exaration, resulting from the Fennoscandia ice cap dislocations, intensively shaped the region before the Quaternary. Pleistocene formations consist of till, sand, gravel, loam and silt. There are also erratic boulders that occur individually or in groups (Augustowski 1977, 14-28).

The forming Baltic Sea and the postglacial uplift of Fennoscandia resulted in water level changes. These processes could have been periodically very dynamic. About 6 ka BC, the breaking apart of the seashore's sand barrier resulted in the appearance of the Pomeranian bay, the withdrawal of the coastline some dozen kilometres southward and the formation of the cliffs of Usedom and Wolin. After that, in the area of the Świna Gate, in the Dziwna river estuary, as well as in the strip of land between present-day Niechorze and Kołobrzeg, sea aggradation and dune formation processes began (see Borówka *et al.* 2005, 87-96). The accumulation of sand led to the cutting off of bays, forming lagoons and coastal lakes. In the depressions, gradually rising groundwater caused the growth of peat bogs. The expansion of forests was dependent on the geological background and the availability of water. Sandy soils fostered the growth of pine forests, and on glacial till oak forests with increasing hazel, elm, lime and maple components developed (Borówka 2005, 14-15).

The relief of the Szczecin lowland varies depending on the region. Its northern edge forms a seashore built of relics of frontal moraine dunes and a sand spit, while the range of the moraine upland (the Gryfice plain) extends behind it. Regions with terminal moraines have an undulating relief and, in some places, hills have substantial height differences. The altitudes are varied, particularly in the western part of the coast, where they reach over 100 m a.s.l. Towards the south lies a lower coastal region, the remnant of the Baltic glaciation's glacial valleys, and the ground moraine area. The Pomeranian glacial valley extends on both sides of the Szczecin lagoon to the Oder's mouth and the Międzyodrze region. The altitudes of the Police plain, the lower Oder valley and the Goleniów plain vary between -3 m a.s.l. (mainly in the regions of Międzyodrze and lake Dąbie) and 25 m a.s.l.. Terraces, made chiefly of water-accumulated glacial sands and slightly rising above wet meadows, were overgrown with small patches of woodland which, somewhat altered, have survived to the present day as the Goleniów and Ueckermünde heath. The highest altitudes are in the regions on both sides of the Oder's mouth, within the terminal moraine's relic ridges (the Szczecin and Bukowe hills). Behind them are the Wełtyń and Pyrzyce plains. The landscape of the two landforms is varied. Both developed on the moraine bedrock (Borówka 2002, 7-22).

The main characteristic of the soils in the region is their diversity (mosaicism). Most are young soils that formed on the moraine in the late Pleistocene and the Early Holocene. Therefore, denudation and erosion processes have not had enough time to sort and wash out the bedrock on which the soils have formed. The soils of the Szczecin coastland are zone soils determined by climatic conditions and vegetation. Podzol soils are currently the predominant type. Marsh soils are also distributed in a mosaic-like fashion and are most widespread in the Oder valley and on the Szczecin lagoon shore. Productive soils, brown and black earths (phaeozems), account for a small percentage of all soils in the region. Tiny patches of black soil occur in the south of the region, next to lakes Miedwie and Płoń, and near Kamień Pomorski (Piszczek 1960, 91-101). Biosphere influence was the main factor in soil modification. Until the fifteenth century, woods covered most parts of the region, accelerating podzolisation. Human impact, deforestation and farming did not substantially influence the environment before the Late Bronze Age.

The climate of the Szczecin lowland in the past and at present develops under the influence of two factors: polar-marine air masses from the north Atlantic and the direct impact of the Baltic Sea and the Szczecin lagoon. Pomerania, including the Szczecin lowland, belongs to the temperate climate zone (Augustowski 1977, 71-82). The flow of western air masses is due to the western and south-western winds prevailing at this latitude. It increases humidity and cloud cover in the summer months, causing a drop in temperatures, while precipitation and temperature rise in the winter. The Baltic Sea's influence is perceptible, especially in the coastal areas, through the change of direction of the breeze coming off the sea during the day and from the land at night. Moreover, sea salt aerosols can be felt mainly on the Trzebiatów coast and Usedom and Wolin, depending on the sea's proximity (Borówka 2002, 57-66).

The prevalent inflows of oceanic air masses mean that the Szczecin lowland has, in principle, a moderate climate. Plant dormancy is relatively short (40-60 days). At night, the temperatures drop below 4° C only relatively late in the year (today: from the first ten days of November). The most extended growth period is currently noted in the lower Oder area and lasts about 230 days (Borówka 2002, 62-64). High air moisture and a large area with relatively high water levels compensate for insufficient rain. Moreover, strong winds cause the region to "dry up".

The Szczecin lowland weather varies at the microclimate scale (topo-climate), related to the relief and vegetation. In all types of depressions (valley floors, glacial tunnels), there are individual microclimates. Wind speed is lower within these landforms, but these regions also have a high 24-hour sum of temperatures. Cold air masses and fog frequently linger in the valleys. Exposure is another vital climate component. Slopes with a southern exposure receive much higher solar radiation than the northern ones, and thus the former remain much drier (Borówka 2002, 66). The periodic inflow of air from the Atlantic in winter causes alternating bouts of cold/frost and warmth/thaw cycles. Western cyclonic circulation causes the highest rate of anomalies (Baranowski 2001, 279-96). Thaws are relatively hazardous to plant growth and cultivation (Czarnecka 2005, 83). These alternate periods of warming and considerable rapid cooling can freeze plants that have started germinating early. For crops, frost could be disastrous and can lead to reduced harvests. Another atmospheric phenomenon that can hurt vegetation is persistent droughts, particularly those lasting more than three weeks between April and October (Kalbarczyk and Kalbarczyk 2005, 171-83).

Soil, water, and climate conditions in the study area would indicate the dominance of forest environments, since forests are climax communities in the European lowlands' succession of vegetation. The Pomeranian section predominantly consists of eutrophic and mesotrophic deciduous woodland (Matuszkiewicz 2008). In the Pomeranian glacier valley area (the Goleniów and Wkra primeval forests), continuous sparse conifer and wetland and riparian forests have survived to modern times. Both forest complexes still existed in the early seventeenth century and have been marked on the so-called Lubinus Map (1618). Irrespective of its shortcomings, the map is indirect evidence for dense forest complexes in this region over time (see Siedlik 2014), despite the substantial gap between the Bronze/Iron Age transition and the period of the map's creation.

As early as 3000 BC, the elm rate in European forests decreased, which was associated with agriculture (including harvesting of leaves and young branches as fodder for livestock) and spreading the so-called Dutch elm disease. It is important to note that beech as an element of forest composition did not appear until the final stage of the Subboreal, no earlier than the early first millennium BC. The increase in hornbeam and beech coincided with the hazel decline in this area, which may be attributable to human activity (farming), and climate changes towards colder and wetter conditions (Ralska-Jasiewiczowa *et al.* 2003, 233-47). There is a quite extensive series of pollen data for the region that show highly dynamic environmental changes over the last thousand years. They are discussed later in this chapter.

It is more challenging to assess the potential vegetation in wetland areas, particularly the Oder river estuary, the Szczecin lagoon, and lake Miedwie. These areas underwent substantial transformations when adjusting them for sailing. Construction and maintenance of hydro-technical infrastructure deepened the changes. The appearance of plant and animal species foreign to the local flora and fauna, which arrived in the ballast tanks of ships, was also significant for those environments (see Latałowa *et al.* 2003, 119-22).

Difficulties also arise in estimating the animal carrying capacity of the Szczecin lowland, due to the changing composition of the fauna caused by the human economy. Assuming the presence of dense forests and extensive wetlands in the early phases of the late Holocene, the expected range of species could be equal or similar to the present ones (red deer, roe deer, wild boar, elk, forest marten, fox, hare, beaver and some species of rodents). That list should be supplemented with those species which no longer occur in this area (wolf, bear, aurochs and lynx) but can be attested by zooarchaeological or historical data. Bone assemblages include aquatic mammals from inland waters (e.g. beaver, otter, European mink) and marine environments (*Phocoena*; grey, ringed and harbour seal). It is not an easy task to recreate the full list of species. The archaeological and historical data do not reflect the total range of animal species either, as not all game animals were brought into settlements and not all animals were hunted. Even if hunted, the whole carcass was not always brought to the settlement. Most prey animals were processed and dismembered right at the kill site (e.g. the remains of animals hunted only for fur were not brought to the settlement; Piątkowska-Małecka 2013). The moderate climate, mainly warm and relatively short winters, and the significant number of water bodies and wetlands in the Szczecin lowland favour periodical visits of many birds, including waterfowl, for wintering and hatching. Today, the Szczecin lowland, together with the lower Oder river valley, the Kamień lagoon, islands in the Świna river mouth, as well as the Miedwie and Dąbie lakes attract most of the birds which winter in the region (see Ławicki *et al.* 2009, 268-82).

The ichthyofauna in the Szczecin coastland's water bodies can survive in both fresh and saline/brackish waters. Some species' life cycle depends on a seasonal change of the environment (most *Salmonidae*, allis shad, Atlantic sturgeon). Lubinus stated that in his times (the seventeenth century), about 70 fish species were known and fished in Pomerania, including those in lakes (Lubinus 1618). He also reports that due to the many forests in the Duchy of Pomerania, there was plenty of valued big wild game: boar, buffalo (probably aurochs), European bison, elk and red deer. The region east of the Miedwie and Płoń lakes would be a habitat for herons with their high-quality feathers (Lubinus 1618).

Only ^{14}C-dated pollen profiles from the Szczecin lowland were included in this study (Figure 8). All are published, except the core of Święte 22. It is not dated, but provides the only evidence for changes in the Pyrzyce plain. The pollen analyses offer the opportunity to evaluate transformations in the environment around the place of coring. Crucially, all the profiles examined here have yielded pollen of plants that indicate local open environments associated with human activities. The plant indicators do not directly reflect crop cultivation in the vicinity of the waterbody, but they suggest the existence of deforested areas (probable pastures for livestock). Most cores come from regions that could not be evaluated in terms of settlement intensity based on the archaeological data. Therefore, these profiles offer indirect evidence of these regions' occupation in the period considered in this study.

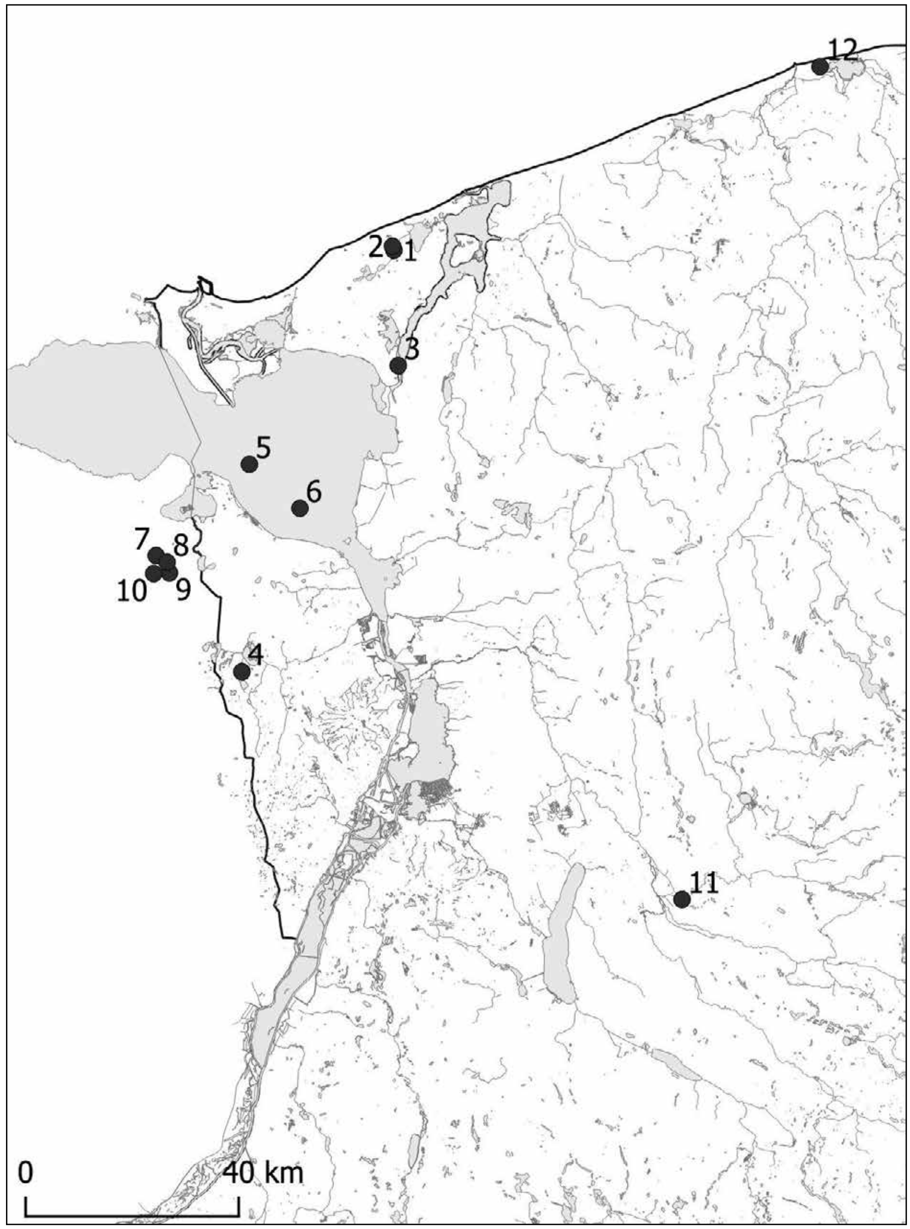


Figure 8. The location of palynological cores.
1. Kołczewo; 2. Racze lake;
3. Wolin II; 4. Bolkowo;
5. Szczecin lagoon Z42/99;
6. Szczecin lagoon Z39/99;
7-10. Albeck lake; 11. Święte 22; 12. Mrzeżyno T28.

The Szczecin lagoon

The cores were extracted from the Szczecin lagoon bed at a considerable distance from the shoreline (Figure 8.5-6). The information on changes in land phytocoenoses in the Subboreal and the Subatlantic periods is sparse. Due to possible deposit redeposition, it is challenging to interpret them in chronological terms. Near the lagoon, many environments had formed: alder fern, woods, tall humid herbs with nettle and bulrush communities. Those were considerably reduced in the Early Holocene, but the rate at which the changes happened is still not precisely known (Latałowa and Święta 2003, 128-29)[3]. However, if one considers the uncertainty of dating and the adjustments suggested by these authors, this level would approximately correspond to the second half of the first millennium BC. Pine and hornbeam decrease, while beech and plants related to grazing (*Plantago lanceolata*) increase. Some cereal pollen (*Triticum*)

---

3 Latałowa and Święta (2003) claim that the date of 3000-2800 BP for the level might be significantly too old, by as much as c. 400 years.

have also been recorded in the profile. During the Late Holocene, the water in the Szczecin lagoon desalinated. Consequently, the proportion of green algae increased in mesotrophic and eutrophic waters (Latałowa and Święta 2003, 128-29).

Wolin island

All three cores from Wolin island are useful for the analysis: one from the peat bog sites at Kołczewo (Figure 8.1), Wolin II (Figure 8.3) and a core from lake Racze (Figure 8.2). The levels SK 8 (Kołczewo), SR 5 (Racze) and SW 6 (Wolin II) correspond to the Lusatian culture in the region. They indicate the drop of tree pollen alongside increasing forest burning indicators (the presence of charcoal and *Pteridium* spores). In the areas surrounding the coring locations, there is an increase in human impact indicators, which M. Latałowa relates to the pastoral exploitation of open environments at this core level. Cereal pollen are present in all cores, especially in that from Kołczewo (*Hordeum, Triticum* and *Secale*) (Latałowa 1992, 123-249).

Pollen records indicate that human settlement activity decreases after 200 BC, simultaneously with forest regeneration. The second half of the first millennium BC is the time of Jastorf culture settlement east of the Dziwna river. The pollen record points to pasture economy with a possible change in crop composition (first rye pollen; Pędziszewska *et al*. 2020).

The Trzebiatów coastland

Core T28 comes from the fossil part of the Samow tunnel valley at the Rega river mouth, near Mrzeżyno (Figure 8.12). The profile shows a decrease in trees and the appearance of plants indicating open landscapes. Based on the pollen of sorrel and *Plantago lanceolata*, the authors concluded that the economy would have been dominated by herding instead of cereal cultivation (Obremska and Cedro 2012, 84).

The Pyrzyce plain

The core was extracted near the archaeological site at Święte 22 (Figure 8.11), in a shallow lake covered by peat during the Subboreal period, which subsequently disappeared. The absence of radiocarbon dates means it is not possible to precisely correlate changes recorded in the profile with the periods of settlement transformation, but four settlement phases were related to the Subboreal period. The last two (phases 3 and 4) could roughly correlate with the period discussed here. Settlement phases have been recognised based on the slight decline of deciduous trees (oak, hazel, alder, ash and hornbeam) and an increase in herbaceous plants, attributed to deforestation. However, there are no indications of fires, such as pieces of charcoal and *Pteridium*. The authors claim that the area around the disappearing water reservoir could have been suitable for grazing – but there are also weed pollen and cereals (rye). The next phase, associated with the beginning of the Subatlantic period, ends with an abrupt drop in anthropogenic indicators and a short forest regeneration phase (Malkiewicz 2009, 114-19).

Unfortunately, the ^{14}C-dated core from lake Racze near lake Miedwie has not been fully published yet. The part dated to the second half of the first millennium BC shows a significant decline in agriculture and less marked pastoral activity only after 200 BC. The decline in the microcharcoal record and an increase in tree pollen indicate reduced settlement activities (Pędziszewska *et al*. 2020).

The Ueckermünde heath

The Bolkowo core (Figure 8.4) and four cores from lake Ahlbeck (Figure 8.7-10) provide some information concerning the Ueckermünde heath. Human/environment interaction data are precious, as there is a limited archaeological record for this area. The part of the Bolkowo core corresponding to the end of the Subboreal is quite poorly preserved and cannot provide the basis for a precise evaluation of the vegetation around lake Świdwie. Human presence is suggested by plant indicators for grazing, with no cereal pollen in this period. The vegetation consisted mostly of phytocenosis with pine, alluvial forests with alder and riparian forests with elm and ash (Latałowa 1994, 220).

In the lake Ahlbeck core, the levels representing the transition between the Bronze Age and the Iron Age are in the upper part of the profile labelled AHL-F and the lower levels labelled AHL-G. At this level, the appearance of hornbeam and beech is evident for the region. The number of indicators of open environments (*Plantago lanceolata*) rises, but there are no indicators for cereal cultivation (see De Klerk 2005, 104; Herking and Wiethold 2004, 21-22).

Discussion: perspectives for in-depth microregional studies

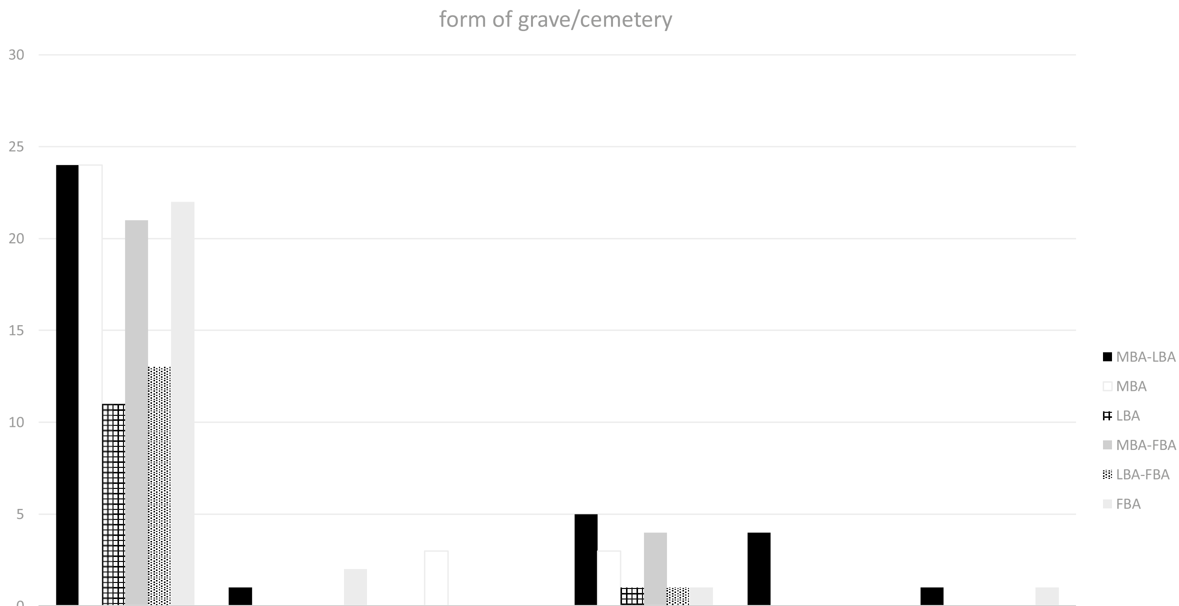
What caused the transformations that mark the transition between the Bronze Age and the Iron Age is still controversially discussed. The transition could have to do with fluctuations of the climate at the end of Subboreal and in the Early Subatlantic, c. 2800-2750 BP (see Dzięgielewski 2012). Problems arise as to the dating of this transitional time. This is due to the so-called Hallstatt plateau in the calibration curve and to the transition between the Subboreal and Subatlantic fluctuations, involving alternating oceanic dominance and continental climate patterns (Urban 2019, 23-25).

Studying the distribution of settlements and burial sites has revealed that occupation was denser in coastal regions, chiefly on Usedom and Wolin and along the Oder river. There are also some site clusters in the adjacent area of the shore up to the Rega river mouth. The most densely settled region was probably the area on both sides of the Dziwna river as far as the Kamień lagoon. Pollen profiles from this area confirm the significant human impact on the environment at the end of the Bronze Age and in the Early Iron Age. Human agency is primarily visible in progressive deforestation, manifested in the pollen record by a decline in tree pollen in favour of herbaceous plants. The presence of *Pteridium* spores testifies that forest fires must have been frequent. Human activity can cause those fires, but not exclusively. Transhumance in fallow fields was conducive to developing meadow environments while holding back the expansion of woodlands. The area is mostly composed of ground moraine formations, but at the mouth of the Dziwna there could have been some mosaic fertile brown and black soils. Fairly good land and different environmental resources could encourage settlement development in the periods corresponding to Hallstatt C and D. The period discussed did not bring any evident changes in the density and extent of settlement.

A high density of archaeological sites was also noted in the southern portions of the study area, mostly in the Pyrzyce plain, along the Oder estuary to the Szczecin lagoon (Szczecin and Bukowe uplands), and on the adjacent Wełtyń plain. The lower density of settlements recorded in the Goleniów and Wkra forests results mainly from insufficient research. At this stage, however, we cannot refute the argument that these low-lying regions with relatively poor soils and endangered by periodic floods were simply not appealing enough for occupation. The pollen data (cf. the Bolkowo core) demonstrate that some areas could serve for seasonal animal grazing, the preferred economic strategy at this time and in this region.

Some scholars argue that at least two provinces of dense occupation were associated with the Lusatian culture during the transition from the Late Bronze to the Early Iron Age (see Bukowski 1998). Looking at the distribution patterns of the surface pottery and burial sites, it seems appropriate to divide the coastal region into an eastern part (including Usedom and Wolin, with the areas adjacent to the Dziwna river) and a western part, the coastal strip between Pobierowo and Mrzeżyno. In the southern province, the density of settlement points is high. Moreover, at this stage of research, it is challenging to separate sub-provinces.

The studies presented above show that there is not enough evidence to regard this period as a turning point marking the transition between the Bronze and the Iron Age. In terms of settlement, burial practices and environmental changes, the first half of the first millennium BC seems to continue the previous period's traditions and patterns. In



	flat cemetery	flat grave	barrow	barrow cemetery	mixed cemetery (flat graves and barrows)	other
MBA-LBA	24	1		5	4	1
MBA	24		3	3		
LBA	11			1		
MBA-FBA	21			4		
LBA-FBA	13			1		
FBA	22	2		1		1

Figure 9. Chronological distribution of different kinds of mortuary site.

this sense, it would be justifiable to use the term “period VI of the Bronze Age” (Final Bronze Age, FBA) for the Oder area. The number of settlement points dated to the early first millennium BC increases. Deforestation also intensifies at this time. The drop in temperature and the precipitation increase do not seem to have been as crucial for this region as they probably were for the area south of Pomerania. However, deforestation, wetter conditions and cooling persisted and caused increased podzolisation of soils. These conditions could have forced changes in the economy, settlement strategies and other aspects of culture that correspond with the advent of the Early Iron Age in the area. The changes could nevertheless have been rather regional. We cannot exclude the possibility that two kinds of societies with divergent economic models coexisted for several hundred years: societies whose economy was based on the “old”, Bronze Age practices, and others with “new”, Iron Age economic modes. The Lusatian style characterises the Late Bronze Age pottery and metal objects and is associated with a village-based settlement pattern and funeral rites including cremation and some grave structures in the form of barrow or stone clusters (Figure 9). The tradition of using the same burial ground for centuries with little change in burial tradition could support the idea of an uninterrupted Bronze Age settlement pattern. The pollen record suggests that the economy was mixed, with a higher rate of cereal agriculture on rich soils and a higher rate of pasture on more deficient soils. The most dramatic changes only took place toward the end of the second half of the first millennium BC and are reflected in a temporary decline in settlement activities. Preliminary results thus support the idea that the Late Bronze Age/Iron Age economy was mixed, responsive to the environment and therefore less susceptible to climate fluctuations. The combined effects of climate change and human-induced environmental change should be then perceived as a “longue durée” process which does not correspond well with archaeologically observed changes in material culture and with the named archaeological units.

Bibliography

Augustowski, B. 1977. *Pomorze*. Warszawa: Państwowe Wydawnictwo Naukowe.

Baranowski, D. 2001. Zróżnicowanie warunków atmosferycznych w Polsce w zależności od typu cyrkulacji. *Prace i Studia Geograficzne* 29, 279-96.

Binford, L.R. 1962. Archaeology as Anthropology. *American Antiquity* 28, 217-25.

Borówka, R.K. 2002. Środowisko geograficzne. In R.K. Borówka and M. Czasnojć (eds), *Przyroda Pomorza Zachodniego*, 6-108. Szczecin: Oficyna In Plus.

Borówka, R.K. 2005. Budowa geologiczna i rozwój rzeźby Pomorza Zachodniego. In R.K. Borówka and S. Musielak (eds), *Środowsko przyrodnicze wybrzeży Zatoki Pomorskiej i Zalewu Szczecińskiego*, 5-28. Szczecin: Oficyna In Plus.

Borówka, R.K., Osadczuk, A., Witkowski, A., Wawrzyniak-Wydrowska, B. and Duda, T. 2005. Late Glacial and Holocene depositional history in the eastern part of the Szczecin lagoon (Great Lagoon) basin – NW Poland. *Quaternary International* 130, 87-96.

Bukowski, Z. 1998. *Pomorze w epoce brązu w świetle dalekosiężnych kontaktów wymiennych*. Gdańsk: Gdańskie Towarzystwo Naukowe.

Cnotliwy, E. 1966. *Powiat kamieński w starożytności*. Szczecin: Muzeum Pomorza Zachodniego.

Czarnecka, M. 2005. Intensywność odwilży atmosferycznych na Pomorzu. *Woda-Środowisko-Obszary Wiejskie* 5, 83-92.

De Klerk, P. 2005. A pollen diagram from the Ahlbecker Seegrund (Ueckermünder Heide, Vorpommern, NE Germany) from the legacy of Franz Fukarek. *Archiv für Naturschutz und Landschaftsforschung* 44, 93-108.

Dzięgielewski, K. 2012. Problemy synchronizacji danych paleoklimatycznych i archeologicznych na przykładzie tzw. wahnięcia subatlantyckiego / Problems of paleoclimatic and archaeological data synchronization as exemplified by the Subatlantic abrupt climatic shift. In W. Blajer (ed.), *Peregrinationes archaeologicae in Asia et Europa Joanni Chochorowski dedicatae*, 109-20. Kraków: Wydanie I.

Herking, C. and Wiethold, J. 2004. Klima und Vegetation während der Bronzezeit – Pollenanalytische Untersuchungen zur Rekonstruktion prähistorischer Umweltveränderungen. In H. Jöns and F. Lüth (eds), *Mythos und Magie. Archäologische Schätze der Bronzezeit aus Mecklenburg-Vorpommern*, 18-23. Lübstorf: Archäologisches Landesmuseum, Landesamt für Bodendenkmalpflege Mecklenburg-Vorpommern.

Kalbarczyk, E. and Kalbarczyk, R. 2005. Identyfikacja okresów suszy atmosferycznej w okolicy Szczecina w latach 1963-2002. *Woda-Środowisko-Obszary Wiejskie* 5, 171-83.

Kondracki, J. 2001. *Geografia regionalna Polski*. Warszawa: Państwowe Wydawnictwo Naukowe.

Kozioł, K. , Czerniec, J. , Bęgziak, B. , Orlikowski, R. 2012. Archeologiczne zdjęcie Polski jako element infrastruktury informacji przestrzennej. *Roczniki Geomatyki* T. 10, z. 4, 133-43.

Latałowa, M. 1992. Man and vegetation in the pollen diagrams from Wolin island (NW Poland). Człowiek i szata roślinna w diagramach pyłkowych z wyspy Wolin (Polska północno-zachodnia). *Acta Paleobotanica* 32, 123-249.

Latałowa, M. 1994. Datowanie palinologiczne i charakterystyka paleobotaniczna profilu archeologicznego w Bolkowie koło Szczecina. *Folia Praehistorica Posnaniensia* VI, 213-24.

Latałowa, M. and Święta, J. 2003. Późnoglacjalna i holoceńska sukcesja roślinności lokalnej na obszarze Zalewu Szczecińskiego. In R.K. Borówka and A. Witkowski (eds), *Człowiek i środowisko przyrodnicze Pomorza Zachodniego (II Środowisko abiotyczne)*, 123-29. Szczecin: Oficyna In Plus.

Latałowa, M., Witkowski, A., Wawrzyniak-Wydrowska, B., Święta, J., Woziński, R. and Borówka, R.K. 2003. Ewolucja ekosystemów na obszarze Zalewu Szczecińskiego w późnym glacjale i holocenie. In R.K. Borówka and A. Witkowski (eds), *Człowiek i środowisko przyrodnicze Pomorza Zachodniego (II Środowisko abiotyczne)*, 119-22. Szczecin: Oficyna In Plus.

Lubinus, E. 1618. *Nova Illustrissimi Principatus Pomeraniae Descripto cum adjuncta Principum Genealogia et Principum veris et potiorum Urbium imaginibus et Nobilium insignibus*. Hamburg: E. Lubin.

Ławicki, Ł., Guentzel, S., Jasiński, M., Kajzer, Z. and Żmichorski, M. 2009. Awifauna lęgowa Doliny Dolnej Odry. *Notatki Ornitologiczne* 50, 268-82.

Malkiewicz, M. 2009. Analiza palinologiczna osadów organicznych stanowiska archeologicznego Święte 22. Aneks 1. In J. Affelski, M. Ignaczak, H. Machajewski, Z. Woźniak and D. Żychliński (eds), *Opracowanie wyników ratowniczych badań archeologicznych na stanowisku nr 22 w Świętym (AZP 33-10/128), gm. Stargard, pow. stargardzki, woj. Zachodniopomorskie. Manuscript,* 104-18. Gniezno: Lider Konsortcjum.

Matuszkiewicz, J.M. 2008. *Potential natural vegetation of Poland (Potencjalna roślinność naturalna Polski). Online study*. Warszawa: Instytut Geografii i Przestrzennego Zagospodarowania Polskiej Akademii Nauk. URL: https://www.igipz.pan.pl/Roslinnosc-potencjalna-zgik.html.

Obremska, M. and Cedro, B. 2012. Rekonstrukcja zmian roślinności w okolicy Mrzeżyna na podstawie analizy pyłkowej osadów z kopalnej części rynny Samowa (profil T28). In B. Cedro (ed.), *Późnoglacjalne i holoceńskie przemiany środowiska przyrodniczego zarejestrowane w osadach profilu T28 z okolic Mrzeżyna na podstawie badań wielodyscyplinarnych,* 73-88. Szczecin: Przedsiębiorstwo Produkcyjno-Handlowe ZAPOL Dmochowski, Sobczyk Spółka Jawna.

Pędziszewska, J., Latałowa, M., Święta-Musznicka, J., Zimny, M., Kupryjanowicz, M., Noryśkiewicz, A. and Bloom, K. 2020. Pollen evidence of change in environment and settlement during the 1st millennium AD. In A. Bursche, J. Hines and A. Zapolska (eds), *The Migration Period between the Oder and the Vistula*, 137-98. Leiden: Brill.

Piątkowska-Małecka, J. 2013. *Łowiectwo ssaków na ziemiach polskich od neolitu do okresu wędrówek ludów*. Warszawa: Wydawnictwa Instytutu Archeologii UW.

Piszczek, J. 1960. Ogólna charakterystyka gleb województwa szczecińskiego. A general characteristic of the soils of the Szczecin voivodeship. *Roczniki Gleboznawcze – Soil Science Annual* 9, 87-101.

Ralska-Jasiewiczowa, M., Nalepka, D. and Goslar, T. 2003. Some problems of forest transformation at the transition to the oligocratic/Homo sapiens phase of the Holocene interglacial in northern lowlands of central Europe. *Vegetation History and Archaeobotany* 12, 233-47.

Siedlik, K. 2014. Analiza prawidłowości przedstawienia treści geograficznej na Wielkiej Mapie Pomorza Eilharda Lubinusa. *Przegląd Zachodniopomorski* XXIX, 15-58.

Siuchniński, K. 1956. Kurhan 60 z cmentarzyska z Wartin pow. Angermünde (N.R.D.). *Materiały Zachodniopomorskie* 2, 7-40.

Urban, J. 2019. *Gospodarka rolna społeczności tzw. kultury łużyckiej*. Warszawa: Wydawnictwo Instytutu Archeologii i Etnologii Polskiej Akademii Nauk.

Peripheral or non-peripheral?

The “world view” of the Bronze Age people in the eastern Baltic

Agnė Čivilytė

Introduction

In Bronze Age research, the eastern Baltic Sea region is often defined as the periphery of the Nordic cultures[1] (Lang 2007) and sometimes even as “periphery of the periphery” (Čivilytė 2005). We can also see the characterisation of this region as peripheral on archaeological maps (Sperling 2016, fig. 4). This opinion has come to the fore as a result of archaeological material clearly demonstrating that there were mutual relations between this area and the Nordic cultures during the Bronze Age, however in a very unequal way. Therefore, Scandinavia is traditionally held to be a centre that was influencing communities living on the opposite coast of the Baltic Sea (Nerman 1933; 1954; Sperling 2014, 3-6). The topic of relationships within the core regions of the so-called Nordic Bronze Age is not new. For example, it was discussed in the Bergen and Helsinki Bronze Age conferences, including northern and eastern regions (Anfinset and Wrigglesworth 2012). The aim of these conferences was firstly to understand the development of the Bronze Age societies of northern Europe, which are often regarded as the periphery of the central European Bronze Age. Furthermore, it became obvious during these discussions that it is important to take into account surrounding areas, such the sub-Arctic/Arctic and eastern Europe as regions of prehistoric interactions. This has also become visible in recent publications (Ojala and Ojala 2020).

The eastern coast region as geographical part of the Baltic Sea can also be seen as an important arena of transcultural relationships in the Bronze Age. The role of the contacts between the societies living here and in the Nordic world has been researched by several scholars since the early 1940s (see the overview by Sperling 2016, 3-10). Most of them argue for Nordic influence on local communities (Jaanusson 1985; Lõugas 1985; Lang and Kriiska 2007; Nerman 1933; 1954) while the opposite opinion is rather an exception (Šturms 1947). In both cases the argumentation relies on bronze artefacts and their typology or on evidence of possible migration of people from the north to the east (the so called “devil’s boat” graves in the eastern Baltic). Only little is known about the pottery and its potential for studying interrelationships across the Baltic Sea (Eriksson 2009; Jaanusson 1981). This

1 The term “Nordic cultures” is here equivalent to the German term “Nordischer Kreis”. More specifically in the literature of this region, the Danish islands and southern coast of Sweden in particular are considered as central for the Nordic cultures of the Bronze Age. Like the narrow coastal areas of central Sweden and Norway, this is an area of fertile soil (Maraszek 2006, 49). Often however, the term “Scandinavia” is used to describe the Bronze Age in the north as a whole, although the cultural development in north and south Scandinavia is different. The geographical determination of “northern lands” is variable. One could argue that the Nordic Bronze Age, in its broadest terms, lies north of the central European area, and that exploring the relations between Nordic communities and central European processes is to take a northern perspective. Within a Nordic context, discussing the northernmost parts of Norway, Sweden and Finland – with references to north-western Russia – would be another and more common interpretation of the concept (Skandfer and Wehlin 2017, 307; Willroth 2002). For a map showing the traditional northern boundary of the Nordic Bronze Age see Skandfer and Wehlin 2017, fig. 1.

In D. Hofmann, F. Nikulka and R. Schumann (eds) 2022. *The Baltic in the Bronze Age. Regional patterns, interactions and boundaries*, Leiden: Sidestone Press, pp. 309-324.

style of approach tends to simplify the cultural situation on the eastern coast of the Baltic Sea and the role of the activities of people in the Bronze Age remains invisible.

This situation makes the eastern Baltic region intriguing, because there is a need for rethinking of how archaeology deals with the cultures without elements of conspicuous display (see also Sperling 2016, 10-14). There is no reason to doubt that the eastern shore of the Baltic was an integral part of the Nordic network of communication and exchange. This started already in the Neolithic, even before the advent of the Corded Ware culture, and continued into the Early Bronze Age (Lang 2007; Lang and Kriiska 2007). This exchange was of different intensity: while in the Early Bronze Age only some imported items from Scandinavia can be related to the sphere of Nordic contacts (Lang and Kriiska 2007), the Late Bronze Age has yielded an impressive amount of material, illustrating the extensive character of relationships.

Keeping in mind that the eastern Baltic was interconnected with the North, the main question remains in how far the term "peripheral" is appropriate to those regions and whether it is still relevant to eastern Baltic archaeology. Furthermore, in order to find the answer, we have to try to elucidate the lifestyle of societies in the region and their role in circum-Baltic connections in the Bronze Age. In line with recently published contributions on this topic (Sperling 2016; Podėnas and Čivilytė 2019), it should be pointed out that the people living here had a lifestyle which was different from those elsewhere, and that this fully met their requirements.

This topic could be tackled from various angles, but in this article I will focus on aspects such as metal imports and copies, metallurgy and technology, economy, social structures and ritual practices in the eastern Baltic Sea region. Overall, this article argues that these societies were open to innovations from far away and shared their ideas with others, but also possessed their own style of life. In this article I am going to discuss the question of periphery in archaeological research and how it can be assessed for the eastern Baltic region. As an alternative, a model of an independent, specific style of life of local societies is presented, which does not necessarily have to be connected to the world system.

Periphery: some remarks

Relations among coexisting societies, especially ones at different levels of socio-political integration, are characterised by the "New Archaeology" and World Systems Theory (WST) as developed by American sociologist and economic historian Immanuel Wallerstein (Sherratt 1993a; 1993b; 1994) as a core and periphery system. A little earlier, the structural theory of imperialism by Norwegian sociologist Johan Galtung (1964) was published. According to Galtung's theory, the world is divided into centre and periphery countries. The distinction between centre and periphery is based on differences among nations in trade partner concentration, export commodity concentration, vertical trade and quality of life. A periphery country tends to export a small number of primary products, while a centre country has a greater diversity of exports, which are principally manufactured goods (Shirazi 1988, 2). Wallerstein's WST seems to be very close to Galtung's ideas. According to WST the new cultural and social values should first (and most intensively) be internalised by the "social centre" and would later gradually be transferred to the "social periphery". This approach assumes an interregional division of labour in which peripheral areas supply core ones with raw materials, the core areas are politically and economically dominant, and the economic and social development of all regions is constrained by their changing roles in the system[2]. The reception of this model in archaeology proceeded in four steps (Găvan and Gogâltan 2014, 29-30)[3] and a focus on WST was also applied to the Nordic Bronze Age (Kristiansen 1987; 1994; 1998).

---

2 For further detail, see Trigger 1989, 332-33; on centre-periphery definitions and concepts, see also Champion 2005; for a detailed overview in particular of the Nordic cultures, see Kienlin 1999, 97-128.

3 A. Sherratt dedicated his 1993 article literally to this problem: "What would a Bronze Age World System look like?"

As Uwe Sperling (2016, 11) has correctly pointed out, this approach was literally repeated by the researches in the Baltic countries, while asymmetric socio-political and economic interdependence were stressed. More specifically, societies with less hierarchical political, economic and technological potentials and infrastructures are seen as having been influenced and stimulated by the centre through the exchange of information, goods and finished products that the peripheral or marginal areas were unable to produce themselves.

However, these works based on the colonialist and capitalist situation of the modern world can hardly be applied to prehistoric societies, even if people produced commodities and gifts which were circulated in macroregional spaces. Many recent works have critiqued centre-periphery thinking in archaeology (see Hofmann *et al.* this volume), first of all because of structural discrepancies between the industrial and pre-industrial worlds, for instance regarding technologies or transport[4]. Where WST has been critically tested, completely different results have been achieved. The Bronze Age tell at Pecica "Şanţul Mare", Romania is a good example for this (Găvan and Gogâltan 2014). It shows what can be achieved using alternative models of interrelationships between societies in the past, such as small cultural groups, which are locally important and each interact with their neighbours and sometimes with areas further afield (Găvan and Gogâltan 2014, 36).

So far, there has been a lack of attention towards the cultural specifics of the eastern area of the Baltic Sea. In terms of the spectrum of archaeological finds, the region could be considered comparable to certain Nordic areas, namely central and northern Sweden, Norway or Finland, where bronze artefacts are extremely rare and found only as single items or in hoards (Maraszek 2006, 69-71). Current research in those regions shows that there is a need to critically examine interregional contacts and the construction of regional entities and borders in the Bronze Age (Ojala and Ojala 2020). Yet, in the following I will assume that neither were relationships between societies with markedly different patterns of social or economic organisation based on dependency from centres, nor was the eastern Baltic a periphery. Rather, it seems that the "world view" – technology, economy/subsistence, trade, interaction and belief systems – of local communities in the eastern Baltic fully met their essential needs and domestic traditions. And, as we will see below, those people were part of a global process called *Bronzization* (Vandkilde 2016). This term was coined to describe the Bronze Age as an overarching globalising phenomenon, tightly connected by one crucial resource and subject to cross-cutting historical change during its duration. Thus, *Bronzization* implies conjuncture and disjuncture in a competitive relationship, which is difficult to fit into WST. Following this idea of *Bronzization,* the eastern Baltic region can be understood as part of intensified interconnectivity and the lifestyle of societies cannot be reduced to defining cores and peripheries.

Technological knowledge and communication

Let us start with bronze casting technology. Knowledge of how to deal with metal is one of the essential vehicles of transregional relationships. Much is known about the metal supply to the societies of the Nordic world and the intensity of long-distance trade and exchange (Ling *et al.* 2013; 2014; 2019). The regions in the north, which yielded comparatively few bronze artefacts, were also included in these networks (Lavento 2019; Melheim *et al.* 2016). Interestingly, in these areas the dislocation between production of bronze objects and their final deposition is noticeable (Melheim *et al.* 2016). The societies in the eastern Baltic region left very similar evidence, which allows us to come to the same observation.

4 More about the critique of WST in archaeology e.g. in Găvan and Gogâltan 2014, 29-30 with references.

More than forty sites with remains of Late Bronze Age metal production are known here (Podėnas and Čivilytė 2019). According to the technical ceramics, the common technologies were used, namely *cire perdue* casting using clay moulds. The quality of metal casting did not differ from other European regions. The same methods and production steps are also known from northern German and Scandinavian sites (Čivilytė 2014; Jantzen 2008). Alongside the numerous casting moulds for rings, the second group of artefacts produced in the eastern Baltic Sea region is socketed axes of a particular type. Out of 110 fragments of casting moulds for axes, roughly 48 (c. 43.6 %) carried negatives attributable to a type. Most of them (44) showed three grooves or the appearance of other distinct decorations that are typical of KAM axes. Their distribution with two concentrations in the north and in the Volga-Kama region provoked a discussion about the relationships between the north and east (Melheim 2015; Ojala and Ojala 2020 with references).

In her article, Lene Melheim problematises connections between the Volga-Kama region and Scandinavia. She notes that the axes produced in Norway are sub-types of KAM axes made in a context of production that was inherently Nordic, but also strongly influenced by the Eurasian metallurgical tradition (Melheim 2015). The same applies to the eastern Baltic region. Here, the casting moulds of KAM axes show variations in size and style. This is why researchers assumed the production of local types with patterns of KAM axes (Luchtanas 1981). Furthermore it is important to say that only few KAM axes are found in the region. Like in Norway, this clearly shows the dislocation between the axes and their production places. This phenomenon requires more explanation.

Thinking about the fact that the metalworkers produced these axes in regions far away from natural sources and furthermore made artefacts of "foreign" forms, it becomes clear that knowledge about the metal and techniques used by craftspersons was connected to well-organised communication between people. Travellers, who were well trained and possessed the ability to contact and to negotiate with local communities, knew special places where they could stop on their long trips (on travelling and transport in the Bronze Age, see Nessel and Uhnér 2019; Nessel *et al*. 2018; Uckelmann 2012). Interestingly, those places were chosen for metallurgical activities like making KAM axes. Hence, we here have to deal with interrelationships between metal suppliers (primary destination), producers (way station) and consumers (final destination).

Why KAM axes were produced in transit regions and who the bearers of metal and ideas were remains unclear. With regard to Scandinavia, it is obvious that the metal did not come from eastern European sources (Melheim 2015, 193). For many years the KAM axes were generally assigned to the Nordic tradition. This opinion still plays a role in current research (Čivilytė 2014; Podėnas and Čivilytė 2019, 179-83). Indeed, the resemblance of KAM axes in the archaeological complexes of the Volga-Kama region to axes of type VII 1a and VII 1b is astonishing (Melheim 2015, fig. 2). However the chemical composition of axes in the Volga-Kama region attests to the use of local metal sources, probably from Kargaly (Melheim 2015, 194). It should be noted that only few KAM axes were analysed and there is still a lack of information about the metal used for their production. However, the analysed KAM axes from Upland in Sweden, in contrast to Norwegian examples, show extremely pure copper, indicating a different source of material. This gap can be covered by new archaeometallurgical investigation of 34 KAM and Ananino axes from cemeteries in the Volga-Kama region[5] (Čivilytė *et al*. in prep.). The new data will help to answer the riddle of the KAM axes in more detail.

The KAM phenomenon is important when speaking about the eastern Baltic region, because of the production places of these axes. They are all located between the two main clusters in the distribution. It is clear that these axes date no earlier than the eighth to seventh centuries BC, because of new dates from settlements with casting moulds

5 This work is part of the project "Pan-European phenomena in prehistory: Bronze Age metal depositions in the eastern Baltic region in the light of long-distance relationships" funded by the Fritz Thyssen foundation.

Fig. 1. KAM axes from the eastern Baltic and casting mould for a KAM axe from the hilltop settlement of Narkūnai (Lithuania).
1. Kalbutiškės (LT);
2. location unknown, LT;
3. location unknown, LT;
4. location unknown, LV;
5. Astangu (ES); 6. Vaškai (LT) and Narkūnai (LT) (photos: A. Čivilytė; T. Eriksson; after Paavel *et al*. 2019, fig. 2).

(Podėnas 2020). The KAM axe found at Astangu in Estonia is dated 510-371 cal BC with 95.4 % probability (Paavel *et al*. 2019). All of these axes as well as the casting moulds in this region are local hybrids. None of the axes are identical to types VII 1a and VII 1b. They are all smaller, but still have vertical ridges in the KAM style. In other words, those axes are recognisable as a type, even if they all are individual (Figure 1).

The appearance of KAM axes corresponds with the establishment of local metallurgy in the eastern Baltic region. That means that communities were interested in acquiring raw material. Hilltop settlements with casting remains are always located in the vicinity of waterways (rivers, lakes or the coastal area; Podėnas and Čivilytė 2019, fig. 7). The fact that no casting moulds for other local artefacts are known suggests that the metalworkers were skilled visiting individuals who were in transit between their primary and final destination. They did not use standardised casting moulds made of bronze or models for producing series of axes. On the contrary, they made the moulds of local clay and created a variety of axes, which all are different but still look similar. In what follows, I show that with regard to metallurgy we can assume the existence of small local cultural centres in the eastern Baltic region. Each of them has its own peculiar traits, and all communicated with each other over short distances, sometimes also reaching more distant areas.

Motivations and forms of communication

The Baltic Sea, like all maritime basins, is a link between different worlds. Journeys across the Baltic were certainly possible. Maritime transport and distances are well described in recent publications (Pfeiffer-Frohnert 1997; Sperling 2016, 14-18; Wehlin 2013). The Baltic Sea has linked people during all archaeological periods. Islands such as Bornholm or Gotland were settled during the Neolithic and attest to long journeys over the open sea covering distances of 45–50 km and more (Lang and Kriiska 2007; Sperling 2016, 16). Moreover the Baltic Sea, as Joakim Wehlin has explained, became more important as a maritime contact network and communication zone in the Bronze Age (Wehlin 2013;

this volume). Interestingly, he asserts that frequent and regular direct sea travel from the eastern Baltic can be questioned because there is no archaeological evidence for any kind of ships on the eastern shore of the Baltic Sea. So, the question about the direction of travel between the eastern Baltic Sea and Scandinavia still remains relevant.

We can discuss much about the significance of metal and technologies, but probably one of the most important criteria here is the history of the invention and use of new kinds of items. In other words, we are dealing with biographies of objects (Fontijn 2002; Vandkilde 2005). When we speak of mutual connections, great significance lies in whether an object was made on site or imported from elsewhere. As there are mostly Nordic forms of artefacts in the eastern Baltic from the Early to the Late Bronze Age (Lang 2007; Paavel 2017), we have to consider the question of what lies behind import and imitation.

This problem can be interpreted in various ways, as the definition of "imports" can be different. For example, objects made on site according to foreign models are seen by some archaeologists not as copies, but as imports (Loba 2006, 5-6; Źychlińska 2004). This simplified interpretation of making copies requires a deeper understanding of how Bronze Age people acted with the foreign artefacts and which meaning the copies acquired. This question has recently been raised using a broad spectrum of approaches (Biehl and Rassamakin 2008; Forberg and Stockhammer 2017; Sørensen 2012). The development of metallurgical craftsmanship in modified local forms is one part of this problem. Maybe a good copy could be as valuable as an original item (Pydyn 2000, 230)? Copying an artefact is not a simple imitation of an exotic or prestigious original and there is the question of how different a copy can be from its model and still be a copy (Sørensen 2012, 45). The main idea is that copying a foreign object in a quasi-identical shape can be interpreted as the attempt to take possession of the foreign. Things being identical was also perceived as meaningful (Stockhammer 2017). There are still a lot of questions left to discuss, such as how the idea of "foreign" things which are similar to the objects from far away can be transmitted if the original finds are missing. Maybe they existed, but we just do not find them? Or were there people who travelled and brought the information back home and the objects transmitted ideas?

In the case of the eastern Baltic region the latter case seems to be most plausible. The casting sites provide a different kind of information, but most importantly, like in Norway (Melheim 2015, 201), we here have a new style of axes which developed through mimicry and innovation and the most important actors in this scenario were the skilled craftspersons. Thus, Gordon Childe's idea of itinerant craftsmen (Podėnas and Čivilytė 2019) seems to be relevant. Most probably there were travellers from the north to the east, as the metal analysis of KAM axes suggests (Čivilytė *et al.* in prep.). We might consider participation in metal production in relation to very specialised technical skill, focused on production of these axes. The very limited assemblages of clay moulds indicate the intentional selection of products to be cast. It is possible that people, living at the strategically important places on the main rivers in the transitional region between west and east welcomed the travelling metalworkers form the north. We still do not know what the advantage of this interaction was; however, the exchange of knowledge about metallurgy likely played the most important role.

The spread of new ideas was the result of craft mobility and contact networks (Nørgaard 2018). Therefore, we can speak about three levels of communication networks: intra-regional eastern Baltic; circum-Baltic, and inter-regional, from the west Baltic to the mid-Volga-Kama basin. The communication dynamics in the eastern Baltic region range from long-distance travel by small groups of people to mediator-based interaction. Expeditors from the north brought technological knowledge to local societies while adapting to new environments. In contrast, host societies started to become familiar with the concept of casting bronze (for further details, see Podėnas and Čivilytė 2019, 183-89).

Following this idea, questions arise as to what motivations lay behind such communication (be they economic, religious, or social) and what led to the consolidation of such connections in the Late Bronze Age. It should be noted that the discussion about

Figure 2. Rings from the Staldzene hoard (Latvia) (photos: A. Čivilytė).

the connections between the "northern lands" and other regions primarily proceeds on the basis of the kinds of metal artefacts circulated and the scale of their distribution. Meanwhile pottery and artefacts made of stone or bone/horn are left out (but see Luik, this volume). For example, we might ask why we find almost no flint daggers on the south-eastern shore of the Baltic, even though there was no shortage of flint in the region. We can speak only of echoes of the dagger period in the eastern Baltic (Piličiauskas 2010). The flint dagger was the main non-metal prestige item deposited in male graves or hoards in Denmark from the end of the Single Grave culture until well into the Bronze Age (Skak-Nielsen 2009). Scandinavian daggers could have spread far from their production places along the southern Baltic coast and through the Åland Isles (Piličiauskas 2010, 13) – but they did not. These differences reflect different manifestations of individual identity and exceptional male status across the Baltic Sea.

Furthermore, the question of the involvement of local metallurgists in the reception of Scandinavian forms remains open. We can assume the short-term stay of specialists at short-lived sites (Podėnas 2020) to cast the products according to local demand in exchange for seeing their own demands met. Moreover, they may have been the ones importing the bronze and later casting it as axes or other objects. Tied together, ring-shaped ingots, such as those found in the hoard of Staldzene (Latvia; Figure 2), could have been conveniently transported. The recently found hoard from former Büsterwalde (Kalinigrad district) included around 30 ingots and fragments in form of bronze sticks, all tied together with rope. There were also very uniform socketed axes of Kalinówka Kośćielna type and neck

Figure 3. Axes and ingots from the Büsterwalde hoard (Kaliningrad district, Russia), bound together with an organic rope (photos: A. Čivilytė).

rings, again all of them carefully tied together (Figure 3). Analogous neck rings are known from the Late Bronze Age hoard I of Kivutkalns (Latvia) and from Golovenskoje, district of Gvardejevsk (former Willkühnen, district of Königsberg). The arguments for mobile craftspersons lie in the high value of the metal in the region at the time and the near certainty that the specialist had originated outside of the eastern Baltic (Podėnas and Čivilytė 2019, 183). The hilltop settlements in Asva (Estonia) and Ķivutkalns (Latvia) could have been established not only as strategically situated workshops but also as ports of trade in the sense of Polanyi (1963), as neutral trading areas in a stateless society. These sites likely represented two or three different interacting cultures of Nordic, Lusatian, and south-eastern Baltic origins, where secure areas were provided for production. These areas were used for either an immediate exchange or in preparation for an exchange further inland (Podėnas and Čivilytė 2019, 183). In recent years archaeological research in the Baltic states and Scandinavia has allowed us to compare the chemical composition of the raw material and resolve the issue of its origin (Čivilytė 2014; Ling *et al.* 2013; 2014; 2019; Melheim *et al.* 2018; Nørgaard *et al*. 2019). Although interpretation of the material depends on the size of the data base and research methods, we can see tendencies which draw out differences and similarities in various regions of the Baltic. The eastern Baltic bronze artefacts are mostly made of copper from the western Carpathians, eastern Alps, and the Banatite Belt in Romania with no indications for the use of Mediterranean sources (Čivilytė 2014).

We can also speak about the spread not only of technical knowledge but also of human behaviour, that is, everyday practices and ritual customs. The deposition of Bronze Age artefacts, which changes from sacrificing single artefacts to offering up whole hoards, illustrates this in a particularly clear way. When we analyse hoards we see clear principles behind the selection of sacrificed objects: in some hoards there are exclusively Nordic items, while in some others only one or two Nordic imports feature alongside locally-made artefacts. General features of object deposition confirm connections between ideas and outlooks.

Beside deposition, burial rituals are also important. Boat-shaped graves and stone cists are observed frequently on both sides of the Baltic Sea (Lang 2007; Vasks 2010; Wehlin 2013). While in Scandinavia, most known Late Bronze Age boat-shaped graves are found on Gotland, in the eastern Baltic they are present at Lülle on the Sõrve peninsula (Saaremaa island), at Väo near Tallinn (Estonia) and in northern Courland. Not only the shape of the graves but also the respective grave goods, including pottery, seem to be of foreign origin. Since Nerman's (1933) ideas about colonising populations there has been little change with regard to the supposed origin of those stone settings, although some odd features in the design of the Courlandic boat settings were already observed by Nerman. Thus, the boat-shaped graves are still considered as barrows built by western groups (Lang 2007, 166; Vasks 2010, 156-57), but the discussion about a "hybrid culture" is also relevant (Wehlin 2013, 47, 52, 77, 185 with references). Even though the exact dating of boat graves is not clear (Laneman *et al.* 2015, 125-27), we can see them as evidence of interrelationships around 1000-700 BC (Wehlin 2013, 59, 68, 80; this volume). In addition, richly-equipped tumuli appeared, which reflect social relations between different groups.

Interregional connections were only possible with the participation of a specific part of society, which was involved in the distribution of goods[6]. Maintaining socio-cultural contacts with the northern cultures had great significance: artefacts of Scandinavian origin are present on opposite shores of the Baltic Sea. Unfortunately, it is very difficult to speak of social structures in the eastern Baltic region (even in Samland) because archaeological evidence remains scarce. Attempts to reconstruct the social system (Merkevičius 2007) are based on simplified and abstract models and this evolutionary framework cannot be seen as the final answer. The fact that up to twenty Bronze Age swords have been found throughout the region from the Samland peninsula to the island of Sarema makes the state of the evidence even clearer (Čivilytė 2007). There are almost no large fortified settlements with special finds in this region, comparable to sites such as Brusczewo in Poland (Czebreszuk and Müller 2015; Czebreszuk *et al.* 2015; Müller *et al.* 2010). At the same time, access to bronze production – according to the traditional scholarly interpretation – was socially restricted. Here we come up against a contradiction: theory tells us what should have been the case (a stratified society), but there is as yet no evidence to support it. In particular, criticism is levelled at the application of a simplistic pyramidal social model. An ideal picture of a social structure emerges when the number of richest graves is the smallest (to form the top of the pyramid), followed by increasingly more people making up the rest of society (to form the middle and bottom of the pyramid). Yet this distribution of social status is undoubtedly open to dispute, because many examples challenging this model of a hierarchical pyramid exist in archaeology (Čivilytė 2012).

Human life and lifestyle also depended on natural conditions and climate. We might call the area around the Baltic Sea a land of forests and lakes – there are no great differences in climate here. Therefore it is very important to investigate the development of economic systems in the Bronze Age, especially after metals appeared. Studies of the cultural landscape in various Baltic regions, issues of human impact on the landscape, the activities of hunter-gatherer-fishers and farmers, environmental and economic changes are the subject of inter-disciplinary research which allows us to grasp economic development and differences or similarities in economic strategies as influenced by local conditions in the Bronze Age. The last several years of archaeological research have shown that the economic development of the eastern Baltic was distinctly different from the rest of northern Europe.

Currently, it is thought that agriculture spread during the Late Bronze Age rather than the Neolithic (c. 3000-1700 cal BC; Lahtinen and Rowley-Conwy 2013; Piličiauskas *et al.* 2017a; 2017b; 2017c). The updated chronology, alongside events such as the adoption of pulses, the appearance of a differentiated regional animal husbandry and the emergence of innovative technologies, which happened simultaneously across the region, provide a truly exceptional prehistoric case. New evidence from enclosed Bronze Age settlements in

---

6 In current Scandinavian research a Marxist approach to political economies in the Bronze Age dominates. This concept explains how the control of the flow of materials leads to inequality (Earle *et al.* 2015). The authors are convinced that long-distance trade in metals and other commodities created a shift from local group ownership towards increasingly individual strategies to obtain wealth from macro-regional trade. For structured deposition, this approach provides the most coherent answer to the question why it was particularly bronze that was deposited on such a massive scale, as political economy takes into account both the role of bronze as a scarce material resource and its general social desirability. Political economies work at supra-regional scales (Earle *et al.* 2015). A different reading is offered by David Fontijn (2020), who proposes to differentiate between "economic" and "religious" depositions. In contrast to the political economy concept, Fontijn sees metal objects as cultural valuables that were crucial in upholding an encompassing social, cultural and moral whole.

Lithuania (Minkevičius *et al.* 2020) indicates the existence of complex economic processes which can no longer be explained using the obsolete economic models of slash-and-burn and shifting cultivation (Girininkas 2019; Girininkas and Daugnora 2015). The newest data seem to deviate from the accepted view that the people of the eastern Baltic region were predominantly using a primitive subsistence model of animal husbandry supplemented with slash-and-burn, shifting agriculture, hunting and fishing. It is necessary to examine the effects which delayed agricultural adoption, the swift appearance of metallurgy, and the emergence of a network of enclosed settlements had on the development of eastern Baltic Bronze Age communities and how this affected inter-regional and intra-regional communication networks[7]. Subsistence was the dominant economic pursuit. Among the inorganic raw materials, salt, stone and metals were the main resources, whereas timber, amber, flax and textile dominated the organic resources. In view of the Baltic Sea connections, it is desirable to compile an overview of the economic resources believed to have driven supra-regional contacts and to further investigate their production.

Amber occupies a key position in Bronze Age research. Of course, there was no shortage of amber in Scandinavia or on the eastern Baltic coast. However, so far there has been little research on the organisation of amber collection and production both in Scandinavia and in the eastern Baltic, with few exceptions such as Bjerre (Thy, Denmark). The long tripartite building uncovered at Bjerre 6 (Bech 1997) contains more than 40 pieces of worked amber and approximately 70 small pieces of unworked amber near its northern wall. Another 85 pieces of amber were spread throughout the building and the nearby area. Another settlement in the same area also yielded traces of amber working. This shows that amber played an important economic and social role (Woltermann 2014, 79-80). The amber question is also relevant in the eastern Baltic, but here we come across an interesting phenomenon – amber seems to disappear from circulation during the Bronze Age. We find only very rare traces of it in settlements or graves (Bliujienė 2007, 191-213). Surprisingly the new excavations of the Late Bronze Age hilltop settlement in Kukuliškiai (Lithuania) on the coast of the Baltic Sea yielded c. 50 pieces of unworked amber (Urbonaitė-Ubė and Ubis 2017). Furthermore, a group of 6 pieces of amber were discovered in 2020, alongside some isolated artefacts (Urbonaitė-Ubė 2021). The pieces had been pushed in between the horizontal timbers of a wall[8] (Figure 4). Such an *in situ* situation can be interpreted as an intentional action of persons living at the settlement. It shows the close connection to the sea, as well as to the raw material and its special treatment in the Late Bronze Age.

The presence of unworked amber in graves, for example in Schleswig-Holstein, underscores the special meaning of amber. As a rule only a single piece of amber is found in such contexts and this reflects the symbolic significance of amber and perhaps even the social status of the dead (Woltermann 2014, 81; 2016). Such examples, albeit rare, are known from Samland and other parts of the Baltic (Bliujienė 2007, 443 attachment 6). These and many other aspects raise questions about the significance of amber in society at that time (Čivilytė 2016). Obviously, the reduction in the amount of amber could not be explained solely by the increased importance of metal exchanges. Amber never lost its relevance and always had a prestige value with symbolic meaning (Varberg *et al.* 2015; 2019).

Conclusion

In the beginning of the article, I emphasised the necessity of going beyond simplistic notions of social interactions as described in political-economic models of centre and periphery. In the case of the eastern Baltic region, there is evidence to support the idea

7 See the ongoing research project "Late Bronze Age (1100-500 BC) economy in the eastern Baltic region: towards a new model (2020-2023)". This project has received funding from the Research Council of Lithuania (LMTLT), Nr. S-MIP-20-46.

8 I want to thank M. Urbonaitė-Ubė (Univeristy of Klaipėda, IBRHA) for this unpublished information.

Figure 4. Pieces of unworked amber, deposited together in a pit between wooden beams and a post at the hilltop settlement of Kukuliškės (Lithuania) (after Urbonaitė-Ubė 2021, fig. 4:2).

of people travelling with metal and with objects from the north towards the east. It is clear that communication was bi-directional and the societies of the eastern Baltic played the role of the mediators. The sea was no barrier to connections, and knowledge of neighbours on its other side persisted from generation to generation. Sites on Saaremaa island and in Courland were in continuous contact with Scandinavian settlements. Inland sites with casting moulds for KAM axes on the eastern coast of the Baltic were mostly located in the vicinity of the significant Daugava river route and the Masurian Lakeland.

Clearly, cultural traditions in the eastern Baltic developed in their own particular way and "foreign" impulses influenced different forms of metal production, exchange and consumption. The eastern Baltic region is often characterised in the literature as exemplifying WST. According to Helle Vandkilde it is one of many local small worlds in the Bronze Age, which were entirely dependent on bronze and were therefore interlinked more tightly than ever before (Vandkilde 2020, 31). However, the long-distance relationship between societies with markedly different patterns of socio-economic organisation can be understood rather in terms of diplomatic interactions: skilled visitors crossed the Baltic Sea during their journeys further to the east, and they stopped in the conspicuous hilltop settlements in between. The economy of local communities in the eastern Baltic fully met the local essential needs, as is visible from the palaeobotanical and archaeozoological material. Living in the geographical transitional zone between west and east, local societies could have played the role of mediators between two different worlds with very different patterns of consumption and discard. Communities interacted with each other, accepted or resisted new ideas, transformed them into specific styles. Knowledge about metallurgy had not only economic, but also symbolic meaning, which is clearly shown in depositional practices. From this point of view, the eastern Baltic region can be seen not as a periphery, but rather as the space where material and social differences worked as cultural communication. This communication was driven by specialised economic needs, such as the search for new material resources in foreign landscapes. Local societies benefited by acquiring metal, accumulating new skills and gaining inspiration for ritual behaviour, which connected different parts of the Baltic Sea.

All these actions can be seen as the result of open-minded activities and adventures rather than as control over the distribution of material resources in settlements in the eastern Baltic. Stylistic codes such as KAM axes show a kind of "solidarisation", and not “differentiation” of societies. Keeping in mind the production of KAM axes on the hilltop-settlements in the eastern Baltic, an alternative model can be considered in future research which does not necessary have to be connected to WST. On the contrary, it is important to think about the possibility of small communities of local significance, each interacting with its neighbours and with areas far away. Maybe it was a privilege to be in the middle of long-distance routes and serve as mediators while imitating special behavioural codes as agreements of understanding.

Acknowledgements

I would sincerely like to thank the two reviewers for their comments, as well as Daniela Hofmann and Robert Schumann for all the support while preparing this article.

Bibliography

Anfinset, N. and Wrigglesworth, M. (eds) 2012. *Local societies in Bronze Age northern Europe*. London, New York: Routledge.

Bech, J.-H. 1997. Bronze Age settlements on raised sea-beds at Bjerre, Thy, NW-Jutland. In J.J. Assendorp (ed.), *Forschungen zur bronzezeitlichen Besiedlung in Nord- und Mitteleuropa. Internationales Symposium vom 9.-11. Mai 1996 in Hitzacker*, 3-15. Espelkamp: Marie Leidorf.

Biehl, P.F. and Rassamakin, J. (eds) 2008. *Import and imitation in archaeology*. Weissbach: Beier & Beran.

Bliujienė, A. 2007. *Lietuvos priešistorės gintaras*. Vilnius: Versus Aureus.

Champion, T.C. 2005. Introduction. In T.C. Champion (ed.), *Centre and periphery. Comparative studies in archaeology,* 1-20. London, New York: Routledge.

Čivilytė, A. 2005. Zur Seltenheit metallener Waffen der Bronzezeit im Ostbaltikum. *Archäologisches Korrespondenzblatt* 35, 329-44.

Čivilytė, A. 2007. Is a warrior without a weapon not a warrior? Some ideas about Bronze Age warfare in the Eastern Baltic region. *Archaeologia Baltica* 8, 39-46.

Čivilytė, A. 2012. In search of a theoretical assessment of Bronze Age society in the Baltic countries. *Archaeologia Baltica* 18, 14-27.

Čivilytė, A. 2014. *Žmogus ir metalas priešistorėje: žvilgančios bronzos trauka.* Vilnius: Diemedžio leidykla.

Čivilytė, A. 2016. How were amber artefacts produced and used during the Bronze Age in the east Baltic? In P.L. Cellarosi, R. Chellini, F. Martini and A.C. Montanaro (eds), *The amber roads. The ancient cultural and commercial communication between the peoples. MILENNI. Studi di archeologia preistorica 13*, 45-55. Firenze: Museo fiorentino di preistoria “Paolo Graziosi”.

Čivilytė, A., Duberow, E., Kuzminyh, S. and Eriksson T. in prep. *New aspects to cultural dynamics between north and east: archaeometallurgical data of KAM axes*.

Czebreszuk, J. and Müller, J. (eds) 2015. *Brusczewo III. The settlement and fortification in the mineral zone of the site*. Bonn: Rudolf Habelt.

Czebreszuk J., Müller, J., Jaeger, M. and Kneisel, J. (eds) 2015. *Brusczewo IV. Natural resources and economic activities of the Bronze Age people*. Bonn: Rudolf Habelt.

Earle, T., Ling, J., Uhner, C., Stos-Galle, Z. and Melheim, A. L. 2015. The political economy and metal trade in Bronze Age Europe: understanding regional variability in terms of comparative advantages and articulations. *European Journal of Archaeology* 18, 633-57.

Eriksson, T. 2009. *Kärl och social gestik*. Uppsala: Uppsala universitet.

Fontijn, D.R. 2002. Sacrificial landscapes. Cultural biographies of persons, objects and “natural” places in the Bronze Age of the southern Netherlands, c. 2300-600 BC. *Analecta Praehistorica Leidensia* 33/34, 1-392.

Fontijn, D.R. 2020. *Economies of destruction: how the systematic destruction of valuables created value in Bronze Age Europe, c. 2300-500 BC*. London: Routledge.

Forberg, C. and Stockhammer, P.W. (eds) 2017. *The transformative power of the copy: a transcultural and interdisciplinary approach*. *Heidelberg Studies on Transculturality 2*. Heidelberg: Heidelberg University Publishing.

Galtung, J. 1964. Foreign policy opinion as a function of social position. *Journal of Peace Research* 3, 206-31.

Găvan, A. and Gogâltan, F. 2014. The "core-periphery" model in archaeology. Case study: the Bronze Age tell settlement from Pecica-Şanţul Mare. In B. Nessel, I. Heske and D. Brandherm (eds), *Ressourcen und Rohstoffe in der Bronzezeit. Nutzung – Distribution – Kontrolle*. *Beiträge zur Sitzung der Arbeitsgemeinschaft Bronzezeit auf der Jahrestagung des Mittel- und Ostdeutschen Verbandes für Altertumsforschung in Brandenburg an der Havel, 16. bis 17. April 2012,* 28-40. Wünsdorf: Brandenburgisches Landesamt für Denkmalpflege und Archäologisches Landesmuseum.

Girininkas, A. 2019. Hoes and the first farmers on Lithuanian territory: from hoe to ard. *Archaeologia Baltica* 26, 66-79.

Girininkas, A. and Daugnora, L. 2015. *Ūkis ir visuomenė Lietuvos priešistorėje vol. 1*. Klaipėda: Klaipėdos universiteto leidykla.

Jaanusson, H. 1981. *Hallunda. A study of pottery from a Late Bronze Age settlement in central Sweden.* Stockholm: Historiska museet.

Jaanusson, H. 1985. Main Early Bronze Age pottery provinces in the northern Baltic region. In A. Loit and J. Selirand (eds), *Die Verbindungen zwischen Skandinavien und Ostbaltikum aufgrund der archäologischen Quellenmaterialien I. Symposium der sowjetestnischen und schwedischen Archäologen, Tallinn 12.-15. Oktober 1982*, 39-50. Stockholm: Almqvist & Wiksell.

Jantzen, D. 2008. *Quellen zur Metallverarbeitung im Nordischen Kreis der Bronzezeit*. Stuttgart: Franz Steiner Verlag.

Kienlin, T.L. 1999. *Vom Stein zur Bronze. Zur soziokulturellen Deutung früher Metallurgie in der englischen Theoriediskussion.* Rahden: Marie Leidorf.

Kristiansen, K. 1987. Center and periphery in Bronze Age Scandinavia. In M. Rowlands, M. Larsen and K. Kristiansen (eds), *Centre and periphery in the Ancient World*, 74-85. Cambridge: Cambridge University Press.

Kristiansen, K. 1994. The emergence of the European world system in the Bronze Age: divergence, convergence and social evolution during the first and second millennia BC in Europe. In K. Kristiansen and J. Jensen (eds), *Europe in the first Millennium BC*, 7-30. Sheffield: J.R. Collis.

Kristiansen, K. 1998. *Europe before history*. Cambridge: Cambridge University Press.

Lahtinen, M. and Rowley-Conwy, P. 2013. Early farming in Finland: Was there cultivation before the Iron Age (500BC)? *European Journal of Archaeology* 16, 660-84.

Laneman, M., Lang, V., Malve, M. and Rannamäe, E. 2015. New data on Jaani stone graves at Väo, northern Estonia. *Estonian Journal of Archaeology* 19, 110-37.

Lang, V. 2007. *The Bronze and Early Iron Ages in Estonia*. Tartu: Tartu University Press.

Lang, V. and Kriiska, A. 2007. The Final Neolithic and Early Bronze Age contacts between Estonia and Scandinavia. In U. Fransson, M. Svedin, S. Bergerbrant and F. Androshchuk (eds), *Cultural interaction between east and west. Archaeology, artefacts and human contacts in northern Europe*, 107-12. Stockholm: Stockholm University.

Lavento, M. 2019. Early Metal Age bronze axes in Finland: an overview. *Zapiski Institut Istorii Materialnoj Kultury RAN* 20, 35-52.

Ling, J., Hjärthner-Holdar, E., Grandin, L., Billström, K. and Persson, P.-O. 2013. Moving metals or indigenous mining? Provenancing Scandinavian Bronze Age artefacts by lead isotopes and trace elements. *Journal of Archaeological Science* 40, 291-304.

Ling, J., Stos-Gale, Z., Grandin, L., Billström, K., Hjärthner-Holdar, E. and Persson, P.-O. 2014. Moving metals II: provenancing Scandinavian Bronze Age artefacts by lead isotope and elemental analyses. *Journal of Archaeological Science* 41, 106-32.

Ling, J., Hjärthner-Holdar, E., Grandin, L., Stos-Gale, Z., Kristiansen, K., Melheim, A.L., Artioli, G., Angelini, I., Krause, R. and Canovaro, C. 2019. Moving metals IV: Swords, metal sources and trade networks in Bronze Age Europe. *Journal of Archaeological Science: Reports* 26, 1-34.
Loba, E. 2006. *„Import" nordyjski na ziemiach polskich w starszej epoce brązu = The Nordic "import" in Polish territories in the Older Bronze Age.* Poznań: Adam Mickiewicz University in Poznań.
Lõugas, V. 1985. Über die Beziehungen zwischen Skandinavien und Ostbaltikum in der Bronze- und frühen Eisenzeit. In A. Loit and J. Selirand (eds), *Die Verbindungen zwischen Skandinavien und Ostbaltikum aufgrund der archäologischen Quellenmaterialien I. Symposium der sowjetestnischen und schwedischen Archäologen, Tallinn 12.–15. Oktober 1982*, 51–60. Stockholm: Almqvist & Wiksell.
Luchtanas, A. 1981. Žalvario apdirbimas ankstyvuosiuose Rytų Lietuvos piliakalniuose. *Lietuvos archeologija* 2, 5-17.
Maraszek, R. 2006. *Spätbronzezeitliche Hortfundlandschaften in atlantischer und nordischer Metalltradition*. Halle (Saale): Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt, Landesmuseum für Vorgeschichte.
Melheim, A.L. 2015. Late Bronze Age axe traffic from Volga-Kama to Scandinavia? The riddle of the KAM axes revisited. *Der Anschnitt. Zeitschrift für Kunst und Kultur im Bergbau* 26, 193-202.
Melheim, A.L., Prescott, C. and Anfinset, N. 2016. Bronze casting and cultural connections: Bronze Age workshops at Hunn, Norway. *Praehistorische Zeitschrift* 2016, 42-67.
Melheim, A.L. [+ 9 others] and Kristiansen, K. 2018. Moving metals III: Possible origins for copper in Bronze Age Denmark based on lead isotopes and geochemistry. *Journal of Archaeological Science* 96, 85-105.
Merkevičius, A. 2007. Material culture and the Bronze Age Society in Lithuania. In A. Merkevičius (ed.), *Colours of archaeology. Material culture and the society*. *Papers from the second theoretical seminar of the Baltic Archaeologists (BASE) Held at the University of Vilnius, Lithuania, October 21st-22nd, 2005*, 93-107. Vilnius, Helsinki, Riga, Tartu: University of Vilnius, University of Helsinki, University of Latvia, University of Tartu.
Minkevičius, K., Podėnas, V., Urbonaitė-Ubė, M., Ubis, E. and Kisielienė, D. 2020. New evidence on the southeast Baltic Late Bronze Age agrarian intensification and the earliest AMS dates of Lens culinaris and Vicia faba. *Vegetation History and Archaeobotany* 29, 327-38.
Müller, J., Czebreszuk, J. and Kneisel, J. (eds) 2010. *Bruszewo II. Ausgrabungen und Forschungen in einer prähistorischen Siedlungskammer Großpolens*. Bonn: Rudolf Habelt.
Nerman, B. 1933. Die Verbindungen zwischen Skandinavien und dem Ostbaltikum in der Bronzezeit und der älteren Eisenzeit. *Acta Archaeologica* IV, 237-52.
Nerman, B. 1954. Yngre bronsåldern – En första svensk vikingatid. *Fornvännen* 49, 257-85.
Nessel, B., Neumann, D. and Bartelheim, M. (eds) 2018. *Bronzezeitlicher Transport. Akteure, Mittel und Wege*. Tübingen: Tübingen University Press.
Nessel, B. and Uhnér, C. 2019. Transportation in Bronze Age Europe. In Sîrbu, V., Comşa, A. and Hortopan, D. (eds), *Digging in the past of Old Europe. Studies in honor of Christian Schuster at his 60th anniversary*, 255-76. Târgu Jiu- Brăila: Editura istros a Muzeului Brălei "Carol I".
Nørgaard, H.W. 2018. The Nordic Bronze Age (1500-1100 BC): craft mobility and contact networks in metal craft. *Praehistorische Zeitschrift* 93, 89-120.
Nørgaard, H.W., Pernicka, E. and Vandkilde, H. 2019. On the trail of Scandinavia's early metallurgy: provenance, transfer and mixing. *PLoS One* 14, e0219574.
Ojala, K., and Ojala C.G. 2020. Northern connections: interregional contacts in Bronze Age northern and middle Sweden. *Open Archaeology* 6, 151-71.
Paavel, K. 2017. Pattern or random? Contextualising Estonian Bronze Age bronze stray finds on the landscape. *Archaeologia Baltica* 24, 26-42.

Paavel, K., Kriiska, A., Lang, V. and Kulkov, A. 2019. Three Bronze axes with wooden haft remains from Estonia. *Estonian Journal of Archaeology* 23, 3-19.
Pfeiffer-Frohnert, U. 1997. Bronzezeitliche Schiffahrt in der baltischen Koine. In C. Becker, M.-L. Dunkelmann, C. Metzner-Nebelsick, H. Peter-Röcher, M. Roeder and B. Teržan (eds), *Chronos. Beiträge zur prähistorischen Archäologie zwischen Nord- und Südosteuropa. Festschrift für Bernhard Hänsel*, 453-68. Espelkamp: Marie Leidorf.
Piličiauskas, G. 2010. Echoes of the dagger period in Lithuania, 2200-1500 cal BC. *Estonian Journal of Archaeology* 14, 3-21.
Piličiauskas, G., Jankauskas, R., Piličiauskienė, G., Craig, O.E., Charlton, S. and Dupras, T. 2017a. The transition from foraging to farming (7000-500 cal BC) in the SE Baltic: A re-evaluation of chronological and palaeodietary evidence from human remains. *Journal of Archaeological Science: Reports* 14, 530-42.
Piličiauskas, G., Jankauskas, R., Piličiauskienė, G. and Dupras, T. 2017b. Reconstructing Subneolithic and Neolithic diets of the inhabitants of the SE Baltic coast (3100-2500 cal BC) using stable isotope analysis. *Archaeological and Anthropological Sciences* 9, 1421-37.
Piličiauskas, G., Kisielienė, D. and Piličiauskienė, G. 2017c. Deconstructing the concept of Subneolithic farming in the southeastern Baltic. *Vegetation History and Archaeobotany* 26, 183-93.
Podėnas, V. 2020. Emergence of hilltop settlements in the southeastern Baltic: New AMS ^{14}C dates from Lithuania and revised chronology. *Radiocarbon* 62, 361-77.
Podėnas, V. and Čivilytė, A. 2019. Bronze casting and communication in the southeastern Baltic Bronze Age. *Lietuvos Archeologija* 45, 169-99.
Polanyi, K. 1963. Ports of trade in early societies. *The Journal of Economic History* 23, 30-45.
Pydyn, A. 2000. Value and exchange of bronzes in the Baltic area and in north-east Europe. In C.F.E. Pare (ed.), *Metals make the world go round. The supply and circulation of metals in Bronze Age Europe. Proceedings of a conference held at the University of Birmingham in June 1997,* 225-32. Oxford: Oxbow Books.
Sherratt, A.G. 1993a. What would a Bronze-Age world system look like? Relations between temperate Europe and the Mediterranean in later Prehistory. *Journal of European Archaeology* 1, 1-58.
Sherratt, A.G. 1993b. ”Who are you calling peripheral?” Dependence and independence in European prehistory. In S. Scarre and F. Healy (eds), *Trade and exchange in prehistoric Europe. Proceedings of a conference held at the University of Bristol, April 1992*, 245-55. Oxford: Oxbow Books.
Sherratt, A.G. 1994. Core, periphery and margin: perspective on the Bronze Age. In C. Mathers and S. Stoddart (eds), *Development and decline in the Mediterranean Bronze Age*, 335-45. Sheffield: J.R. Collis.
Shirazi, F.B. 1988. *An empirical assessment of the centre-periphery hypothesis in international economic relations.* PhD dissertation, Portland State University. Available at https://pdxscholar.library.pdx.edu/open_access_etds/1206/ (last access December 2021)
Skak-Nielsen, N.V. 2009. Flint and metal daggers in Scandinavia and other parts of Europe. A re-interpretation of their function in the Late Neolithic and Early Copper and Bronze Age*. Antiquity* 83, 349-58.
Skandfer, M. and Wehlin, J. 2017. The northern perspective 2000 BC – AD 1. In S. Bergerbrant and A. Wessman (eds), *New perspectives on the Bronze Age. Proceedings of the 13th Nordic Bronze Age symposium held in Gothenburg 9th to 13th June 2015*, 307-12. Oxford: Archaeopress.
Sørensen, T.F. 2012. Original copies: seriality, similarity and the simulacrum in the Early Bronze Age. *Danish Journal of Archaeology* 1, 45-61.
Sperling, U. 2014. *Aspekte des Wandels in der Bronzezeit im Ostbaltikum. Die Siedlungen der Asva-Gruppe in Estland*. Tallinn: Estonian Academy Publishers.

Sperling, U. 2016. Visitors to the other side: some reflections on the Baltic Sea as frontier and contact zone in late prehistory. In A. Kannike and M. Tasa (eds), *The dynamics of cultural borders,* 106-32. Tartu: University of Tartu Press.

Stockhammer, P.W. 2017. The dawn of the copy in the Bronze Age. In C. Forberg and P.W. Stockhammer (eds), *The transformative power of the copy: a transcultural and interdisciplinary approach,* 169-89. Heidelberg: Heidelberg University Publishing.

Šturms, E. 1947. Regionale Unterschiede in den Beziehungen zwischen dem Ostbaltikum und Skandinavien in der Bronzezeit. *Contributions of Baltic University* 53, 1-10.

Trigger B.G. 1989. *A history of archaeological thought*. Cambridge: Cambridge University Press.

Uckelmann, M. 2012. Land transport in the Bronze Age. In H. Fokkens and A. Harding (eds), *The Oxford handbook of Bronze Age Europe*, 398-413. Oxford: Oxford University Press.

Urbonaitė-Ubė, M. 2021. Kukuliškių piliakalnio su gyvenviete tyrimai. *Archeologiniai tyrinėjimai Lietuvoje 2020 metais*, 132-38.

Urbonaitė-Ubė, M. and Ubis, E. 2017. Kukuliškių piliakalnis. *Archeologiniai tyrinėjimai Lietuvoje* 2017, 115-19.

Vandkilde, H. 2005. A biographical perspective on Ösenringe from the Early Bronze Age. In T. Kienlin (ed.), *Die Dinge als Zeichen: Kulturelles Wissen und materielle Kultur*, 263-81. Bonn: Rudolf Habelt.

Vandkilde, H. 2016. Bronzization: the Bronze Age as pre-modern globalization. *Praehistorische Zeitschrift* 91, 103-23.

Vandkilde, H. 2020. Amber, weapons and circulating ideas about leadership at the threshold to the Middle Bronze Age in Europe. In J. Maran, R. Băjenaru, S.C. Ailincăi, A.D. Popescu and S. Hansen (eds), *Objects, ideas and travelers. Contacts between the Balkans, the Aegean and western Anatolia during the Bronze and Early Iron Age,* 31-43. Bonn: Rudolf Habelt.

Varberg J., Gratuze, B. and Kaul, F. 2015. Between Egypt, Mesopotamia and Scandinavia: Late Bronze Age glass beads found in Denmark. *Journal of Archaeological Science* 54, 168-81.

Varberg, J., Kaul, F. and Gratuze, B. 2019. Bronze Age glass and amber. Evidence of Bronze Age long distance exchange. *Adoranten* 2019, 5-29.

Vasks, A. 2010. Latvia as part of a sphere of contacts in the Bronze Age. *Archaeologia Baltica* 13, 153-61.

Wehlin, J. 2013. *Östersjön skeppssättningar: monument och mötesplatser under yngre bronsålder.* Gothenburg: University of Gothenburg.

Willroth, K.-H. 2002. Die nordische Bronzezeit. Anmerkungen zu ihrer Herausbildung. *Bericht der Römisch-Germanischen Kommission* 83, 99-122.

Woltermann, G. 2014. Bernsteinschmuckproduktion in der Hügelgräberzeit. In B. Nessel, I. Heske and D. Brandherm (eds), *Ressourcen und Rohstoffe in der Bronzezeit. Nutzung – Distribution – Kontrolle. Beiträge zur Sitzung der Arbeitsgemeinschaft Bronzezeit auf der Jahrestagung des Mittel- und Ostdeutschen Verbandes für Altertumsforschung in Brandenburg an der Havel, 16. bis 17. April 2012*, 74-86. Wünsdorf: Brandenburgisches Landesamt für Denkmalpflege und Archäologisches Landesmuseum.

Woltermann, G. 2016. *Die prähistorischen Bernsteinartefakte aus Deutschland vom Paläolothikum bis zur Bronzezeit*. Bonn: Rudolf Habelt.

Źychlińska, J. 2004. Recepcja "importu" nordyjskiego na ziemiach polskich we wczesnych fazach kultury łużyckiej. *Folia Praehistorica Posnaniensia* 12, 311-16.

Bronze Age globalisation in numbers

Volumes of trade and its organisation

Kristian Kristiansen

From relative to absolute numbers: the nature of Bronze Age trade

How do we distinguish between the role of gifts as prestige goods and commodities as objects of trade when discussing Bronze Age trade? While some wish to abolish such categories as being linked to a modern perception of the past (Brück 2015), others maintain that the Bronze Age indeed represents the beginning of a pre-modern era (Kristiansen 2018d; Vandkilde 2016), even if it was still couched in the mythological role of prestigious travels (Kristiansen and Larsson 2005, chapter 2) and an ideology of ritual destruction (Fontijn 2019). We are thus dealing with two different value regimes, and it is therefore considered meaningful to apply both the concept of prestige goods as a means of forging political alliances (social value) and the concept of commodities as a means to characterise trade (economic value) (Kristiansen and Larsson 2005, fig. 38; Risch 2016 for comparative analysis of surplus). It has also been suggested that by the Bronze Age inter-regional trade across the European continent, at least in part, was based on competitive advantages that different regions possessed, such as tin from Cornwall or amber from south Scandinavia (Earle *et al.* 2015, fig. 1). However, so far it has been difficult to quantify volumes of trade, which has left the discussion in a sort of stalemate.

I propose that we now have a new foundation for discussing the organisation of trade, which allows us to move from relative to absolute volumes of trade[1]. The role of demography is a prerequisite for this. Here we have seen much recent research (Harper 2017; Nikulka 2016). In the following I shall combine macro and micro levels of information in order to evaluate the reliability of recent demographic models

1 It also provides a more realistic background for reconstructing the nature of social organisation needed to sustain long-distance trade. Here, two fundamentally different models are at hand, as reflected in the debate between Kienlin (2015) and Kristiansen and Earle (2015) for Carpathian tell societies, but with implications for the wider Bronze Age discourse. See also Gogâltan (2016) for a balanced assessment, and Mittnik *et al.* 2019 for a demonstration of social hierarchies in the Early Bronze Age.

In D. Hofmann, F. Nikulka and R. Schumann (eds) 2022. *The Baltic in the Bronze Age. Regional patterns, interactions and boundaries*, Leiden: Sidestone Press, pp. 325-344.

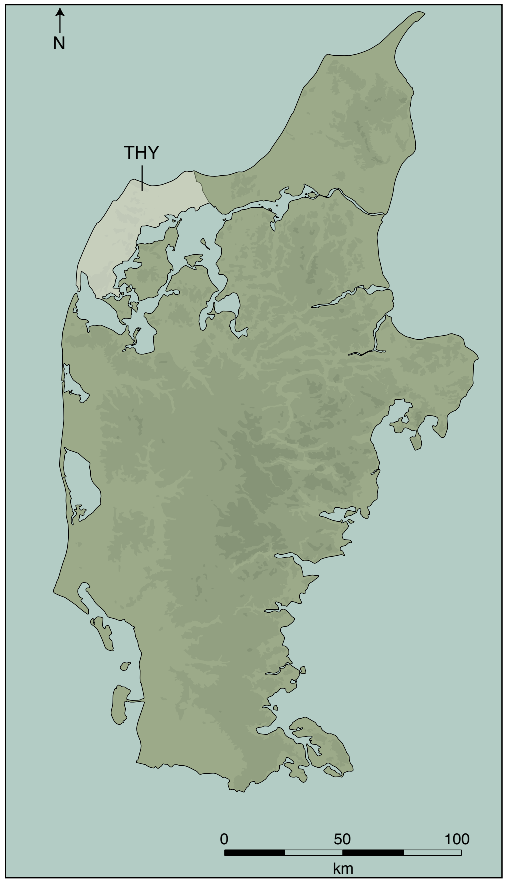


Figure 1. The location of Thy in Denmark.

(Müller 2015a)[2]. More precisely, I shall employ high-resolution evidence from Thy in north-western Jutland (Figure 1) as a starting point for estimating Bronze Age populations in Denmark (Bech *et al.* 2018). This will then be compared with broader European trends. Thus, European Bronze Age populations nearly double between 2000-1500 BC according to the macro-model by Johannes Müller (2015a; 2015b), reaching 13 million, and setting Europe's population on a par with the Near East in a decentralised, interconnected world of trade. A new "pre-modern" political economy took over, one that continued during the Iron Age and Viking Age. What factors lay behind this dramatic increase?

2 The figures from Müller (2015a, figs 17.7, 17.9) are based to some degree on older literature, thus we may expect them to rise with new, updated calculations. The methodology is discussed in Müller and Diachenko (2019). Contrary to this, the systematic and impressive study of Nikulka (2016) for central Europe reaches lower population figures, from 1-6 per km^2 throughout most of later prehistory, which in part can be explained by problems of including burials/cemeteries, since they are hardly representative of population size. Modelling should be based on settlements in combination with environmental data, and total mapping of sites in select regions. An example is the recent modelling of the Bronze Age city of Kanesh in Anatolia, which is now estimated to have held a population of 27,000 people at the beginning of the second millennium BC (Barjamovic 2014). Likewise recent calculations from Tripolje settlement areas reach figures around 15,000 people (Müller *et al.* 2016), which however declined dramatically during the later fourth millennium BC, as nearly everywhere in temperate Europe (Hinz *et al.* 2012; Shennan *et al.* 2013). The Bronze Age rise between 2000 and 1500 BC should thus in part be understood against a background of a previous decline along with the spread of plague epidemics (Rascovan *et al.* 2019; Valtueña *et al.* 2017). Here, the recent documentation of a ranked system of fortified settlements, from mega-size to large and smaller, in south-eastern Europe provides new evidence of the demographic expansion during the Late Bronze Age (Molloy *et al.* 2020).

A new metal economy created permanent, regular connectivity (Radivojević *et al.* 2019). A new wool economy created healthier dress habits (Kristiansen and Sørensen 2019). New food treatments such as salting and smoking of meat, taking place at an industrial level in some areas like Hallstatt and the Carpathians (Harding 2013; Kern *et al.* 2009), increased food preservation, which supported long-distance journeys, just as we witness an increasingly varied and protein-rich diet (Münster *et al.* 2018, fig. 4). All of this led to better health, lower child mortality and older age at death, especially after 2000 BC (Tornberg 2018). Thus, European Bronze Age economies, while still without urban settlements, began to match those of the Near East in scale. Here urban populations were already boosting a commercial economy of long-distance trade in commodities, from fine woollen textiles to copper and tin. From the Hittite town of Kanesh in Anatolia we have the most detailed evidence of the magnitude of such trade during 30 years shortly after 1900 BC based on preserved merchant archives (Barjamovic 2018; Larsen 2015): 110 tonnes of tin, which makes 4 tonnes per year, providing for 40 tonnes of bronze implements per year. Tin arrived into Assur from the "east", probably from central Asia. Textiles were a main import amounting to 115,000 fine textiles of many kinds. Internal copper trade, however, was substantial as well. One big operation mentions 24 tonnes of copper that were exchanged for wool, and wool was traded for silver, the currency of the Old Assyrian traders, who would return part of that capital to the family businesses in the mother city of Assur to allow for new investments. Individual households in Kanesh had bronze implements from cauldrons to kitchen ware in the order of 50-75 kg. Kanesh had an estimated population of around 27,000, perhaps 1000 or more likely 2000 households. If we make a conservative calculation, then 1000 households meant 50 tonnes of bronze in circulation. By adding up city states we end up with huge annual demands for bronze throughout the Near East.

We also learn from the merchant archives in Kanesh how trade caravans were organised. Typically, caravans of 500 donkeys each were put together, and they needed 8000 litres of water and 1500 kg of food daily. A whole system of inns took care of feeding animals and humans along the 1100 km route, where caravans moved regularly. Services were paid for in metal. Guards and guard posts were located at bridges and along the route for protection. Societies along the route were thus transformed. We may envisage a related system in operation in Europe, since demands for long-distance caravans and their support did not differ much. What differed was rather the economic organisation of trade, where the Near East by 1900 BC had already reached a mature level comparable to pre-modern Europe in AD 1500. Thus, a postal system carried letters between Assur and Kanesh and probably most city states in the Near East. A banking system with loans, contracts, agents and so on developed among the merchants families, which in Kanesh alone amounted to 40 family companies.

Such highly organised trade meant that knowledge about faraway places was extensive, something that was part of the profession of the trader (Barjamovic 2011). It also meant that political agreements with city state rulers, providing trade monopolies, were normal. Traders represented a specific social and economic class and were settled in a specific quarter of town in Kanesh. There is much to suggest that a similar system was in operation throughout the Near East (Monroe 2009).

Thus, when approaching the organisation of trade in the decentralised political economies of Europe, there are still aspects of the Near Eastern and Anatolian trade that should be considered, first and foremost the need for political alliances to secure protection and food along the routes, as well as the need to organise regular caravans, whether as maritime journeys or over land. Here oxen could easily replace donkeys as pack animals. It should also be remembered that knowledge existed in Europe about the kingdoms and city states in the eastern Mediterranean through trade connections (Alberti and Sabatini 2012). After 1750 BC the city states of the eastern Mediterranean increasingly turned their interest westwards and looked to Europe in order to secure the import of copper and tin (Kristiansen 2018c). This started a period of more intense trade relations between the east Mediterranean, especially Greece, Italy and central Europe (Kristiansen 2016; Vandkilde 2014). It also started a period of expanding trade networks across Europe, and the introduction of a full-scale bronze and wool economy. However, to understand and evaluate the economic and demographic impact of these changes we need to analyse well-excavated settlements from which we can deduce quantities of goods in use at the local level.

Population figures and metal consumption

While temperate Europe never employed a full-scale metal economy for households, since pottery and wooden implements (cups, spoons etc.) made up the bulk of household goods, it can indirectly be demonstrated through cutmarks on animal bones that bronze knives and axes were increasingly used to cut and prepare meat, starting in the Balkans and south-eastern Europe in the Middle Bronze Age after 2000 BC, and in northern Europe mostly from the Late Bronze Age onwards (Marciniak and Greenfield 2013). In the north flint knives and flint sickles were still in use during the Middle Bronze Age (Eriksen 2018), whereas bronze axes were in daily use for timber work from at least 1600 BC onwards, probably earlier (see below).

When we consider well-excavated settlements with exceptional preservation such as Must Farm in England (Knight *et al.* 2019; see also www.mustfarm.com) or the lakeshore settlements in Switzerland, where we get a glimpse of the everyday use of a range of objects, and extrapolate these insights to larger regions using statistics, we arrive at figures with a rather high degree of probability. Regarding bronze, at Must Farm every house had several bronze tools, and this is similarly the case in the lakeshore settlements (Menotti and Leuzinger 2013). In addition, data from well-surveyed/excavated regions, such as Thy in north-western Denmark (Figure 1), can be used as a parameter for calculating the density of farmhouses within a particular settled region. For Thy, the many farmsteads and barrows suggest household density was overall 1 per km^2 and locally higher (Bech and Rasmussen 2018). With households probably consisting of ten extended family members and various itinerant members, a population density of 15 per km^2 seems reasonable (Sørensen 2010). This estimate equates surprisingly well with pre-industrial historical populations (Kristiansen 2018b). It also corresponds well with the evidence from a newly REVEALS-calibrated absolute pollen diagram from Thy, which shows that by the later Middle Bronze Age Thy was completely deforested, as it has been ever since (Figure 2). Remaining tree pollen in the diagram are mostly due to long-distance transport. Evidence from excavations of houses with preserved wood confirms this picture, as it could be demonstrated that even bog oak discovered during turf cutting for fuel had been used for building timber, as well as low-quality timber from driftwood collected on the beach (Malmros 2018). The larger chiefly farms with good quality timber must therefore have depended on timber import from more forested regions. The use of bog turf for heating the houses confirms the picture of a barren landscape without forests. This was a densely settled region, and the open treeless landscape was common over much of north-western Europe at this time (Prøsch-Danielsen *et al.* 2018).

Based on such data, a recent analysis (Holst *et al.* 2013) has proposed an estimate of the bronze in daily use in Denmark during 1500-1100 BC. Using a conservative estimate based on the distribution of 50,000 Early Bronze Age barrows in Denmark, combined with our knowledge of farm densities, half of Denmark (22,000 km^2) was likely settled at one farm per km^2, resulting in a living population of at least 330,000 if we assume 15 persons in a household, including commoners and unfree persons. Each farm had at least two working axes of c. 500 g (the most important tool for daily purposes). Thus, the 22,000 farms required a stock of 22 metric tonnes of bronze. Because axes would have been worn down by daily use and sharpening, as documented by use-wear analysis, it was conservatively proposed they were reduced annually by 5 % (25 g per farm), suggesting a replacement rate for Denmark of 1 ton per year (Holst *et al.* 2013). In parallel with this need for annual import, a continuous re-melting of worn-down axes to form

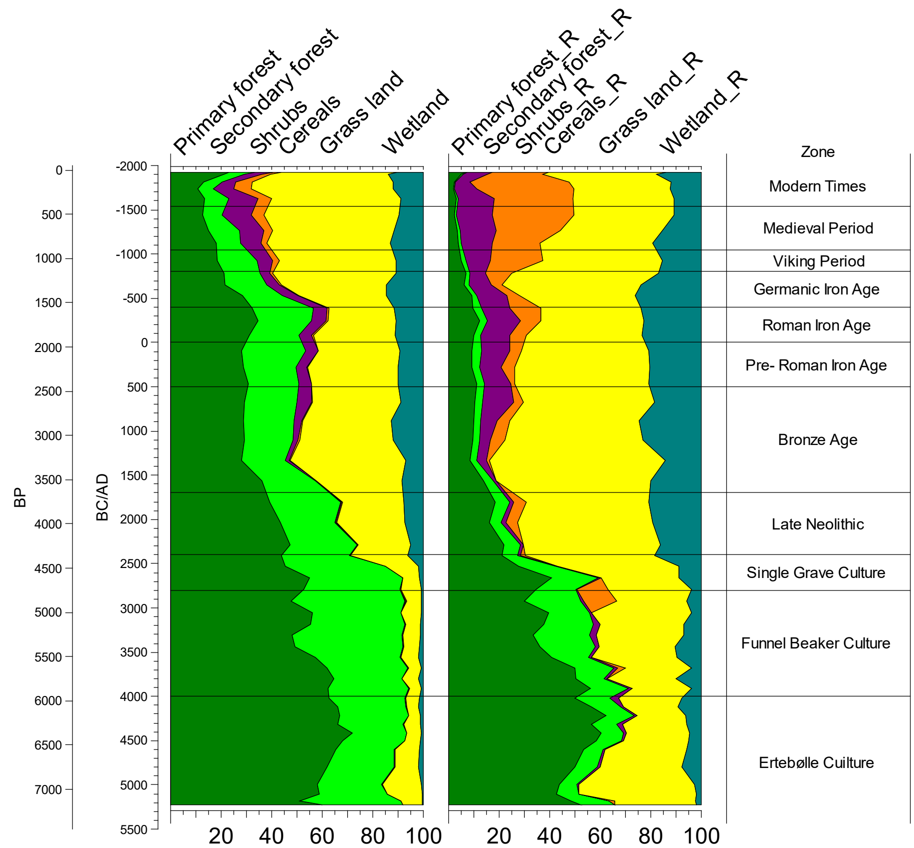


Figure 2. Summary pollen diagram from Lake Ove, Thy. Left: traditional relative values; right: calibrated REVEALS absolute values. The REVEALS calibration was carried out by M. Fischer Mortensen. After Kristiansen *et al.* 2020.

new axes must have taken place. Based on these assumptions, it has been calculated that the replacement rate of the whole stock of bronze in Denmark was 22-25 years, obviously subject to fluctuations if some trade routes were temporarily closed. To this must be added a considerable consumption of bronze sickles, weapons and ornaments that needed regular replacement after burial and hoard consumption. Between 10,000 and 20,000 swords alone were deposited during Period II-III (1500-1100 BC) in Denmark (Bunnefeld 2016a; 2016b; Kristiansen and Suchowska-Ducke 2015). As this covered a period of some 400 years, this means that 25-50 swords were deposited each year. From these rough extrapolations, annual imports of metal must have been very high, at least from Period II (1500 BC) onwards, and would have demanded regular and well-organised trade expeditions.

Based on the evidence from Thy we consider that each farm unit corresponded to at least one barrow and often several (Mikkelsen 2018, figs 28, 29), because the total number of barrows is 50,000[3] from the period between 1500 and around 1150 BC, when barrow construction ceased. As each barrow would contain only a few burials (Holst 2013), it is rather obvious that the majority of the population were not buried here. If we assume an average of five burials per barrow (based on well-excavated examples, but even then this is rather a high estimate), then 250,000 individuals were buried during a period of

3 A total of 86,000 barrows are recorded in Denmark (Holst 2013), and the proportion of those belonging to the Bronze Age was considered by Holst to be at least 36 %, probably somewhat higher, as Bronze Age barrows are the most numerous group. To this should be added the underrepresentation of barrows due to destruction and levelling by farming. Based on an analysis of aerial photos from western Jutland with good barrow preservation, 32 % could be added to the existing number, a figure much higher for the Danish islands (Kristiansen 1985b). Thus, 50,000 Bronze Age barrows remains a realistic figure (Holst *et al.* 2013).

350 years, i.e. around 700 per year. If we assume an average life expectancy of 35 years, and accept the size of the living population calculated above for Thy, then between 2.2 and 3.3 million people lived and died during Montelius periods II-III (350-400 years long). The number of people who were buried in barrows therefore amounts to c. 10 % (see Holst *et al.* 2013 for details of these calculations). If we only consider the adult population, as children were rarely buried in barrows, we arrive at a maximum proportion of around 20 %[4]. In conclusion, barrows were the prerogative of a certain segment of the adult population: the free-men/women of the local chiefly lineage, sometimes also their children; in effect the leaders of the household[5]. Commoners were not entitled to be buried in a barrow, and children only rarely so. They were instead buried in flat graves and stone cist graves without grave goods (Bergerbrant *et al.* 2017). Consequently, the competition for power and prestige, as reflected in barrow construction, took place within the group of free farmers that constituted the local chiefly lineages.

If we extrapolate these population figures from Denmark to Europe, we reach the following numbers: Europe to Urals is 10 million square kilometres, but some large regions in Scandinavia and northern Russia were sparsely settled. If we assume that at least 3 million square kilometres were densely settled with ten people per km^2, we arrive at 30 million people. Johannes Müller (2015a; 2015b) calculated 13 million, based on a lower number per km^2. It suggests that his figures are realistic minimum figures, where some regions would command higher populations. Our maximum figure of three million households would demand a minimum replacement of 3000 tonnes of copper per year, if we assume a 5 % loss per year (see above). Using the minimum population figure of Müller, there would still be an annual need of 1500 tonnes for replacement. We can compare these figures with estimates of production in some Bronze Age mines that were not destroyed by later works. According to O'Brien (2015, 270-71), Kargaly in the Urals produced an estimated 150,000 tonnes of copper during the Bronze Age, extracted from 2-2.5 million tonnes of copper ore. Two thirds of this production, around 100,000 tonnes, took place during the period 1700-1400 BC. We have also figures of 25,000-30,000 tonnes of copper from several mining areas in central Asia. The Austrian Alps around Mitterberg produced an estimated 18,000 tonnes of raw copper, while Great Orme, with a rather brief Middle Bronze Age production period, had an estimated output of 800-1500 tonnes, but here later activity destroyed much of the Bronze Age mines (Williams and Le Carlier de Veslud 2019). We have no figures for some of the very large Middle and Late Bronze Age mining areas in Slovakia, the Italian Alps and Spain. Thus, if we use Kargaly as a baseline and apply more or less similar figures to some of these major mining areas in the Italian Alps and Spain, we can begin to understand the scale of Bronze Age copper production, especially after 1600 BC (Brinkman 2019). Following from this, annual figures of yearly consumption of, say, 1500 tonnes of copper based on our population and settlement model for Europe seem realistic.

It is worth remembering that one kilo of pure copper demanded a much larger extraction of mineralised copper ore, which then had to go through a process of purification or beneficiation (O'Brien 2015, chapter 8). This may also explain why a few large mining operations dominated the production of copper in Bronze Age Europe.

---

4 This should be considered a maximum figure, as Holst's analysis of Bronze Age barrows indicated that most were erected over a single individual, but normally one or two more burials were added, alongside a new layer (Holst 2013). A few barrows contain many burials, but they are exceptions. However, most barrows were not totally excavated, so a figure between 2.5 and 5 burials per barrow is probably realistic. Holst calculated 3.1 burials per barrow. Lowering the figure will also lower the percentage of chiefly lineages of free farmers being buried.

5 Barrows were not only the visible manifestation of a political landscape of ancestors (Holst *et al.* 2013); each barrow also encapsulated in symbolic form the cosmology of Bronze Age religion (Holst 2015). Therefore, we can truly speak of a widely shared political-religious landscape, which accompanied travellers along their routes and made them feel at home along the way, whether in Denmark, the Netherlands or south Germany.

Investments in labour and organisation compared to final output were too heavy for local communities to undertake. Thus, in Kargaly huge assemblages of animal bones, mostly of cattle, testify that outside communities provisioned the miners who lived there in permanent settlements between 1700-1400 BC (Černych 2002). Trade in cattle for meat supplies could therefore have early origins (see also note 8). To get a better handle on the circulation of bronze among settlements in Denmark we shall now take a closer look at work axes.

The role of bronze work axes

Work axes were needed by every farm for all kinds of timber work, and were thus used on a daily basis (Figure 3). Their use-wear as reflected in blade shortening is hence a good indicator of the overall supply situation. I therefore used the Aner *et al.* (1973-2014) volumes from Denmark to count axes of Period I, including Late Neolithic II, and of Periods II and III, which allows a comparison of the initial period of bronze use (c. 2000-1500 BC) with the mature period of bronze use (1500-1100 BC). I further divided Denmark into three geological zones. I applied a three-step scale: no use-wear, moderate, and heavy use-wear. I define no use-wear as an axe with no visual signs of reduction of size (below 10 %) of the axe body below the hafting, but sharpened up and ready for use. Medium use-wear is defined as a reduction of the axe body between 10 % and 50 % (less than 50 %), and heavy use-wear is defined as a reduction of the axe body above 50 %. My classification was done subjectively, since you cannot measure what is not there, but is based on knowledge of full-size axes attested by casting forms (Aner *et al*. 1973, Volume 1, no 96)[6]. It should also be made clear that nearly all working axes were deposited outside burials, in a separate ritual. Since working axes were needed by all households, their use-wear provides an important indication of the availability of metal.

Results are presented in Figures 4-5. What becomes immediately clear is that when it comes to work axes, there are no major differences in use-wear/circulation time from the beginning of the Bronze Age around 2000 BC until 1100 BC. Most axes were deposited when they had been in use for quite some time, some moderately used, some really used up. To employ such axes for a ritual deposition makes sense from an economic point of view. We can also hypothesise that prestige was linked to depositing only slightly used or nearly unused axes, thus suggesting that wealthier farms were responsible for those depositions. These would be the farms that were able to monopolise bronze in the networks, and such entrepots did emerge after 2000 BC (Vandkilde 2017).

What stands out, however, is the regional difference, albeit moderate, between Jutland and the Danish isles in terms of unused (but sharp) axes deposited, especially during the period 2000-1500 BC. If we assume that deposition of more unused or slightly used axes than moderately or heavily used axes was possible when fresh metal supplies were available to replace the deposited axes, then the Danish islands overall had better access to supplies of copper and tin. For the period 2000-1500 BC Vandkilde has demonstrated that eastern Denmark and Scania were part of the Únětice metal network, and had richer depositions than Jutland (Vandkilde 2017, fig. 87). It also corresponds to the arrival of large farm buildings (Sparrevohn *et al.* 2019), some of mega-size, also known from the

6 I did not include non-functional, newly cast axes, or decorated ritual war axes from burials. During early Period II there can be overlap between ritual and work axes. Also it has to be admitted that it is more difficult to evaluate axes from the Late Neolithic/Early Bronze Age Period I, since they often have no clear divide between the upper hafting part and the lower cutting part, as in Period II-III. Vandkilde (2017) carried out use-wear analysis of Late Neolithic axes divided into two categories: blade shortening (my moderate and heavy use-wear), and asymmetrical cutting edge, which could possibly include some of my moderate use-wear. Axes with clear blade shortening amounted to 32 % for Denmark, while 71 % showed damage to the cutting edge and edge asymmetries. From Sweden the figures were 38 % with blade shortening, and 73 % with asymmetrical cutting edge (Vandkilde 2017, 125). From the early period 2000-1500 BC, axes were probably multi-functional, and could be used both as work axes and for warfare, as proposed by Meller (2019).

Figure 3. The most common type of working axe during Period II-III perfectly fits the cut marks on this roof-bearing post from Bjerre house 6, dated to the transition between Periods II and III (photo by J.-H. Bech; improved by K. Wentink).

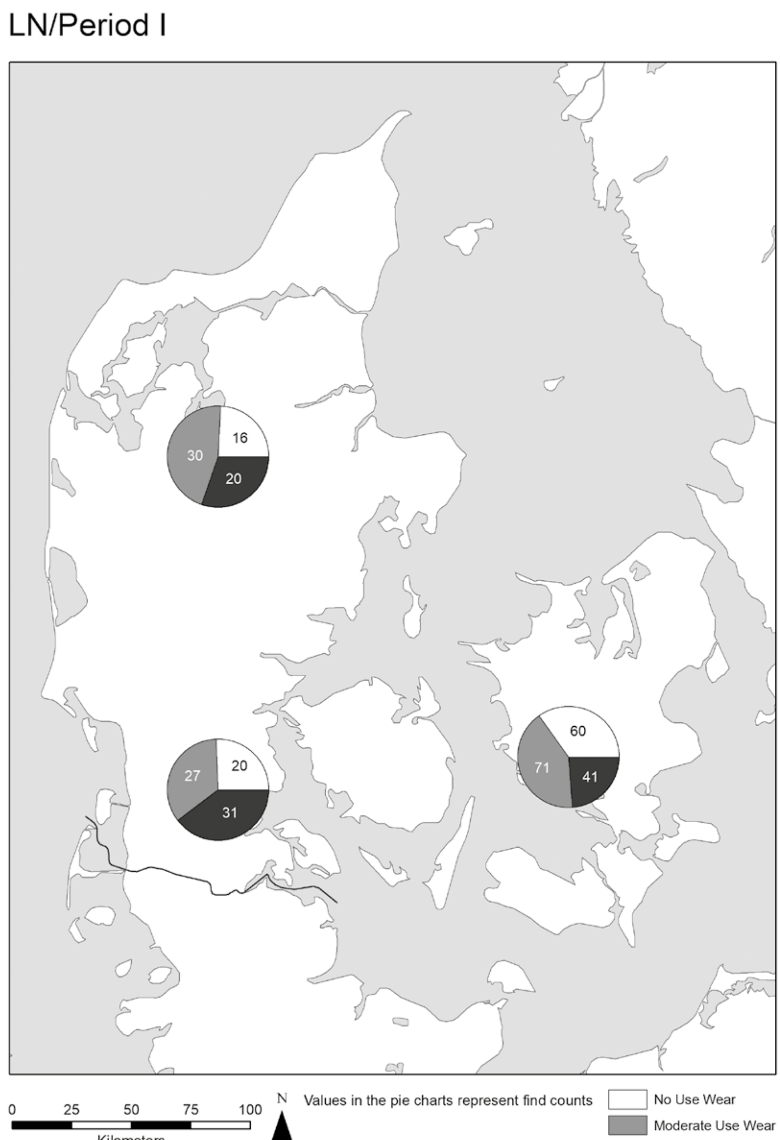


Figure 4 Use-wear on axes defined by blade shortening during the period 2000-1500 BC.

Únětice culture, where they are linked to the formation of complex power structures after 2000 BC (Meller 2019, figs 18, 22; Mittnik *et al.* 2019). It seems that new elites were established who controlled local production networks as well as metal trade networks, and these elites emerged in so-called hubs or entrepots with an advantageous location in the networks (Vandkilde 2017, fig. 91). The maritime networks of the Danish islands apparently played an important role, which lasted until 1500 BC (Horn 2018; Vandkilde 2017, figs 98-100). During these 400-500 years a stock of bronze was built up, which from around 1600 BC would allow the use of bronze for many new types of objects, from weapons to ornaments. The production, distribution and consumption of metal reached a new level, which was to continue more or less during the next 400-500 years. This coincides with a change in trade routes; new copper supplies from the Italian Alps came to dominate, even if there was also some copper coming from Austria/Mitterberg and Slovakia (Melheim *et al.* 2018). This new situation is reflected in more varied strontium isotopic values for non-local individuals after 1600 BC (Frei *et al.* 2019).

Thus, from around 1500 BC we see the emergence of the full-blown Nordic Bronze Age, where the metal economy penetrated most spheres of life. Flint and stone axes increasingly

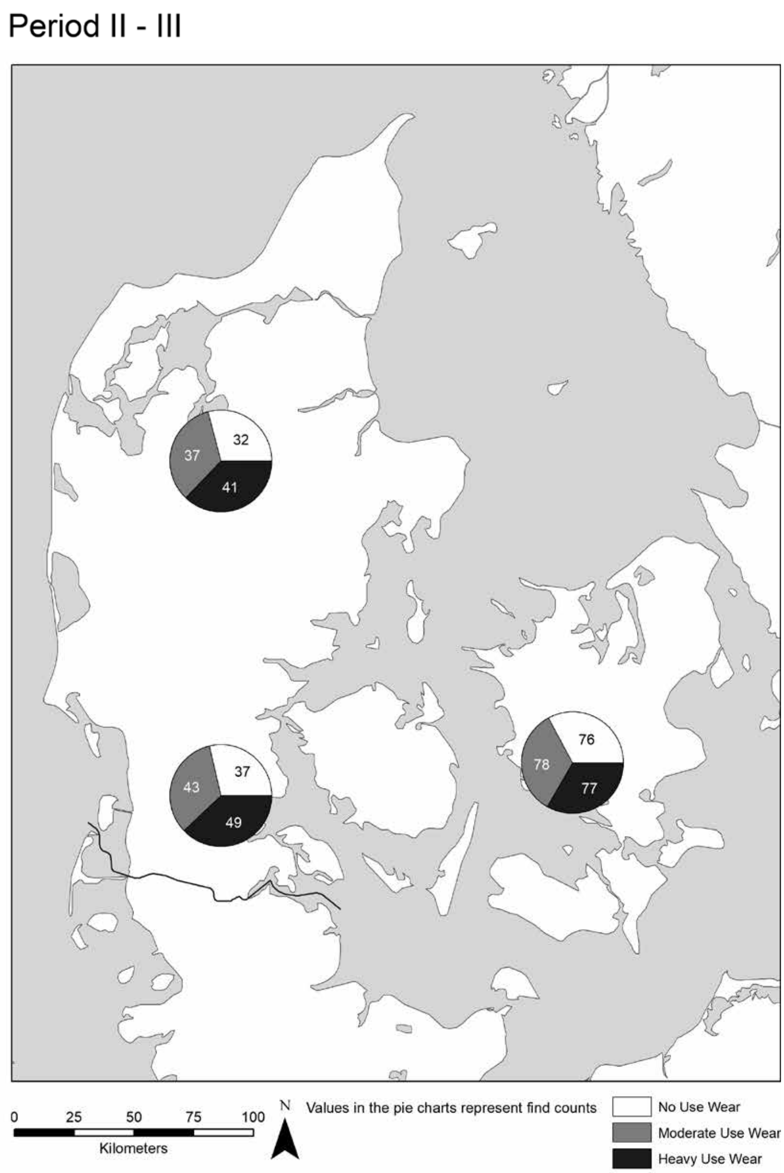


Figure 5 Use-wear on axes defined by blade shortening during the period 1500-1100 BC.

went out of use, and became fully replaced by bronze axes. Some flint sickles were still in use, especially in western Jutland, linked to a specialised production (Mikkelsen 2018). As during the previous period, most work axes were deposited individually, perhaps linked to building activities. Some axes were from hoards assembled either for re-melting or for redistribution of newly cast axes. The largest such hoard is Smørumovre on north-eastern Zealand (Aner *et al.* 1973, volume 1, no. 354). It represents a centrally organised workshop where axes and weapons were cast in large numbers, as well as older pieces collected for re-melting. It is situated close to some of the richest Period II burials on Zealand (Johannsen 2015). There are other small hoards with newly cast axes not ready for use, which must represent more local distribution (Aner *et al.* 2014, volume XIII, no. 6421). Chiefly control of high-quality workshops is also confirmed by analyses of female ornaments (Nørgaard 2017; 2018), and swords (Bunnefeld 2016a; 2016b). This evidence conforms well with the ability to control the metal trade in order to accumulate enough copper and tin to support such workshops, and is reflected in the organisation of metalwork from settlements (Nørgaard 2019; Sörman 2018; 2019). The products from such central workshops were then distributed in smaller portions to clients and supporters within the chiefly sphere of control, as evidenced in smaller hoards, as well as in the distribution of high-quality ornaments from such workshops. These latter, however, could also represent women moving with the ornaments (Nørgaard 2017).

Again we notice that the Danish islands exhibit slightly more unused axes than Jutland, and in terms of numbers there are more axes deposited as well. This corresponds well with a previous analysis of use-wear on swords, where the Danish islands stood out with the deposition of full-hilted swords with no use-wear (Kristiansen 1979, figs 2-3). But western Jutland also had many unused full-hilted swords, whereas there are few axe depositions in this region. It was largely deforested, but work axes were still needed for house building, so we must conclude that this old core area of the Single Grave culture had a different ritual tradition for hoarding (Kristiansen 1985b, fig. 21). However, we do see more bronze sickles and bronze saws on the Danish islands than in Jutland, suggesting that they had entered a more extensive metal economy with less reliance on flint tools.

The use-wear on work axes suggests that metal supplies reached a stable level in Denmark after 2000 BC, but still not sufficient to allow a full-blown metal economy. This only happened during the sixteenth century when new, rich mining areas in the Italian Alps opened and provided most of Europe with high-quality copper during the subsequent centuries, even if Slovakian and Austrian mines were still operating on a more modest scale (Ling *et al.* 2019). This, in combination with the expansion of the Tumulus culture, allowed the formation of a full-blown Nordic bronze economy from 1500 BC onwards. Yearly supplies to the Danish region were now in the order of one to two tonnes of copper, and sufficient supplies of tin were also available, as demonstrated in an optimal balance between tin and copper in alloys during the period 1500-1100 BC. However, the trade in metals probably also included other products, such as wool textiles.

Trade in wool textiles

Recent research has made it clear that wool textiles were not produced locally in northern Europe, not even at a moderate scale (Frei *et al.* 2017b)[7]. Several reasons for this can be mentioned. The production of wool textiles demanded not only new technology, it also substantially affected the social and economic organisation of society, including setting aside large tracts of land for grazing flocks of sheep and the ability to pluck and assemble enough wool from a larger region, as the amount of wool produced by Bronze Age sheep was limited compared to later breeds. It therefore demanded the collaboration of many

7 Around 75 % of wool textiles were from outside the Danish region. However, lack of tools for wool production from more than a thousand excavated Danish Bronze Age settlements suggest that the remaining 25 % could also have come from outside Denmark. Regions with isotopic baselines similar to Denmark are found in Hungary and northern Italy, which were among the main wool producers of the Middle Bronze Age.

settlements and large tracts of land to produce enough wool for textiles, not least if intended for export. This change in economy can be observed already from the beginning of the Middle Bronze Age in Hungary during the earlier second millennium BC, and slightly later in the Po delta in the Terramare culture (Kristiansen and Sørensen 2019). The changes also involved a new division of labour between settlements, as observed in the Terramare culture in northern Italy (Sabatini 2019; Sabatini *et al.* 2018). Thus, the introduction of wool textile production contributed just as much as metal production to the emergence of a new political economy in Europe after 2000 BC (Earle and Kristiansen 2010). However, it also introduced a global division of labour between northern and central/southern Europe: in the north neither copper mining nor wool production was adopted on any grand scale. This is reflected in the distribution of loom weights (Kneisel and Schaefer-Di Maida 2019, fig. 4.7), as well as the number of sheep in north versus central/southern Europe (Van Amerongen 2016, fig. 9.32). Therefore, the north needed to import most of its woollen textiles in the form of proto-industrially produced, uniform and large pieces of cloth (Bergerbrant 2019). In northern Europe, especially north-western Europe from the Netherlands to north-western Jutland and Thy, cattle dominated the domestic animal spectrum with up to 80 % (Bech and Rasmussen 2018, fig. 2.19; Van Amerongen 2016, fig. 9.32). this suggests a cattle-based economy perhaps also for some export to the south[8].

In Denmark with its population of around 300,000 we can estimate that 40-60,000 people belonged to the more wealthy free farmers (those buried in barrows, see above) who would have worn woollen dress as a sign of their elevated status. For the rest of the population we can only guess what their dress looked like; some wool was probably employed, but it is more likely that leather and skin dominated. However, even to dress 40-50,000 people would demand a substantial yearly import of woollen textiles to replace wear and loss. If we estimate two big pieces of cloth (2 x 3 m) per person for a full garment, to be replaced every ten years, an annual import of 4000 pieces of cloth is required. The young Egtved and Skrydstrup women and their travels exemplify the highly organised level of such trade (Frei *et al.* 2015; 2017a).

We still need to qualify the economic relations between northern and central/southern Europe during the Bronze Age, not least since woollen textiles have been added as a substantial and costly import. However, it is clear that south Germany and Denmark stand out as centres of wealth consumption (Müller 2015b).

Trade and the political economy

The figures for yearly quantities of imported copper and textiles have obvious implications for the organisation of trade. Thus, it becomes increasingly clear that safe, regular journeys for trade purposes along networks of interlinked trails and spanning several hundred kilometres would have been impossible without the existence of large chiefdoms, or confederacies of chiefdoms (Earle 1997), which secured safe passage, guest-friendship for overnight accommodation and a range of other necessary services. Long linear confederacies are typical of the nomadic and maritime societies that also characterise the Bronze Age (Gibson 2011; Ling *et al.* 2018; concrete examples are found in Kristiansen and Larsson 2005, fig. 107; Nørgaard 2018, fig. 4.007). The two can be joined together to characterise chiefly confederacies from south Germany to Denmark during the period 1500-1300 BC. The homes of such confederacies could very well have been

8 Bullocks can walk long distances and carry goods as well (cows cannot walk similarly long distances, and bulls are too difficult to drive). Long-distance trade in bullocks and steers is especially well attested from historical times. During the sixteenth and seventeenth centuries AD a substantial export from north-western Europe took place, as well as from Hungary and Ukraine, supplying the expanding urban populations of central and southern Europe. Around AD 1600 the annual European export amounted to 250,000 bullocks. Similarly, internal exports took place within Britain, where Wales produced around 60,000 bullocks annually. In Sweden, internal trade in bullocks supported the large mining communities, as well as the expanding Stockholm region (Frandsen 1994).

associated with the bottlenecks or hubs of large, richly-furnished barrows, and the largest chiefly halls/farmsteads, which could offer guest-friendship and protection (Kaul 2022). Such farmsteads were already in existence from around 2000 BC, when the copper trade took off. They can be up to 400-500 m^2 in size, like later royal Viking halls (Dollar and Poulsen 2015; Poulsen 2017). Central hubs or bottlenecks existed in the system where greater riches accumulated, such as Thy. The system needed such regular meeting places or hubs for the negotiation of all kinds of deals – from the trading of goods to the reinforcement of alliances.

According to Holst and Rasmussen (2013), we should envisage the long lines of barrows which connected northern and southern Jutland, and west and central Jutland, as cattle trails for herdsmen driving cattle to shifting grazing grounds in a horizontal system of transhumance. Perhaps we should envisage farms with twin living quarters, such as that at Legaard (Mikkelsen and Kristiansen 2018), as being geared to accommodating these groups of herders during the grazing season. The barrow lines could stretch hundreds of kilometres (Rasmussen 2017, fig. 1A), and ultimately led further south along the Elbe and Weser, or land routes to the south of the rivers. We should envisage groups of warriors/traders on the move, sometimes driving small herds of cattle along with them for trade, and perhaps for dowries to cement alliances with partners along this long north-south route (Bergerbrant 2007; Holst and Rasmussen 2013).

Quantities and distances involved presuppose small to medium-sized groups or caravans in order also to secure protection between stops. Warriors would have to accompany the journeys, and sometimes they would stay and not return to their homeland, taking service in the chiefs' retinues. This would explain the occurrence of the many foreign swords during this period in Denmark, namely octagonally-hilted and flange-hilted warrior swords (Bergerbrant 2007 124-26). A case in point is a warrior burial from Thy with a foreign sword of type Rixheim and a local fibula, dating to the beginning of Period III. The strontium isotope analysis conducted on tooth enamel from the Jestrup individual yielded a strontium isotopic signature that lies above the baseline for present-day Denmark, indicating that this individual was of non-local provenance. The signature could originate from several areas within Europe, and the closest are among others southern Sweden, the island of Bornholm, central Germany, and some areas of the United Kingdom. However, areas in other parts of Europe are also potential candidates. Future, more detailed baseline studies across Europe might shed further light on this matter. Here the typological origin of the sword type may provide an answer.

Accepting that the Jestrup individual was an immigrant to Thy, a possible conclusion regarding the metalwork is that he brought with him the foreign sword when arriving to present-day Denmark, and acquired the fibula and the double button locally. We might then consider that he was a trader/warrior involved in the copper trade, coming from an area with established trade connections with south Tyrol, as this was also the lead isotope origin of the copper used in his sword (Kristiansen *et al.* 2020), as well as the origin of the Rixheim sword type (Schauer 1971, Tafel 115).

The semi-professional warrior was part of the new political economy of the Middle Bronze Age in Europe (Kristiansen 2018b; see also Molloy and Horn 2020 for further discussion on the professionalisation of warriors). The numbers of such people must have been substantial, even if local retinues were small, and the provision of weapons, especially swords and spears, was likewise an important goal. The Thy project once again may offer a glimpse of the organisation of retinues, as there are more warrior burials here than anywhere else in Europe.

In eastern Thy, around the local Aas area, Mikkelsen was able to calculate the number of settlements to around 60, each with one or two barrows (Mikkelsen 2018). He could further show that from the barrows there was information on 26 swords mainly from Period III, which means that at least 30 % of all settlements had a sword-carrying warrior – perhaps more, since not all barrows are excavated. It therefore seems reasonable to suggest that every farm had at least one warrior, furthermore that all warriors would have two spears, which was common in the few burials with spears in Europe at the time and on Greek vase painting (Sandars 1978, figs 75, 112, 123). Spears were weapons for close combat, not for throwing, as demonstrated by extensive use-wear studies by Christian Horn (2013; 2017, fig. 21.3). In Denmark spears were not considered grave goods, but rather functional weapons, and most are therefore found in hoards.

Thus, if we assume that all household heads provided one warrior with two spears, 44,000 spears would have been in circulation in Denmark. If we reduce the number of spear-carrying warriors by half, the figures are still high enough to heavily impact annual needs for new supplies of bronze. If we estimate one sword-carrying leader per ten farms, 4,000 swords were in use at any one time. If we apply the higher figure from eastern Thy of every three farms, then the figure would be 12,000 swords in circulation. If these figures are applied to Europe, we are talking about several hundred thousand warriors and spears at any given time.

Even if we assume that not all warriors were carrying spears, but also bows and arrows, which were much used in the Tollense valley (e.g. Terberger *et al*. 2018; Harten- Buga *et al.* this volume), we are talking about substantial numbers that should be added to the demand for copper and tin which we calculated for work axes.

In a decentralised political economy, horizontal networks provided social security and supplies for travelling trading parties, which allowed annual movements of thousands of wool textiles and hundreds of kilos of copper between central and northern Europe. But these very same networks were also able to mobilise substantial numbers of warriors from a wide geographical area in case of regional conflicts or threats, as witnessed in the Tollense valley, where the strontium evidence demonstrated diverse geographical origins (Price *et al.* 2017). An apparently small-scale economy at the local level has in the context of hundreds of connected settlements the capacity to operate occasionally at a much larger and more powerful scale.

From local to global Bronze Age economies

The point I wish to reiterate in conclusion is that we need to understand the local organisation of society, as exemplified through interdisciplinary projects such as the Thy project (Bech *et al.* 2018), in order to understand how local communities in a decentralised political economy were able to participate in a global economic system (Vandkilde 2016; 2017). By combining high-resolution data from the Thy project with regional big data from Denmark we are able to model the number of settlements and population figures. Such absolute numbers are important as they allow us to quantify and subsequently qualify social differentiation and exploitation. Nordic Bronze Age society was already heavily stratified, with a minority group of free household-owning farmers and warriors dominating a majority of commoners and unfree labour.

This differentiation was ritually sanctified, as exemplified in different types of burials for elites and commoners. However, it allowed for an efficient organisation of trade systems, including political confederacies, which was supported by mobile warriors protecting caravans and providing oarsmen for sea journeys. The formation of a maritime economy started already around 2000 BC, as documented by Helle Vandkilde (2017, fig. 27), and the interaction between cattle-owning farmers and maritime specialists along coastal hubs in Scandinavia was materialised in coastal cairns and rock art from 1500 BC onwards (Austvoll 2018; Ling *et al.* 2018, fig. 1). In this respect Bronze Age society and Viking Age society are very similar, only the geographical scale expanded further with more advanced Viking Age ship technologies (Ling *et al.* 2018). Having said that, we must allow for some regional variation in political economies and population densities, as well as temporal fluctuations linked to outbreaks of epidemics or local environmental changes, which could lead to regional migrations, as evidenced in the Mediterranean (Capuzzo *et al.* 2018; Roberts *et al.* 2019). However, demographic figures in combination with a quantification of consumption patterns demonstrate the scale of Bronze Age trade. This testifies to a need to distribute huge quantities of copper throughout western

Eurasia from a few large-scale mining areas. This rise of an interregional metal trade was linked to regional competitive advantages in other products as well (Earle *et al.* 2015). Amber, perhaps also cattle and slaves from Scandinavia were traded south, while metal and woollen textiles from central Europe were traded north, creating a global economy for the first time in world history. However, we need many more local interdisciplinary projects throughout Europe, as well as big data, to establish a more solid foundation for such a scenario.

Bibliography

Alberti, M.E. and Sabatini, S. (eds) 2012. *Exchange networks and local transformations. Interaction and local change in Europe and the Mediterranean from the Bronze Age to the Iron Age.* Oxford: Oxbow Books.

Aner, E., Kersten, K. and Willroth, K.-H. 1973-2014. *Die Funde der älteren Bronzezeit des nordischen Kreises in Dänemark, Schleswig-Holstein und Niedersachsen* I-XIII. Neumünster: Wachholtz.

Austvoll, K.I. 2018. *Seaways to complexity. A study of sociopolitical organisation along the coast of northwestern Scandinavia in the Late Neolithic and Early Bronze Age.* PhD thesis, University of Oslo.

Barjamovic, G. 2011. *A historical geography of Anatolia in the Old Assyrian Colony Period.* København: Museum Tusculanum Press.

Barjamovic, G. 2014. The size of Kanesh and the demography of Early Middle Bronze Age Anatolia. In L. Atici, F. Kulakoğlu, G. Barjamovic and A. Fairbairn (eds), *Current research in Kültepe/Kanesh: an interdisciplinary and integrative approach to trade networks, internationalism, and identity during the Middle Bronze Age*, 55-68. Atlanta, GA: Lockwood Press.

Barjamovic, G. 2018. Interlocking commercial networks and the infrastructure of trade in Western Asia during the Bronze Age. In K. Kristiansen, T. Lindkvist and J. Myrdal (eds), *Trade and civilisation. Economic networks and cultural ties, from prehistory to the Early Modern Era*, 113-42. Cambridge: Cambridge University Press.

Bech, J.-H. and Rasmussen, M. 2018. Thy and the outside world in the Bronze Age. Regional variations in a North Sea perspective. In J.-H. Bech, B.V. Eriksen and K. Kristiansen (eds), *Bronze Age settlement and land-use in Thy, northwest Denmark 1*, 25-106. Højbjerg: Jutland Archaeological Society, Aarhus University Press.

Bech, J.-H., Eriksen, B.V. and Kristiansen, K. (eds) 2018. *Bronze Age settlement and land-use in Thy, northwest Denmark.* Højbjerg: Jutland Archaeological Society, Aarhus University Press.

Bergerbrant, S. 2007. *Bronze Age identities: costume, conflict and contact in northern Europe 1600-1300 BC. Stockholm Studies in Archaeology no 43*. Lindome: Bricoleur Press.

Bergerbrant, S. 2019. Wool textiles in the Early Nordic Bronze Age: local or traded? In S. Sabatini and S. Bergerbrant (eds), *The textile revolution in Bronze Age Europe. Production, specialisation, consumption*, 255-73. Cambridge: Cambridge University Press.

Bergerbrant, S., Kristiansen, K., Allentoft, M.E., Frei, K.M., Price, T.D., Sjögren, K.-G. and Tornberg, A. 2017. Identifying commoners in the Early Bronze Age: burials outside barrows. In S. Bergerbrant and A. Wessman (eds), *New perspectives on the Bronze Age. Proceedings of the 13th Nordic Bronze Age symposium, held in Gothenburg 9th June to 13th June 2015*, 37-64. Oxford: Archaeopress.

Brinkman, J. 2019. Copper output, demand for wood and energy expenditure – evaluating economic aspects of Bronze Age metallurgy. In M. Dal Corso, W. Kirleis, J. Kneisel, N. Taylor, M. Wieckowska-Lüth and M. Zanon (eds), *How's life? Living conditions in the 2nd and 1st millennia BCE*, 11-34. Leiden: Sidestone Press.

Brück, J. 2015. Gifts or commodities? Reconfiguring Bronze Age exchange in northwest Europe. In P. Suchowska-Ducke, S. Scott Reiter and H. Vandkilde (eds), *Forging identities. The mobility of culture in Bronze Age Europe 1*, 47-56. Oxford: British Archaeological Reports.

Bunnefeld, J.-H. 2016a. *Älterbronzezeitliche Vollgriffschwerter in Dänemark und Schleswig-Holstein. Studien zu Form, Verzierung, Technik und Funktion.* Kiel, Mainz: Wachholtz.
Bunnefeld, J.-H. 2016b. Crafting swords. The emergence and production of full-hilted swords in the Early Nordic Bronze Age. *Praehistorische Zeitschrift* 91, 379-430.
Capuzzo, G., Zanon, M., Dal Corso, M., Kirleis, W. and Barceló, J.A. 2018. Highly diverse Bronze Age population dynamics in central-southern Europe and their response to regional climatic patterns. *PLoS ONE* 13: e0200709. DOI: 10.1371/journal.pone.0200709.
Černych, E.N. (ed.) 2002. *Kargaly volume II: Gorny – the Late Bronze Age settlement. Topography, lithology, stratigraphy. Household, manufacturing and sacral structures. Relative and absolute chronology*. Moscow: Jazyki Slavjanskoj Kul'tury.
Dollar, S.R. and Poulsen, M.E. 2015. Early Bronze Age settlements at Vejen in southern Jutland, Denmark: new perspectives on the three-aisled longhouses from Period II. In P. Suchowska-Ducke, S. Scott Reiter and H. Vandkilde (eds), *Forging identities. The mobility of culture in Bronze Age Europe 1*, 175-81. Oxford: British Archaeological Reports.
Earle, T. 1997. *How chiefs come to power*. *The political economy in prehistory*. Stanford: Stanford University Press.
Earle, T. and Kristiansen, K. 2010. *Organizing Bronze Age societies*. Cambridge: Cambridge University Press.
Earle, T., Ling, J., Uhnér, C., Stos-Gale, Z. and Melheim, L. 2015. The political economy and metal trade in Bronze Age Europe: understanding regional variability in terms of comparative advantages and articulations. *European Journal of Archaeology* 18, 633-57.
Eriksen, B.V. 2018. Bronze Age flint-working at Bjerre, Thy. In J.-H. Bech, B.V. Eriksen and K. Kristiansen (eds), *Bronze Age settlement and land-use in Thy, northwest Denmark 2*, 281-347. Højbjerg: Jutland Archaeological Society, Aarhus University Press.
Fontijn, D. 2019. *Economies of destruction*. *How the systematic destruction of valuables created value in Bronze Age Europe, c. 2300-500 BC*. London, New York: Routledge.
Frandsen, K.-E. 1994. *Okser på vandring*. *Produktion og eksport af stude fra Danmark i midten af 1600-tallet*. Ebeltoft: Skippershoved.
Frei, K.M. [+ 9 others] and Frei, R. 2015. Tracing the dynamic life story of a Bronze Age female. *Nature Scientific Reports* 5, 10431. DOI: 10.1038/srep10431.
Frei, K.M. [+ 12 others] and Frei, R. 2017a. A matter of months: high precision migration chronology of a Bronze Age female. *PLoS One* 12, e0178834. DOI: 10.1371/journal.pone.0178834.
Frei, K.M., Mannering, U., Berghe, I.V. and Kristiansen, K. 2017b. Bronze Age wool: provenance and dye investigations of Danish textiles. *Antiquity* 91, 640-54.
Frei K.M. [+ 9 others] and Kristiansen, K. 2019. Mapping human mobility during the third and second millennia BC in present-day Denmark. *PLoS ONE* 14, e0219850. DOI: 10.1371/journal.pone.0219850.
Gibson, D.B. 2011. Chiefdom confederacies and state origins. *Social Evolution & History* 10, 215-33.
Gogâltan, F. 2016. Building power without power? Bronze Age fortified settlements on the lower Mureș basin. In F. Gogâltan and C. Cordoş (eds), *Prehistoric settlements: social, economic and cultural aspects*. *Seven studies in the Carpathian area*, 87-113. Cluj-Napoca: Editura Mega.
Harding, A. 2013. *Salt in prehistoric Europe*. Leiden: Sidestone Press.
Harper, T.K. 2017. Demography and climate in Late Eneolithic Ukraine, Moldova, and Romania: multiproxy evidence and pollen-based regional corroboration. *Journal of Archaeological Science: Reports* 23, 973-82.
Hinz, M., Feeser, I., Sjögren, K.-G. and Müller, J. 2012. Demography and the intensity of cultural activities: an evaluation of Funnel Beaker societies (4200-2800 cal BC). *Journal of Archaeological Sciences* 39, 3331-40.
Holst, M.K. 2013. South Scandinavian Early Bronze Age barrows – a survey. In M.K. Holst and M. Rasmussen (eds), *Skelhøj and the Bronze Age barrows of southern Scandinavia 1*, 27-128. Højbjerg: National Museum of Denmark, Jutland Archaeological Society.

Holst, M.K. 2015. Bronze Age geometry and cosmology. In M.K. Holst and M. Rasmussen (eds), *Skelhøj and Bronze Age barrows of southern Scandinavia 2*, 53-89. Højbjerg: National Museum of Denmark, Jutland Archaeological Society.

Holst, M. K. and Rasmussen, M. 2013. Herder communities: longhouses, cattle and landscape organisation in the Nordic Early and Middle Bronze Age. In S. Bergerbrant and S. Sabatini (eds), *Counterpoint: essays in archaeology and heritage studies in honour of Professor Kristian Kristiansen*, 99-110. Oxford: British Archaeological Reports.

Holst, M.K., Rasmussen, M., Kristiansen, K. and Bech, J.-H. 2013. Bronze Age "Herostrats": Ritual, political, and domestic economies in Early Bronze Age Denmark. *Proceedings of the Prehistoric Society* 79, 265-96.

Horn, C. 2013. Weapons, fighters and combat: spears and swords in Early Bronze Age Scandinavia. *Danish Journal of Archaeology* 2, 20-44.

Horn, C. 2017. Yet another revolution? Weapon technology and use wear in Late Neolithic and Early Bronze Age southern Scandinavia. In P.W. Stockhammer and J. Maran (eds), *Appropriating innovations*. *Entangled knowledge in Eurasia 5000-1500 BCE*, 262-68. Oxford: Oxbow Books.

Horn, C. 2018. Warfare vs. exchange? Thoughts on an integrative approach. In C. Horn and K. Kristiansen (eds), *Warfare in Bronze Age society,* 47-60. Cambridge: Cambridge University Press.

Johannsen, J.W. 2015. Serial production and metal exchange in Early Bronze Age Scandinavia: Smørumovre revisited. In P. Suchowska-Ducke, S. Scott Reiter and H. Vandkilde (eds), *Forging identities. The mobility of culture in Bronze Age Europe 2*, 73-83. Oxford: British Archaeological Reports.

Kaul, F. 2022. Middle Bronze Age long distance exchange: amber, early glass, and guest friendship, *xenia.* In J. Ling, R.J. Chacon and K. Kristiansen (eds), *Trade before civilization,* 109-49. Cambridge: Cambridge University Press.

Kern, A., Kowarik, K., Rausch, A.W. and Reschreiter, H. (eds) 2009. *Kingdom of salt. 7000 years of Hallstatt.* Vienna: Natural History Museum.

Kienlin, T.L. 2015. *Bronze Age tell communities in context. An exploration into culture, society, and the study of European prehistory*. *Part 1: critique. Europe and the Mediterranean.* Oxford: Archaeopress.

Kneisel, J. and Schaefer-Di Maida, S. 2019. Loom weights in Bronze Age central Europe. In S. Sabatini and S. Bergerbrant (eds), *The textile revolution in Bronze Age Europe. Production, specialisation, consumption,* 80-116. Cambridge: Cambridge University Press.

Knight, M., Ballantyne, R., Robinson Zeki, I. and Gibson, D. 2019. The Must Farm pile-dwelling settlement. *Antiquity* 93, 645-63.

Kristiansen, K. 1979. The consumption of wealth in Bronze Age Denmark. A study in the dynamics of economic processes in tribal societies. In C. Paludan-Müller and K. Kristiansen (eds), *New directions in Scandinavian archaeology*, 158-90. Copenhagen: National Museum of Denmark.

Kristiansen, K. 1985a. Early Bronze Age burial finds. In K. Kristiansen (ed.), *Archaeological formation processes*. *The representativity of archaeological remains from Danish prehistory*, 116-28. Copenhagen: National Museum of Denmark.

Kristiansen, K. 1985b. Bronze hoards from the Late Neolithic and Early Bronze Age. In K. Kristiansen (ed.), *Archaeological formation processes*. *The representativity of archaeological remains from Danish prehistory*, 129-41. Copenhagen: National Museum of Denmark.

Kristiansen, K. 2016. Interpreting Bronze Age trade and migration. In E. Kiriatzi and C. Knappett (eds), *Human mobility and technological transfer in the prehistoric Mediterranean,* 154-81. Cambridge: Cambridge University Press.

Kristiansen, K. 2018a. Warfare and the political economy: Europe 1500-1100 BC. In C. Horn and K. Kristiansen (eds), *Warfare in Bronze Age society*, 23-46. Cambridge: Cambridge University Press.

Kristiansen, K. 2018b. The rise and fall of Bronze Age societies in Thy, northwest Jutland. In J.-H. Bech, B.V. Eriksen and K. Kristiansen (eds), *Bronze Age settlement and land-use in Thy, northwest Denmark 1*, 107-32. Højbjerg: Jutland Archaeological Society, Aarhus University Press.

Kristiansen, K. 2018c. The Rise of Bronze Age peripheries and the expansion of international trade 1950-1100 BC. In K. Kristiansen, T. Lindkvist and J. Myrdal (eds), *Trade and civilisation. Economic networks and cultural ties, from prehistory to the Early Modern Era*, 87-113. Cambridge: Cambridge University Press.

Kristiansen, K. 2018d. Theorizing trade and civilisation. In K. Kristiansen, T. Lindkvist and J. Myrdal (eds), *Trade and civilisation. Economic networks and cultural ties, from prehistory to the Early Modern Era*, 1-24. Cambridge: Cambridge University Press.

Kristiansen, K. and Earle, T. 2015. Neolithic versus Bronze Age social formations: a political economy approach. In K. Kristiansen, L. Šmejda and J. Turek (eds), *Paradigm found. Archaeological theory. Present, past and future. Essays in honour of Evžen Neustupný,* 234-47. Oxford: Oxbow Books.

Kristiansen, K. and Larsson, T.B. 2005. *The rise of Bronze Age society. Travels, transmission and transformations.* Cambridge: Cambridge University Press.

Kristiansen, K. and Sørensen, M.L.S. 2019. Wool in the Bronze Age: concluding reflections. In S. Sabatini and S. Bergerbrant (eds), *The textile revolution in Bronze Age Europe. Production, specialisation, consumption,* 317-32. Cambridge: Cambridge University Press.

Kristiansen, K. and Suchowska-Ducke, P. 2015. Connected histories: the dynamics of Bronze Age interaction and trade 1500-1100 BC. *Proceedings of the Prehistoric Society* 81, 361-92.

Kristiansen, K., Melheim, L., Bech, J.-H., Mortensen, M.F. and Frei, K.M. 2020. Thy at the crossroads: a local Bronze Age community's role in a macro-economic system. In K.I. Austvoll, M. Hem Eriksen, P.D. Fredriksen, L. Melheim, L. Prøsch-Danielsen and L. Skogstrand (eds), *Contrasts of the Nordic Bronze Age: essays in honour of Christopher Prescott*, 269-82. Turnhout: Brepols.

Larsen, M.T. 2015. *Ancient Kanesh. A merchant colony in Bronze Age Anatolia.* Cambridge: Cambridge University Press.

Ling, J., Earle, T. and Kristiansen, K 2018. Maritime mode of production. Raiding and trading in seafaring chiefdoms. *Current Anthopology* 59, 515-16.

Ling, J., Hjärthner-Holdar, E., Grandin, L., Stos-Gale, Z., Kristiansen, K., Melheim, A.L., Artioli, G., Angelini, I., Krause, R. and Canovaro, C. 2019. Moving metals IV: swords, metal sources and trade networks in Bronze Age Europe. *Journal of Archaeological Science: Reports* 26, 1-34.

Malmros, C. 2018. Ressource problems in a treeless cultural landscape. Investigations of building timbers and charcoal from the Bronze Age settlements at Bjerre Enge. In J.-H. Bech, B.V. Eriksen and K. Kristiansen (eds), *Bronze Age settlement and land-use in Thy, northwest Denmark 1*, 231-50. Højbjerg: Jutland Archaeological Society, Aarhus University Press.

Marciniak, A. and Greenfield, H. 2013. A zooarchaeological perspective on the origin of metallurgy in the North European Plain: butchering marks on bones from central Poland. In S. Bergerbrant and S. Sabatini (eds), *Counterpoint: essays in archaeology and heritage studies in honour of Professor Kristian Kristiansen*, 457-67. Oxford: Archaeopress.

Melheim, L. [+ 9 others] and Kristiansen, K. 2018. Moving metals III. Possible origins for copper in Bronze Age Denmark based on lead isotopes and geochemistry. *Journal of Archaeological Science* 96, 85-105.

Meller, H. 2019. Princes, armies, sanctuaries. The emergence of complex authority in the central German Únětice culture. *Acta Archaeologica* 90, 39-79.

Menotti, F. and Leuzinger, U. 2013. Houses and domestic life in the circum-Alpine region in the Bronze Age. In M. Madella, G. Kovács, B. Kulcsarne-Berzsenyi and I.B. Godino (eds), *The archaeology of household*, 131-58. Oxford: Oxbow Books.

Mikkelsen, M. 2018. The Bronze Age settlement at Aas, eastern Thy, Denmark. In J.-H. Bech, B.V. Eriksen and K. Kristiansen (eds), *Bronze Age settlement and land-use in Thy, northwest Denmark 2*, 477-504. Højbjerg: Jutland Archaeological Society, Aarhus University Press.

Mikkelsen, M. and Kristiansen, K. 2018. Legaard. With contributions from B. Draiby and T. Earle. In J.-H. Bech, B.V. Eriksen and K. Kristiansen (eds), *Bronze Age settlement and land-use in Thy, northwest Denmark 2*, 505-38. Højbjerg: Jutland Archaeological Society, Aarhus University Press.

Mittnik, A. [+ 22 others] and Krause, J. 2019. Kinship-based social inequality in Bronze Age Europe. *Science* 366, 731-34.

Molloy, B. and Horn, C. 2020. Weapons, warriors and warfare in Bronze Age Europe. In G.G. Fagan, L. Fibiger, M. Hudson and M. Trundle (eds), *The Cambridge world history of violence. The prehistoric and ancient worlds*, 117-41. Cambridge: Cambridge University Press.

Molloy, B., Jovanović, D., Bruyère, C., Marić, M., Bulatović, J., Mertl, P., Horn, C., Milašinović, L. and Mirković-Marić, N. 2020. A new Bronze Age mega-fort in southeastern Europe: Recent archaeological investigations at Gradište Iđoš and their regional significance. *Journal of Field Archaeology* 45, 293-314.

Monroe, C.M. 2009. *Scales of fate. Trade, tradition, and transformation in the eastern Mediterranean ca. 1350-1175 BCE.* Münster: Ugarit-Verlag.

Müller, J. 2015a. Eight million Neolithic Europeans: social demography and social archaeology on the scope of change – from the Near East to Scandinavia. In K. Kristiansen, L. Šmejda and J. Turek (eds), *Paradigm found. Archaeological theory. Present, past and future. Essays in honour of Evžen Neustupný*, 200-15. Oxford: Oxbow Books.

Müller, J. 2015b. Bronze Age social practices: demography and economy. Forging long-distance exchange. In P. Suchowska-Ducke, S. Scott Reiter and H. Vandkilde (eds), *Forging identities. The mobility of culture in Bronze Age Europe 1*, 231-36. Oxford: British Archaeological Reports.

Müller, J. and Diachenko, A. 2019. Tracing long-term demographic changes: The issue of spatial scales. *PLoS ONE 14*: e0208739.

Müller, J., Hofmann, R., Brandtstätter, L., Ohlrau, R. and Videiko, M. 2016. Chronology and demography: how many people lived in a mega-site? In J. Müller, K. Rassmann and M. Videiko (eds), *Trypillia mega-sites and European prehistory 4100-3400 BCE*, 133-70. London, New York: Routledge.

Münster, A. [+ 16 others] and Alt, K.W. 2018. 4000 years of human dietary evolution in central Germany, from the first farmers to the first elites. *PLoS ONE* 13: e0194862.

Nikulka, F. 2016. *Archäologische Demographie. Methoden, Daten und Bevölkerung der europäischen Bronze- und Eisenzeiten.* Leiden: Sidestone Press.

Nørgaard, H.W. 2017. Bronze Age metal workshops in Denmark between 1500-1300 BC: elite-controlled craft on Zealand. In S. Bergerbrant and A. Wessman (eds), *New perspectives on the Bronze Age. Proceedings of the 13th Nordic Bronze Age symposium held in Gothenburg 9th to 13th June 2015*, 127-52. Oxford: Archaeopress.

Nørgaard, H.W. 2018. *Bronze Age metalwork. Techniques and traditions in the Nordic Bronze Age 1500-1100 BC*. Oxford: Archaeopress.

O'Brien, W. 2015. *Prehistoric copper mining in Europe, 5500-500 BC*. Oxford: Oxford University Press.

Poulsen, M.E. 2017. Continuity and change in settlement from LN II to EBA II. New results from a southern Jutland inland region. In S. Bergerbrant and A. Wessman (eds), *New perspectives on the Bronze Age. Proceedings of the 13th Nordic Bronze Age symposium held in Gothenburg 9th to 13th June 2015*, 203-17. Oxford: Archaeopress.

Price, T.D., Frei, R., Brinker, U., Lidke, G., Terberger, T., Frei, K.M. and Jantzen, D. 2017. Multi-isotope proveniencing of human remains from a Bronze Age battlefield in the Tollense Valley in northeast Germany. *Archaeological and Anthropological Sciences* 11, 33-49.

Prøsch-Danielsen, L., Prescott, C. and Holst, M.K. 2018. Economic and social zones during the Late Neolithic/Early Bronze Age in Jæren, southwest Norway. Reconstructing large-scale land-use patterns. *Praehistorische Zeitschrift* 93, 48-88.

Radivojević, M. [+ 12 others] and Broodbank, C. 2019. The provenance, use, and circulation of metals in the European Bronze Age: the state of debate. *Journal of Archaeological Research* 27, 131-85.

Rascovan, N., Sjögren, K.-G., Kristiansen, K., Nielsen, R., Willerslev, E., Desnues, C. and Rasmussen, S. 2019. Emergence and spread of basal lineages of Yersinia pestis during the Neolithic decline. *Cell* 176, 295-305.

Rasmussen, M. 2017. Time warps and long-term structures: images of Early Bronze Age landscape organisation in south-west Denmark. In S. Bergerbrant and A. Wessman (eds), *New perspectives on the Bronze Age. Proceedings of the 13th Nordic Bronze Age symposium held in Gothenburg 9th to 13th June 2015*, 177-86. Oxford: Archaeopress.

Risch, R. 2016. How did wealth turn into surplus profit? From affluence to "scarcity" in prehistoric economies. In H. Meller, H.P. Hahn, R. Jung and R. Risch (eds), *Rich and poor – competing for resources in prehistoric societies. 8. Mitteldeutscher Archäologentag vom 22. bis 24. Oktober 2015 in Halle (Saale),* 33-48. Halle: Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt, Landesmuseum für Vorgeschichte.

Roberts, N., Woodbridge, J., Palmisano, A., Bevan, A., Fyfe, R. and Shennan, S. 2019. Mediterranean landscape change during the Holocene: synthesis, comparison and regional trends in population, land cover and climate. *The Holocene* 29, 923-37.

Sabatini, S. 2019. Weaving in Bronze Age Italy: the case of the Terramare settlement at Montale. In S. Sabatini and S. Bergerbrant (eds), *The textile revolution in Bronze Age Europe. Production, specialisation, consumption*, 39-79. Cambridge: Cambridge University Press.

Sabatini, S., Earle, T. and Cardarelli, A. 2018. Bronze Age textile and wool economy: the case of the Terramare site of Montale, Italy. *Proceedings of the Prehistoric Society* 84, 359-85.

Sandars, N. 1978. *The Sea Peoples. Warriors of the ancient Mediterranean 1250-1150 BC*. London: Thames & Hudson.

Schauer, P. 1971. *Die Schwerter in Süddeutschland, Österreich und der Schweiz I (Griffplatten-, Griffangel- und Griffzungenschwerter)*. München: C.H.Beck.

Shennan, S., Downey, S.S., Timpson, A., Edinborough, K., Colledge, S., Kerig, T., Manning, K. and Thomas, M.G. 2013. Regional population collapse followed initial agriculture booms in mid-Holocene Europe. *Nature Communications* 4, 2486.

Sørensen, M.L.S. 2010. Households. In T. Earle and K. Kristiansen (eds), *Organizing Bronze Age societies. The Mediterranean, central Europe and Scandinavia compared*, 122-54. Cambridge: Cambridge University Press.

Sörman, A. 2018. *Gjutningens arenor. Metalhantverkets rumsliga, sociala och politiska organisation i södra Skandinavien under bronsåldern.* PhD dissertation, University of Stockholm.

Sörman, A. 2019. Casting in the longhouse. The organisation of metalworking in Late Bronze Age settlements in south-eastern Sweden. *Current Swedish Archaeology* 27, 143-89.

Sparrevohn, L.R., Kastholm, O.T. and Nielsen, P.O. (eds) 2019. *Houses for the living. Two-aisled houses from the Neolithic and Early Bronze Age in Denmark.* Copenhagen: The Royal Society of Northern Antiquaries, University Press of Southern Denmark.

Terberger, T., Jantzen, D., Krüger, J. and Lidke, G. 2018. Das bronzezeitliche Kampfgeschehen im Tollensetal – ein Großereignis oder wiederholte Konflikte? In S. Hansen and R. Krause (eds), *Bronzezeitliche Burgen zwischen Taunus und Karpaten*. 103-23. Bonn: Rudolf Habelt.

Tornberg, A. 2018. *Health, cattle and ploughs. Bioarchaeological consequences of the secondary products revolution in southern Sweden, 2300-1100 BCE.* PhD dissertation, University of Lund.

Valtueña, A. [+ 21 others] and Krause, J. 2017. The Stone Age plague and its persistence in Eurasia. *Current Biology* 27, 3683-91.

Van Amerongen, Y.F. 2016. *Wild West Frisia. The role of domestic and wild resource exploitation in Bronze Age subsistence.* Leiden: Leiden University Press.

Vandkilde, H. 2014. Breakthrough of the Nordic Bronze Age: transcultural warriorhood and a Carpathian crossroad in the sixteenth century BC. *European Journal of Archaeology* 17, 602-33.

Vandkilde, H. 2016. Bronzization: the Bronze Age as pre-modern globalization. *Praehistorische Zeitschrift* 91, 103-23.

Vandkilde, H. 2017. *The metal hoard from Pile in Scania, Sweden. Place, things, time, metals, and worlds around 2000 BCE.* Aarhus: Aarhus University Press, The Swedish History Museum.

Williams, R.A. and Le Carlier de Veslud, C. 2019. Boom and bust in Bronze Age Britain: major copper production from the Great Orme mine and European trade, c. 1600-1400 BC. *Antiquity* 93, 1178-96.

Bloody warriors?

The Tollense valley conflict and its relation to the Baltic Sea region

Detlef Jantzen, Gundula Lidke

Thousands of young men fighting a bloody battle at the Tollense river (Figure 1) in the Early Bronze Age is a fascinating idea. In the public perception, the "battlefield in the Tollense valley" has therefore become one of the most exciting archaeological sites in Germany (Figure 2). The great public interest has not gone unnoticed by the scientific community and has spurred them on to new, exciting discoveries and interpretations. However, it is worth taking a critical look at supposed certainties at regular intervals. "We are following all lines of enquiry" is not only a platitude from police work, but also a warning that both science and the public need to take seriously. We must always look for other possibilities of interpretation besides the apparently safe, intuitive and immediately plausible explanations (Figure 3).

Conflict: yes, but in what context?

The conviction that the sites in the Tollense valley – mainly characterised by disarticulated skeletal remains of currently more than 140 individuals and a handful of horses – are the remains of a major violent conflict has now become accepted almost everywhere. Initial doubts as to whether the sites might represent traces of a cemetery or the consequences of deadly rituals performed over longer periods of time have been largely dispelled[1]. This is a result of the research conducted in the Tollense valley from 2009 to 2016 with funding from the German Research Foundation (DFG), which led to a number of publications[2] by the project group that provided convincing arguments for the scenario of a major violent conflict limited to a short period of time (for a general overview see Jantzen *et al.* 2014; for recent discussions see Lidke *et al.* 2018; 2019).

There is also a broad consensus that the event has to be seen in a supra-regional context and permits conclusions to be drawn about the cultural and economic conditions in a wider area. In this context, four factors in particular are of importance: the transport geography, the origin of the individuals, the origin or cultural affinities of the goods and weapons found in the Tollense valley, and finally the phenomenon of "conflict" as an aspect of culture. These will now be discussed in turn, with a view to presenting possible alternative readings which fit the evidence as well as the generally voiced interpretation of a pitched battle between rival and possibly semi-professional armies.

Transport geography

The place of conflict in the Tollense valley was connected to both waterways and overland routes. To the north, the Tollense river provides a direct connection to the Baltic via the Peene river, to the south it forms a natural connection to the inland waterways, only

1 Criticism of the interpretation as a battlefield has recently been formulated above all by H. Peter-Röcher (2018, 76).

2 An overview of the published literature can be found at https://www.kulturwerte-mv.de/Landesarchaeologie/Forschung/Tollensetal%E2%80%93Projekt/#veroeffentlichungen

In D. Hofmann, F. Nikulka and R. Schumann (eds) 2022. *The Baltic in the Bronze Age. Regional patterns, interactions and boundaries*, Leiden: Sidestone Press, pp. 345-354.

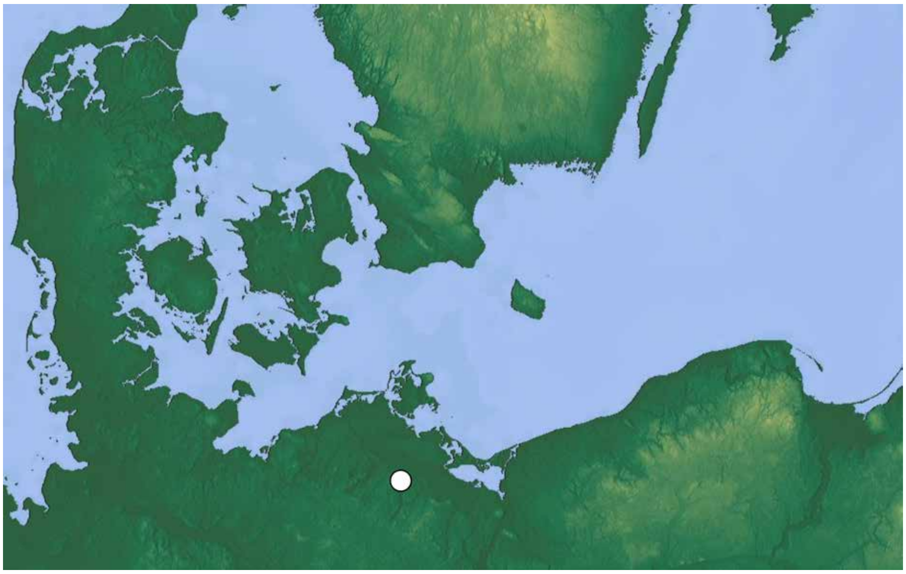


Figure 1: The location of the site in the Tollense valley. Map: R. Schumann based on maps-for-free.com.

interrupted by a stretch of about 13 km (as the crow flies) between lake Tollense and the river Havel. The waterway network has always been assumed to be of importance for long-distance trade, simply because of the relative ease with which even heavy loads can be transported, even if the rivers were certainly shallower and more meandering in the Bronze Age; the archaeological data (Kristiansen and Suchowska-Ducke 2015) also generally seem to support this hypothesis.

The extent of the network of land roads is as yet unknown. In the Tollense valley, this aspect became immediately visible through a valley crossing in the form of a sand embankment supported with wood and in places also stones, which was built around 1900 BC and existed at least until around 1200 BC. The mere fact that at least sections of a professionally developed road network existed (Jantzen *et al.* 2014) is remarkable.

The discovery of the Bronze Age valley crossing – perhaps one of several – also provided a possible explanation for why the conflict took place here in particular: taking into account the topography of the wide, marshy valley with its relatively steep slopes, such an interface between land and water transport network appears to be a plausible site for a violent event, especially under the assumption that a conflict party familiar with the area could take advantage of the topography. However, the relatively clear picture ends rather abruptly on the slopes of the Tollense valley; the settlement structure and density outside the valley is still unclear.

Origin of individuals

The strontium isotope analyses carried out so far mainly provide the insight that the dead from the Tollense valley are a potentially very heterogeneous group. On the basis of bones of small animals with restricted foraging ranges, it is possible to determine a local strontium range that corresponds to the values of some human individuals, but it is unclear how large the region is in which this “local” isotope ratio applies (Price *et al.* 2017; 2019). In the glacial landscapes of the north German lowlands and adjacent areas, a more precise delimitation is certainly difficult if not impossible.

According to the strontium isotope ratios, individuals from southern Germany, the Eifel, the French Massif Central, Bohemia or central or northern Scandinavia may be among the “non-locals” (Price *et al.* 2017). However, a reliable determination is not possible here either. The same is true for the horses from the Tollense valley. One of the individuals is apparently local, another apparently of non-local origin.

Regarding the strontium isotope analyses performed so far, it must also be noted self-critically that the investigations did not differentiate between the values of the molars M1

Figure 2: A large number of people were killed in the Tollense valley. Their disarticulated remains have been preserved due to the fact that they were embedded in peat. Photo: G. Lidke.

Figure 3: Close-up of one of the deceased individuals. Photo: S. Sauer.

and M3, i.e. no statements can be made as to whether the examined individuals changed their residence area in childhood or adolescence. The strontium values therefore only provide the insight that this is a heterogeneous group of people and that this can also be demonstrated for the horses.

Origin or cultural affinities of goods and weapons

Some of the metal objects found in the Tollense valley have come a long way. This is true for the tin rings (Krüger *et al.* 2012), as well as for the "Bohemian" palstave (Dombrowsky 2017, 147-48) and the Riegsee sword (Schmidt 2016), and possibly also for some of the "box fittings" (Uhlig *et al.* 2019). However, this phenomenon applies to large parts of Bronze Age northern Europe, the material culture of which is characterised by the seemingly self-evident presence of imported metal objects. Ultimately, the entire northern European metal culture is based on the import of enormous quantities of copper and tin, most probably from the east Alpine region. A more detailed examination of the metal finds from the Tollense valley, which would allow a statement as to whether they reflect specific contacts that are not or not so easily grasped elsewhere, is still pending.

On a somewhat larger scale, the Tollense area in period III (c. 1300-1100 BC) is located at the eastern edge of the Mecklenburg Group, which is distinguished from the neighbouring cultural areas by a number of stylistic peculiarities (sloping ladder bands, lattice-hatched zones as decorative elements on metal dress items; see Schmidt 2007, 80). The grave finds of the Mecklenburg Group show a remarkable range, from very rich assemblages with goods imported from extremely long distances (silk; Scherping and Schmidt 2007), gold objects (gold brooches, gold rings; Schmidt 2013) and weapons (swords) to extremely sparsely furnished graves (Endrigkeit 2014, 48).

It remains to be seen to what extent these grave assemblages reflect real wealth or power relations, or whether those buried with weapons actually used them during their lifetime, rather than the weapons simply conveying a certain image of the deceased[3] (Anderson 2018, see also the discussion in Fyllingen 2006, 325). The key point for our present argument is that the imported goods show that the people living in the region had access to long-distance trade items. In this context, reference must also be made once again to the extremely rich set of female dress items from the Neustrelitz hoard, accumulated over a long period of time, which were not classified as personal possessions and thus not as personal wealth, but as "regalia" used for representational purposes (Jantzen and Schmidt 1999). The glass beads of the Neustrelitz hoard are again related to long-distance trade, the possible areas of origin are Mesopotamia or Egypt (Mildner *et al.* 2009; Varberg *et al.* 2016). The oldest piece of the assemblage, a heavily worn and repaired belt disc of Nordic type, however, shows that prestige goods from the core zone of the Nordic Bronze Age were also known and appreciated.

The phenomenon of "conflict" as an aspect of culture

The prospect of being faced with a conflict of such magnitude that the only comparison for this period is the historically attested Battle of Kadesh in present-day Syria undoubtedly raises the question of whether there could also be a comparable cultural background. It is at least to be conjectured that not only goods but also information could be exchanged over great distances; this in turn makes it plausible that cultural concepts, which unfortunately include war (in the sense of large-scale, organised conflicts between armed groups), were also spread along these lines (Hansen 2015, 208).

If the conflict in the Tollense valley is indeed a battle or even relates to a war, then we could also hypothesise that there were corresponding power structures in the background, pursuing wider interests and strategic considerations. In fact, there is much to be said for this assumption. But at this point, a clear demarcation of secure knowledge from intuitive "certainties" is also necessary. The idea of an invading army "from the south"[4] is more likely among the latter.

However, archaeological research has been able to convincingly demonstrate that elites are to be expected in the Bronze Age Mecklenburg Group. These elites had access to long-distance trade as far away as the eastern Alps and the Mediterranean (silk, glass beads, bronze cups), but were also well connected to the north and shared a preference for certain prestige goods (gold objects; see also Kaul 2014, swords, belt discs, glass beads) with the elites there.

Against this background, an exchange of ideas and cultural concepts seems almost imperative[5]. Disputes over transport routes, trade routes, areas of influence – all this is conceivable against this background, right up to highly organised communities that are

---

3 This issue has for instance been addressed through use-wear analyses, see e.g. Horn and Karck 2019.

4 See e.g. the WELT headline on 16.10.2019: "Die Invasoren kamen womöglich doch aus dem Süden" [The invaders might have come from the south after all].

5 On the role of mobile groups in the exchange of raw materials, goods and innovations see also Spengler *et al.* 2014.

capable of mobilising large crowds of people to assert their interests. Period III is also a time of cultural change, probably economically unstable at times and therefore rich in conflict (Kristiansen and Suchowska-Ducke 2015, 376). This does not necessarily mean, of course, that conflicts in the north had to follow the same pattern and organisational background as the Battle of Kadesh.

Conclusion

That a major violent conflict took place in the Tollense valley is largely undisputed. However, some questions which are important for the classification of the conflict in a supra-regional context could not yet be clarified. This means we should not yet narrow our view to one or a few interpretations. In addition to the intensively discussed relations to the south or south-east, there are also indications of links to the Baltic Sea region. This has implications for the interpretation of the conflict, as will be further explored below. First of all, however, it is necessary to take another critical look at previous interpretations of the supposed conflict.

Dead individual = warrior?

Where a major violent conflict has taken place, the question inevitably arises as to whether those killed were warriors (Terberger *et al.* 2014). This is first of all a value-free hypothesis in need of further corroboration. One option to pursue this would be to examine the equipment of the killed. This option does not exist in the Tollense valley, because none of the victims can be assigned any personal (weapon) equipment, probably due to looting after the conflict.

The "warrior hypothesis" can therefore only be tested on the basis of the skeletal material that was recovered in large quantities. It reveals which signs of physical stress the individuals show and whether these indicate an "activity" consistent with a regularly training and occasionally fighting warrior. Only when this has been demonstrated with sufficient probability can it be argued that those killed were warriors. Results so far do not support this interpretation. The osteoarchaeological investigations have shown musculo-skeletal markers indicating that the victims were individuals with a comparable routine activity level, possibly including moving on foot for long distances and/or carrying/lifting heavy weights rather than trained swordsmen, lancers, archers or close combatants (Lidke *et al.* 2019, 46-48). Also, the previous injuries they exhibit are often unspecific (even though there are also weapon-related ones; Brinker *et al.* 2015, 349). Together with the fact that the finds situation so far provides no information about the armament of the "defeated" party in the conflict, it even seems possible (if unlikely) that this party was not armed at all.

Many victims – but also a battle?

If so far there is no evidence that the dead were trained as "professional" warriors in a modern sense and no evidence that they were armed, the scenario of a well-organised battle in which two or more "professional" conflict parties took up arms against each other loses some of its persuasive power. Instead, these observations point to another scenario that has already been discussed, namely an attack. The topography in the Tollense valley offers good conditions for this: a treeless, swampy valley, which could probably only be crossed at certain points, with – for northern German conditions – relatively steep slopes. Anyone in the valley has only few possibilities to avoid an attack. This is especially true for larger groups, which are an easy target in this landscape. High casualty figures can therefore be easily reconciled with this scenario, while the number of attackers does not necessarily have to be the same or similarly high.

People only needed to stay in the valley if they wanted to cross it or move along or on the river. Potential attackers, on the other hand, could expect that both the river and the river crossing were regularly frequented; in this respect these were predestined places for an attack.

Who were the dead?

These considerations lead back to the question of who the victims were. The realisation that the stress markers on these individuals, in connection with their rather gracile physiques, do not directly indicate professional warriors, raises fundamentally new questions:

- On what occasion did a large group, made up exclusively or almost exclusively of men, most of whom were perhaps used to carrying heavy loads over long distances, come together?
- How can the relatively homogeneous age structure (with only some few older and younger individuals) and the regionally heterogeneous origin of the individuals be explained?
- For what reason was this group present in the Tollense valley?
- And for what reason was it attacked there?

A conclusive explanation could be precisely the carrying of heavy loads over long distances. It is undisputed that there was extensive long-distance trade in the Bronze Age. However, opinions differ widely as to the details of how it was conducted north of the Alps, which is not surprising given the extremely poor sources[6]. It is possible, however, that the site in the Tollense valley can help to close this gap.

A relationship between the place of conflict in the Tollense valley and long-distance trade is already evident from the transport geography (see above). The presence of exceptional long-distance trade goods in the region is impressively demonstrated, for example, by the Neustrelitz hoard. At the same time, the hoard points to the existence of an elite that was able to accumulate goods over long periods of time and thus represent their power. Against this background, the fact that a large group of predominantly young men, perhaps used to carrying heavy loads, were present in the Tollense valley does not appear to be a coincidence.

If one considers them as a kind of caravan that transported trade goods over long distances, the regionally diverse origins can also be explained: new "followers" can join a caravan on the way, and it is not a disadvantage to have people from different regions who know the routes and speak the various languages. Of course, a caravan can also include armed forces to protect the load bearers and the trade goods. Even though it is relatively difficult to get an idea of the safety of travelling under Bronze Age conditions[7], there is much to be said for such an assumption. However, it cannot be proven because of the particularities of the find situation in the Tollense valley.

In a caravan one can even imagine members of an elite. In any case, the gold rings found in the valley clearly show the presence of an elite (Lidke *et al.* 2015, 345); in the context of a caravan, the idea of long-distance traders who might have used the gold rings for instance as a sort of identification mark comes to mind. Unfortunately, due to the disarticulated find situation it is not possible to connect these items with specific individuals. The precise social composition of the group (e.g. some or many elite members; potential presence of other social groups) thus remains impossible to pinpoint.

The extraordinary finds from the Tollense valley can also be reconciled with this hypothesis. The tin rings, for example, are very much commercial goods, and the extraordinary accumulation of metalworking tools (spout hammers, anvils, beating fist; see Jantzen *et al.* 2014, 16-17; Schmidt 2014) can also be placed in this context. It is even possible that the horses were the commodity or part of the commodities being traded, for instance as payment for imported goods. According to the archaeozoological

6 The situation is different in the Mediterranean region, where written records together with archaeological sources reveal not only the structures of long-distance trade itself, but also the political and diplomatic background (Kristiansen and Suchowska-Ducke 2015, 362).

7 On the dangers of Bronze Age trade in the Mediterranean and the protection of trade routes cf. Kristiansen and Suchowska-Ducke 2015, 366.

Figure 4: Close to one individual's arm bones, a flint arrowhead sits in the soil. It looks like this projectile had penetrated the tissue. Together with other flint and bronze arrowheads discovered among the skeletal remains, this is another indication that the group were attacked by archers (see also Harten-Buga *et al.*, this volume). Photo: G. Lidke.

investigations, they do not show any clear or typical patterns of stress. Maybe they carried loads, maybe not; there is so far no evidence that they were ridden (Benecke and Dräger 2014, 234-35). In any case, they are not to be interpreted as "warhorses"[8].

What does the Tollense valley have to do with the Baltic Sea region?

What conclusions can be drawn from this for the wider Baltic Sea region? One could hypothesise that the men killed in the Tollense valley were part of a caravan, and further that they regularly transported trade goods, perhaps early mature horses among them (Benecke and Dräger 2014, 233), from the southern Baltic Sea area to the eastern Alpine region. From there, they may have returned with metal and other goods, which they had perhaps taken over from caravans ranging further south[9]. In such a case, how could the further, circum-Baltic interaction have proceeded? Which goods could have been the equivalents of metal and luxury goods[10]? What role did sea transport play? After all, the Tollense valley is not directly situated on the land or river route that one would take from the eastern Alps towards Scandinavia. However, the contacts of the Mecklenburg Group in both directions suggest that a part of the trade passed through their territory[11]. In any case, there must have been interfaces between

8 Unfortunately, the study by J. Kveiborg (2018) does not take into account the dating of the horse bones recovered from the Tollense valley; as a result, medieval horses also find their way into the determination of size and stature. The values given by Kveiborg are therefore not applicable to Bronze Age horses from the Tollense valley.

9 In this context, the research on the origin of the "Silk Road" also deserves attention. Apparently, its complex network of paths was successively established around 4,500 years ago by nomadic cattle breeders and subsequently used by other interest groups (e.g. traders organised in caravans) for long-distance travel (Frachetti *et al.* 2017).

10 Cf. the – certainly not exhaustive – enumeration in Kristiansen and Suchowska-Ducke (2015, 367, 369); the almost exclusive focus on amber as a counterpart for the "incredible prosperity" of southern Scandinavia in the Early Bronze Age is not convincing, however.

11 J.-P. Schmidt (2007, 110) had already come to this conclusion: "The […] Mecklenburg cultural group had assumed a mediating role between central Europe and Scandinavia during Period III. It had evidently succeeded in diverting the flow of bronze from central Europe to the north into its own channels" (translation by the authors).

the continental and the circum-Baltic trade network[12]. Perhaps the Tollense valley even is such an interface, where people met regularly to exchange goods.

The interpretation offered here does not call into question that a large-scale violent conflict with a considerable number of victims took place in the Tollense valley. However, this reading could re-evaluate the role of those killed on the basis of the findings that have since become available and comes to the conclusion that there is no reliable evidence of their status as "specialised warriors". The realisation that they may have predominantly been occupied otherwise, namely as travellers on foot and carriers of heavy loads, leads to the "caravan hypothesis"[13] presented here. It can be reconciled without contradiction with the attack scenario (Figure 4), which has been under discussion for some time and according to which a possibly small group of aggressors, who need not be represented in the skeletal assemblage, attacked a larger group of people, who were travelling in the valley or crossing it, from a protected position and involved them in a deadly confrontation. In this scenario, the larger group of people is not a military force, but a caravan made up of people of different origins, different functions and different statuses, who transported trade goods over long distances – but possibly also included armed individuals.

The picture that emerges is no less fascinating, on the contrary: it shows the events in the Tollense valley intersect with Bronze Age long-distance trade and at the same time provides an idea of how this long-distance trade might have been organised.

Bibliography

Anderson, K. 2018. Becoming the warrior: constructed identity or functional identity? In C. Horn and K. Kristiansen (eds), *Warfare in Bronze Age society*, 213-28. Cambridge: Cambridge University Press.

Benecke, N. and Dräger, J. 2014. Ergebnisse der archäozoologischen Untersuchungen. In D. Jantzen, J. Orschiedt, J. Piek and T. Terberger (eds), *Tod im Tollensetal. Forschungen zu den Hinterlassenschaften eines bronzezeitlichen Gewaltkonfliktes in Mecklenburg-Vorpommern 1*, 233-38. Schwerin: Landesamt für Kultur und Denkmalpflege Mecklenburg-Vorpommern.

Brinker, U., Schramm, A., Flohr, S. and Orschiedt, J. 2015. Die menschlichen Skelettreste aus dem Tollensetal. In H. Meller and M. Schefzik (eds), *Krieg – eine archäologische Spurensuche. Begleitband zur Sonderausstellung im Landesmuseum für Vorgeschichte Halle (Saale) 6. November 2015 bis 22. Mai 2016*, 347-50. Halle (Saale): Landesmuseum für Vorgeschichte in Halle.

Dombrowsky, A. 2017. Der gefiederte Tod in Zeiten des Umbruchs. Bronzene Waffenfunde von der Fundstelle im Tollensetal, Mecklenburg-Vorpommern. In D. Brandherm and B. Nessel (eds), *Phasenübergänge und Umbrüche im bronzezeitlichen Europa. Beiträge zur Sitzung der Arbeitsgemeinschaft Bronzezeit auf der 80. Jahrestagung des Nordwestdeutschen Verbandes für Altertumsforschung*, 143-57. Bonn: Rudolf Habelt.

Endrigkeit, A. 2014. *Älter- und mittelbronzezeitliche Bestattungen zwischen Nordischem Kreis und süddeutscher Hügelgräberkultur. Gesellschaftsstrukturen und kulturhistorische Beziehungen.* Bonn: Rudolf Habelt.

Frachetti, M.D., Smith, C.E., Traub, C.M. and Williams, T. 2017. Nomadic ecology shaped the highland geography of Asia's Silk Roads. *Nature* 543, 193-98.

Fyllingen, H. 2006. Society and the structure of violence: a story told by Middle Bronze Age human remains from central Norway. In T. Otto, H. Thrane and H. Vandkilde (eds), *Warfare and society. Archaeological and social anthropological perspectives*, 319-29. Aarhus: Aarhus University Press.

12 Cf. also Kristiansen and Suchowska-Ducke 2015, 361: "Network of Networks".

13 Surprisingly, the "caravan hypothesis" is not new at all: the term caravan appears for the first time in an article written by Frank Pergande in the FAZ newspaper (Die Erfindung des Kriegs, 27.12.2013). However, it subsequently received little attention.

Hansen, S. 2015. Krieg in der Bronzezeit. In H. Meller and M. Schefzik (eds), *Krieg – eine archäologische Spurensuche. Begleitband zur Sonderausstellung im Landesmuseum für Vorgeschichte Halle (Saale) 6. November 2015 bis 22. Mai 2016*, 205-12. Halle (Saale): Landesmuseum für Vorgeschichte in Halle.

Horn, C. and Karck, T. 2019. Weapon and tool use during the Nordic Bronze Age. *Danish Journal of Archaeology* 8, 1-20.

Jantzen, D. and Schmidt, J.-P. 1999. Ein Hortfund der Periode III aus Neustrelitz, Lkr. Mecklenburg-Strelitz. *Bodendenkmalpflege in Mecklenburg-Vorpommern* 47, 7-127.

Jantzen, D., Orschiedt, J., Piek, J. and Terberger, T. (eds) 2014. *Tod im Tollensetal. Forschungen zu den Hinterlassenschaften eines bronzezeitlichen Gewaltkonflikts in Mecklenburg-Vorpommern. Teil 1: Die Forschungen bis 2011. Beiträge zur Ur- und Frühgeschichte Mecklenburg-Vorpommerns 50*. Schwerin: Landesamt für Kultur und Denkmalpflege.

Jantzen, D., Lidke, G., Dräger, J., Krüger, J. Rassmann, K., Lorenz, S. and Terberger, T. 2014. An early Bronze Age causeway in the Tollense valley, Mecklenburg-Western Pomerania – The starting point of a violent conflict 3300 years ago? *Berichte der Römisch-Germanischen Kommission* 95, 13-49.

Kaul, F. 2014. Bronze Age gold from Denmark. In H. Meller, R. Risch and E. Pernicka (eds), *Metalle der Macht – Frühes Gold und Silber. 6. Mitteldeutscher Archäologentag vom 17. bis 19. Oktober 2013 in Halle (Saale)*, 885-902. Halle (Saale): Landesamt für Denkmalpflege und Archäologie in Sachsen-Anhalt.

Kristiansen, K. and Suchowska-Ducke, P. 2015. Connected histories: the dynamics of Bronze Age interaction and trade 1500-1100 BC. *Proceedings of the Prehistoric Society* 81, 361-92.

Krüger, J., Nagel, F., Nagel, S., Jantzen, D., Lampe, R., Dräger, J., Lidke, G., Mecking, O., Schüler, T. and Terberger, T. 2012. Bronze Age tin rings from the Tollense valley in northeastern Germany. *Prähistorische Zeitschrift* 87, 29-43.

Kveiborg, J. 2018. Traversing sky and earth. The Nordic Bronze Age horse in a long-term perspective. *Prähistorische Zeitschrift* 93, 225-64.

Lidke, G., Terberger, T. and Jantzen, D. 2015. Das bronzezeitliche Schlachtfeld im Tollensetal – Fehde, Krieg oder Elitenkonflikt? In H. Meller and M. Schefzik (eds), *Krieg – eine archäologische Spurensuche. Begleitband zur Sonderausstellung im Landesmuseum für Vorgeschichte Halle (Saale) 6. November 2015 bis 22. Mai 2016*, 337-46. Halle (Saale): Landesmuseum für Vorgeschichte in Halle.

Lidke, G., Jantzen, D., Lorenz, S. and Terberger, T. 2018. The Bronze Age battlefield in the Tollense valley, northeast Germany. Conflict scenario research. In M. Fernández-Götz and N. Roymans (eds), *Conflict archaeology. Materialities of collective violence from prehistory to late Antiquity. Themes in Contemporary Archaeology 5*, 61-68. London/New York: Routledge.

Lidke, G., Brinker, U., Schramm, A., Jantzen, D. and Terberger, T. 2019. Warriors' lives: the skeletal remains sample from the Bronze Age battlefield site in the Tollense valley, north-eastern Germany. In M. dal Corso, W. Kirleis, J. Kneisel, N. Taylor, M. Wieckowska-Lüth and M. Zanon (eds), *How's life? Living conditions in the 2nd and 1st millennia BCE*, 35-56. Leiden: Sidestone.

Mildner, S., Falkenstein, F., Schmidt, J.-P. and Schüssler, U. 2009. Materialanalytische Untersuchungen an ausgewählten Glasperlen des bronzezeitlichen Hortfundes von Neustrelitz, Lkr. Mecklenburg-Strelitz. *Bodendenkmalpflege in Mecklenburg-Vorpommern* 57, 43-63.

Peter-Röcher, H. 2018. Krieg in prähistorischer Zeit: Fakten und Fiktionen. In S. Hansen and R. Krause (eds), *Bronzezeitliche Burgen zwischen Taunus und Karpaten. Bronze Age hillforts between Taunus and Carpathian mountains*, 67-81. Bonn: Rudolf Habelt.

Price, T.D., Frei, R., Brinker, U., Lidke, G., Terberger, T., Frei, K.M. and Jantzen, D. 2017. Multi-isotope proveniencing of human remains from a Bronze Age battlefield in the Tollense valley in northeast Germany. *Archaeological and Anthropological Sciences* 11, 33-49.

Price, T.D., Spicuzza, M.J., Orland, I.J. and Valley, J.W. 2019. Instrumental investigation of oxygen isotopes in human dental enamel from the Bronze Age battlefield site at Tollense, Germany. *Journal of Archaeological Science* 105, 70-80.

Scherping, R. and Schmidt, J.-P. 2007. Seide im Norden – die Textilreste am älterbronzezeitlichen Halskragen von Thürkow, Lkr. Güstrow (Mecklenburg-Vorpommern). *Archäologisches Korrespondenzblatt* 37, 207-20.

Schmidt, J.-P. 2007. Die älterbronzezeitlichen Gräber von Thürkow, Lkr. Güstrow. *Bodendenkmalpflege in Mecklenburg-Vorpommern* 55, 67-118.

Schmidt, J.-P. 2013. Crivitz, Lkr. Ludwigslust-Parchim. Fpl. 53. *Bodendenkmalpflege in Mecklenburg-Vorpommern* 61, 249-50.

Schmidt, J.-P. 2014. Der älterbronzezeitliche Werkzeughort von Golchen, Lkr. Mecklenburgische Seenplatte. In D. Jantzen, J. Orschiedt, J. Piek and T. Terberger (eds), *Tod im Tollensetal. Forschungen zu den Hinterlassenschaften eines bronzezeitlichen Gewaltkonfliktes in Mecklenburg-Vorpommern 1,* 181-90. Schwerin: Landesamt für Kultur und Denkmalpflege Mecklenburg-Vorpommern.

Schmidt, J.-P. 2016. Wodarg, Lkr. Mecklenburgische Seenplatte. Fpl. 3. *Bodendenkmalpflege in Mecklenburg-Vorpommern* 64, 202-03.

Spengler, R., Frachetti, M., Doumani, P., Rouse, L., Cerasetti, B., Bullion, E. and Mar'yashev, A. 2014. Early agriculture and crop transmission among Bronze Age mobile pastoralists of central Eurasia. *Proceedings of the Royal Society B* 281, 20133382.

Terberger, T., Dombrowsky, A., Dräger, A., Jantzen, D., Krüger, J. and Lidke, G. 2014. Professionelle Krieger in der Bronzezeit vor 3300 Jahren? Zu den Überresten eines Gewaltkonfliktes im Tollensetal, Mecklenburg-Vorpommern. In T. Link and H. Peter-Röcher (eds), *Gewalt und Gesellschaft. Dimensionen der Gewalt in ur- und frühgeschichtlicher Zeit. Internationale Tagung an der Julius-Maximilians-Universität Würzburg 14.-16. März 2013,* 93-109. Bonn: Rudolf Habelt.

Uhlig, T., Krüger, J., Lidke, G., Jantzen, D., Lorenz, S., Ialongo, N. and Terberger, T. 2019. Lost in combat? A scrap metal find from the Bronze Age battlefield site at Tollense. *Antiquity* 93, 1211-30.

Varberg, J., Gratuze, B., Kaul, F., Haslund Hansen, A., Rotea, M. and Wittenberger, M. 2016. Mesopotamian glass from Late Bronze Age Egypt, Romania, Germany, and Denmark. *Journal of Archaeological Science* 74, 184-94.

Bronze Age cultural changes, population movements, and the formation of the Proto-Finnic ethnos

Valter Lang

Introduction

The research area for this article covers the modern-day region of Estonia, south-western Finland and northern and north-western Latvia. The period of this study ranges from the end of the Neolithic to the end of the Pre-Roman Iron Age, which according to the Estonian-Finnish-Latvian prehistoric chronologies is c. 2000 BC-AD 1.

In the early fourth millennium BC, this area received strong cultural and demographic impulses from the east European forest belt in the form of the Comb Ceramic (CC) culture. In the early third millennium BC, new groups of people with battle axes and cord-decorated pottery (Corded Ware (CW) culture) arrived from the south or south-east. Both cultural traditions coexisted in the study area until the turn of the third and second millennia BC and after that disappeared completely. The early second millennium BC is rather poor in archaeological sites and finds almost everywhere in the research area. The situation gradually changed during the second part of the second millennium BC. From c. 1500 BC in south-western Finland, c. 1400/1300 BC on the lower reaches of the Daugava river and c. 1200 BC in northern coastal Estonia, monumental above-ground burial mounds emerged (Haggrén *et al.* 2015; Lang 2007a; Vasks *et al.* 2021). These graves were accompanied by cup-marked stones (mostly) in Estonia and Finland, by block-shaped fields in Estonia, and by ship settings in Finland, Estonia and Latvia; grave goods and isolated finds of bronze became more and more numerous. In the early first millennium BC, fortified settlement sites on hilltops were established, soon followed by early *tarand* cemeteries, i.e. burial sites consisting of rectangular enclosures (Lang 2007a; 2018; 2019; 2020).

This is our current knowledge of the sequence of culture development in the research area. The problem here lies not in that this knowledge has changed markedly over time (and will certainly change in future), but in the fact that certain cultural changes have been linked to ethnic (language) changes and to new people settling in this region. In the 1930s and 1950s, the emergence of the CC culture in Finland, Estonia and Latvia was already interpreted as the spread of Finno-Ugrian tribes from the east (Moora 1935; 1958). This interpretation inevitably assumed that the demographic and cultural development after that event had to be continuous (without breaks) until historical times. However, this assumption has long presented serious problems for researchers, at least for two "time windows": the Early Bronze Age and the Pre-Roman Iron Age (see below). Both periods were poor in finds when the theory of continuity was put forward, but they were followed by the emergence of large numbers of sites, new site types and rich finds assemblages.

In D. Hofmann, F. Nikulka and R. Schumann (eds) 2022. *The Baltic in the Bronze Age. Regional patterns, interactions and boundaries*, Leiden: Sidestone Press, pp. 355-372.

Considering all this, the paper will address three inter-connected research questions.

1. Was there really a demographic and cultural continuity during the transition (1a) from the Neolithic to the Bronze Age and (1b) from the Bronze Age to the Early (Roman) Iron Age – as has been previously suggested in Estonian and Latvian archaeology since the mid-1930s (e.g. Jaanits *et al.* 1982; Moora 1935; 1958; Vassar 1943) and in Finnish archaeology since the 1980s (e.g. Meinander 1984; Nuñez 1987; Salo 1984a; 1996)? If there are any reasons to doubt this, then when exactly did any discontinuity happen and what was the context and significance for the prehistory of the region?

2. How do we (re)interpret – in the light of current knowledge – the emergence and subsequent distribution of many new archaeological site types which are common for the entire research area, such as fortified settlements, early *tarand* cemeteries, and mounds with stone cists or ship settings? As usual in the case of such questions, there are in principle two possible answers: these monuments either emerged as a result of internal social and cultural developments (e.g. as a "culture explosion", see Lang 2007a) or they were brought in by newcomers from outside (e.g. Lang 2018; 2020). There can also of course be several gradations between these two extremes.

3. Finally, when did the ancestors of the modern Finnic peoples start living in the northernmost eastern Baltic region and Finland? Where are their archaeological traces?

In brief, after deconstructing arguments for population continuity between the Neolithic and the Bronze Age, I introduce the three major changes that characterise the Estonian archaeological record of the time: the emergence of stone-cist graves, most likely inspired from the west; the building of fortified settlements, with material culture characteristic of more eastern areas; and the establishment of *tarand* graves. By integrating aDNA and linguistic evidence, it can be argued that Estonia saw several episodes of migration and interaction stretching over half a millennium and formed a crossroads between east and west.

The problem of continuity and discontinuity

In arguing for his "continuity theory" – which connected the arrival of Finno-Ugrians to the eastern Baltic and Finland with the emergence of the CC culture in c. 3000 BC (today dated as 3900 BC) – Harri Moora (1935, 28) stated that everywhere in the area of the Neolithic CC culture, further cultural development was continuous, without noticeable breaks, leading to the culture of the historically attested Finno-Ugric peoples. This long line of continuity proposed by Moora still presented some "minor" problems, however. Two periods were identified that were very poor in finds, firstly the (Early) Bronze Age (1a) and secondly the Pre-Roman Iron Age (1b). The former problem with continuity was solved by extending the dates for Neolithic cultural traits (pottery, stone and bone/antler artefacts, burial traditions etc.) well into the Bronze Age. By also assuming that the Late Bronze Age pottery found in fortified settlements, today labelled as south-western Tapiola ware (see below and Figure 5), was the descendant of CC (as both have pit decorations), the demographic and cultural continuity became evident. The latter problem, i.e. the lack of archaeological material from the Pre-Roman Iron Age, was disregarded by arguing that this poverty alone is enough to prove a demographic and cultural continuation from the previous period, which was also poor in finds. Although some new groups were supposed to have settled in the coastal areas at the end of the Bronze Age, erecting and subsequently burying their dead in monumental above-ground stone-cist graves, these graves were assumed to have soon been adopted by the local population. Their date was stretched across the Pre-Roman Iron Age until the Early Roman period, after which the grave form itself was supposed to have been transformed into *tarand* cemeteries that became characteristic of the Roman Iron Age. These supposed close ties between the stone-cist graves and *tarand* cemeteries were meant to prove that the people building and using them shared a common ethnic origin (Moora 1935; Vassar 1938; 1943).

In this way, a continuity lasting over two millennia was constructed for Estonia (and north Latvia) in the 1930s. In Finland, Alfred Hackman (1905) had already developed his "immigration theory" some thirty years earlier. He suggested that the ancestors of the Finns moved from Estonia to south-western Finland in the Roman Iron Age, as evidenced by the construction of *tarand* cemeteries. One of the cornerstones of this theory was that the Pre-Roman Iron Age in Finland was almost devoid of finds, supporting the idea of a break in continuity and the immigration of a new people bringing with them new burial customs and a rich material culture. The development of material culture both in Finland and in the eastern Baltic was considered continuous from the Roman Iron Age onwards by Hackman. As continuity was never questioned for the population (and culture) of Finland from the Stone Age through the Bronze Age (1a), the only discontinuity remaining was in the transition to the Pre-Roman Iron Age (1b).

However, a further century of investigation subsequently developed and strengthened the idea of continuity for the Pre-Roman Iron Age (but not the Early Bronze Age) on both sides of the Gulf of Finland. In 1969 Carl F. Meinander published an article on a *tarand* grave at Dåvits, south-western Finland, which he dated to the Pre-Roman Iron Age. In it he also discussed a number of other finds, including some pottery of the Morby type, that could have belonged to the last few centuries BC. Slowly but steadily the Pre-Roman centuries started to fill with archaeological evidence relating to the continuity of culture and settlement from the Bronze Age to the Roman Iron Age. The whole continuity theory, as understood in Estonia from the 1930s, was subsequently accepted in Finland in the early 1980s (e.g. Meinander 1984; Nuñez 1987; Salo 1984a). In Estonia, it became clear in the early 1990s that the large number of *tarand* cemeteries excavated so far in the northern and western coastal areas should actually be dated to the Pre-Roman Iron Age – and not the (Early) Roman Iron Age as initially suggested. It was established that these early cemeteries form a separate subgroup (subsequently named "early *tarand* cemeteries"), distributed in the coastal areas of Estonia, Finland, eastern central Sweden and north-western Latvia. The monumental *tarand* cemeteries of the Roman Iron Age were classified as "typical *tarand* cemeteries" (Lang 1987; 1996). Later research also proved that the Estonian stone-cist graves must be re-dated to a somewhat earlier period than previously thought, mostly to the Late Bronze Age and earlier part of the Pre-Roman Iron Age. It was also found that for a short period they were in use at the same time as the early *tarand* cemeteries, but not with the typical *tarand* cemeteries of the Roman Iron Age (Laneman 2012; Laneman and Lang 2013; Laneman *et al.* 2015; Lang 1996, 297).

The fate of the continuity/discontinuity debate for the transition from the Neolithic to the Bronze Age (1a) developed differently. With the dendrochronological calibration of radiocarbon samples, it was discovered that all the radiocarbon dates initially assigned to the earlier second millennium BC, once calibrated, turned out to fall into the third millennium instead. However, the radiocarbon dates from the first millennium BC did not get much older, perhaps only a few centuries at most. The result was that a major part of the second millennium BC became very empty in terms of calibrated radiocarbon dates. In Finland, the most noticeable decrease in these dates is in the earlier part of the second millennium BC (the lowest point being around 1700 BC; see Tallavaara *et al.* 2010). In Estonia the situation was almost the same, with no radiocarbon dates at all from c. 1750 to 1500 BC. Unfortunately, there are no data from Latvia.

In Estonia, archaeological sites and finds from the period between 2000/1700 and 1200 BC are extremely rare, even today. It seems that no new pottery styles were developed after the disappearance of late CW and CC at the beginning of the second millennium BC. The number of known settlement sites from this period is extremely small and the burials are almost non-existent (for a few exceptions see Tõrv and Meadows 2015). Isolated finds of bronze items, imported either from Scandinavia or eastern Europe, are quite rare (less than 30). Late stone shaft-hole axes, dated from the end of the Neolithic to the Late Bronze Age, are a bit more numerous (c. 400); yet, in comparison with the thousands of axes from western and southern neighbouring regions (e.g. Lekberg 2002; Vasks 2019), this is really not enough. All these factors imply a demographic crisis, i.e. that a depopulation event almost certainly took place in the area of modern-day Estonia.

The same can almost be said about south-western Finland, although a new pottery style – Kiukainen ware – developed there out of both CC and CW. According to radiocarbon dating from the organic residue on these vessels, this pottery dates between 2500 and 1900 BC. Other dates (taken from charcoal) extracted from the cultural layers of sites mainly containing Kiukainen ware allow this period to be extended to at least 1750 BC (Asplund 2008, 208 and note 88). After this date there seems to be a break in the use of pottery, mirroring the situation in Estonia. This is because the next development in ceramic style – Paimio ware – can hardly be older than the end of the second millennium BC. The number of late stone axes is barely half that found in Estonia, but remarkably the number of Early Bronze Age bronze artefacts is much higher. The main reason for the latter is probably increased contact with Scandinavia from c. 1500 BC onwards, when numerous monumental stone graves were built in the coastal zone of Finland. These graves most likely indicated the arrival of new people from the west (Carpelan 1999; Kivikoski 1961, 92; Meinander 1954; Salo 1984b).

As far as Latvia is concerned, its northern area (up to the Daugava river in the south) faced similar developments to those occurring in Estonia. One exception, however, was evidenced by the presence of so-called Lubāna pottery, which was found in eastern Latvia (around the Lubāns lake) and a few sites in south-eastern Estonia. It has been suggested that this pottery style derives from the late CW and the late CC and was used in the Early Bronze Age (Loze 1979). Such a date is disputable, however. There are no direct radiocarbon dates for this pottery so far, but the calibrated values of two dates taken from one of the settlement sites containing this pottery (Lagaža) fall between 2350 and 1750 BC (see Loze 1979, 107, 121). Also the stone, bone and antler artefacts from the settlement sites containing Lubāna pottery do not differ typologically from those found in other local Late Neolithic sites (Loze 1979, 61-79). This pottery style should therefore be included in the Neolithic / Epineolithic as well, not the Bronze Age. Interestingly, no pottery styles are known in (northern) Latvia from the subsequent centuries until the emergence of fortified settlements in the Late Bronze Age.

In answering the first research question, it is now clear that the development of settlements and their related material culture faced a remarkable setback during the end of the Neolithic and the Early Bronze Age (1a). This setback occurred across a large region, which stretches latitudinally from south-western Finland in the north down to the Daugava river in the south, then also longitudinally from the Baltic Sea coastline in the west to lake Peipus in eastern Estonia. However, in terms of this setback, the eastern border is difficult to establish. There is no evidence of discontinuity in this region for the Pre-Roman Iron Age (1b); quite the opposite: the period is rich in archaeological sites and material culture, witnessing a continuity of settlement, culture, and people since the (Later) Bronze Age.

Estonian stone-cist graves and their communities

The emergence of burial mounds with stone cists suggests that this setback and demographic crisis started to improve around 1500 BC in coastal Finland and around 1200 BC in coastal Estonia. The current evidence indicates that the stone-cist graves in northern Latvia are a few centuries younger (Ciglis and Vasks 2017). Also it is possible that the construction of the huge multi-layered Reznes type barrows (containing hundreds of burials, both within and outside cists) on the lower reaches of the Daugava river had already started during the Middle Bronze Age (Graudonis 1967; Vasks *et al.* 2021). Although differentiated regionally by their construction methods, these barrows still have much in common: they are all round, monumental, above-ground structures, containing central stone-cist constructions for burials (Figures 1 and 2). The existence of

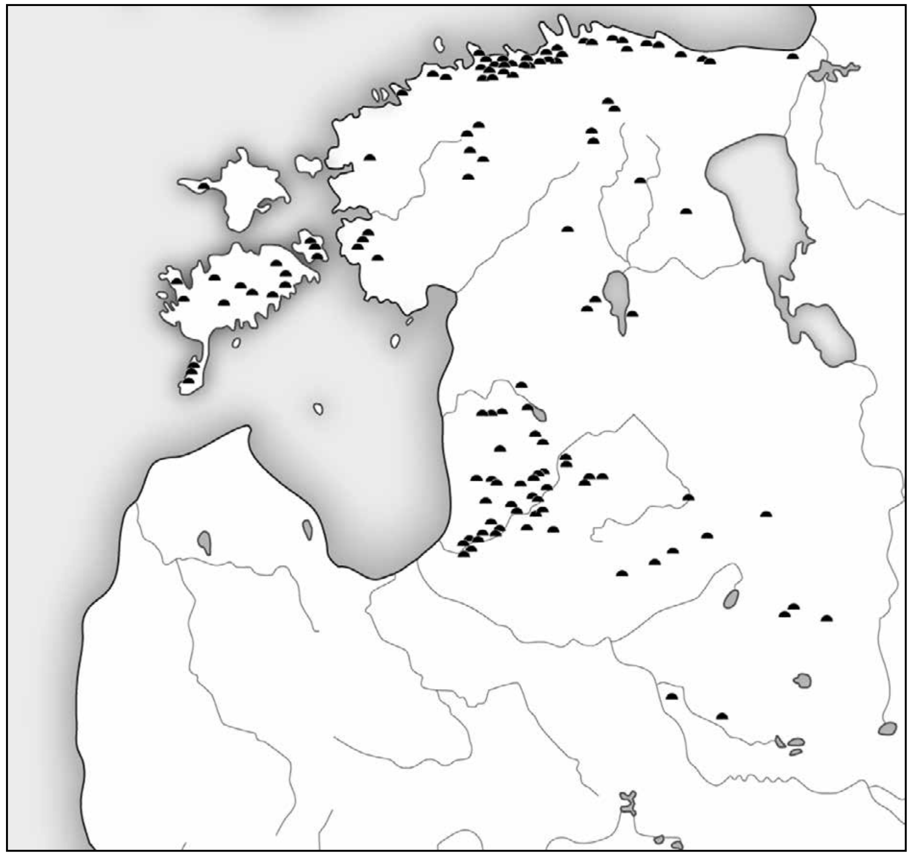


Figure 1. The distribution of stone-cist graves in Estonia and Latvia (Lang 2018, fig. 5.5).

Figure 2. Stone-cist grave I at Rebala, northern Estonia (photo: V. Lang).

cists allows their classification as stone-cist graves. More detailed descriptions of these burial mounds can be found in numerous publications for each country (e.g. Graudonis 1967; Lang 2007a; Meinander 1954); in the following text, I will discuss the results of the latest investigations of Estonian stone-cist graves.

The stone-cist graves in present-day Estonia are mainly distributed around the narrow northern and western coastal areas, including the bigger islands. Conversely they are quite rare in the interior. Recent research into the chronology of these graves (Laneman

2012; Laneman and Lang 2013; Laneman *et al.* 2015) showed that the earliest were erected around 1200/1100 BC, and the latest around 400 BC, but with many of them continuing to be used for burials well after that (until the Middle Ages). The presence of grave goods in these burials is quite rare. When found they typically comprise single decorative bone pins with spade-shaped heads, plain spiral temple ornaments of bronze, razors, tweezers, buttons, etc. (see Lang 2007a, 155-60). Pottery, however, is noticeably missing in the earliest stone-cist graves. It does not appear in burial inventories before the tenth or ninth century BC. When it does appear, it is in the form of a south-western group of Tapiola ware.

Research into the ancient DNA of 16 Bronze Age burials from stone-cist graves (Saag *et al.* 2019) showed a genetic difference between this population and those living in Estonia during the Neolithic. That is to say that the Bronze Age inhabitants differed significantly from both the CC and CW populations. This difference became clearly visible in ADMIXTURE analysis, but was not detected in uniparental lineages, as all Bronze Age males belonged to Y-chromosome haplogroup R1a (R1a1, R1a1'2, R1a1c, R1a1'6), which was also the main haplogroup during the CW culture period. However, the composition of the maternal lines was very varied: H1b2, H1c, K1c1h, K1b2a, J1b1a, J1c2k, J1c4, T1a1b, T2a1b1a1'2, U2e2a1, U3b2a, U4a2b, U5a2a1, U5b1b1, and W6. A clear shift toward west Eurasian hunter-gatherers was noticed among these Estonian samples and they clustered together with Latvian and Lithuanian Bronze Age individuals. The population buried in these Bronze Age stone-cist graves in Estonia was characterised by the light pigmentation of eyes, hair and skin and relatively high lactose tolerance, often associated with modern northern Europeans (incl. Estonians). The discovery of two second-degree relatives among such a limited number of samples (dispersed over 500 years) and from different settlement contexts supports the idea that these graves were built by and for a limited circle of people, possibly an elite (Lang 2011; Saag *et al.* 2019). Unfortunately, there is as yet no genetic evidence for a coastal Estonian population existing separately to these "stone-cist-people".

The similarity of Estonian "stone-cist-people" with Latvian (Ķivutkalns site) and Lithuanian (Turlojiške site) Bronze Age populations (Mittnik *et al.* 2018) is of some interest, as these latter groups did not bury their dead in monumental, above-ground barrows (either stone or sand) containing stone cists. The Ķivutkalns community instead created a flat cemetery of pit graves, located on a hillock, which was later used as a fortified settlement (Denisova *et al.* 1985). According to craniological measurements (Denisova *et al.* 1985), the Ķivutkalns population was rather heterogeneous; at least one part of this community consisted of newcomers, while the rest were most likely locals. The heterogeneity of mitochondrial haplogroups (H1b1, H1b2, H1c, H10a, H28a, J1b1a1, T1a1b, U5a1a1, U5a2a1, U5a1c1) confirms the craniological variability, while the Y-chromosome haplogroups are mostly represented by R1a (R1a1, R1a1a, R1a1a1b) and in one case by R1b1a2 (Mittnik *et al.* 2018). The Turlojiške individuals buried further south in Lithuania either came from pit graves or wetland sacrifices (Merkevičius 2012).

It is reasonable to suggest that the composition of the Estonian "stone-cist" and Ķivutkalns populations was similar in as far as they both consisted of a mix of locals and immigrants. Yet, judging from the new and strange grave type and burial customs appearing in coastal Estonia, one can suppose that these newcomers attained a dominant position here. In order to understand the actual demographic situation of that time, some additional evaluations are needed. Around 800 stone-cist graves have been recorded in Estonia to date. They are located in c. 120-130 groups of varying size. Of course it is not known how many mounds have been destroyed over the centuries, but given that the majority of stone-cist graves are located on thin alvar-type soils[1], considered to have modest agricultural value in later times, one can assume that the number of completely

1 Alvar-type soils are rendzina soils on limestone bedrock, rich in humus, thin and easy to cultivate with primitive tillage tools (such as ards); formations similar to alvar soils are known on the Swedish islands of Öland and Gotland.

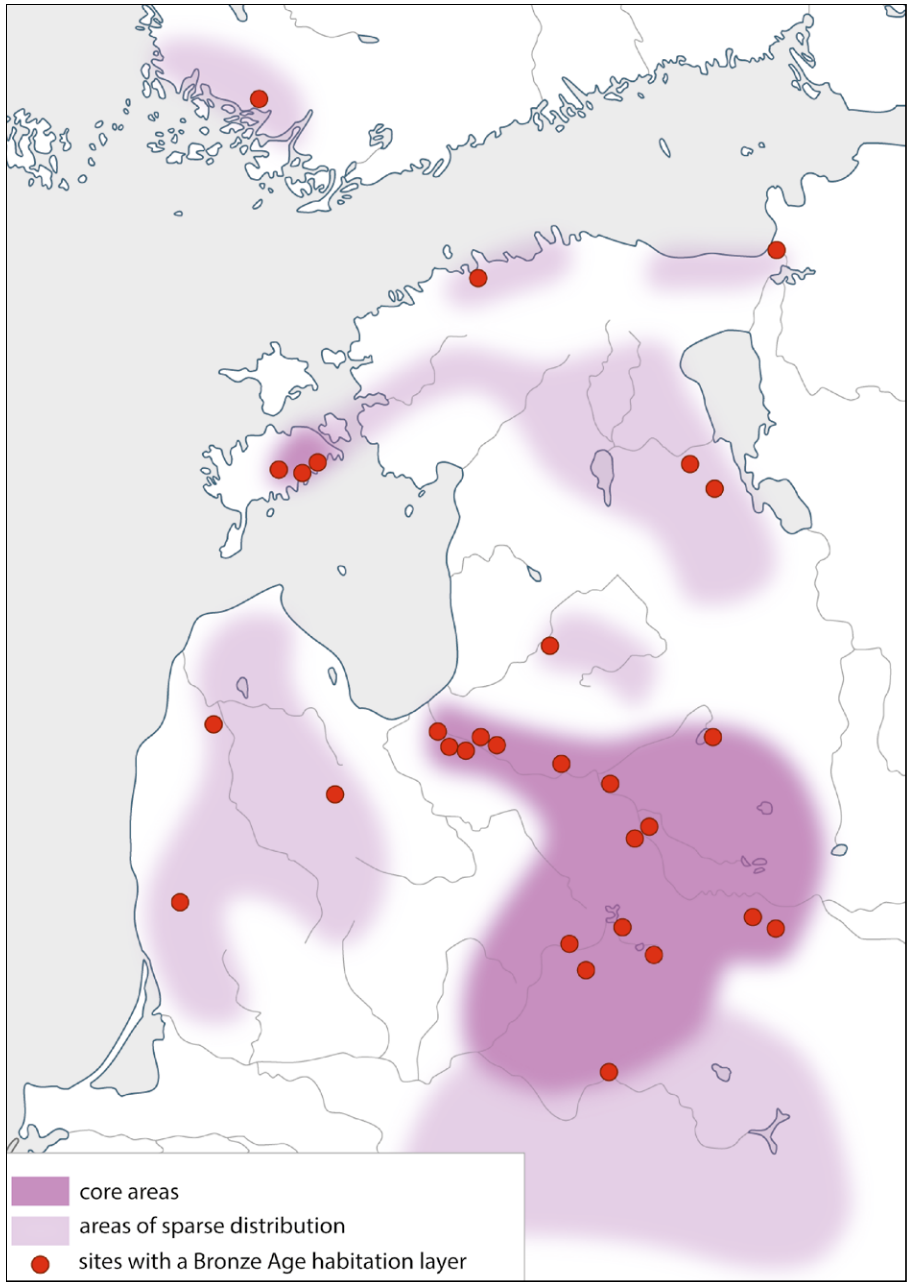


Figure 3. The distribution of fortified settlements and other hilltop sites of the Bronze and Early Iron Ages (map: V. Lang).

destroyed stone-cist graves is rather small, perhaps not larger than the number of remaining ones[2].

According to palaeodemographic calculations and some other considerations (Lang and Ligi 1991), the communities building stone-cist graves in coastal Estonia were most likely single agricultural farms. The length of the stone-cist era was c. 800 years, i.e. c. 30-40 generations (during which c. 1600 graves were built). Therefore, if we proceed from a premise that each farm erected one new grave for every generation, then the average number of contemporary farms involved in the building of stone-cist graves could not be bigger than c. 40-50 for the whole of (coastal) Estonia. In this case, the

2 The preservation effect of alvar soils is also evidenced by the existence of prehistoric field remains – all Bronze and Pre-Roman Iron Age fields found so far in Estonia are located in this soil zone.

average number of people living simultaneously in those farms was only around 400-500 (assuming there were c. 10 people per farm). But the actual numbers were certainly much smaller at the beginning of the stone-cist era and conversely much bigger at the end. The oldest radiocarbon dates so far (reaching back to c. 1200 BC) have only been recorded at two or three sites, which might indicate that the number of first-generation immigrants around 1200 BC did not exceed c. 50-100 people. More people could have arrived later perhaps, and certainly from different directions, as indicated by the varying origin of some grave goods. These numbers might seem very small to attain dominance; yet one has to consider that those coastal alvar areas settled by immigrant farmers were almost depopulated before their arrival.

Genetically speaking, these newcomers must have come from areas with stronger western hunter-gatherer ancestry (Saag *et al.* 2019). However, we do not know yet where this area was, due to insufficient knowledge of Bronze Age DNA from the Baltic Sea region. The analysis of strontium and oxygen isotopes of four burials excavated from two sites containing stone-cist graves (Oras *et al.* 2016) indicated a local origin for most of the individuals. One female was possibly not a local, but her exact origin is unknown. She could have either come from western Estonia or the Baltic islands around Estonia or Sweden. A recent study on population genomics from the much later Viking world discovered a strong affinity between a selection of people from Gotland and samples from the Baltic Bronze Age. This was interpreted as evidence for Baltic (pre-)Viking Age migration to the island (Margaryan *et al.* 2020). This affinity, however, could also reflect a Bronze Age migration from Gotland to the east, whereby the Iron Age Gotlanders with east Baltic Bronze Age characteristics could be the direct descendants of those staying behind. There is a wide range of archaeological evidence for Gotland's cultural influence on those living on the eastern shores of the Baltic during the Bronze Age. Conversely, the later Iron Age influence from the eastern Baltic to Scandinavia is mainly limited to eastern central Sweden.

The Estonian stone-cist graves discussed above, together with a number of other related grave goods, prove a Gotlandic (or more widely Scandinavian) influence on the region. In addition, there are many more sites – stone-ship settings, block-shaped fields of the (pre-)Celtic type, cup-marked stones – and numerous artefacts that indicate the same connections (Lang 2007a). In addition to this western influence, there are some other artefacts discovered in Estonian stone-cist graves that imply a local or eastern origin, including bone pins and plain spiral temple ornaments. Pottery produced after the tenth to ninth century BC also has its roots in the east European forest belt.

Fortified settlements and their communities

At the beginning of the first millennium BC, a new settlement type spread across the east Baltic, reaching as far as south-western Finland (e.g. Vanhalinna in Lieto) and eastern central Sweden (Darsgärde) (Figures 3 and 4). This phenomenon of so-called fortified settlements is known from many central and eastern European regions as well (see Lang 2019 and references therein). One critical, pan-regional feature of these fortified settlements is the absence of cemeteries. Because of this we lack biological information about the communities living in these sites. But we do know from archaeological sources that these groups consisted of several families (c. 30-60 people). They subsisted on a mixed economy based on cattle breeding, primitive agriculture and hunting-fishing; they fortified their settlements (or at least located them on higher ground with restricted access) and were connected to each other via water routes. Several of these fortified sites are also known for their bronze casting activities. It is also important to note that the find assemblages at all the fortified settlements in our study area have a strong eastern character, having direct parallels in the east European forest belt, up to the Volga-Oka rivers region. This eastern character was already attested in some of the small, open settlements in the region a few centuries before the first fortified settlements (i.e. at the

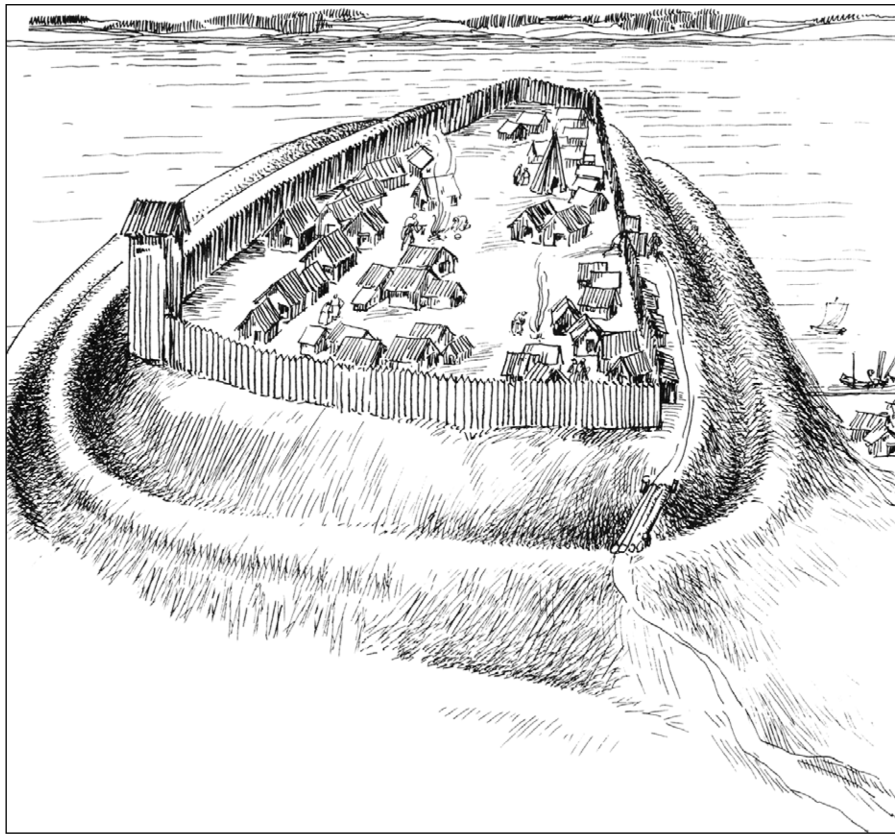


Figure 4. Reconstruction of the fortified settlement at Brikuļi, eastern Latvia (Radiņš 1996, 115).

turn of the second and first millennia BC). However, with the emergence of the fortified settlements, a clear cultural re-orientation towards the east can be observed.

This cultural change is clearly visible in the pottery (Figure 5). In Estonia, this new pottery was previously labelled as "coarse-grained pottery of the Asva type", while in Finland it was called the "Paimio type". As there is no difference between these "styles", I have suggested to combine them into an earlier group of south-western Tapiola ware (Lang 2018)[3]. SW-Tapiola pottery also has its roots in the Volga-Oka-Moscow rivers region, as does the material culture of fortified settlements in general. It evidently spread westwards from this region to the eastern Baltic. For this paper's study area, it is important to note that after the introduction of early SW-Tapiola ceramics, the development of pottery technology is continuous up to the introduction of wheel-made pottery. It would hence be difficult to imagine any break in, or change of, population when interpreting the evidence for pottery production and consumption.

However, the fortified settlements in Estonia and south-western Finland are also well-known for another style of pottery, which has been labelled "fine-grained Bronze Age pottery" (Figure 6; Lang 2018; 2020). This pottery style is absent elsewhere in the eastern Baltic region and further east[4], but is widespread in central and northern Europe (the Lausitz culture area and southernmost Scandinavia respectively). Various characteristics of this pottery have counterparts in different areas within this region, but it is suggested that this pottery style was mainly developed in Estonian fortified settlements (Sperling 2014). It is hard to imagine, however, that this was undertaken without direct contact

3 The north-western group of Tapiola ware consisted of the so-called Textile Pottery, which spread in north-western Russia and the Finnish interior (see below, Figure 9, the white arrow from the east to the interior of Finland); for the fuller debate see Lang 2018, 143-51; 2020, 178-89.

4 Except some vessels from ship settings in Courland and a few pieces at Ķivutkalns in Latvia.

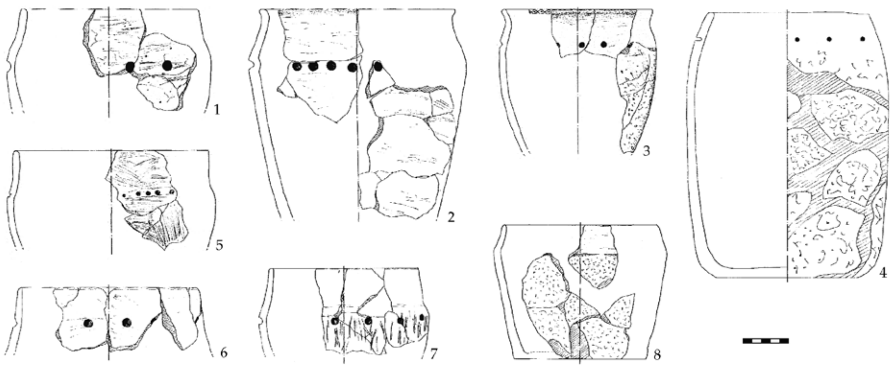


Figure 5. South-western group of Tapiola ceramics (Lang 2007a, fig. 58; Sperling 2014).

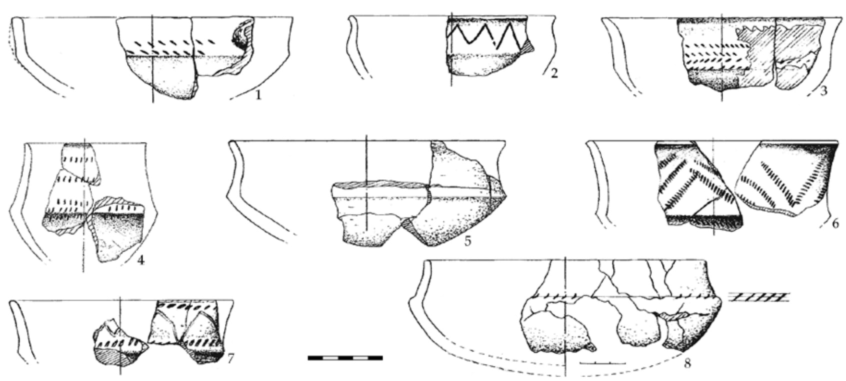


Figure 6. Fine-grained pottery of the Bronze Age (Lang 2007a, fig. 59; Sperling 2014).

between the inhabitants of fortified settlements and the people in western cultural regions. It is not clear whether these contacts took place in the west or in Estonia/Finland, but judging by the evidence, including the limited distribution of this pottery, one can suspect that master potters living in Estonian fortified settlements were well versed in western pottery traditions.

Early *tarand* cemeteries and their communities

A new type of stone cemetery tradition became widespread in the study area between 800 and 500 BC[5]. It can be characterised by the introduction of rectangular ground-level burial chambers or enclosures built of stone, which in Estonian are called *tarand*s (Figure 7). The early *tarand* cemeteries are mainly distributed in the same micro-regions as the stone-cist graves, that is the coastal parts of Estonia and Finland, northern Latvia, but also Ingermanland and central eastern Sweden (Figure 8). These early *tarand* cemeteries can be dated from the end of the Bronze Age to the end of the Pre-Roman Iron Age.

The oldest of these *tarands* were frequently built next to earlier stone-cist graves (sometimes even on top of them, see Figure 7), therefore it was previously thought that these rectangular cemeteries were simply formed by either increasing the size of the stone cist or by replacing the circular wall with a rectangular one. Today, however, it is clear that the early *tarand* graves are a completely new type of cemetery tradition. The prototype for this practice can be found in the eastern Finno-Ugric peoples' burial tradition, in the so-called "houses of the dead". The main difference is that these houses of the dead were built of wood and dug into the ground (Patrushev 2000), as opposed

5 Because of the so-called Hallstatt calibration plateau, it is impossible to establish this date more exactly. The oldest radiocarbon dates obtained from uncremated human bones in *tarand* graves fall between 2530±41 and 2430±35 radiocarbon years BP (see Saag *et al.* 2019, appendix).

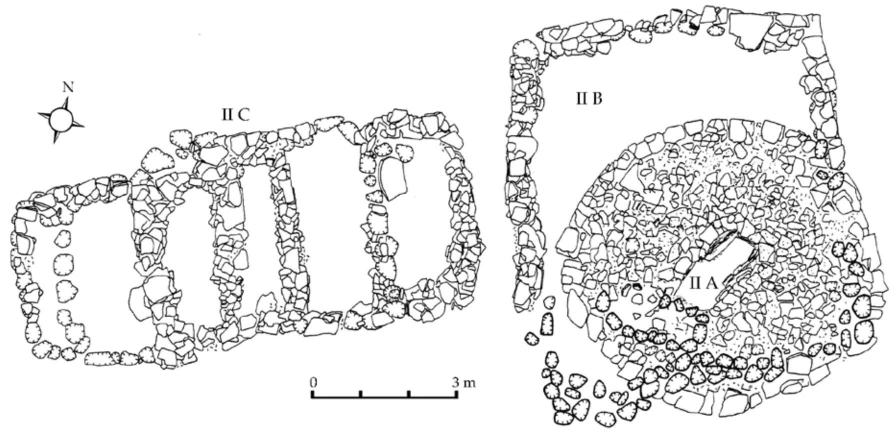


Figure 7. Stone-cist grave IIA and early *tarand* cemeteries IIB and IIC at Tõugu, northern Estonia (map: V. Lang).

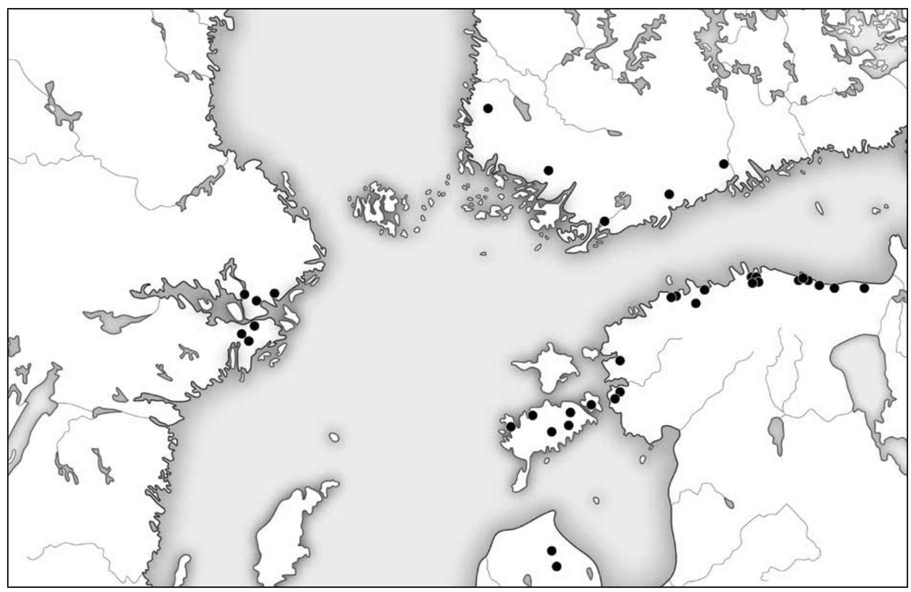


Figure 8. The distribution of excavated early *tarand* cemeteries (Lang 2018, fig. 5.7).

to the enclosures in our study area, which were built of stone and are at ground level – similar to the construction of stone-cist graves. The main feature however – the construction of (rectangular) burial chambers next to each other, in one or several rows – is exactly the same.

The study of aDNA (see Saag *et al.* 2019) confirmed that early *tarand* cemeteries may indeed have been built by people from the east. The Y-chromosome haplogroup N3a (N1c1) was discovered in three out of the five individuals sampled (the other two being R1a). This is the earliest evidence of the presence of this eastern haplogroup in Estonia. The results for the maternal lines were very heterogeneous once again: H1a, H1c, H6a1a, H13a1a1a, HV0, I1a1c, T1a1b, T2a1b1a1, U5a1d and W3a1d. Based on the genetic results, the communities buried in the early *tarand* cemeteries are firmly located between those buried in stone-cist graves and modern Estonians, mainly differing from the former by the existence of the so-called Siberian (Nganasan) component. Immigration could also be connected with the *tarand* cemeteries through the results of an isotope study of two men buried in the Kunda *tarand* cemetery (Oras *et al.* 2016): both turned out to be first-generation immigrants, one of them with haplogroup N3a, the other with R1a.

The emergence of these early *tarand* cemeteries marks a new change in material culture. Although there is a small set of grave goods common to both the *tarand* and stone-cist graves – neck-rings of the Bräcksta type, massive iron bracelets, decorative bronze and iron pins, round bronze mounts and so on (Lang 2007a) – the majority of artefacts are different. The pottery differs as well, as now we are dealing with what used to be called pottery of the Ilmandu type (or Morby type in Finland), which is supposedly a development from the earlier SW-Tapiola ware under new influences from the east European forest belt. This pottery can now be reclassified as the later (younger) group of SW-Tapiola ware. Decorative bone pins, which are so characteristic of both stone-cist graves and fortified settlements, are totally missing in the *tarand* cemeteries.

Discussion: becoming Proto-Finnic

The evidence for this study area suggests that there are at least three major changes present in the archaeological record for the Middle and Late Bronze Age: the emergence of stone-cist graves, the spread of fortified settlements, and the subsequent emergence of early *tarand* graves. The archaeogenetic evidence reveals two changes, the emergence of a "stone-cist" population and "*tarand*" population. It reveals nothing about a "fortified site" population because there are no cemeteries.

A further scientific approach to study ethnic histories is historical linguistics. It currently sees only one major change during this period: the replacement of all the earlier languages – whatever they were – by the Proto-Finnic language. This conflicts with previous continuity theories, which suggested that Finno-Ugric settlement in the eastern Baltic and Finland began in the Neolithic (e.g. Moora 1935; 1958; Salo 1984a) or even the Early Mesolithic (Wiik 2004). However, recent advances in historical linguistics have led to the conclusion that the Proto-Finno-Ugrian language did not disintegrate before c. 2000 BC, therefore its daughter languages, such as Proto-Finnic, could only have arrived in the eastern Baltic some time after this (Häkkinen 2009; Honkola 2016; Kallio 2006). Considering that the "homeland" of those Proto-Finno-Ugrians was situated somewhere between the Volga and Oka rivers and the Ural mountains, the arrival of a Finno-Ugric ethnic component to the eastern Baltic region could have taken place only during the Bronze Age or even the Early Iron Age. It also follows from the linguistic evidence that the Stone Age archaeological cultures on the eastern shores of the Baltic were not a part of the (Proto-)Finno-Ugric world.

The aDNA research (Mittnik *et al.* 2018; Saag *et al.* 2017; 2019) supports the linguistic evidence. It is now clear that the genetic legacy from the Late Mesolithic and Neolithic periods (i.e. the Narva, CC and CW cultures) is not sufficient to explain the genetic composition of modern Estonians and Finns. Critically there had to be one more influx of genes after the Neolithic to explain the arrival of the so-called Siberian component and Y-chromosome haplogroup N3a (most likely from the east). This haplogroup is still missing in the genes of both the Estonian stone-cist people (from the Middle and Late Bronze Age) and Latvian Ķivutkalns people (from the end of the Bronze Age). These populations also cluster tightly together in a principal-component analysis. Although both populations revealed a new external genetic component (that is, in comparison with earlier periods), it cannot be connected with the proposed migration of Finno-Ugric speakers from the east. This had to take place later or, at least, in the context of other archaeological evidence. As mentioned above, the earliest genetic proof of this later eastern migration was obtained from the early *tarand* graves between 800 and 500 BC.

However, the archaeological evidence clearly shows that the eastern influence had already arrived a few centuries before the building of the first *tarand* graves, i.e. at the turn of the second and first millennia BC. This is evidenced, first, by the emergence of small settlement sites containing early SW-Tapiola ware. This was a new pottery style with eastern origins that appeared after a gap of several centuries without any ceramics in the archaeological record. Next, this pottery, and other items of eastern origin, appeared in stone-cist graves during the tenth to ninth centuries BC (the stone-cist graves of the twelfth and eleventh centuries being without ceramics). Finally, the spread of fortified settlements after the (late) ninth century BC also carried a strong, perhaps the strongest, eastern influence prior to the construction of the earliest *tarand* graves.

Taken as a whole, these waves of cultural and genetic influence from the east European forest belt appear to indicate the migration of new peoples rather than the simple infiltration of new ideas and goods. Perhaps this is best envisaged as a long-term process of half a millennium, involving several distinct episodes of new arrivals, the last of which can be most likely connected with the arrival of the Proto-Finnic language. It is also certain that these eastern populations repeatedly interacted with the local stone-cist people; they probably lived together and even buried their dead together in stone-cist graves. The integration of these two groups can be seen in two ways, firstly in the location of some *tarand* graves constructed alongside older stone-cist graves. Secondly, the builders of some of the later stone-cist graves chose to adopt the *tarand* practice of building new burial enclosures side by side to each other. The latter is observable, for instance, at the Jaani grave in Väo (north Estonia) and Buļļumuiža grave in Latvia (Graudonis 1967, fig. 25; Laneman *et al.* 2015; Lang 2007b). The big question is, why are these eastern people missing in the archaeogenetic data from the stone-cist graves?

Maybe they are not? The critical thing missing from the genes of the stone-cist population, but present in the people from *tarand* graves, is the so-called Siberian (Nganasan) ancestry. Otherwise the genes from these two groups are very similar to each other (Saag *et al.* 2019). There are two ways to explain this. Firstly, as the sample size is rather small, we may not have found this missing component (which supposedly was not very frequent) in the stone cists yet. It is useful to mention in this context that a male with Siberian component was actually found in a stone-cist grave located at Loona on the island of Saaremaa (Saag *et al.* 2019). This male was one of the later burials in this grave dating to the Early Pre-Roman Iron Age and was furnished with typical grave goods characteristic of the early *tarand* grave people[6]. This further example indicates an integration between *tarand* and stone cist builders, but as the burial dates to the Pre-Roman Iron Age, it cannot be used for characterising events some 500 years earlier. Secondly, the earliest migrants could have come from areas in the east where this Siberian component and haplogroup N3a were uncommon. In fact, one of the first-generation immigrants from the Kunda *tarand* grave did have haplogroup R1a instead of N3a. This has been the most common Y-chromosome haplogroup in this part of Europe since the CW culture. The suggestion that the different waves of newcomers came from slightly different eastern areas is based on the archaeological evidence (Lang 2018; 2020).

Therefore, the distribution of fortified settlements, the emergence of SW-Tapiola ware together with characteristic bone and antler artefacts, the building of *tarand* cemeteries, and the spread of eastern genes are all very much in line with the proposed arrival of the Proto-Finnic language from the Volga and Oka rivers region. All these processes took place in the same time frame and they all point to one direction, the east (Figure 9:2). The story behind the Estonian stone-cist graves a few centuries earlier was different, however – they point to the west. As mentioned earlier, there is good reason to suppose that a migration took place, most likely from Scandinavia (Gotland). But regions south of the Baltic Sea must be taken into account as well (Figure 9:1). It seems reasonable to suggest that people came from many different directions but not in large numbers. Whatever their origins, these western newcomers most likely spoke some kind of Pre- or Proto-Germanic language. They settled along the alvar-dominated landscape of coastal Estonia, an environment that was very similar to the islands of Gotland and Öland. They also started to cultivate block-shaped fields in a very similar manner to those found in Scandinavia (particularly on Gotland), and to create cup-shaped depressions on rocks, as found everywhere in the west. The newcomers erecting monumental cairns in coastal Finland, however, came from a different region, most likely from the western shore of the Gulf of Bothnia (Figure 9:1), and at least initially they probably did not farm.

---

6 Due to this, the Loona burial – although found in a stone-cist grave – was linked to the burials from *tarand* graves (group EstIA in Saag *et al.* 2019).

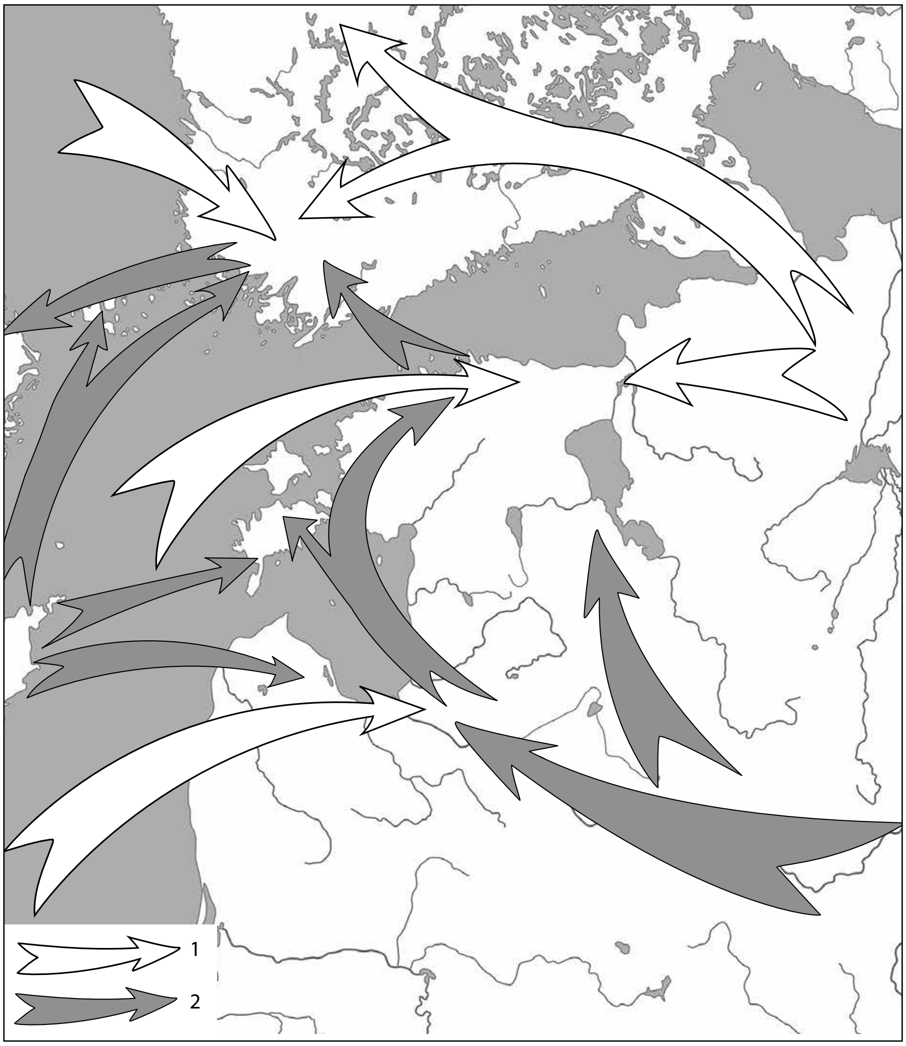


Figure 9. The main routes of the spread of ideas, artefacts and people in the late second millennium (1) and early first millennium BC (2) in the north-east Baltic and southern Finland (map: V. Lang).

The indigenous settlements in coastal Estonia and Finland were extremely sparse prior to the new arrivals from the west. It is understandable therefore that over time the newcomers came to dominate their cultural and social spheres. The indigenous people were most likely assimilated very quickly into the new society, or at least they became practically invisible in the archaeological record. Perhaps the only objects that can be the associated with an indigenous population are the decorative bone pins, either with triangular or spade-shaped heads. This is because they were very popular in the Ķivutkalns community, showing no genetic evidence of eastern immigration. Also, similarly shaped bone pins are well represented in Estonian stone-cist graves. The genetic similarity of both communities can be explained by the co-existence of both locals and newcomers. Furthermore, different burial customs point to cultural differences between coastal Estonia and the lower reaches of the Daugava river. Although the genetic components were similar in both communities, their cultures (and perhaps languages) became different over time, possibly because the newcomers held a different position in these societies as they developed.

Conclusions

In conclusion, the process of becoming Proto-Finnic can be sketched out as follows: although the land did not become totally depopulated, the Neolithic period ended with a severe demographic crisis. Slight human activity is still evident in pollen diagrams as well as by the presence of a few scarce archaeological finds. Therefore, the existence of an indigenous population must be taken into consideration when describing the following processes.

A new tradition in burial practice emerged in coastal Finland from the middle of the second millennium BC. This tradition also appears to have emerged in Latvia, on the lower reaches of the Daugava river, at the same time. In coastal Estonia, however, its arrival can be more accurately placed to around 1200 BC. This new burial practice saw the construction of cemeteries containing what is best described as monumental, above-ground burial mounds containing stone cists. It is likely that this change in tradition happened due to the arrival of newcomers from the western and/or southern areas of the Baltic Sea (Figure 9:1). These newcomers probably spoke some kind of Pre- or Proto-Germanic language. The power and influence obtained by these newcomers in the local societies appears to have varied in different areas, but after a few generations both groups became fully assimilated in a process of ethnogenesis. It is very possible that a Germanic language became dominant, at least in coastal Finland and coastal Estonia.

The first few settlement sites containing SW-Tapiola ware emerged at the turn of the second and first millennia BC, and were followed by the emergence of fortified settlements a few centuries later. These changes also witnessed a strong influence from the east European forest belt (Figure 9:2), especially from around the Volga-Oka-Moscow rivers region. These changes should be associated with two waves of migration. We do not know anything as yet about the genes of these first influxes of eastern migrants, but the eastern connection can be seen in both aDNA and isotope analyses for the next, the third, wave of migration. This wave brought about yet another change in burial tradition, the emergence of the early *tarand* cemeteries. The linguistic evidence suggests that the newcomers most likely spoke a West-Uralic language that over time became Proto-Finnic. This language was also strongly influenced by Proto-Baltic or Proto-Balto-Slavic on its way to the eastern Baltic (e.g. Junttila 2012; Lang 2016). In the coastal areas of Estonia and Finland, the newcomers met a Germanic-speaking (or at least Germanic-dominated) population. The integration that followed is evidenced by the following points:

1. The appearance of SW-Tapiola ware in later stone-cist graves.
2. Artefacts common to both stone-cist and *tarand* graves.
3. The location of some *tarand* graves that were constructed alongside stone-cist graves.
4. The builders of some later stone-cist graves appropriated some features from *tarand* graves in their construction.
5. aDNA indicates that people with eastern roots (Siberian component) were buried in stone-cist graves at least at Loona.
6. The linguistic evidence shows a strong influence of a Proto-Germanic language in Proto-Finnic, starting during the Bronze Age (Kallio 2012; Koivulehto 1984). An influx of Germanic-speaking people could also have followed afterwards, as suggested by the emergence of ship settings and perhaps fine-grained pottery.

The first culture changes after the Early Bronze Age crisis oriented the coastal areas of Estonia, Finland and Latvia towards the west. The subsequent changes show that these areas gradually turned towards the east, at least ethnically. In cultural terms, however, the northernmost eastern Baltic region and south-western Finland became transitional between the east and west, a situation that continued in the long term.

Acknowledgements

I am grateful to Marcus Adrian Roxburgh for revising my English and Jaana Ratas for drawing figures 3 and 9.

Bibliography

Asplund, H. 2008. *Kymittæ. Sites, centrality and long-term settlement change in the Kemiönsaari region in SW Finland.* Turku: University of Turku.

Carpelan, C. 1999. Käännekohtia Suomen esihistoriassa aikavälillä 5100…1000 eKr. In P. Fågelberg (ed.), *Pohjan poluilla. Suomalaisten juuret nykytutkimuksen mukaan,* 249-80. Helsinki: Finnish Society of Sciences and Letters.

Ciglis, J. and Vasks, A. 2017. Jauni bronzas un senākā dzelzs laikmeta apbedīšanas vietu datējumi ar radioaktīvā oglekļa metodi. *Latvijas Vēstures Institūta Žurnāls* 102, 34-61.

Denisova, R.Ja., Graudonis, Ja.Ja. and Gravere, R.U. 1985. = Денисова Р.Я., Граудонис Я.Я. and Гравере Р.У. *Кивуткалнский могильник эпохи бронзы.* Riga: Zinātne.

Graudonis, Ja.Ja. 1967. = Граудонис Я.Я. *Латвия в эпоху поздней бронзы и раннего железа. Начало разложения первобытнообщинного строя.* Riga: Zinātne.

Hackman, A. 1905. *Die ältere Eisenzeit in Finnland, I. Die Funde aus den fünf ersten Jahrhunderten n. Chr.* Helsingfors: Aktiengesellschaft F. Tilgmanns Buch- und Steindruckerei.

Haggrén, G., Halinen, P., Lavento, M., Raninen, S. and Wessman, A. 2015. *Muinaisuutemme jäljet. Suomen esi- ja varhaishistoria kivikaudelta keskiajalle.* Helsinki: Gaudeamus.

Häkkinen, J. 2009. Kantauralin ajoitus ja paikannus: perustelut puntarissa. *Suomalais-Ugrilaisen Seuran Aikakauskirja* 92, 9-56.

Honkola, T. 2016. *Macro- and microevolution of languages: exploring linguistic divergence with approaches from evolutionary biology.* PhD dissertation, University of Turku.

Jaanits, L., Laul, S., Lõugas, V. and Tõnisson, E. 1982. *Eesti esiajalugu*. Tallinn: Eesti Raamat.

Junttila, S. 2012. The prehistoric context of the oldest contacts between Baltic and Finnic languages. In R. Grünthal and P. Kallio (eds), *A linguistic map of prehistoric northern Europe,* 261-96. Helsinki: Suomalais-Ugrilainen Seura.

Kallio, P. 2006. Suomen kantakielten absoluuttista kronologiaa. *Virittäjä* 110, 2-25.

Kallio, P. 2012. The prehistoric Germanic loanword strata in Finnic. In R. Grünthal and P. Kallio (eds), *A linguistic map of prehistoric northern Europe,* 225-38. Helsinki: Suomalais-Ugrilainen Seura.

Kivikoski, E. 1961. *Suomen esihistoria.* Helsinki: WSOY.

Koivulehto, J. 1984. Itämerensuomalais-germaaniset kosketukset. In S.-E. Åström (ed.), *Suomen väestön esihistorialliset juuret. Tvärminnen symposiumi 17.-19.1.1980,* 191-205. Helsinki: Societas Scientarum Fennica.

Laneman, M. 2012. Stone-cist grave at Kaseküla, western Estonia, in the light of AMS dates of the human bones. *Estonian Journal of Archaeology* 16, 91-117.

Laneman, M. and Lang, V. 2013. New radiocarbon dates for two stone-cist graves at Muuksi, northern Estonia. *Estonian Journal of Archaeology* 17, 89-122.

Laneman, M., Lang, V., Malve, M. and Rannamäe, E. 2015. New data on Jaani stone graves at Väo, northern Estonia. *Estonian Journal of Archaeology* 19, 110-37.

Lang, V. 1987. Tallinna ümbruse tarandkalmed. *Eesti NSV Teaduste Akadeemia Toimetised. Ühiskonnateadused* 36, 190-206.

Lang, V. 1996. *Muistne Rävala. Muistised, kronoloogia ja maaviljelusliku asustuse kujunemine Loode-Eestis, eriti Pirita jõe alamjooksu piirkonnas. I-II.* Tallinn: Eesti teaduste akadeemia ajaloo instituut.

Lang, V. 2007a. *The Bronze and Early Iron Ages in Estonia.* Tartu: Tartu University Press.

Lang, V. 2007b. Joining together graves and souls. In A. Merkevičius (ed.), *Colours of archaeology. Material culture and the society. Papers from the second theoretical seminar of the Baltic archaeologists (BASE) held at the University of Vilnius, Lithuania, October 21st-22nd, 2005,* 79-91. Vilnius, Helsinki, Riga, Tartu: University of Vilnius, University of Helsinki, University of Latvia, University of Tartu.

Lang, V. 2011. Traceless death. Missing burials in Bronze and Iron Age Estonia. *Estonian Journal of Archaeology* 15, 109-29.

Lang, V. 2016. Early Finnic-Baltic contacts as evidenced by archaeological and linguistic data. *Journal of Estonian and Finno-Ugric Linguistics* 7, 11-38.
Lang, V. 2018. *Läänemeresoome tulemised.* Tartu: University of Tartu.
Lang, V. 2019. Fortified settlements in the eastern Baltic: from earlier research to new interpretations. *Archaeologia Lituana* 19, 13-33.
Lang, V. 2020. *Homo fennicus. Itämerensuomalaisten etnohistoria.* Helsinki: Suomalaisen Kirjallisuuden Seura.
Lang, V. and Ligi, P. 1991. Muistsed kalmed ajaloolise demograafia allikana. In L. Jaanits and V. Lang (eds), *Arheoloogiline kogumik*, 216-38. Tallinn: Agu.
Lekberg, P. 2002. *Yxors liv. Människors landskap. En studie av kulturlandskap och samhälle i Mellansveriges senneolitikum.* PhD dissertation, University of Uppsala.
Loze, I.A. 1979 = Лозе И.А. *Поздний неолит и ранняя бронза Лубанской равнины.* Riga: Zinātne.
Margaryan, A. [+ 83 others] and Willerslev, E. 2020. Population genomics of the Viking world. *Nature* 585, 390-96.
Meinander, C.F. 1954. Die Bronzezeit in Finnland. *Finska fornminnesföreningens tidskrift* 54, 5-242.
Meinander, C.F. 1969. Dåvits. En essä om förromersk järnålder. *Finskt Museum* 76, 27-69.
Meinander, C.F. 1984. Kivikautemme väestöhistoria. In S.-E. Åström (ed.), *Suomen väestön esihistorialliset juuret. Tvärminnen symposiumi 17.-19.1.1980,* 21-48. Helsinki: Societas Scientarum Fennica.
Merkevičius, A. 2012. Turlojiškė archaeological complex. In G. Zabiela, Z. Baubonis and E. Marcinkevičiutė (eds), *Archaeological investigations in independent Lithuania. 1990-2010,* 12-16. Vilnius: Lietuvos archeologijos draugija.
Mittnik, A. [+ 20 others] and Krause, J. 2018. The genetic prehistory of the Baltic Sea region. *Nature Communications* 9, 442.
Moora, H. 1935. Kiviaeg. In H. Kruus and H. Moora (eds), *Eesti ajalugu I. Esiajalugu ja muistne vabadusvõitlus,* 10-62. Tartu: Eesti Kirjanduse Selts.
Moora, H. 1958. Zur ethnischen Geschichte der ostseefinnischen Stämme. *Suomen Muinaismuistoyhdistyksen Aikakauskirja* 59, 1-39.
Nuñez, M.G. 1987. A model for early settlement of Finland. *Fennoscandia Archaeologica* IV, 3-18.
Oras, E., Lang, V., Rannamäe, E., Varul, L., Konsa, M., Limbo-Simovart, J., Vedru, G., Laneman, M., Malve, M. and Price, T.D. 2016. Tracing prehistoric migration: isotope analysis of Bronze and Pre-Roman Iron Age coastal burials in Estonia. *Estonian Journal of Archaeology* 20, 3-32.
Patrushev, V. 2000. *The early history of the Finno-Ugric peoples of European Russia.* Oulu: Societas historiae Fenno-Ugricae.
Radiņš, A. 1996. *Ceļvedis Latvijas senvēsturē*. Rīga: Zvaigne ABC.
Saag, L. [+ 12 others] and Metspalu, M. 2017. Extensive farming in Estonia started through a sex-biased migration from the steppe. *Current Biology* 27, 2185-93.
Saag, L. [+ 28 others] and Tambets, K. 2019. The arrival of Siberian ancestry connecting the eastern Baltic to Uralic speakers further east. *Current Biology* 29, 1701-11.
Salo, U. 1984a. Esihistoriallisen asutuksen jatkuvuudesta Suomen rannikolla. In S.-E. Åström (ed.), *Suomen väestön esihistorialliset juuret. Tvärminnen symposiumi 17.-19.1.1980,* 175-90. Helsinki: Societas Scientarum Fennica.
Salo, U. 1984b. Pronssikausi ja rautakauden alku. In E. Laaksonen, E. Pärssinen and K.J. Sillanpää (eds), *Suomen historia I*, 99-249. Helsinki: Weilin+Göös.
Salo, U. 1996. Suomalais-ugrilainen kielihistoria Suomen esihistorian näkökulmasta. In K. Julku (ed.), *Congressus primus Historiae Fenno-Ugricae. Historia Fenno-Ugrica, I: 2,* 335-53. Oulu: Societas Historiae Fenno-Ugricae.
Sperling, U. 2014. *Aspekte des Wandels in der Bronzezeit im Ostbaltikum. Die Siedlungen der Asva-Gruppe in Estland.* Tallinn: Estonian Academy Publishers.

Tallavaara, M., Pesonen, P. and Oinonen, M. 2010. Prehistoric population history in eastern Fennoscandia. *Journal of Archaeological Science* 37, 251-60.
Tõrv, M. and Meadows, J. 2015. Radiocarbon dates and stable isotope data from the Early Bronze Age burials from the Riigiküla I and Kivisaare settlement sites, Estonia. *Radiocarbon* 57, 645-56.
Vasks, A. 2019. Simple stone work axes in Latvia: typology, chronology and distribution. *Latvijas Vēstures Institūta Žurnāls* 1, 5-29.
Vasks, A., Zariņa, G., Legzdiņa, D. and Plankājs, E. 2021. New data on funeral customs and burials of the Bronze Age Reznes cemetery in Latvia. *Estonian Journal of Archaeology* 25, 3-31.
Vassar, A. 1938. Drei Steinkistengräber aus Nordestland. *Õpetatud Eesti Seltsi Aastaraamat* I, 304-64.
Vassar, A. 1943. *Nurmsi kivikalme Eestis ja tarandkalmete areng.* Tartu: Manuscript in the University of Tartu Library.
Wiik, K. 2004. *Suomalaisten juuret.* Jyväskylä: Atena.

Baltic stone ships

Monuments of a “maritory” in Late Bronze Age northern Europe

Joakim Wehlin

In search of a maritime institution in the Baltic Sea

The Nordic Bronze Age (1700-500 cal BC) was a period of far-reaching networks, long-distance travel and trade (e.g. Kristiansen and Larsson 2005; Ling *et al.* 2018; Montelius 1885; Thrane 1975; Vandkilde 2016). Most of the movement must have occurred on water, along the coasts and on inland water systems. Moreover, the ship is by far the most important symbol of the period, carved in rocks, depicted on bronze artefacts and constructed as stone monuments.

The geographical area of the Nordic Bronze Age is more or less captured between two seas. The main focus of archaeological research has been towards the western waters; the North Sea, Skagerrak, Kattegat and the Danish straits. The Baltic Sea, in the east, is on the other hand seen as a border and the periphery of the Nordic Bronze Age sphere; I found this surprising given that water was the main facilitator of movement and that the ship was such an important symbol during the period. The Baltic Sea could instead be used as a geographical springboard for research. A nuanced understanding of certain phenomena at the local, regional and interregional levels can be reached with such a perspective (Figure 1).

By studying the Bronze Age from a Baltic perspective it is clear that the region stands out from the grand Nordic Bronze Age narrative in many ways. Local objects emerged, such as certain bronze artefacts and house urns, as well as monuments such as fortified

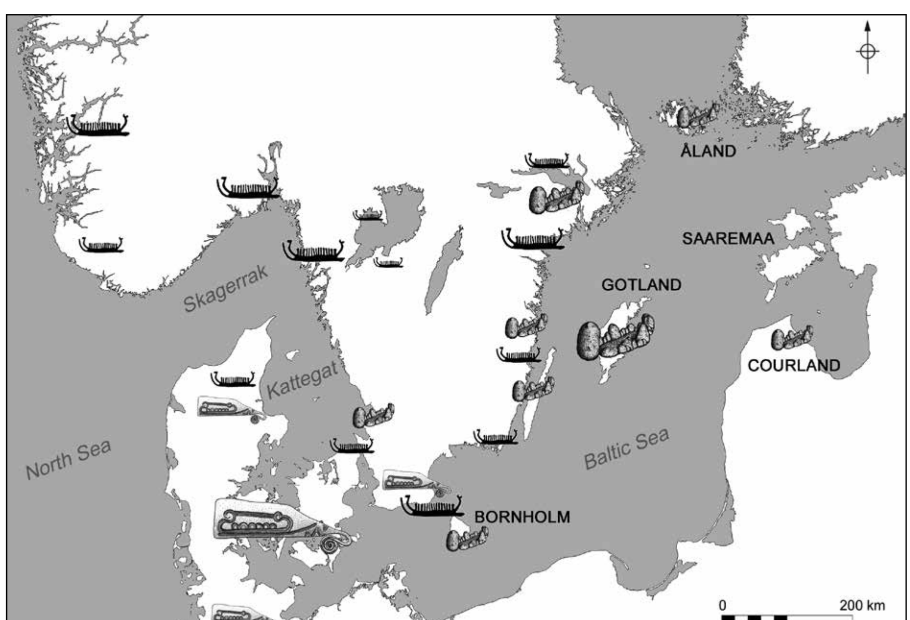


Figure 1. Southern Scandinavia and the Baltic Sea region with important areas of ship-decorated artefacts, rock art and stone ships from the Bronze Age (illustration: J. Wehlin).

In D. Hofmann, F. Nikulka and R. Schumann (eds) 2022. *The Baltic in the Bronze Age. Regional patterns, interactions and boundaries*, Leiden: Sidestone Press, pp. 373-388.

structures, mounds with fire-cracked stones and burials in stone ship settings. All these objects and remains have been clearly associated with the maritime cultural landscape (e.g. Baudou 1960; Eriksson 2009; Hansson 1927; Ojala 2016; Runesson 2014; Sabatini 2007; Wehlin 2013).

I will in this paper take a maritime perspective on the Baltic Bronze Age. The main focus are the stone ship settings that will be examined in a broader context than as mere funerary monuments. This context is particularly palpable as regards ship settings, and therefore the monuments and locations themselves should be investigated and understood as significant and active agents in the formation of social identity. Monuments are part of the landscape, a social space created, used and altered by people (Bradley 1998; Tilley 1994).

Baltic stone ships

In the Baltic Sea region, there are several concentrations of ship settings from the Bronze Age; Gotland is the main area of distribution, but there are also several known monuments on the islands of Bornholm, Saaremaa, Åland, Öland and in the north of Courland (Latvia), the Lake Mälaren valley and the county of Kalmar and Blekinge on the east coast of Sweden. Concentrations of ship settings can also be found in the south of Halland and on the Bjäre peninsula in north-west Scania (Sweden). A small number of Bronze Age ship settings are also known from south-west Norway and in Denmark (Artelius 1996; Capelle 1986; Nordenborg Myhre 2004).

There are clear morphological differences between ship settings both inter-regionally within the Baltic Sea area and locally on Gotland. There are four main types (Figure 2): type 1 generally comprises large standing stones, which are often sparsely placed monoliths. The ship settings of this type are rather short, generally 6-10 m long and 2-4 m wide. Type 2 has fewer and more closely spaced stones, sometimes with prominently larger stones at the ends. The ship settings of type 2 and 3 are usually longer and narrower than type 1, generally 10-20 m long and 2-5 m wide. Type 2 mainly differs from type 3 in that the stones in the outline are much smaller and recumbent rather than upright. Type 3 ship settings comprise standing stones, but these are generally smaller than those of type 1. The type 3 stones are taller towards each end, resembling a gunwale viewed from the side. Type 4 ship settings are buried underground, or in certain cases are slightly visible on the surface. The ship settings of type 4 often comprise upright limestone slabs or plaques, erected in a single or double row of kerbstones. These ship settings are often smaller than those of the other types, generally 4-6 m long and 2-3 m wide. All ship settings of types 1-4 can be found singly or in small groups.

There are two other types of construction which have been the subject of discussion in connection to ship settings (Figure 2). Firstly there are what are known as “the south constructions” (Martinsson-Wallin and Wehlin 2018; Nylén 1993). There are a number of variants, and they are usually discovered south to south-west of stone cairns. In some cases, they comprise solitary upright stones, and in others several upright stones forming an oval or rhombic construction. Secondly, there are the boat-shaped stone cists. These are later than the ship settings, and have always been

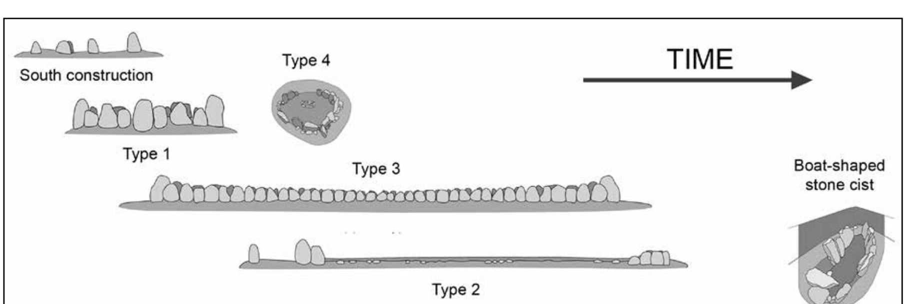


Figure 2. The different types of stone ship settings and associated stone constructions with approximate chronology based on ^{14}C dates and typology (illustration: J. Wehlin).

discovered underground or in “stone settings” (low stone cairns). The cists are built of limestone and/or granite slabs. They differ significantly in size from ship settings, as they are much smaller.

The dates of ship settings have been placed between Montelius periods IV-V (1100-700 cal BC), thus representing a time span of about 400 years. By studying all excavated ship settings in terms of morphology, typology and ^{14}C analyses it might be possible to indicate a chronological classification of the different types of ship settings (Wehlin 2013). Types 1 and 4 are earlier, mainly dating to period IV (1100-900 cal BC). Types 2 and 3 mainly date to period V (900-700 cal BC).

On Gotland, the connection between the earlier cairns and the later ship settings is problematic. Tore Artelius (1996) claimed that there was no evidence indicating that the origin of the ship setting tradition could be found in previous mortuary monuments. I have earlier contested this opinion and suggested that a development from stone cairns to ship settings might be discerned in the “south constructions” (Wehlin 2013). These are juxtaposed with the cairns and in some cases are impossible to differentiate morphologically from type 1 ship settings. There is also a clear relationship between more conventional ship settings and the smaller cairns. The primary contexts of ship settings of period VI (700-500 cal BC) have not yielded any definite dating. This period marked the return of inhumation graves, and it would appear that pre-existing ship settings were merely used for secondary burials. The same period marked the appearance of boat-shaped cists, which usually contained unburnt human bones. Inhumation graves in ship settings, as well as the boat-shaped cists, continued to be used right through to the middle of the Pre-Roman Iron Age (c. 200 cal BC).

From symbolic ships to representations of boats

The post-processual wave within archaeology gave an added impetus to the discussion on ship settings, especially regarding the ship as a symbol and carrier of meaning (Artelius 1996; Crumlin-Pedersen and Munch Thye 1995). In later years, focus was directed towards a comparison of the ship symbol in different media (Bradley 2006; Bradley *et al.* 2010; Kaul 1998; Kristiansen and Larsson 2005; Wehlin 2012) as well as towards a maritime perspective (e.g. Ling 2008; 2013; Wehlin 2010; 2013). Overall, the interpretations of the function of ship symbolism in Bronze Age society can be said to have five different trains of thought. The first is that the ship, according to Kaul (1998), was part of an interregional celestial conception. The second is the notion of the significance of ship symbolism in a fertility cult, as suggested for example by Oscar Almgren (1927). The third concerns eschatology and the journey to the next life, while the fourth is the significance of the ship as a symbol for metaphysical presence and communication (Artelius 1996). The fifth is the significance of the ship within maritime practice (Kristiansen and Larsson 2005; Ling 2008; Wehlin 2013). Recently Fredrik Fahlander (2019) has highlighted yet another aspect, arguing that rock art motifs, particularly boats, are independent material articulations, made to do something rather than to represent. Fahlander wants to change our perspective from representation to articulation, and from object to being.

As shown earlier there are four different types of Bronze Age ship settings. In earlier studies I have shown that there is a change in morphology over time (Wehlin 2013). The earlier ship setting types are rather pointed ovals and cannot in any manner be described as having the shape of a ship. It is their general similarities with the later, more ship-like, monuments that caused them to be subsumed under the same terminology. I will therefore argue in the following that the ship settings change from being symbolic ships to imitating real boats more closely.

In such an endeavour, cross-media comparative analysis based on the ship settings, rock art and decorated bronze artefacts is highly productive (Bengtsson 2017; Bradley *et al.* 2010; Skoglund and Wehlin 2013; Wehlin 2012; 2013), primarily regarding a series of interesting construction details found on ships in different media. These details can be understood by studying the concurrent boat-building traditions. By undertaking a cross-media comparative analysis, as well as a comparison with the somewhat earlier boat finds from the British Isles (e.g. Clark 2004; 2009; Wright 1990), it is possible to achieve an understanding of Bronze Age ship technology in the Baltic Sea area and it seems that there were plank-built and sewn boats during this period, as the Hjortspring boat and the British finds indicate. The size of the boats can be calculated based on the crew strokes depicted on the ships in rock carvings and bronze objects (Bradley *et al.* 2010; Kaul 1998; Ling 2008). These calculations correspond well with the size of the ship settings. The most common type of boat must have been between 5 and 13 m long and crewed by 6-14 individuals, although other types of boats also appear to have existed. These were more pointed at each end and probably about 18-20 m long, with a crew of up to 22 individuals.

There are more characteristics on the later ship settings, type 2 and 3, that make it plausible to suggest that they were intended to represent replicas of wooden ships. As is known from depictions of ships in rock art, and on metal items from the Bronze Age, ships were not symmetrical. The stern was constructed differently compared to the prow. This trait distinguishes Bronze Age ships from Iron Age ships, which have a symmetrical shape. Moreover, Bronze Age ships – as known from pictorial evidence – have raised keel extensions in the stern which, during the Late Bronze Age, is markedly upturned (Kaul 1998; Ling 2008).

In comparison, ship settings in the Baltic Sea commonly appear with extended uprights running from one of the ends, sometimes referred to as the trunk of the ship (Wehlin 2013; Figure 3). However, as shown in rock art, the stem and the upturned keel extension often ended in animal heads. We must reckon these to have been sculpted out of wood, even though preserved wooden details from Scandinavian Bronze Age boats are lacking. Another feature of interest often appears opposite the extension stones, a distinct rectangular compartment (Figure 3). This feature is extremely small and on a real ship could accommodate only one person, presumably the commander of the crew who was operating the steering oar. This might explain why burials and traces of other activities are sometimes found at the very end of the ship settings (Skoglund and Wehlin 2013).

This square compartment is not found on the Hjortspring vessel, which in plan is pointed with symmetrical stems. In contrast, the best preserved British sewn-plank boat, Ferriby 1, has an asymmetrical plan which might be compared with the pictorial evidence for ships mentioned above. The reconstruction of the same vessel (see figure in McGrail 2001, 186) suggests that one end has a squared compartment with measurements comparable to the constructions found on ship settings. These two construction details, extension stones and the square compartment, show that it is possible to understand in which direction the ship settings are meant to sail.

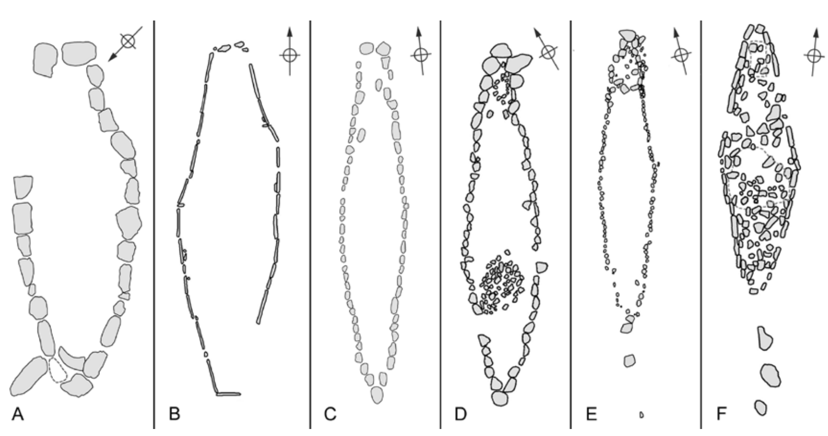


Figure 3. Example of stone ship settings from Gotland with a square compartment and/or extension stones. A) Norrlanda 89; B) Tofta 26; C) Visby 3; D) Grötlinbo 4; E) Lau 41; F) Fårö 57. Not to scale (illustration: J. Wehlin).

From graves to social units

As shown above, there are relatively large morphological differences between the design of the early and later types of ship settings. There are also differences in what they contain. In the following I will argue for yet another change in use of the ship setting monuments over time, from graves to social units.

Quite a large number of the ship settings in the eastern Baltic countries and on Gotland have undergone archaeological investigation (c. 20 %). The excavated materials have great potential, not least due to the large quantity of burnt bones. Osteological and ^{14}C analyses of the bone material show interesting results and change the earlier picture of the Baltic ship settings (Blinova Högberg 2019; Laneman *et al.* 2015; Wehlin 2013; Wehlin and Sabatini 2020).

Previously, ship settings have generally been seen as burial monuments providing a grave for one or several individuals. Funerals were by way of cremation, with the cremated remains often deposited in an urn along with a few small bronze objects, such as a razor and tweezers. This is a general trend particularly in the earlier types of ship settings (1 and 4), although a number of discrepancies occur. There are great differences in what has been unearthed in the ship settings (Wehlin 2013), the most remarkable element of all being that about 40 % of the ship settings investigated on Gotland contain only a handful of human bones (less than 200 g). There are also opposing instances where the ship settings contain the remains of a large number of individuals; this has led to the interpretation of these monuments as family and/or communal graves (Hallin 2002; Skoglund 2008). Recent osteological analyses (Blinova Högberg 2019; Wehlin 2013; Wehlin and Sabatini 2020), however, indicate yet another situation. The ship settings with cremated bones generally contain one or two buried individuals. There is no particular tendency regarding sex or age, although the deceased have often reached adulthood – at least 18 years of age.

Of particular interest are the paired ship settings. These occur in three different variants: prow to stern, side by side, and with no specific pattern. Whenever the ships are in pairs it would seem as though one of the ships contains a small amount of cremated bones, although in certain cases they are completely devoid of bones. Why? The theory that one of the ships might have been the pyre, while the other was the actual grave has been tested (Wehlin 2013) by way of a study of the recovered bone material, and the results confirmed that this is a possibility. Many questions still remain unanswered however. In many cases there is no pyre layer or even a grave.

Ships in pairs are also known from rock art panels; it is notable that one of these ships is often depicted without crew and sometimes even placed upside down (Figure 4). Scholars have suggested that these circumstances reflect a transformation and a narrative about death and resurrection (e.g. Bradley 2006). This is interesting in comparison with the ship settings (Figure 4), where this could also apply. Perhaps the funeral should not be viewed as an isolated event, but rather as a process and/or a transformation. At excavated sites bones are sometimes found scattered both within and between ship settings. In some cases with two or more ships per site, it seems as if the bones were moved between the ships. Further, in view of the small quantity of bones which are normally unearthed, it would also seem likely that the remains of the deceased were spread to other places (Wehlin 2013).

In this context, the activities which took place near the monuments are of particular significance and my focus is on a discussion of social practices. In the transition to the Nordic Late Bronze Age (1300-1100 cal BC) there was a pronounced change in the attitude towards the individual, not least manifested by a changed attitude to the body, which entailed the embellishment of graves and complex funerary rituals. However, it is important to understand that a burial is first and foremost the concern of the living who participated in the ceremony, and that the grave ritual may have played a significant role in social strategies (cf. Oestigaard and Goldhahn 2006). The funeral provides a platform for vying for power and forming alliances. A funeral is also an opportunity to reiterate the principles of cosmological beliefs, as well as to recall historical myths and heroic adventures, which can frequently be found in iconography (Andrén 1993; Kristiansen

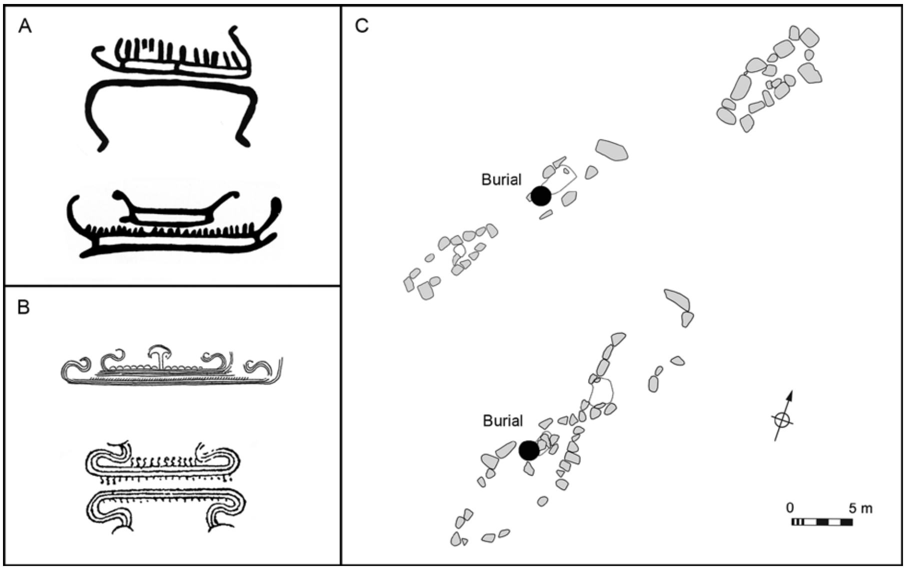


Figure 4. Motifs of paired ships with and without crew in A) rock art and B) on decorated bronze artefacts. C) Stone ship setting site on Gotland (Alskog 9) with five closely built ships of which four are in pairs. Only one ship in each pair contained a burial (illustration: J. Wehlin).

and Larsson 2005). It has previously been claimed that the idea of the "ship and the heavenly journey" is a basic interregional concept which is being related in different ways (e.g. Kaul 1998; Kristiansen and Larsson 2005), but the ship and ship symbolism are predominantly located in coastal regions and therefore are most likely to have been part of a social ritual act linked to maritime practice.

In this case, another cross-media comparative analysis could be carried out regarding the relation of the ship to the circle. This has been the subject of lively discussions concerning ships in rock carvings and on bronze objects (e.g. Almgren 1927; Kaul 1998). Circles by way of round "stone settings" are also common in juxtaposition with ship settings (Hansson 1927; Wehlin 2012). Yet these circles should instead be interpreted as being affiliated with the ship monument. A further discussion concerns the direction of movement of the ship, which is generally considered to be towards the south and thus towards the zenith of the sun. The ship settings and the round "stone settings" therefore find a place in the commonly referenced celestial notion of the passage of the sun, where the ship is the sun's carrier (Kaul 1998). On the other hand, for people who are in continuous contact with the sea and maritime life, the sun, moon and stars have a different significance. Throughout the entire world and across all periods heavenly bodies have been used as important navigation aids. In Polynesia, for example, different star signs are called *avei´a, kaveinga, kavenga* or *kaavenga* (=escort) and used as mind maps during navigation at sea (e.g. Lewis 1975; Malinowski 1984 [1922]). In contrast to Kaul's (1998) theory that a ship leads the sun across the firmament, I suggest that it could well be the sun, moon and stars which led the ship and its crew on their journey. Navigation could also be the cause of the prominent role that the moon and stars play on the sky disc of Nebra (cf. Meller 2004).

A maritime perspective also provides the possibility to interpret the upright stones which some of the ship settings are built from. These stones can be interpreted as crew strokes (Bradley *et al.* 2010). An upright stone can, however, be interpreted in many different ways. It is nonetheless clear that the stones are often carefully selected and sometimes bear certain characteristic features, for example a stone which is bent at the top and which is usually found near the stern of the ship setting (Figure 5). There are a series of other possible interpretations of what the upright stones in the ship settings might represent. The upright stones might represent the ship's crew, refer to different families' connections to the ship's crew or similar, constitute representations for a memory tool, for example for sea routes or genealogies (Vansina 1965), or be representations of the points of the compass, direction of the wind and surging of the waves. This would have been a tool for teaching navigation and life at sea, as is known from Polynesia (e.g. Lewis 1975).

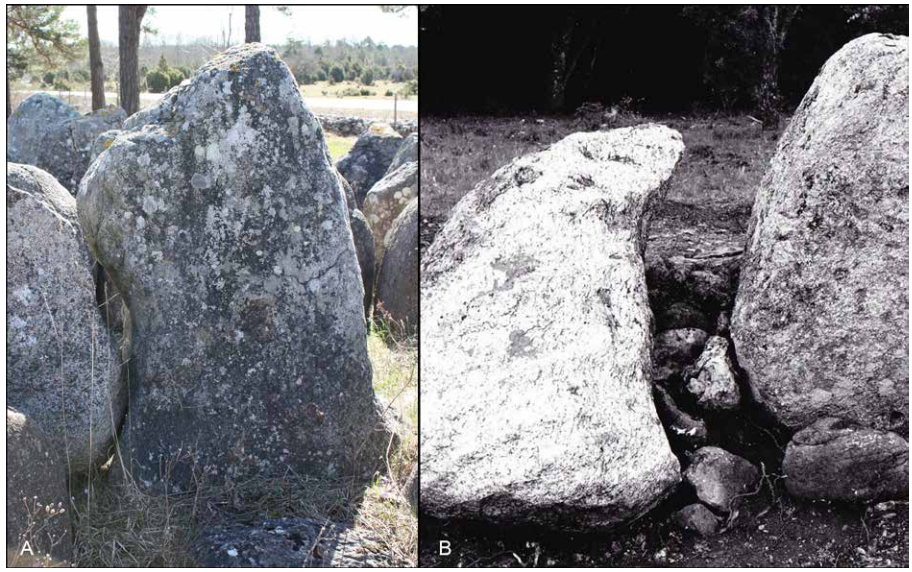


Figure 5. Examples of stones with bent tops in ship settings from Gotland. A) Lärbro 62; B) Lau 49 (photos: J. Wehlin and Gotland museum archive).

Meetings in a maritime landscape

As I have shown so far there seems to be a change in construction and practice regarding the Baltic ship settings over time. It is relatively clear that the later ship settings are built to represent real boats or canoes. The question to answer is why.

The spread of material culture and ideas shows that there must have existed a far-reaching network in the Baltic Sea during the Middle and above all the Late Bronze Age. Such a network needs specialised maritime groups of people with relatively well-developed boats or possibly even ships (canoes). These maritime groups must have been given support by the various communities along the seaboard of this inland sea at that time. If so, then there should be uniformly structured locations for these people to meet in, some kind of antecedents of harbours. It is also probable, with reference to Polanyi's (1963) "ports of trade", that such meetings took place in special forms and in special places. Polanyi (1963, 34) evokes "remnants of semi-enclosed spots open towards the sea and showing ruins of an altar, separated only by a low stone wall from the background area. The low wall did not by itself offer defence against attack, it merely indicated the area to which the protection of the altar and the 'peace' of the emporium extended".

A wider perspective must be adopted in order to find these places and understand the society and people behind them. I will therefore move on and place the ship settings in a landscape context, a maritime one. It is currently a basic assumption that ship settings largely follow the Bronze Age coastline. There are, however, anomalies; many of them are situated beside prehistoric lakes and watercourses, many of which would probably have been important inland waterways in prehistory (Nimura *et al.* 2019; Wehlin 2010). In the present, however, most of the ship settings are situated quite far inland. This is partly due to shore displacement, and partly to later human influence on the landscape, predominantly through agricultural activities. Landscape analysis and site visits make it quite clear that the ship settings were situated beside Bronze Age bodies of water, creating a spatial borderland between land and water (Wehlin 2013).

One starting point could be clusters of ship settings. The greatest number of known ship settings on Gotland is found near the river Gothemsån and the Linamyr fen in the north-east of the island (Figure 6). Beside the many ship settings, one particular site of interest is a 500 m long rampart which screens off a prehistoric headland where the Gothemsån has its outflow. An ongoing virtual landscape reconstruction project proposes that the location may have been a small island. However, the wall, which has been dated to the Middle Bronze Age (Wallin *et al.* 2011), is in a geographically significant position.

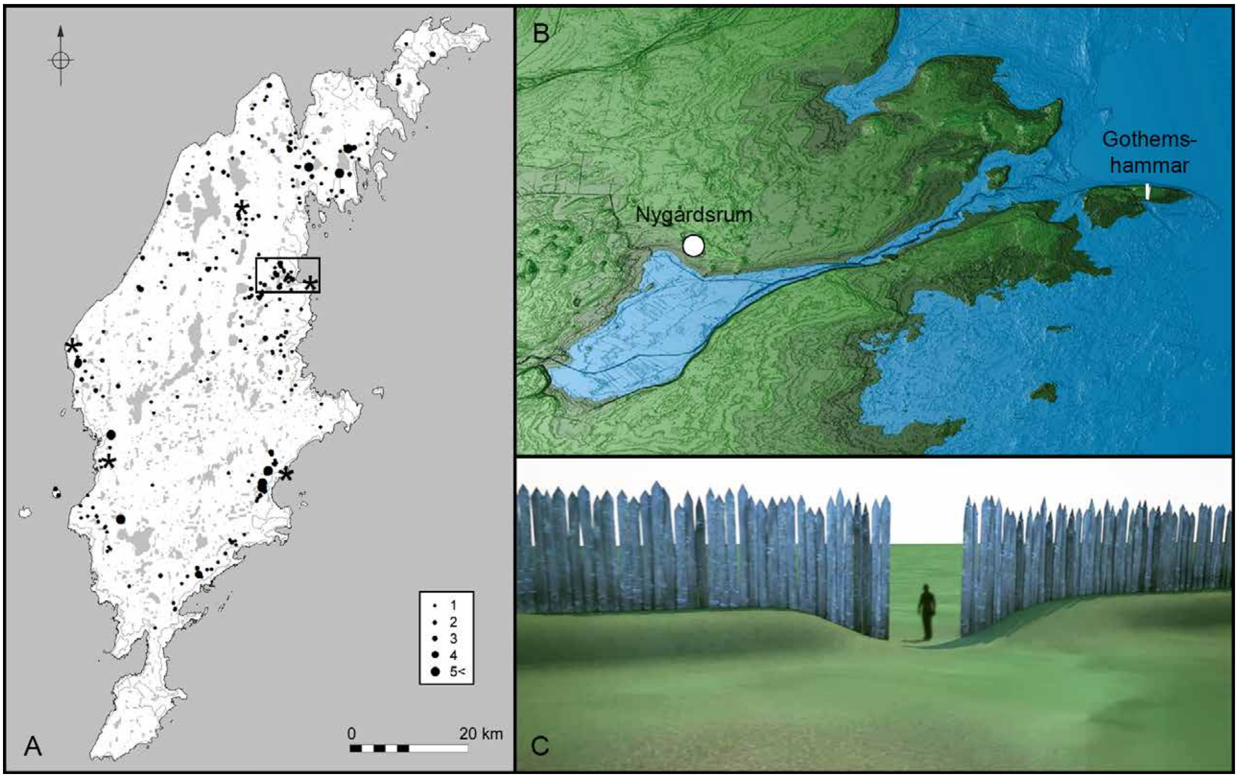


Figure 6. A) Distribution of stone ship settings on Gotland, alongside Late Bronze Age wall structures and ramparts (asterisk); B) Location of the Gothemshammar wall from a bird's-eye perspective; C) Reconstruction of the Gothemshammar wall (illustration: J. Wehlin; virtual project on Gothemshammar: P. Wallin).

Examples of similar monumental structures include known Bronze Age sites in Mälardalen and on Åland (e.g. Olausson 1995; Wehlin 2013). All of these ramparts are strategically situated on the coast and beside the central watercourses. They also share a common feature in that their fortification-strategic aspect is questionable. None of the structures which have been investigated produced any traces of permanent activity. On the other hand these places are located on navigational spots with a gravitational pull on travellers. Furthermore, these ramparts create demarcated locations which might have been a sign to approaching guests/strangers that they could expect a warm welcome (Cassel 2008).

From the Late Bronze and Early Iron Age, there is another variant of forts and ramparts in the Baltic Sea region; these structures are normally called fortified settlements or hilltop settlements (Lang 2007; Merkevičius this volume; Olausson 1995). Could it be possible to link these later forts to the earlier structures and could they be based on the same concept? Apart from the fact that they succeed each other chronologically, they are also spread within the same geographical area, although the later forts are distinctly oriented towards inland waterways (Arnberg 2007). Perhaps they were places for mutual business: activities which required a larger number of people than the individual household could muster.

Instead of viewing these monumental structures as just fortifications they should be seen as nodes where network traffic met or gathered, as aggregation sites (see e.g. Bradley *et al.* 2020). It is important to remember that different sorts of traffic with different purposes produce different types of places or nodes (cf. Sindbæk 2007), and that the economic and political aspects helped to create these variations: aspects and prerequisites changed over time and subsequently forced change in the construction and use of hilltop settlements, fortifications and ramparts.

It is, however, important to understand that these places not only relate to exchange and trade; a more complex view is required (see e.g. Ilves 2011; Sindbæk 2007). The activities which probably also took place here would have been linked to rituals and events

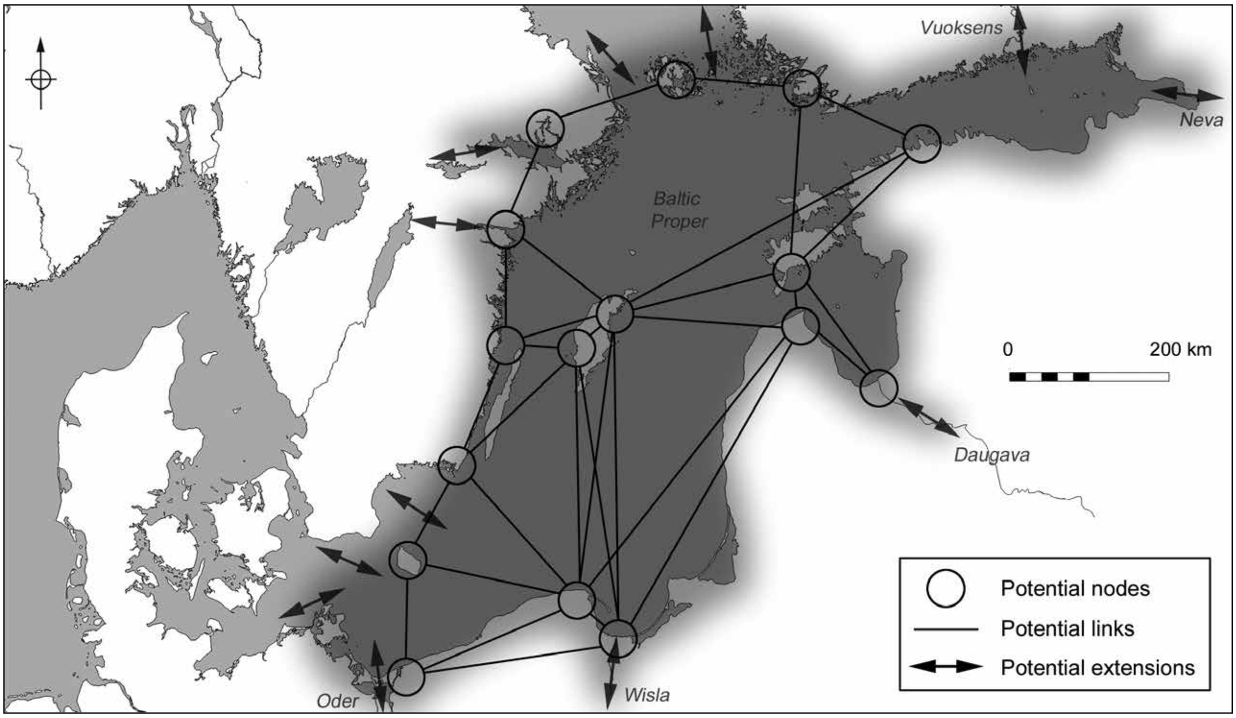


Figure 7. A tentative map of the Baltic "maritory" (illustration: J. Wehlin, inspired by Needham 2009)

connected with arrivals and departures from the place as well as social gatherings and meetings. Such activities may have included "rites of passage" and the transfer of power.

Activities related to the ship settings should be linked to the maritime sphere in society and rituals and ceremonies in connection with departure and/or return from long-distance journeys. These places would have been coupled to meetings, arrivals or departures. For this reason, it is natural that burials and/or funerary ceremonies were linked to such places. Thus two types of journeys find their expression in the same "harbour" and transition site: from life to death and from home to faraway shores, i.e. from the known to the unknown.

A Baltic maritory

Previous research on the Late Bronze Age in the Baltic region (Baudou 1960; Eriksson 2009; Lang 2007; Nerman 1954; Nylén 1972; Ojala 2016; Röst 2016; Sabatini 2007; Sörman 2018; Sperling 2014; Wehlin 2013) indicates certain changes taking place in the region during this period, moving from an earlier southern Scandinavian cultural influence to more local and, to a certain extent, eastern influences. This began in the Middle Bronze Age, when a series of local types of objects emerged, such as the Bornholmian fibulae and the later socketed axes of the Mälar- and Gotland-type. In terms of pottery, there has been recurrent discussion regarding eastern influences in Scandinavia during this period. The rather early occurrence of iron processing (Hjärthner-Holdar 1993) also provides an indication of vibrant contacts with the central and eastern parts of Europe in the Late Bronze Age.

The material culture of communities around the Baltic Sea in the Late Bronze Age differed from the Nordic Bronze Age sphere, and it is quite clear that a change took place in about 1000 cal BC. At this time ship symbolism had reached its zenith, which might have been due to the fact that a maritime group had established itself in society (cf. Ling 2013; Wehlin 2013). Furthermore the change in the design of the ship settings in the Baltic Sea region could be seen as indication that these specific groups of people were utilising their practices to position and articulate themselves in the landscape. In the wake of these maritime groups, there emerged what could be called a Baltic Sea culture (e.g. Eriksson 2009; Nerman 1954; Sabatini 2007). This Baltic Sea culture continued to exist, albeit in a gradual state of change, up to about 200 cal BC (Wehlin 2013).

The people living on the seaboard of this inland sea seem to have reached a certain degree of consensus as the result of a set of shared and common interests. A substantial part of this concordance might well be explained by the intricate and complex dependency on metal (cf. Earle *et al.* 2015; Hodder 2012; 2018; Ling *et al.* 2014). This explanation would not be possible without an infrastructure or network, in this case a maritime one. Such a network might be explained by the maritory concept (Needham 2009). A maritory is defined as a geographical system, rather than a geographical area. In this way, both biological and ecological elements can be included, as well as their structural relations and functional processes. These elements include maritime resources, streams, river estuaries, people, provisions and essential materials (Figure 7).

Long-distance journeys within, and on occasion beyond, the maritory should be viewed as well-planned undertakings, involving the main bulk of society and requiring appreciable investments; these decisions were probably made for well-founded reasons. The prime lure at this time was metal. The question is raised, however, as to what goods travelled in the opposite direction. An early suggestion was amber. Yet however important amber might have been in this network (Kaul 2018; Ling *et al.* 2014), it was probably not of sufficient importance *per se* to sustain the entire network. There is a whole range of alternative suggestions for possible southward-bound export goods. Furs and hides were likely important components (Kristiansen 1998) and maybe even more important sheep, given the significance of wool and textiles (e.g. Sabatini and Bergerbrant 2020). The importance of seals has also been overlooked (e.g. Gustavsson 1997). Even people were likely commodities in this network, not only through marriage alliances, but also as slaves and mercenaries (e.g. Ling *et al.* 2018).

Which routes were followed by these objects and people? There is, for example, evidence that the amber trade route moved in a more easterly direction during the latter part of the Bronze Age (Kristiansen 1998). It would also seem that an established channel of communication was already in existence between the Mälardalen region and Gotland, including the Oder and Wisla region in present day northern Poland and Germany (e.g. Gustavsson 1997; Kneisel 2012; Pokutta 2013; Sabatini 2007). A possible channel of communication would be from the south coast of the Baltic Sea via the Baltic states to the gulf of Riga and then across to Gotland and on to the Mälardalen region. Another possibility would be a direct link to Gotland from northern Poland. A third variant would be from the Swedish east coast and Mälardalen region across Gotland or Åland to the Estonian islands of Hiiumaa and Saaremaa, as well as to northern Latvia and onwards along the river Daugava in a southerly direction (Figure 7).

Kristian Kristiansen and Thomas B. Larsson (2005) have proposed that chieftains undertook long-distance journeys in order to learn new skills which would win them favour at home. However, I feel somewhat reluctant to accept this theory. It may well be that some leading individuals initially carried out journeys, but if one’s clout on home ground is to be maintained, a continuous presence is vital. I suppose that the journeying traders and maritime specialists should be seen as more liberated from the local political elite (cf. Oka and Kusimba 2008). Prerequisites for sovereignty of the sea probably included being in control of resources and acquiring the necessary knowledge to be able to carry out these journeys. The ruling chieftains carried local clout, and thereby the wealth to defray the costs of journeys abroad. The maritime specialists should thus be viewed as a group of people with the entitlement to travel, granted by the prerequisites of their society. These maritime specialists were specifically linked by their practices and directly related to the maritory, which might well explain the different designs of the ship setting monuments. In all probability it is the venerable maritime specialists and their closest kin who can be related to a particular monument.

Above, I have proposed that areas with clusters of ship settings and larger monumental hillforts and ramparts might constitute suitable locations for meeting places. Hillforts have been interpreted as consumption and production sites which were used for temporary gatherings and events, activities which required a progression and a larger number of people than the individual household could muster. Such activities could be related to the maritory, for instance boat building or production of goods for export and exchange. Hillforts might have been places where settlement units gathered, but also in a broader sense where different social units from different districts convened; the larger locations might have been the hub of the district/chiefdom. These locations can be viewed as temporarily used sites where people within the district gathered, for example on the arrival of certain goods such as bronze. Thus, a large bulk of resources would have been channelled to these sites irregularly, depending on the arrival of significant consignments by boat. The hillforts thereby acquired a multifaceted position, both as symbols of power and status, and of defence. Since hillforts were found within the entire Baltic Sea region, they were also a recognisable factor, which created a spatial structure and a sense of security for visitors (cf. Cassel 2008).

Conclusion

The Baltic ship settings mainly date to Montelius periods IV-V (1100-700 cal BC). At this time the number of metal objects in the Baltic Sea region increased tremendously. Mobility and interaction in this northern inland sea intensified; the ship settings could be an expression of this intensified interaction. In this paper I have shown that the Baltic ship settings should be related to a specific group of people, who through the ship monuments utilised their practices to position and articulate themselves in the landscape. These people might have been part of a maritime institution specialising in trade and long-distance journeys during this period, thus achieving a more maritime way of life in the Baltic Sea.

With such a view of the ship settings, their place and the surrounding landscape could be discussed in terms other than just as burial monuments. Firstly, some ship settings do have special features which can only be understood in the context of a contemporary ship-building tradition. These features, together with ship images from the same period, such as in rock art, give indications of how Bronze Age ships might have looked. Secondly, the upright stones in and around the ship settings can be interpreted in different ways. One example includes representations for a memory tool, such as for sea routes or genealogies. This would have been a tool for teaching navigation and life at sea. Thirdly, the location of ship settings in the landscape could give insights of possible places for meetings, a sort of antecedent of harbours. Clusters of ship settings are often located at navigational points or nodes in the landscape. Near these sites are larger monumental constructions such as hillforts and ramparts. Some of these mega-structures have been dated to the Bronze Age and might well have been early meeting places and aggregation sites.

Moreover, there are several indications of changes taking place during the Late Bronze Age. To some extent the communities around the Baltic Sea differed from the Nordic Bronze Age sphere. In the wake of these maritime groups, there emerged what could be called a Baltic Sea culture c. 1000-200 cal BC. The communities around the Baltic Sea, through the establishment and sharing of mutual interests, seem to have reached a certain degree of consensus. This concordance might well be explained by the complex dependency on metal. Such a manifestation would not have been possible without an infrastructure or network, in this case a maritime one: a “Baltic maritory”.

Acknowledgements

The author thanks Paul Wallin at Uppsala University, Campus Gotland, for providing results from the virtual project on Gothemshammar.

Bibliography

Almgren, O. 1927. *Hällristningar och kultbruk: bidrag till belysning av de nordiska bronsåldersristningarnas innebörd*. Stockholm: Wahlström & Widstrand.

Andrén, A. 1993. Doors to other worlds: Scandinavian death rituals in Gotlandic perspectives. *Journal of European Archaeology* 1, 33-56.

Arnberg, A. 2007. *Där människor, handling och tid möts: en studie av det förromerska landskapet på Gotland*. Stockholm: Stockholms universitet.

Artelius, T. 1996. *Långfärd och Återkomst – skeppet i bronsålderns gravar.* Kungsbacka: Riksantikvarieämbetet Arkeologiska Undersökningar.

Baudou, E. 1960. *Die regionale und chronologische Einteilung der jüngeren Bronzezeit im nordischen Kreis.* Stockholm: Almqvist & Wiksell.

Bengtsson, B. 2017. *Sailing rock art boats: a reassessment of seafaring abilities in Bronze Age Scandinavia and the introduction of the sail in the North*. Oxford: BAR Publishing.

Blinova Högberg, S. 2019. *Gravskick i Gotländska skeppssättningar. En osteologisk analys av kremerade ben. Kandidatuppsats i osteologi.* Uppsala: Uppsala universitet.

Bradley, R. 1998. *The significance of monuments: on the shaping of human experience in Neolithic and Bronze Age Europe*. London: Routledge.

Bradley, R. 2006. Danish razors and Swedish rocks. Cosmology and the Bronze Age landscape. *Antiquity* 80, 372-89.

Bradley, R., Skoglund, P. and Wehlin, J. 2010. Imaginary vessels in the Late Bronze Age of Gotland and south Scandinavia: ship settings, rock carvings and decorated metalwork. *Current Swedish Archaeology* 18, 79-103.

Bradley, R., Nimura, C. and Skoglund, P. 2020. Meetings between strangers in the Nordic Bronze Age: the evidence of southern Swedish rock art. *Proceedings of the Prehistoric Society* 86, 261-83.

Capelle, T. 1986. Schiffssetzungen. *Praehistorische Zeitschrift* 61, 1-63.

Cassel, K. 2008. *Det gemensamma rummet: Migrationer, myter och möten*. Huddinge: Södertörns högskola.

Clark, P. (ed.) 2004. *The Dover Bronze Age boat in context. Society and water transport in prehistoric Europe*. Oxford: Oxbow Books.

Clark, P. (ed.) 2009. *Bronze Age connections. Cultural contact in prehistoric Europe.* Oxford: Oxbow Books.

Crumlin-Pedersen, O. and Munch Thye, B. (eds) 1995. *The ship as symbol in prehistoric and medieval Scandinavia. Papers from an international research seminar at the Danish National Museum, Copenhagen, 5th-7th May 1994*. Copenhagen: National Museum.

Earle, T.K., Ling, J., Uhnér, C., Stos-Gale, Z. and Melheim, L. 2015. The political economy and metal trade in Bronze Age Europe: understanding regional variability in terms of comparative advantages and articulations. *European Journal of Archaeology* 18, 633-57.

Eriksson, T. 2009. *Kärl och social gestik: keramik i Mälardalen 1500 BC-400 AD*. Uppsala: Uppsala universitet.

Fahlander, F. 2019. Fantastic beings and where to make them: boats as object-beings in Bronze Age rock art. *Current Swedish Archaeology* 27, 191-212.

Gustavsson, K. 1997. *Otterböte: new light on a Bronze Age site in the Baltic*. Stockholm: Stockholms universitet.

Hallin, G. 2002. *Kummel, skepp och koksten – en studie om bosättningsområden och social struktur under bronsåldern på Gotland*. Stockholm: Stockholms universitet.

Hansson, H. 1927. *Gotlands Bronsålder.* Stockholm: Stockholms universitet.

Hjärthner-Holdar, E. 1993. *Järnets och järnmetallurgins introduktion i Sverige.* Uppsala: Uppsala universitet.

Hodder, I. 2012. *Entangled: an archaeology of the relationships between humans and things*. Malden, MA: Wiley-Blackwell.

Hodder, I. 2018. *Where are we heading? The evolution of humans and things*. New Haven: Yale University Press.

Ilves, K. 2011. Is there an archaeological potential for a sociology of landing sites? *Journal of Archaeology and Ancient History* 2, 1-31.

Kaul, F. 1998. *Ships on bronzes. A study in Bronze Age religion and iconography*. Copenhagen: National Museum.

Kaul, F. 2018. Middle Bronze Age long distance exchange. Early glass, amber and guest-friendship, xenia. In B. Nessel, D. Neumann and M. Bartelheim (eds), *Bronzezeitlicher Transport, Akteure, Mittel und Wege,* 189-211. Tübingen: Tübingen University Press.

Kneisel, J. 2012. *Anthropomorphe Gefäße in Nord- und Mitteleuropa während der Bronze- und Eisenzeit. Studien zu den Gesichtsurnen – Kontaktzonen, Chronologie und sozialer Kontext.* Bonn: Rudolf Habelt.

Kristiansen, K. 1998. *Europe before history*. Cambridge: Cambridge University Press.

Kristiansen, K. and Larsson, T.B. 2005. *The rise of Bronze Age society. Travels, transmissions and transformations*. Cambridge: Cambridge University Press.

Laneman, M., Lang, V., Malve, M. and Rannamäe, E. 2015. New data on Jaani stone graves at Väo, northern Estonia. *Estonian Journal of Archaeology* 19, 110-37.

Lang, V. 2007. *The Bronze and Early Iron Ages in Estonia*. Tartu: Tartu University Press.

Lewis, D. 1975. *We, the navigators. The ancient art of landfinding in the Pacific*. Honolulu: University of Hawaii Press.

Ling, J. 2008. *Elevated rock art. Towards a maritime understanding of Bronze Age rock art in northern Bohuslän, Sweden*. Göteborg: Göteborgs universitet.

Ling, J. 2013. *Rock art and seascapes in Uppland.* Oxford: Oxbow Books.

Ling, J., Stos-Gale, Z., Grandin, L., Billström, K., Hjärthner-Holdar, E. and Persson, P-O. 2014. Moving metals II: provenancing Scandinavian Bronze Age artefacts by lead isotope and elemental analyses. *Journal of Archaeological Science* 41, 106-32.

Ling, J., Earle, T.K. and Kristiansen, K. 2018. Maritime mode of production: raiding and trading in seafaring chiefdoms. *Current Anthropology* 59, 488-524.

Malinowski, B. 1984 [1922]. *Argonauts of the western Pacific. An account of native enterprise and adventure in the archipelagos of Melanesian New Guinea*. Long Grove, IL: Waveland Press.

Martinsson-Wallin, H. and Wehlin, J. 2018. Stones in the south – decoding Bronze Age ritual practices on Gotland. *Current Swedish Archaeology* 25, 227-56.

McGrail, S. 2001. *Boats of the world: from the Stone Age to medieval times*. Oxford: Oxford University Press.

Meller, H. (ed.) 2004. *Der geschmiedete Himmel. Die weite Welt im Herzen Europas vor 3600 Jahren.* Stuttgart: Theiss.

Montelius, O. 1885. *Om tidsbestämning inom bronsåldern med särskildt afseende på Skandinavien*. Stockholm: Kungliga Vitterhetsakademien.

Needham, S. 2009. Encompassing the sea: “maritories” and Bronze Age maritime interactions. In P. Clark (ed.), *Bronze Age connections. Cultural contact in prehistoric Europe*, 12-37. Oxford: Oxbow Books.

Nerman, B. 1954. Yngre bronsåldern – En första svensk vikingatid. *Fornvännen* 49, 257-85.

Nimura, C., Skoglund, P. and Bradley, R. 2019. Navigating inland: Bronze Age watercraft and the lakes of southern Sweden. *European Journal of Archaeology* 23, 186-206.

Nordenborg Myhre, L. 2004. *Trialectic archaeology. Monuments and space in southwest Norway 1700-500 BC*. Stavanger: Arkeologisk museum i Stavanger.

Nylén, E. 1972. *Mellan brons- och järnålder. Ett rikt gravfynd och dess datering med konventionell metod och C14*. Stockholm: Kungliga Vitterhetsakademien.

Nylén, E. 1993. The stones in the south. *TOR* 25, 119-28.

Oestigaard, T. and Goldhahn, J. 2006. From the dead to the living: death as transaction and re-negotiations. *Norwegian Archaeological Review* 39, 27-48.

Ojala, K. 2016. *I bronsålderns gränsland. Uppland och frågan om östliga kontakter*. Uppsala: Uppsala universitet.

Oka, R. and Kusimba, C.M. 2008. The archaeology of trading systems, part 1: towards a new trade synthesis. *Journal of Archaeological Research* 16, 339-95.
Olausson, M. 1995. *Det inneslutna rummet: om kultiska hägnader, fornborgar och befästa gårdar i Uppland från 1300 f. Kr. till Kristi födelse*. Stockholm: Stockholms universitet.
Pokutta, D.A. 2013. *Population dynamics, diet and migrations of the Únětice culture in Poland*. Göteborg: Göteborgs universitet.
Polanyi, K. 1963. Ports of trade in early societies *The Journal of Economic History* 23, 30-45.
Röst, A. 2016. *Fragmenterade platser, ting och människor. Stenkonstruktioner och depositioner på två gravfältslokaler i Södermanland, ca 1000-300 f Kr*. Stockholm: Stockholms universitet.
Runesson, G. 2014. *Bronsålderns bosättningsområden och boplatser på Gotland. Många syns inte men finns ändå.* Stockholm: Stockholms universitet.
Sabatini, S. 2007. *House urns. Study of a Late Bronze Age trans-cultural phenomenon*. Göteborg: Göteborgs universitet.
Sabatini, S. and Bergerbrant, S. (eds) 2020. *The textile revolution in Bronze Age Europe: production, specialisation, consumption*. Cambridge: Cambridge University Press.
Sindbæk, S.M. 2007. Networks and nodal points: the emergence of towns in Early Viking Age Scandinavia. *Antiquity* 81, 119-32.
Skoglund, P. 2008. Stone ships: continuity and change in Scandinavian prehistory. *World Archaeology* 40, 390-406.
Skoglund, P. and Wehlin, J. 2013. A Bronze Age ship made of stone: record and analysis of a ship setting from Lau, Gotland. In S. Bergerbrant and S. Sabatini (eds), *Counterpoint: essays in archaeology and heritage studies in honour of Professor Kristian Kristiansen*, 491-98. Oxford: Archaeopress.
Sörman, A. 2018. *Gjutningens arenor. Metallhantverkets rumsliga, sociala och politiska organisation i södra Skandinavien under bronsåldern*. Stockholm: Stockholms universitet.
Sperling, U. 2014. *Aspekte des Wandels in der Bronzezeit im Ostbaltikum. Die Siedlungen der Asva-Gruppe in Estland*. Tallinn: Estonian Academy Publishers.
Thrane, H. 1975. *Europæiske forbindelser. Bidrag til studiet af fremmede forbindelser i Danmarks yngre broncealder (periode IV-V)*. København: Nationalmuseet.
Tilley, C. 1994. *A phenomenology of landscape: places, paths and monuments*. Oxford: Berg.
Vandkilde, H. 2016. Bronzization: the Bronze Age as pre-modern globalization. *Praehistorische Zeitschrift* 91, 103-223.
Vansina, J. 1965. *Oral tradition. A study in historical methodology*. Chicago: Aldine Publishing Company.
Wallin, P., Wehlin, J., Norderäng, J. and Kristiansson, M. 2011. *Stenvallen i Gothemshammar: Rapport över arkeologisk undersökning 2009. RAÄ-131, Busarve 1:34 och 1:35, Gothem sn, Gotland*. Visby: Avdelningen för arkeologi, Högskolan på Gotland.
Wehlin, J. 2010. Approaching the Gotlandic Bronze Age from sea. Future possibilities from a maritime perspective. In H. Martinsson-Wallin (ed.), *Baltic prehistoric interactions and transformations: the Neolithic to the Bronze Age,* 89-109. Visby: Gotland University Press.
Wehlin, J. 2012. Accompanying the stone ships. Circular stone settings in relation to the Gotlandic ship settings. In R. Berge, M.E. Jasinski and K. Sognnes (eds), *N-TAG TEN. Proceedings of the 10th Nordic TAG conference at Stiklestad, Norway 2009,* 59-70. Oxford: Archaeopress.
Wehlin, J. 2013. *Östersjöns skeppssättningar. Monument och mötesplatser under yngre bronsålder.* PhD dissertation, Göteborgs universitet.
Wehlin, J. and Sabatini, S. 2020. Två nya husurnor från Gotland. *Fornvännen* 115, 198-202.
Wright, E. 1990. *The Ferriby boats. Seacraft of the Bronze Age*. London: Routledge.

THE BALTIC IN THE BRONZE AGE

The Bronze Age is a time of increasing interaction with large-scale connections that cover vast parts of Europe. Some parts and regions of the Bronze Age are very well explored and for some very strong narratives of hierarchisation and differentiation, dependence on external raw material supplies and specialisation have been proposed.

In other regions, however, only some of these aspects appear, even though networks of contact would at least have been possible. This is the case in the Baltic area, where western and eastern regions show dramatic differences in subsistence, the amounts of metal produced and deposited (and therefore presumably the social role of metal), the settlement pattern and scale of social groups. A particularly interesting question is the intensity of culture contact that the eastern Baltic regions entertained across the sea with Scandinavia and also with directly neighbouring continental regions.

This volume brings together scholars from all regions around the Baltic Sea to discuss different aspects of Bronze Age interactions. It offers a perspective on regional and interregional connectivity and exchange beyond the usual large-scale models discussed in Bronze Age archaeology and includes both case studies of individual regions or finds categories and broader overview papers focusing on the diversity of interconnections – and their sometimes striking absence.

sidestonepress

ISBN: 978-94-6427-018-1

9 789464 270181 >

Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

UNIVERSITY OF BERGEN