Bronze Age Metalwork

Techniques and traditions in the Nordic Bronze Age 1500-1100 BC

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Archaeopress Archaeology

ARCHAEOPRESS PUBLISHING LTD
Summertown Pavilion
18-24 Middle Way
Summertown
Oxford OX2 7LG

www.archaeopress.com

ISBN 978-1-78969-019-4
ISBN 978-1-78969-020-0 (e-Pdf)

Cover: Three belt plates from the Vellinge Mose depot, Bederslev sogn, Odense Amt. The belt plates NM 25788, NM B2654 and B2655 are located in the Nationalmusem Copenhagen. Pictures were taken by Heide W. Nørgaard with permission of the National Museum Copenhagen.

The research leading to this book has received funding from the European Union Seventh Framework Program (FP7/2007-2013) under grant agreement no. 212402.

Publishing was made possible through the funding of the Danish National Research Council, Sapere Aude program.

To my husband and my two perfect girls,

Thank you

„Seht ihr den Mond dort stehen?
Er ist nur halb zu sehen,
und ist doch rund und schön!
So sind wohl manche Sachen,
die wir getrost verlachen,
weil unsre Augen sie nicht sehen.“

(Matthias Claudius, 1790)

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Preface

This book presents the slightly reworked version of my PhD dissertation entitled 'Craftsmanship and Metalwork in the Nordic Bronze Age: Craft Organisation, Craftspeople and their Areas of Contact', submitted in December 2014 at Aarhus University.

Due to the vast topic and range of potential approaches to the subject, this study is divided into four main parts – an introductory section, two methodological sections, and an evaluation of the material and data. In order to allow the reader to individually choose preferences, while structuring the work, much attention was paid to ensuring that each part (the analysis as well as the theoretical background) in itself is coherent. As such, each part has a separate introduction and history of research, in order that the basic literature on each of the three main parts (material, craft and theory) can be quickly established.

Acknowledgements

The research leading to the results presented here has received funding from the European Union Seventh Framework Program (FP7/2007-2013) under grant agreement no. 212402.

Additionally, this work would not have been possible without the support of my supervisors Helle Vandkilde and Svend Hansen, as well as my colleagues in Moesgård and in the Eurasia Department in Berlin hereunder, especially Constanze Rassmann and Sam Reiter and the rest of the 'Forging team'. The publication of this study is supported by the Danish National Research Council Sapere Aude program.

My special thanks to all the supporting museums and collections who allowed me to closely examine the artefacts in the museums and gave me permission to use the material for this study:

Archäologisches Landesmuseum Mecklenburg, Schwerin (Detlef Jantzen, Jens-Peter Schmidt and Peter Teichert-Köster), Archäologische Museum Oldendorf/Luhe (Gemeinde Oldendorf/Luhe und Dietmar Gehrke), Bergbaumuseum Bochum (Andreas Hauptmann, Michael Prange, Ingolf Löffler, Moritz Jansen, Dirk Kirchner, Andi Ludwig) Helms Museum Hamburg-Harburg (Michael Merkel), Landesmuseum für Kunst und Kulturgeschichte Schloss Gottorf (Ingrid Ulbricht), Nationalmuseet København (Flemming Kaul; Kirsten Lindhard), Niedersächsisches Landesmuseum Hannover (Ulrike Weller, Katja Lembke, Stephan Veil), Moesgård Museum Aarhus (Peter Mikkelsen, Helle Strehle, Lise Frost), Museum für Ur-und Frühgeschichte Berlin (Alix Hänsel), Museum Lüneburg (Dietmar Gehrke, Heike Düsselder), Regionalmuseum Neubrandenburg (Rolf Voß, Ralf Bruse).

Introduction

This study has its roots in a source-critical classification of Nordic Bronze Age collars, from which was born the question as to the extent to which a formal typological classification of objects would allow statements about the actors behind such artefacts. Knowing that occasionally workshops are determined using typological studies (i.e. Jockenhövel 1991: 51; also Aner 1962; Torbrügge 1965: 98; Jankuhn 1969: 89) a pertinent question was how far ranging the significance of a formal type-classification could be, and if more information than just the chronological and regional distribution might be extracted from classificatory studies. Consequently, a series of questions was formulated, centred around the possibility of tracing the acting agent behind the material culture bequeathed to us from the Bronze Age in northern Europe.

After consulting selected anthropological and sociological literature, which aroused my interest, partly due to my background as a trained goldsmith, the core questions were developed: is it possible, by an intensive study of the material remains of the Bronze Age in northern Europe, to reconstruct the production of metal artefacts, and to determine the workshop in which these artefacts were made, as well as their area of influence? Can an identification of the acting agent be of use in regard to the organisation of metalcraft in the Nordic Bronze Age (NBA)?

The fact that the basic physical properties of the materials under study are not subject to any change in time allows a reconstruction of craft techniques based on traces left on the object. The aim of the study was not to ascertain a name and 'telephone number' to the acting agent, but rather to show that knowledge of the individual and his/her actions can make a large contribution to the understanding of broader social groups, an opinion different to that the one expressed by Marcia-Anne Dobres: 'attributing some identity to a past social dynamic...is not necessarily going to help us understand how such practices were part of social tradition' (2000: 142).

The material to be examined was defined quickly. In order not to manipulate the interpretation of possible traces or decorative elements through utilising artefacts falsely interpreted as being of Nordic origin, the source material needed to be critically examined, for example the neck collars of the NBA periods II and III (Nørgaard 2011). In addition, all bronzes discovered in the same context were considered potentially suitable for investigation, so that the material selected included the majority of the magnificently decorated ornaments within the chosen area, such as neck collars, belt discs and plates, pins, fibula, tutuli and, occasionally, arm and leg ornaments.

In archaeology it has long been a common assumption that stylistic similarity is equal to technical similarity and, thus, that the dissemination area of typological groups can be related to workshops. With the understanding that formal similarities can actually arise independently of their production, and that they should, therefore, be considered separately, it was noted that workshops can only be detected by the exact knowledge of all objects of a formal group and then only by technical comparison. This statement can be restricted even more: a determination of a prehistoric workshop is only possible if the production traces, metal compositions and other production-related properties of the object match.

The term 'workshop' in the modern sense, as defined in the Oxford Dictionary, is 'a room/ building in which things are made or repaired using tools' (Phillips *et al.* 2010: 1779). A very different meaning applies in art history to the term 'workshop'. Beyond the simple description of the workplace, the workshop concept involves a close relationship between the living and working space of the artist (also potentially several people), and the work area should meet specific requirements. Workshops are compared with handicraft production facilities and the training of apprentices is included in the same manner under this term, as art schools and 'Meisterhäuser' are equated with workshops (Strauss *et al.* 1987). Art produced in one workshop is not necessarily made by one artist, rather, it should be seen as work that was done by several persons working for the specific artist (Strauss 1994). As for prehistory, a direct correlation should not be made, the workshop concept needs to be redefined in our sense. Thus, one needs to define between workplace and workshop. A workplace includes the working space of one or several craftspeople as well as those who are involved in the crafting operations, for instance helping hands or apprentices. A workshop, on the other hand, is defined by the people, the close technical interaction between craftspeople, and not the physical location were these actions are executed. As such, this study introduces the term of an *analytical workshop*, to determine the closest interaction group of craftspeople and a probable location were these craftspeople operated, solely based on the material culture investigated. Within this study it will be outlined that within a workshop the individuals are in close relationship (physically and technically), and thus, the term 'analytical workshop' will be used to describe the specific way in which the objects were made.

The foundation for a successful identification of workshops is based on the knowledge that each craftsman's intuition leaves its mark, like fingerprints. The choice of the tool, the way in which a decorative element is introduced and combined, and the various techniques used, are individual decisions that make the object of a craftsman unique and allow us to assign artefacts to specific individuals. A similar approach is a common tool in art history as a means of determining the artist through a chain of individual characteristics (Gell 1998). Specific face types, a small mouth and small pointed noses, may be assigned to the Cologne Master. The way in which the ornamental foliages and brocade fabrics are made can be used as a clear indication of the influence of Broederlam[1] and their simplification might indicate the development of these forms by his apprentices (Panofsky 1981: 87-89).

In our modern world it is almost impossible within all the mass-produced products to identify the individual character of an object. In the Bronze Age, however, above all between 1700-1100 BC, it is very likely that the ornaments and weapons were unique. Thus, the uniqueness of an object depends to a large extent on the technology with which it was produced. The Nordic Bronze Age is characterised by large, massive bronze ornaments, some of which are extensively decorated. Nevertheless at the beginning of this period, simple weapons appear, as well as mainly undecorated ornaments. This stylistic difference is based on the technique used to craft the artefacts. Ornaments, between 1800-1600 BC, were mostly made by forging. Only weapons and tools were cast in clay and stone moulds, and later also via *cire perdue*. The metalworkers of NBA IB were true masters of their craft, as demonstrated by the neck ring set from Tinsdahl (Drescher 1953).

Conversely, the large bronze ornaments of NBA II and III were mainly made via casting. The 'new methods', such as the *cire perdue* cast, allowed a much finer decoration, since the individual motifs were introduced into a wax model. On forged objects individual tracks are easily recognisable as the metal, once deformed, cannot be returned to its original form without leaving a trace. Artefacts produced by casting in reusable moulds may resemble each other strongly, and since all errors and peculiarities of the original or the form are passed on here, additionally the possibility exists of an identification of related artefacts (see Jantzen 2008). However, objects that are made via *cire perdue* are inevitably individual pieces. In this situation, where the final form is already defined in the wax model and the design applied using specially made tools it might be possible to identify the Bronze Age smith and his/her area of influence.

As such the artefacts with similar or identical tool-traces shall be related to an individual craftsperson. Artefacts mirroring similar techniques or ways of doing may also be made by one and the same person, however, they can also derive from a closely related group of craftspeople, from a workshop. A workshop, as used in this work, displays the smallest interaction group in metalcraft (after Redman 1977: 44), based on the concept that craftspeople working in close interaction are able to share tacit knowledge and, thus, parts of their *habitus* will be similar. As the artefacts within this study are assigned to a specific workshop solely by their residues of the crafting process, the predicted location of this specific workshop is fictive. Only occasionally are physical workshops preserved, which can be explained through the invisibility of the stationary tools in settlements, although, this study relies on the material culture to define these workshops. As a result, these workshops should be seen as 'analytical workshops' and stay as such until further studies will reveal the actual location where the artefacts might have been crafted. Hereafter, the defined analytical workshops are indicated as (AW), however, within the text the term workshop will still appear and is to be understood in the above-defined way. All physical excavated sites related to metalwork will be named working or metalworking places.

Definition of terms

In the following, the terminology is discussed in order to provide an understanding of key terms and to demonstrate how the perspective of the author relates to the methodologies and analyses employed in the study.

Technique and technology

Technique and technology should be considered as two independent concepts. Yet their meanings have undergone change over the centuries, with the result that both terms are interpreted in a modern perspective in a very different way than contained in the origin of the word (Ingold 2000: 312ff.).

Regardless of modern views (see Ingold 2000: 312-313), technique as well as technology should (in the study of prehistoric communities) be understood through a return to the roots of the respective terms. Thus the word technology originates from the Greek *tekhnē* and *logos*. *Tekhnē is* the pictorial representation of an inseparable combination of art, skill, craft, law, as well as knowledge, attitudes, understanding and

[1] Melchior Broederlam von Ypern (from 1387 to 1409 named in the account books at the court of King Phillip of Burgundy) was one of the greatest Pre-Eyckian panel painters. His most important works are the paintings on the wooden altar created by Jacques de Baerze (1394), including the 'Adoration of the Magi' and the 'Childhood of Christ' cycle (Panofsky 1981: 83-88).

awareness (see Phillips *et al.* 2010; Dobres 2000: 50-59; Ingold 2000: 316). *Logos* in its original meaning is not only reason, the structure of reality, but also language and accountability. Interestingly, the term *technikos* in its original meaning includes the ability, the art and practicality, and thus all things *tekhnē* means (see Dobres 2000: 52).

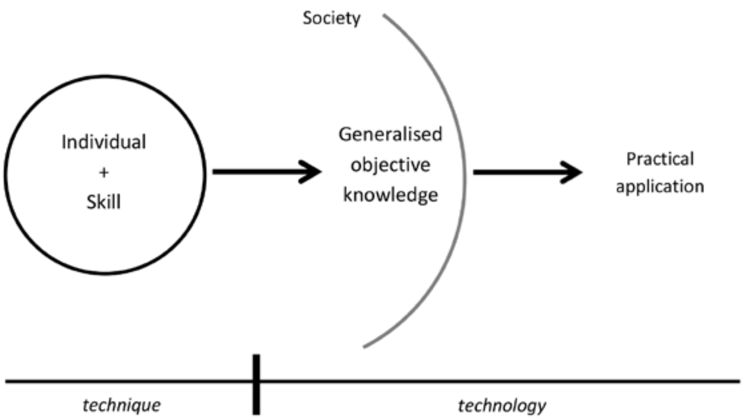


Figure 1.001: Schematic illustration of the difference between technique and technology.

What, then, is technique? The definition in the German Language Dictionary *Duden* 'die Gesamtheit der Maßnahmen... die dazu dienen, naturwissenschaftliche Erkenntnisse praktisch nutzbar zu machen' (Wermke *et al.* 2001: 981), demonstrates clearly the controversy concerning the origin of the word. The Oxford Dictionary defines technique as 'a way of carrying out a particular task, especially the execution or performance of an artistic work or a scientific procedure' (Phillips *et al.* 2010: 1589). However, when defining the word technique Ingold remembers its Greek origin (whether classically interpreted by Aristotle or non-Aristotelian) and describes technique as 'personal skills and capabilities where the person ... applies motor force, guides the movement of the tool' (Ingold 2000: 315).

Nevertheless, why should technology and technique be considered independently if indeed the origins of both words contain similar meanings?

According to the state of the art in the humanities, technology can be considered as an embodied form of social practice (Dobres 1999a; 1999b: 126; Mauss 1973; Lemonnier 1993: 3; Ingold 2000: 314) and is in this not just limited to craft activities, because technologies are the driving forces in material, as well as in social change, and serve as a medium through which views are expressed (see Dobres 1999b: 128; Berg 2007: 234; Zagal-Mach 2008: 197; Coupaye 2009: 434). Technologies are thus man-made processes that offer a way for further development and are 'a major causal motor of cultural evolution...(and it) is said to underline and thus shape most other aspects of culture' (Dobres 2010:103).

Technology can first and foremost be viewed as an agglomeration of different choices that express the cultural environment, and not a process driven by a single individual. The triggers are 'the satisfaction of various needs' (Mahias 1993: 166; see also Berg 2007: 234). Technology is born from the knowledge of what is possible (Sillar and Tite 2000: 9; Zagal-Mach 2008: 197; Ingold 2000: 315).

The origin of both words contains the direct reference to an individual's ability to create. This does not require any equipment or tool, in contrast to modern definitions. Ingold underlines the difference clearly when he shows that ability and knowledge come from the individual and a possible tool is to be regarded as the extension of limbs: 'If all technical activity is tool-using activity, it is because the technique is seen to reside, outside the user, in the tool, and to come "packaged" – like the instruction manual for a piece of modern machinery – along with the tool itself... to the contrary... technique is embedded in, and inseparable from, the experience of particular subjects in the shaping of particular things' (Ingold 2000: 315).

Thus, the basis of both terms is the ability of the agent, his knowledge and the practical exercise (Dobres 2000: 52; Ingold 2000: 316). The fundamental difference between technique and technology lies therefore in the integration of the social (Figure 1.001). With the objective knowledge of the society, techniques become technologies (see also Martinón-Torres 2002: 35).

In this work, the term 'technology' is defined as follows: a certain way to carry out a practical action (a technique) that is controlled by society. In this, the knowledge of individuals and the knowledge in which way such an action is to be executed is to be seen as the basis – the knowledge of the possible. The society that controls this knowledge directs the processes and decides when and what action seems appropriate. Technology is to be regarded as a social process; as a whole grown from the group, which builds on the knowledge and skills of individuals. Technique, however, should be understood as the individual's ability to create an object in combination with his knowledge, skill and will.

Craft or craftsmanship

The term 'craft' is shaped by our modern society. Jantzen explains in regard to the German term 'Handwerk', that: 'der Begriff „Handwerk" eine Organisationsform bezeichnet, die sich erst im Mittelalter und in der Neuzeit herausbildet' (Jantzen 2008: 6).

Craft was considered as a counterpoint to pre-industrial production. Craft in this sense describes commercial products based on production by hand. However, this does not mean at all that a use of the term in prehistory is not possible (in contrast: Jantzen 2008: 6).

To further extract the meaning of the discussed term, both the English and German word is examined. The German word consists of two parts, 'Hand' and 'Werk'. A definition of the first term is not necessary because of its unambiguity. The second part, however, should be considered in more detail. A 'Werk' is equated with work or activity. Interchangeably the term 'creation' can be used. In its basic meaning 'Handwerk' is therefore the work of the hands. Viewed in this way, the term does not include any reference to the modern industrial world. It just describes an activity exerted by hand.

In English, the term craft is accompanied by two similar terms. One is craftsmanship and the other handicraft. The latter similarly connects to the German concept of an activity executed by hand. The first term is somewhat more informative. The *Oxford Dictionary* explains craftsmanship as: 'the level of skill shown by somebody in making something beautiful with their hands', and craft is 'an activity involving a special skill at making things with your hands' (Phillips *et al.* 2010: 354).

In this explanation, the ability to create something is the main point. Moreover, in the combination of hand and activity, the qualitative aspect within this combination is of importance. Craft is therefore qualitative work executed by the hand. The term craftsmanship should thus be used by referring directly to extremely skilled work. Understood in this respect the term can be applied within this work without compromise, since the objects presented here are considered to be of high quality and definitely created by hands.

However, what makes craft? What does it take to be a craftsman? According to Sennett 'The craftsman is a more inclusive category ...he or she represents in each of us the desire to do something well, concretely, for its own sake' (2008: 144). Sennett describes as a decisive factor for craftsmanship the desire to do a good job for its own sake (2008: 9). For this, the executive agent requires skills. These are acquired through practical exercise and give the artisans, combined with the necessary knowledge (which can be acquired through learning), the ability to create objects.

On the origin of these skills, there are two different views. One is represented by Sennett and says that 'we

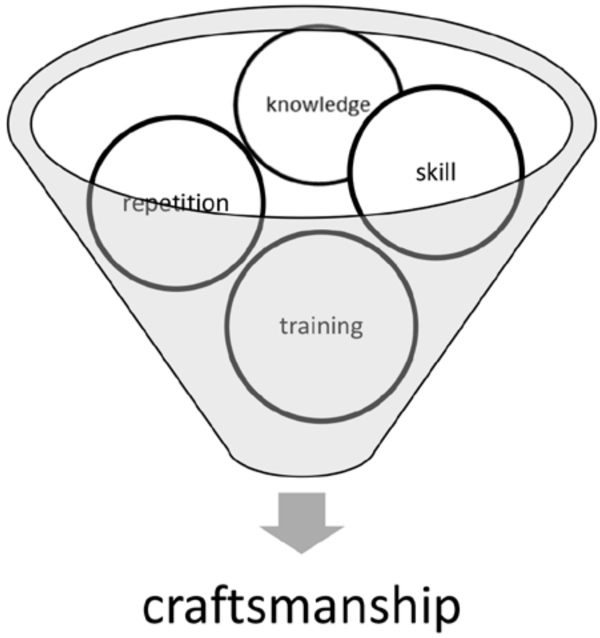


Figure 1.002: Pictured craftsmanship.

share in common and in roughly equal measure the raw abilities that allow us to become good craftsman' (2008: 241) and '... skill is trained practice' (2008: 37). Others see within the abilities of a person an innate 'ability to use one's knowledge effectively and readily in execution or performance' (Bamforth and Finlay 2008: 1). Unity lies, however, within the fact that skills are deepened and expanded through knowledge and practice (Bamforth and Finlay 2008: 19; Berg 2007: 244).

In summary, craft can be defined as follows: The base of craft is the skill of the individual person. A motivation resting within the interest in craft favours the acquisition of skills through practice and learning. The goal is quality work (Figure 1.002).

However, upon a consideration of craft in prehistory a restriction must be made. Schlesier in 1981 first categorised artisanal activities, to facilitate their handling in prehistory. He tried to divide craft with respect to the varying degrees of specialisation, the underlying motivation and its quality, into categories that in the following discussion will help to make statements regarding its integration into a community (Figure 1.003).

Basically, Schlesier distinguished between housecraft and handicraft and defined a third form of craft, the so-called 'subsistence-craft'. This term should describe the intermediate step between homecraft (the items crafted in a household for one´s own use) and full-time crafting (Schlesier 1981: 13; see also Santley and Arnold 1986: 2-4; Olausson 1997: 269; Zagal-Mach 2008: 190). Craftsmen doing subsistence craft produce both for their own use and on demand for others, but without

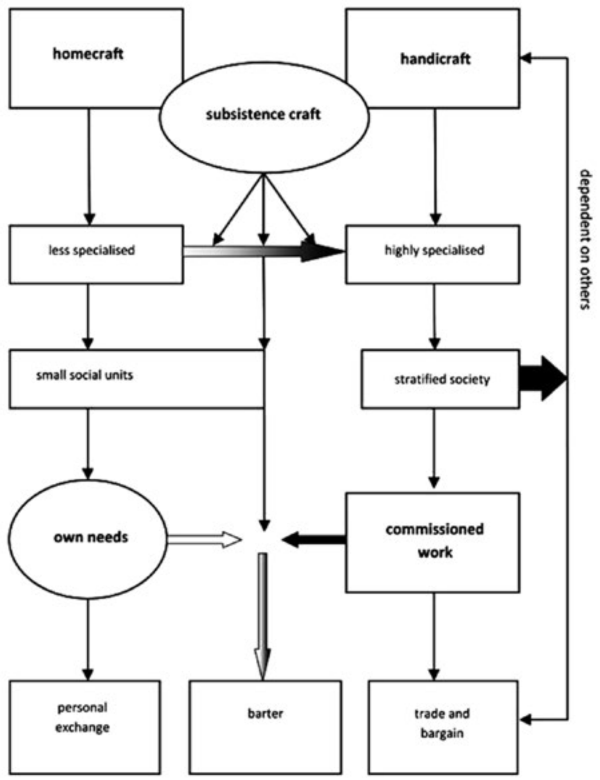


Figure 1.003: Diagram shows the different categories of craftsmanship explained in the text (based on Schlesier 1981).

the intention of selling. Items change hands as barter goods. With this definition, Schlesier created a direct link to the specific market demand and enabled in the same way a statement regarding the 'employment' of the craftsman. Schlesier´s separation of the term craft should initially clarify if the described craft was seen as a full-time activity or a part-time craft, where, in addition, normal economic activities were carried out.

A study of craftsmen activities in prehistory inevitably raises the question of full-time or part-time craft. To get a better picture of the intensity of prehistoric craft it is necessary to be aware of the economic factors required for the performance of a full-time craft. Then a correlation with the possible situation during the Early and Middle Bronze Age can be executed to make an assessment as to whether full-time employment of Bronze Age craftsmen was within the realm of possibility.[2] It is only in surplus-economies that the community is able to provide for other members´ food and living in exchange for specialised work (Rowlands 1971: 212). The ethnography, however, displays additional possibilities for the existence of full-time specialists. The majority of published research on this issue has shown that full-time craftsmanship is commonly related to privileged minorities, or, in other words, elites (Rowlands 1971; 1980; Brumfiel and Earle 1987; Peregrine 1991; Olausson 1997; 1993).

Additional examples demonstrate the exclusion of the metalcraftsman from social obligations due to religious views. This results in an extension of the craft repertoire to other materials such as wood or ceramic. The execution of the described wide range of activities is thus a full-time activity on a low-quality level. In addition to various craft works in wood, the metalworkers of the Margi and Dogon in West Africa operate in the same way as an undertaker or a priest. In return, the population supply these craftsmen with the necessary food and goods (Neipert 2006: 69).

However, the vast majority of ethnographic studies deal with craftsmen who commonly participate in the general economy in addition to their profession. Ethnographic examples, such as that of the Celebres in Indonesia (Marschall 1968: 143), show special forms of part-time metalworkers. They are especially needed before or after the harvest. During this period, customers come with broken or worn tools to be repaired. The otherwise only part-time activity is strongly focused on demand and can thus be applied as a seasonal full-time activity.

The latest thinking on Bronze Age society is that it is considered as a hierarchical society with a complex structure made up of smaller to medium-sized chiefdoms connected through an intensive interaction (i.e. Artursson 2009; 2010; Kristiansen and Larsson 2005; Vandkilde 1996; and with a critical touch also: Johansen *et al.* 2004). In such a society craftsmen bound to an elite would be in the same way imaginable as housecraft and subsistence craft (to stay with Schlesier´s terms). Additionally, the organisational form of village-dependent metalworkers who perform duties according to demand was also highly probable in the Bronze Age. It seems, concerning the question of full-time or part-time activity, that there is no either/or, rather a more varied picture emerges.

Craftsmen and artists

Today the difference in art and craft seems to be quality related, assuming that artists have no knowledge about technical activities and craftsmen no sense for artistic features. Some researchers tend to project this modern separation on prehistory: 'In terms of practice, there is no art without craft' (Sennett 2008: 65).

This postulation brings the scientific debate about art and craft to the fore, because the crucial point is whether there is craft without art in terms of prehistory. However, the Greek philosophers saw the craftsman as inferior next to the artist, so Plato linked the skills in craft with *poiein*, the root word for 'making'. This

[2] In this case, the assumption applies not only to metalcraft, but to prehistoric crafts in general.

same word is the parent word for poetry, which even in Homer is seen as craft activity (Sennett 2008: 24).

What then is the difference between art and craft, or more precisely between artists and craftsmen? It seems that art and craft are closer together than are artists and craftsmen. This seems to be general and valid across time, which could also answer the question on the presence of artists in the history: 'Art seems to draw attention to work that is unique...whereas craft names a more anonymous, collective, and continued practice; (Sennett 2008: 66).

Additionally, in regard to the agent involved in the action a similar difference appears:

> 'art and craft are distinguished first by agency: art has one guiding or dominant agent, craft has a collective agent...and by time: the sudden versus the slow' (Sennett 2008: 73).

Due to the agent and his/her motivation, the fundamental difference between an artist and a craftsman is the agent his or herself (see also Harriman 2007: 5). If one were to ask an artist within a work process as he/she decides the next step, so the answer might be 'While making the object there are nearly no thoughts, just the making'.[3] On the other hand, one sees traditional crafts, where within a workflow each step is directed towards the aim of creating the desired object. Each object requires a specific sequence of work guided by tradition so that it meets expectations. Even unique objects demand a prescribed sequence due to the used technique. It seems as if only the artist is free to create just 'because' (see also Ingold 2010: 97). Exactly this statement leads to another important difference – the group of consumers. An artist is, at best, free in his actions. Even when the artist works on demand, the client is interested in the artist's own facets and therefore in a picture or object of exactly this person. A craftsman is integrated in the social community and rarely independent in his work. From him, made objects serve a purpose and the purpose is of a higher priority than the name of the craftsman. Thus, also in regard to the sales market the agent is the decisive criteria. The products of an artist become valuable because of the artist (Gell 1998: 13), the products of a craftsman are valuable because of their quality. An artist puts *himself* in the forefront (signed works), a craftsman the *object*.

Additionally, Ingold could clarify another difference with respect to the created objects:

> '(Art) does not, in other words, seek to replicate finished forms that are already settled, whether as images in the mind or as objects in the world... It seeks, rather, to join with those very forces that bring form into being' (2010: 91).

To what extent is this distinction relevant for prehistory? There is no doubt that a definition of the discussed terms is not related to the skills of the people. Based on the statement that there is no art without craft (Sennett 2008: 65; Ingold 2000: 350), the two respective kinds of creation are based on skills (poiein). To this end, a distinction between an artist's or a craftsperson's work should not be made based on the quality of the object. Rather it should be oriented on the ideas described above. However, so far the use of such elaborate bronzes, as investigated in this work, and the organisation of metalcraft in the Bronze Age is only partially reconstructed. A definitive statement on the existence of artists and craftsmen as opposite poles is thus hardly possible. However, a few facts can be collected that will help to define arts and crafts in prehistory. An important factor is the representation of the actor behind the created object by using signatures. The overall majority of Bronze Age artefacts in northern Europe have no features that can be understood as a signature of the producer. Furthermore, even the most ambitious bronze ornaments are part of an object group (such as belt plates) and thus, according to Ingold, not to be categorised as art (Ingold 2010: 91). Nevertheless, they show a high degree of artistic skill and inspiring action. However, as already noted in the introduction, the weight of the distinction is not on the skills necessary for the production.

With respect to the issue addressed in this work, and possibly generally transmittable to metalcrafting in prehistory, I want to distance myself from the concept of the artist. I would like to even go as far as to assert that within the metalwork of the Bronze Age there was no distinction between artists and craftsmen, just very talented craftsmen. This is based on the fact that a craftsman, who creates such detailed bronzes, can only achieve this result if he/she is familiar with all operations within the operational sequence. From the moment the object develops in the mind of the craftsman until its completion, a qualified craftsman is able to perform all steps of the necessary sequence: alloying the required alloy, forming the best possible mould, decorating the model or the cast piece, the casting itself – all these steps can be performed by the same agent. Only one who knows how the red-hot metal flows and what problems could occur can also decide how the model must be shaped so that the casting succeeds. Even if in the production of many objects several actors might be involved, the production of such an object must be controlled by one person. Modern ethnographic sources indicate that the production of bronzes, made by the lost-wax process, in India is the result of a very effective division of labour

[3] This information is taken from a personal comment by the craftsperson Helen Marton (Cambridge, 10 April 2013).

(Levy *et al.* 2008). However, the production is guided and monitored by the master of the workshop. To transfer such a structure to the Bronze Age, however, would be too hasty. The extent to which a division of labour and cross-craft activities in metalcraft existed will be examined in the course of this work. However, it can be assumed that a division into craftsmen and artists, one being responsible for the metallurgical processes[4] and the other for artistic work, is not conceivable. Much more likely is a breakdown by skills, should there have been a division of labour in the Bronze Age. In no case, however, can it be assumed that the respective metalcrafter saw himself as an artist (or according to today's definition is regarded as an artist).

Metalworker

Having defined the term 'craftsman' and discussed the difference between craftsmen and artists, the only definition left is the metalworker. In current research, the mining, smelting and extraction of metals is associated with the metalworker in the same way as the tool-making process, *toreutics* (a process in metalcraft in which the metal is formed by hammer and anvil or through engraving), as well as specialised casting processes and highly developed model making.[5] Is it advisable, however, to define a term so frequently used in research literature as the metalworker so broadly? In the following section it is discussed which 'professions' the term metalworker might include and if a distinction in smaller units would be wise and realistic.

The variety of metalworking activities is commonly shown in ethnographic examples. The Awka smiths of south Nigeria demonstrate a generalised skill repertoire. They deal with iron forging as well as lost-wax casting and toreutics (Neaher 1979: 358). In Katanga, a southern province of the Republic of Congo, the copper mining and extraction of raw metals is performed by the villagers under the leadership of the chiefs during the three-month dry season (Rowlands 1971: 212). The actual processing of the metal, however, is executed by others. In the Swamimalei hereditary bronze manufacture in Tamil Nadu, India, individual employees (from this modern manufacture) deal exclusively with the embedding of the wax models in the clay mould (Levy *et al.* 2008: 62). These examples clearly show the range of activities that are united in metalcrafts (Figure 1.004). Barbara Ottaway has followed up which activities require specialised knowledge and therefore should be

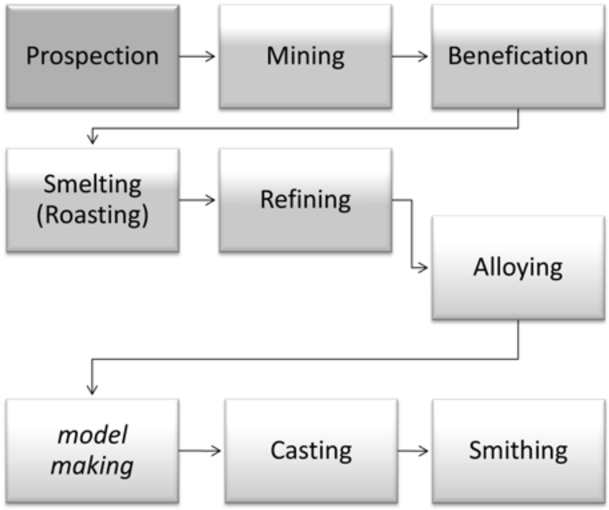


Figure 1.004: Single steps of a metallurgical chain (based on Ottaway 2001).

performed by a specially trained professional more thoroughly. She divides the 'metallurgical process' into eight fundamentally different fields of work (Ottaway 2001: 90-100). Each metallurgical process starts with the prospecting, exploring and collecting of metal-containing ores. There is no doubt that for finding the right ores a trained eye is required (Ottaway 2001: 90). However, in this process each member of a group could be involved, as illustrated by the above-mentioned ethnographic example (Rowlands 1971: 212).

Prospecting may be essential for the beginning of the metallurgical process, however, it cannot be regarded as a separate field of work, but should be seen in direct association with mining. The mining of the ores, as well as their beneficiation, requires a high level of knowledge. In particular, underground mining demands special knowledge of shaft lining, tool making, the exploration of prospective veins and the extraction and beneficiation of the ores (Ottaway 2001: 91). In comparison to the forming areas of metalwork, fundamentally different skills are needed here. A separation of these two fields into two 'professions' seems to make sense. As Ottaway (2001: 90-91; also Edmonds 1995: note 66) assumes, the people involved in mining and processing were by no means highly skilled craftsmen, but rather ordinary people. For the organisation of such an undertaking and for the training of the workers a knowledgeable person with great authority is required. The first three steps of the metallurgical process do not seem directly connected with the metalworker (the smith), they require fundamentally different skills. Additionally, the work areas just described are highly dependent on the geological conditions. In areas without, or with unused, copper deposits mining and related work is not to be expected, as might have been the case in northern Germany and Denmark (i.e Vandkilde 1996; Gerloff 2010; Ling *et al.* 2012; Ling *et al.* 2014; but Melheim 2012).

4 In this case, the processes that are concerned with the preparation of the bronze alloy, the casting mould and the casting.

5 There are exceptions, however, among which M. Primas sees the directed mining of metal ores as an organised profession with specialised knowledge (Primas 2008: 135), and R. Rowlands gives several examples from ethnographic studies in which mining is not executed by the actual craftsmen (Rowlands 1971: 212; see also Vandkilde 2007: 98).

The next step in the metallurgical chain (Figure 1.004) is bound to the previous steps in the sense that the ores were brought in their raw state to the furnaces, or the already smelted and refined raw metals had to be transported (Ottaway 1994: 89). It is likely that within copper mining larger spatial distances are in between the mining area and the smelting furnaces, as for example with iron smelting. Also, archaeological evidence is known for smelting in settlements (Ottaway 2001: 93; Rothenberg 1990a; 1990b; Lippert 1992; Hauptmann *et al.* 1996).

However, smelting in turn requires other skills than the previous processes. In addition to the knowledge of the structure of smelting furnaces, the executing agent must also be aware of the particular needs of the ore metal (i.e. smelting temperature). Also great experience is needed to achieve a reducing atmosphere, which is used to separate the copper from the ore (Ottaway 2001: 93). It is likely that exercise and instructions (in the sense of training) are necessary to execute a properly constructed furnace and produce the desired temperature and atmosphere. The smelting of metals and their processing requires specialised knowledge and therefore should be seen as independent steps in the metallurgical chain (Ottaway 2001: 94-95). However, to what extent smelting can be regarded as an independent craft is uncertain, since the smelting of ores was probably a seasonal activity (see Rowlands 1971; Edmonds 1995; Ottaway 2001: 95).

With the metal ready for use, the metallurgical chain now reached a stage at which the end product of the first part is achieved – the pure metal. If only for this reason, a separation in metal extracting and metalworking crafts is a useful step. The required specialised knowledge for each part was illuminated above and the possible independent crafts highlighted.

However, the following activities demand a new range of skills. As the first step in metalworking craft, Ottaway sees the alloying of pure metals (Figure 1.004). I am well aware that in research it is highly disputed whether the expert smith or smelter is responsible for the alloying of metals (i.e. Ottaway 2001: 98). However, due to the limited tin deposits in northern Europe, a centralised alloying of the metals in a place with good tin resources is probable (see Ling *et al.* 2012; Ling *et al.* 2014). From a technical point of view, alloying is an important part of the production of an artefact, since even small differences in the alloy may have an impact on the whole process. A compromise transferable to the Bronze Age would be the dissemination of bronze (alloyed in a standard norm) from a central point. Within the specific workshops this bronze could have been transformed and adapted to the desired purposes. This would also explain the occasional very bad or unusual alloys.

Another additional step essential for the successful processing of metal to finished artefact is model making. In terms of this work the production of wax models is meant. However, it should be noted that for the production of axes, and occasionally also swords, stone or ceramic moulds are required, which require a high level of skill and should be executed perfectly. Wooden models for the 'mass production' of axes should be well thought through so that the result is flawless. Even simple clay moulds require intensive knowledge with regard to the material (the clay itself and the metal that should be poured in). Therefore, the construction of models must be given a separate position within the metallurgical chain. However, model making should not be considered as a working process separate from the rest of the sequence. Only with the knowledge of the properties of the metal, the casting process itself and the final shape of the object can the model can be successfully made. The following steps in the chain (the casting and working of the cast object) require a high degree of knowledge, experience and training. Nevertheless, none of the steps should be considered as an individual process, but as a series of techniques and processes, all of which are interwoven and as a result produce the finished artefact. In the same way that the first part of the metallurgical chain finishes with pure metal, the second part, in which the metal is worked, ends with the desired product.

The traditional goldsmith's craft examined by Sennett can be used as an example of the immutability of traditional crafts. The following facts allow the drawing of conclusions about prehistoric conditions, as done previously (Høgseth 2012; 2007). The traditional goldsmith worked with a material that had 'political and economic significance' and was responsible for and 'certified that the wealth of a nobleman or a city was genuine' (Sennett 2008: 61). This craft was exposed to only a few changes over the centuries; on the one hand due to the requirements of the material – which do not change – and therefore not the techniques used. On the other hand, through the social pressure that demands honest work, a goldsmith can be viewed as a metalworker, whose task is all the steps of the second part of the metallurgical chain. Traditional goldsmithing sees no division into individual professions (see Brepohl 1996; Wolters 1991), but requires the intense involvement of apprentices and the following of a certain division of labour. Additionally, this craft seems to have been resistant to individualism across the centuries. Artists within this profession arose with the Renaissance: 'The medieval goldsmith furnished proof of his worth through communal rituals, proof about the work´s worth through the process of proceeding slowly and carefully. These are irrelevant standards for judging originality' (Sennett 2008: 71).

It is not my intention to make a direct comparison between the medieval goldsmith and the Bronze Age fine smith. However, I would point out that fundamental properties have remained the same for centuries within this craft, due to the value of the material as a status symbol and the underlying character of this craft to create reliable work. I would like to venture as far as to claim that the Bronze Age metalcrafters also had to fulfil an obligation because they worked with a status indicator – bronze. Thus, if the circumstances of the craft and the setting of the craftsman are comparable, then why should the prehistoric craftsman be so much more limited in his/her knowledge and have other demands on the job?

In summary, the metallurgical chain can be divided into two parts. The term metalworker should be applied to the second part of the chain, which includes such tasks as smelting, alloying and casting, in the same way as the production of models and tools. All these processes lead to the production of the artefact and are coordinated with each other. Only the knowledge of the properties of the metal, also in its liquid state, allows the production of a successful wax model. Only one who knows how the different metals behave in liquid form can decide which alloy must be chosen and what embellishments it is possible to create. The extraction and mining of raw metals, as the above example shows, do not fall within the repertoire of the metalcrafter defined in this way (Vandkilde 2007: 98; Primas 2008: 135).

Specialisation and specialists

The previous section clearly presented the different degrees of knowledge and the possible specialisation related to a particular field of knowledge. Now this inevitably raises the question of the difference between a specialisation and 'specialists'. The following section gives a short definition of the named terms within the context of this work and a brief presentation of the differences between them.

The concept of specialisation relates primarily to the repertoire, meaning the spectrum of the crafted goods (see Ottaway 2001: 89; Costin 2000: 378). Whereas a specialist is characterised by outstanding skills, he has mostly achieved within a limited repertoire (Primas 2008: 87). For instance, a founder is regarded as a specialised metalworker, even if his work is not of exceptional quality, only by the fact that it is limited to bronze casting. In contrast, the highly talented craftsman who has specialised in the production of richly decorated ornaments is considered to be a specialist, due to the outstanding quality of the items produced. The step from specialisation to specialists is thus mainly in terms of spectrum and number of artefacts, and thereby brought about by the experience gained during the manufacture of certain pieces by one craftsman.

A single, but striking, example in which a specialisation caused special skills in one craft direction could be found more than once in the previous sections. The exclusive preoccupation with the embedding of wax models in clay to form a mould led to the development of a specialisation, and therefore to a specialist (Levy *et al.* 2008: 62). As previously remarked, some branches of the craft require specialised knowledge but not specialised skills (Ottaway 2001: 99-100). The knowledge needed, for instance, for the successful smelting of ores is the result of a combination of interest, learning, and the specific capabilities of a person. Such specialised knowledge is part of the technological knowledge of each group and passed on through generations. However, the performing agent is not a specialist in the sense defined above. From a certain degree of specialisation (associated with an improvement in quality) and the amount of time required, the craftsman is only to a small degree able to care for his own economic existence (Primas 2008: 87; Olausson 1993: 2; Costin 1986: 344). Specialisation in the Bronze Age, as a form of production organisation (see Costin 1991: 3; Zagal-Mach 2008: 192), is hardly detectable with the available archaeological sources. As defined, specialisation limits only the spectrum of produced goods. A distinctive impact on craft organisation can be first assumed when the special abilities of a craftsman are combined with the possibility for a deeper exploration of this activity, meaning more time spent on the mentioned craft. Therefore, the craftsman will not be able to attend to daily duties and is dependent on supply by others. As such, the occurrence of specialists within a craft is inevitably linked with the economic possibilities of a society (see Apel 2007: 10). As already explained, the full-time employment of craftsmen is only possible in a surplus society (see Chapter 1.0.2) and this cannot be expected to have occurred in a regular way during the Bronze Age.

In summary, specialisation is a matter of the craftsman's repertoire, whereas only the ability of the craftsman, in combination with an increased amount of time spent on the relevant activities, creates specialists.

Methodology

As previously mentioned, this study is divided into four parts, of which the first presents the chronological and geographical framework of the study, as well as a detailed discussion of the material under investigation.

A description of the research area, probable regional groupings and a chronological classification of the finds is the main focus of the first part, together with a survey of the available archaeological sources on metalworking and workers. Additionally, a detailed presentation of each individual artefact category, partly on the basis of previous research, and partly newly developed by the author in regard to belt discs and belt plates, is presented.

Here, the objective is to provide a fundamental understanding of the examined material. Additionally, the first part contains a socio-cultural analysis of the material, which should be understood as a *suggestion*, perhaps to illuminate these objects based on ethnographic sources.

The second part of the study represents the core analytical part and deals with the technical investigation, which can be divided into archaeological, visual (technical) and scientific processes. The archaeological investigation – in this case the classification and presentation of the material – is examined in the first chapters. The visual/technical examination took place in museums and the analysis in this study includes a detailed metric documentation and a graphical record of the finds. The photographic recording aimed to document each piece down to the smallest detail. Through different light reflections even the smallest trace of crafting could be made visible within the photograph. The photographs were numbered consecutively to provide a better overview, and, additionally, an overview chart with the respective photograph numbers connected to the respective parts of the object was created from each object. The data gathered during the examination of the artefacts were collected in different databases that are published in a slightly abbreviated form in table 1-3 of this study. The metric data was entered into an extra database designed for this purpose, and the visual documentation was collected in another specific database. A part of the visual examination included the analysis of the images based on the expertise I gained during my training as a goldsmith (with continuing education courses for gem-setting and casting). Additionally, this background knowledge enables me to distinguish between the original crafting traces and marks left through excavation or deposition. Here, to visualise the results the artefacts were photographed with a Canon EOS 450D SLR camera and a Sigma EX 105mm1: 2.8 DG Macro lens. The images captured were thus able to reproduce the object with 2.8x magnification. With the collected data, the investigation of individual craft traces took shape.

In addition, I was able to draw on an intensively-researched database of prehistoric crafting traces, which was composed of previous research (see for example Oldeberg 1942; 1943; Herner 1987; Foltz 1979; Andersson 1995; Benner Larsen 1984; Benner Larsen 1985; Armbruster 1995; Meeks *et al.* 2001; Schwab *et al.* 2007). Characteristic details of the design and any traces of the production were stored in a photographic database to facilitate further comparisons and to ensure unbiased assessment. The collated data provides information about the tool marks and the traces related to specific techniques.

Further scientific investigations were also carried out. The purpose of the metallographic observation was to gain a detailed insight into the changes in the crystalline structure of the metal objects, which can help to validate visual traces and establish certainty about the way in which an object has been created. A detailed description of the applied method is presented in Part 2, Chapter 7. The comparison of metallographic and macroscopic recordings of similar traces leads to a definitive statement about the technology used.

The third part of the work deals with skilled craft as a theoretical construct and is initiated by an introduction to the topic with an attached research history. A wide range of theoretical approaches to craft is reviewed with an extensive insight into the existing literature. Following this, the processes of craft action will be scrutinised, starting from the whole (the operational sequence) up to the individual element. All theories and models will be demonstrated on the material. Therefore, repetitions are possible. However, the direct connection to the material is obligatory, mainly because Bronze Age research can only draw from this source. Within this part a new model is introduced and applied using operational sequences to study prehistoric metalwork. The aim of the third part is to understand craft and to interpret the traces left in the most effective way.

Within Part 4 the knowledge gained on metalcrafting in the NBA is evaluated, with the aim of discussing the previous three parts of this study and presenting conclusions towards analytical results and theoretical considerations. In this section the focus is on answering the preliminary questions regarding the relationship of individual craftsmen to their environment, regarding possible workshops and the structure and organisation of metalcraft.

Finally, the work is appended with a Catalogue containing all the edited finds and the measuring data. All information in the catalogue that relates to the find context is well documented elsewhere and is, therefore, only given in abridged form, provided with the most relevant literature. In contrast, the Catalogue includes a detailed object description and the possible crafting techniques used.

PART 1
MATERIAL CULTURE

Chapter 1

The examined material culture

This study aims to define the technologies involved in crafting metal artefacts of the Nordic Bronze Age. As such, the artefacts investigated within this study must meet some criteria to ensure that the technological knowledge used is part of this specific cultural unit. Accordingly, the artefacts needed to have their typological and stylistical origin within the material culture of the Nordic Bronze Age and their area of dissemination must be known and critically analysed. Kersten defined this cultural unit, also called 'Nordic group', in the late 1930s. In a core zone (cultural centre) which extends from Scania, over the Danish islands to the major part of Jutland, the most magnificent and richest artefacts occur. The adjacent regions in the south are included in Zone II, namely the southern part of Jutland, Schleswig-Holstein and the area above the Weser in Lower Saxony, Pomerania, as well as in NBA III Mecklenburg. Within this area there are, despite some similarities in social habits and material culture, many regionally distributed groupings.

Differences in aspects of material culture, and partially in their burial customs and costume preferences, are striking. On Zealand, for example, eight different regional groups were defined solely through decorative preferences during NBA II. However, within NBA III the wealth displayed through ornaments decreases and the stylistic regions seem to grow larger. The ornaments to be examined in the course of this study, which can be viewed chronologically, were already part of the material culture from the beginning of NBA II (after Montelius), i.e. neck collars, belt plates, needles and costume trimmings. They extend to NBA III, a period in which, among other things, the very large belt plates occur. The intensive research, concerning the periods of interest, namely 1470/1450-1300 BC (NBA II) and 1300-1100 BC (NBA III), allows a fine chronological separation of the material. The ornaments especially, which have counterparts in the oak coffin burials, such as belt plates and neck collars, can be dated in a time frame of only 70 years.

1.0 Introduction: the investigated material culture

Generally speaking, the present work deals with metal objects of the Early and Middle Bronze Age in northern Europe. With 'Bronze Age', the era is to be understood in which 'Metallurgy is now for the first time fully integrated in the social practices of the north' (Vandkilde 2007: 91). Of particular importance for the spread of bronze technology (after which the Bronze Age is named) was an intensive cultural contact between southern and northern Europe. Around 2000 BC, in central Europe, an increasing use of metal objects and a recognisable change in the material culture and social structures can be observed (Vandkilde 2007: 96). The north, however, was at this time still under the strong influence of the Bell Beaker cultures. The first metal ages in northern Germany and Denmark can be detected at the Late Neolithic (LN II) under increasing Únětician influence (Vandkilde 2007: 97). From the First Bronze Age period, an adoption of new social organisation, technological skills and a new kind of construction can be found in Scandinavia, of clearly southern origin, and probably accompanied by a lively exchange of people (i.e. Kristiansen and Larsson 2005: 207; Vandkilde 1996; 1998).

The first part of this study, which is investigating the development of metallurgy and the social organisation within metalcraft, circles around the presentation of the material under investigation as well as its chronological and geographical context. The 323 bronze ornaments examined within this study, namely neck collars, belt discs and plates, pins, fibula, tutuli and, occasionally, arm and leg ornaments, had to fulfil specific criteria to be included in the study.

The criteria fulfilled were as follows:

1. An origin within the material of the Nordic Bronze Age, as well as chronological placement within NBA II or III.
2. The main distribution area of the object group should be known and the find location should be at least roughly reconstructed (particularly in Mecklenburg many very beautiful pieces could not be assigned to specific locations, however, due to their exceptional preservation conditions these artefacts were included in the study without known localities).
3. Their preservation conditions should meet the requirements of a craft technical examination (as completely destroyed objects have a very low information potential, while elaborately decorated bronzes reveal much technical information).
4. They should be available for examination.

The last factor seems self-evident, but accessibility in museums was one of the criteria that most influenced the selection of the pieces. It is still the case today that the most beautiful pieces have been moved to unknown addresses or have been lost since the Second World War. Therefore 323 artefacts, from 190 localities, were examined (Map 01), with occasionally some very loose scattering, especially in Jutland. A variety of female ornaments were in focus, namely neck collars, belt discs and plates, pins, fibula, tutuli and, occasionally, arm and leg ornaments (Figure 1.005), and these were studied in terms of their craft technical characteristics. The oldest objects date to the beginning of NBA II, including the neck collars of Oldendorf, Rehlingen and Westerweyhe in central Lower Saxony. The youngest objects come from the developed NBA III, as for example the neck collar of Weisin in Mecklenburg or Weitgendorf in Brandenburg.

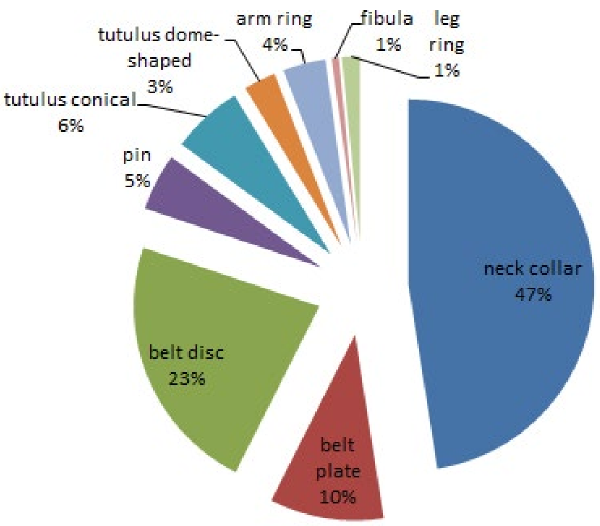
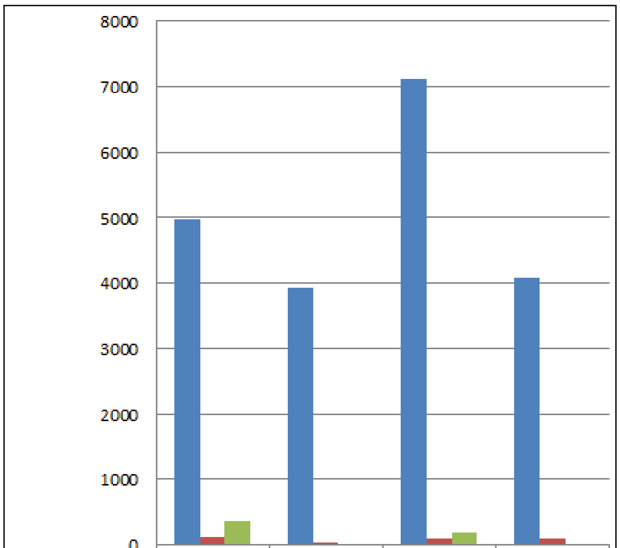


Figure 1.005: Percentage distribution of the individual object groups in the study.



	NBA zone I		NBA zone II	
	P II	P III	P II	P III
assumed finds	4987	3931	7124	4078
neck collars	126	25	101	106
belt plate/ disc	364	14	189	7

Figure 1.006: Ratio of the examined object groups to the overall findings in regard to the periods and regions.

Compared to the overall number of artefacts, the kind of artefacts investigated represent only a small number of the overall artefact totals within these periods, a criterion for their special position within the material culture of NBA II and III (Figure 1.006). Thus, these magnificent decorated bronze ornaments are considered to be an indicator of the social status of the owner.

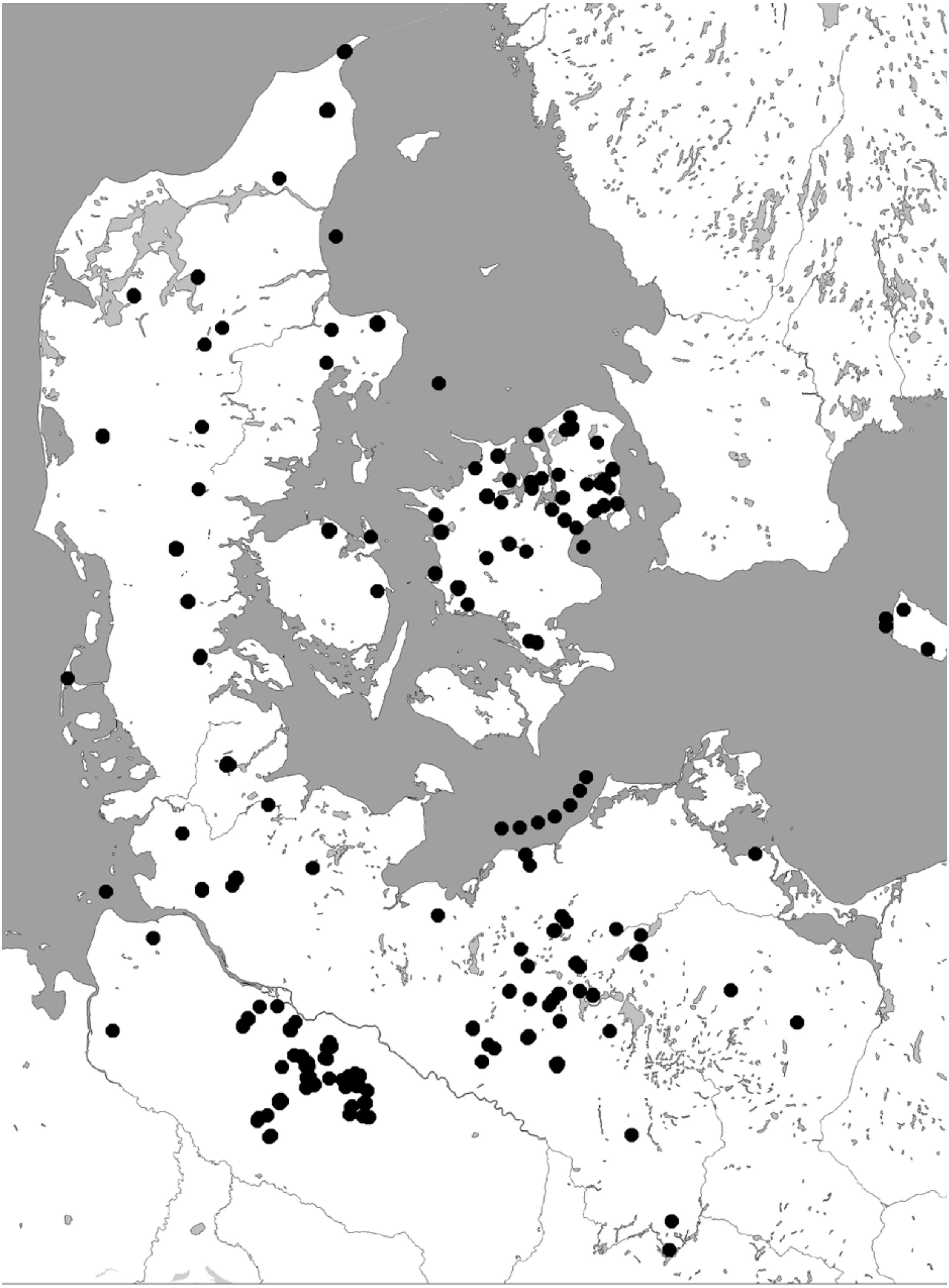
1.1.1 The chronological context of the investigated material culture

Fundamental to the chronology used in this study is the periodic division of the Bronze Age material in the north by Montelius. In 1885 Montelius[1] classified the northern European region using the typological method (Montelius 1885) in six periods (I - VI). He assigned each period a distinctive set of artefacts. For Montelius a high concordance of objects was an indication of low temporal differences. In this way the modelled series of development revealed a pre- and post-temporality of certain objects (Figure 1.007). However, the typological method loses its accuracy if the used material consists not only of creations of a region, but includes a wider region in which developments and innovations overlap (Rassmann 2004: 41; Gräslund 1987: 89; Montelius 1885). Also, the Darwinian idea of the typological method is often discussed today (see Rassmann 2004; Müller 1884). Nevertheless, the classification of the Nordic Bronze Age created by Montelius is unchallenged as the backbone of chronology until today (Randsborg 1996: 63), not only because of the widely used stratigraphic evidence but also because of the carefully selected archaeological context.

The system by Montelius in the north is in southern-central Europe compared with the chronology created by Paul Reinecke. He divided the Early Bronze Age into stages Ba A1 to A2, the Middle Bronze Age into levels Ba B to Ba C2, and the Late Bronze Age into levels Ba D to Ha B (i.a. Willroth 1997: 11; Jockenhövel 2000; Vandkilde 2007: 121).

Absolute chronological fixations of the northern European Bronze Age in regard to the central European region, the Carpathian Mountains and the Aegean Sea were created by N. Åberg and J. Fossander in the 1930s using special finds, such as the cult wagon of Peckatel or the situla of Granzin (Åberg 1935; Forssander 1936). A synchronisation of the Mycenaean shaft graves followed

[1] The first to apply the typological method for structuring prehistoric finds, was the art historian H. Hildebrand (1842-1913). He not only created the word 'typology', but also used the typological method in 1866 and 1869 in his classification of numismatic objects (Hoops 2002: 205).



Map 01: Map of the artefacts examined in this book.

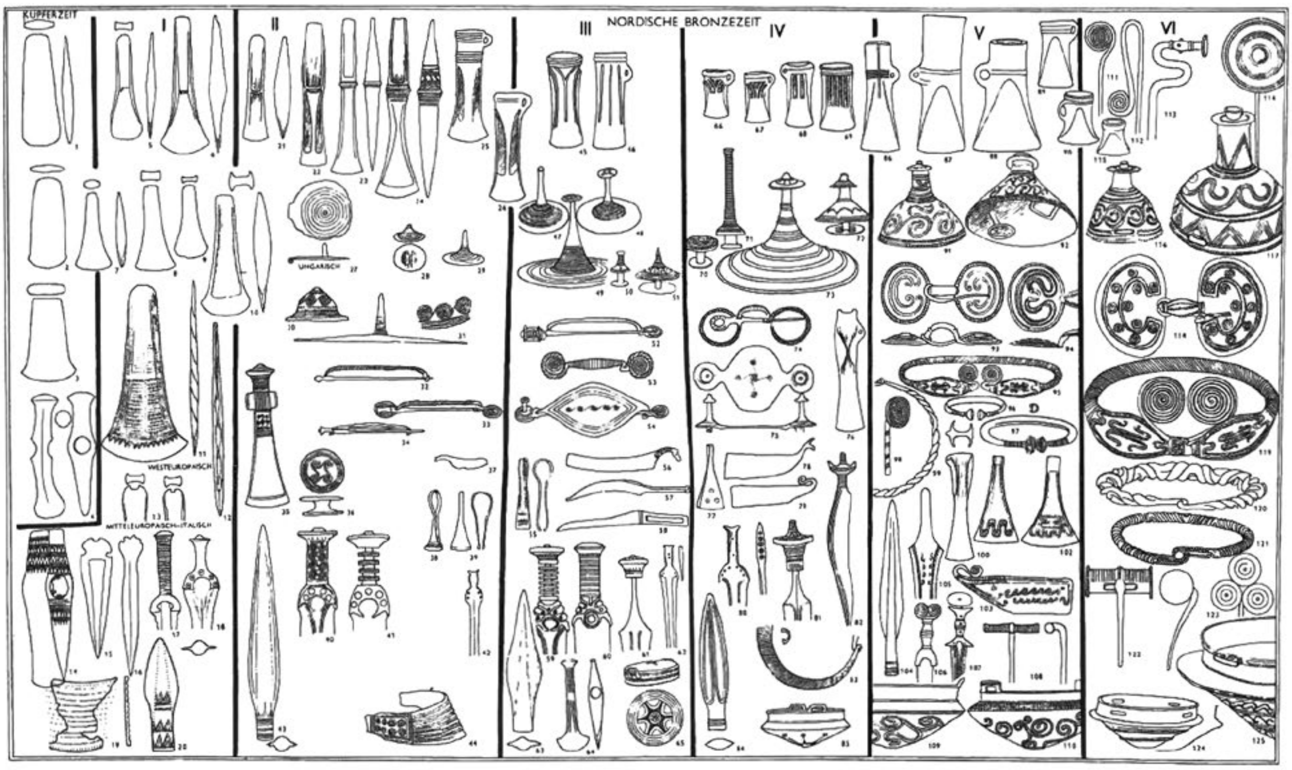


Figure 1.007: Typological sheet after Montelius (1885) supplemented by Åberg (1936) (after Randsborg 1996: 63).

(Werner 1950; Milojčić 1959; Hachmann 1957), which were at that time dated to the 16th century BC, but are today placed over 100 years earlier (Rassmann 2004: 42; Dietz 1991). A significant shift in the conception of the Bronze Age cultures in northern Europe and their absolutely reliable chronological classification was due to the increasingly frequent scientific dating methods which began in the 1950s (Rassmann 2004: 42; i.e. Vandkilde *et al.* 1996; Randsborg and Christensen 2006; Olsen *et al.* 2011; Hornstrup *et al.* 2012). Among these the dendrochronological datings of the northern and central European area are especially considered as reliable values that have become the focus of Bronze Age research again, particularly in recent years (Randsborg and Christensen 2006). The biggest impact of the dendrochronological dates was on the chronology of the beginning of the Bronze Age. A first result was that the Early Bronze Age (PIa-PIIa) in northern central Europe was predated to 2100/2000 - 1600/1500 BC with the dates achieved from the mounds of Leubingen (Thuringia) and Helmsdorf (Saxony), and additionally dates from wetland settlements in the foothills of the Alps (Rassmann 2004: 46). In a second step, Nordic C-14 dating enabled a new fixation of the first metalworking cultures in northern Europe in correlation with cross-regional comparisons (Vandkilde *et al.* 1996). The transition from the Late Neolithic to Early Bronze Age was particularly in focus.

Using dendrochronological data from 29 oak-coffin burials Randsborg updated the Bronze Age II period (Randsborg and Christensen 2006; Randsborg 1996). Here, mainly the transition zones were of interest, especially those of the Bronze Age II to Bronze Age III periods, but also the beginning of Bronze Age II (Randsborg 1968; Hornstrup *et al.* 2012).

One of the most recent studies in terms of absolute chronological classification of the Scandinavian Bronze Age took advantage of the latest technologies in order to gain C-14 Data from cremated bones (for this procedure, see Lanting *et al.* 2001). The increasing amount of data makes it possible to more precisely assign absolute numbers to each period, and to fill the previously existing data vacuum, especially for the Late Bronze Age (Hornstrup *et al.* 2012; Olsen *et al.* 2011; Vandkilde *et al.* 1996).

To summarise the chronological discussion, according to the current state of research, a comparative chronology could be established (Figure 1.008), which should in the Nordic region already start with the Late Neolithic for better comparison.

Imported artefacts found within the LN phase I (Late Neolithic I) are, according to Vandkilde (1996), proof of a simultaneity with the central European Early Bronze Age (Reinecke Ba A1). In the north of the Danish mainland a clear influence of western European Beaker cultures

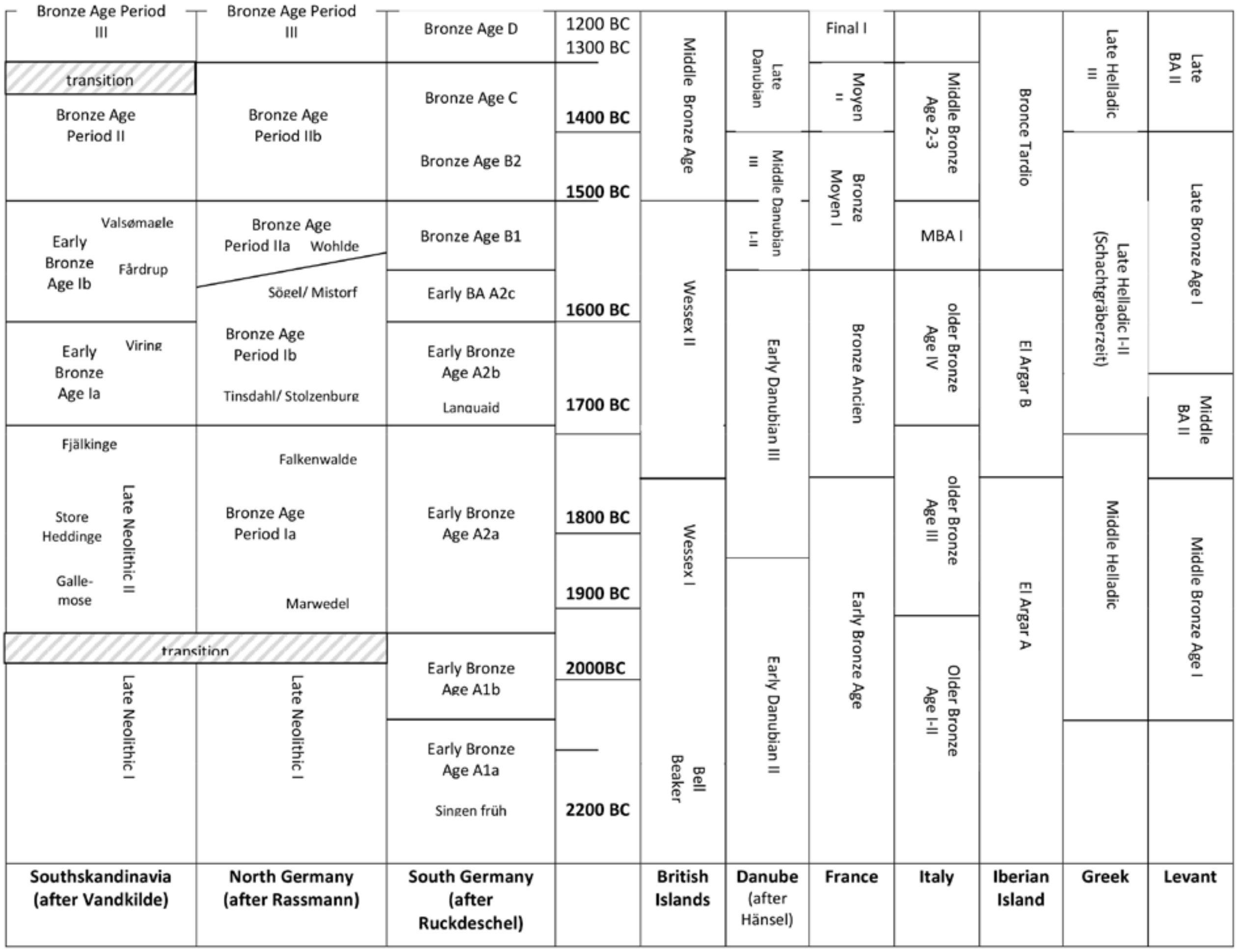


Figure 1.008: Chronology scheme of the early and middle Bronze Age, with comparisons to south and west Europe (based on i.e. Vandkilde 1996; 1996; 1998; 2007; Rassmann 2004a; Ruckdeschel 1978).

is visible, while the southeastern part of Scandinavia is under Únětician influence (Vandkilde *et al.* 1996: 187; Vandkilde 1996; 177ff.; 1989). Based on C-14 data an extension of the phase LNI from 2400-2280 BC to 2010-1910 BC could be established (Vandkilde *et al.* 1996: 187). In Scandinavia, however, the LN phase II (Late Neolithic II) marks the beginning of the Metal Ages. Vandkilde argues that the contact, as well as the simultaneity, to the central European Bronze Age (Reinecke Ba A2a)[2] is secure. Additionally, imports of Anglo-Irish axes witness simultaneity with the Amorico-British phase of the Wessex culture in the British Isles (Vandkilde *et al.* 1996: 188). In regard to the phase LN I, a small overlap in the C-14 data seems to show the transition to the following phase. Therefore the beginning of phase LN II can be assumed around 1980 to 1890 BC, and the end between 1790-1690 BC. The dendrochronological dates received from Leubingen and Helmsdorf can confirm the extent of the phase LN II, as they are considered a marker of the advanced Early Bronze Age (Ba A1b) in a period from 1942/1900 BC (Leubingen) to 1840/1800 BC (Helmsdorf) (Becker *et al.* 1989; Lorenz 2013; Vandkilde 2007: 109).

The NBA I, introduced by Montelius, comprises a time span from 1750/1700 BC to 1560/1480 BC, supported by the latest scientific dating. This phase can be correlated with the older Early Bronze Age Ba A2 by Reinecke, especially the phase *Lanquaid*. Vandkilde (1996) was able to clearly define, based on stratigraphic features, the two phases of the Danish Early Bronze Age (see also Randsborg 2006: 15). With respect to the direct effects of the central European Early Bronze Age on the Scandinavian material culture, it was stated that during NBA IA many imported goods occurred, with a retreat during NBA IB (Vandkilde *et al.* 1996: 189; Vandkilde 1996: 147; 1989). Also, a new direction in the material culture appears within the NBA IB (Fådrup and Valsømagle horizon), and with the Valsømagle horizon all the characteristics of the Nordic style are present (i.e. Vandkilde 1996: 223 ff.).

Even if Randsborg (2006: 16) does not agree with the placement of the Valsømalge horizon at NBA IB, he

[2] After Ruckdeschel it is more likely that LN II correlates to Ba A2a than Ba A1b (Ruckdeschel 1978).

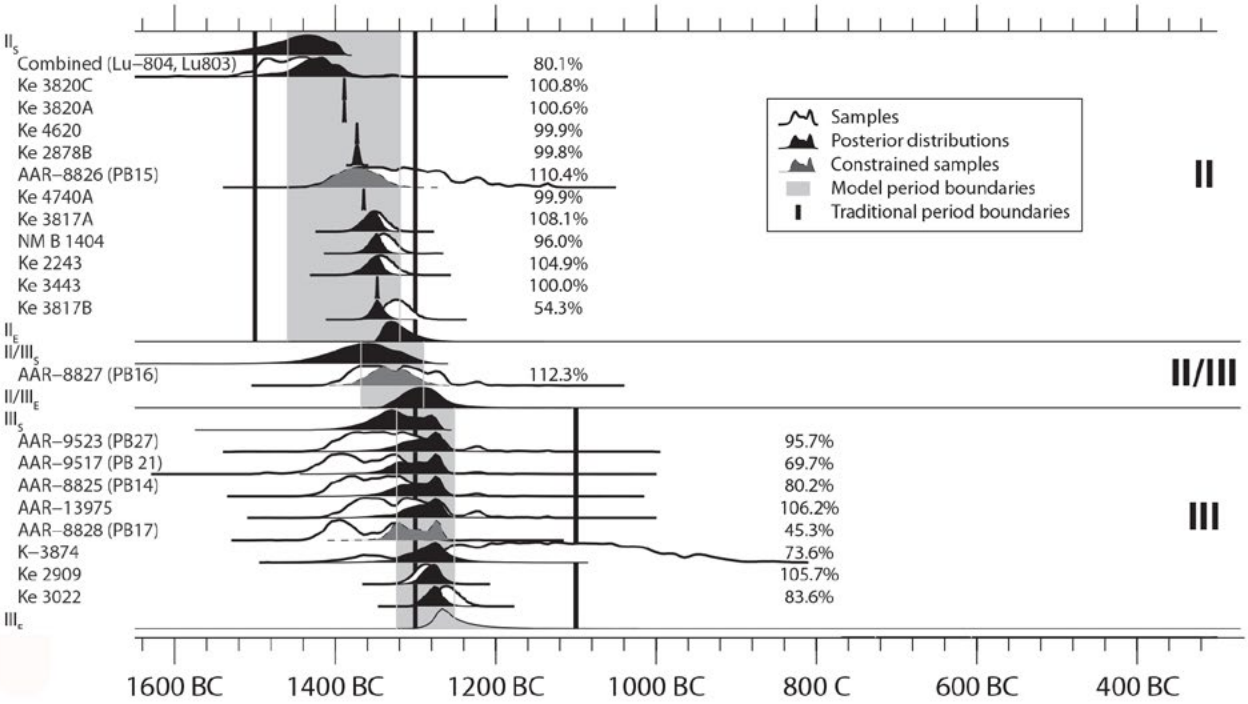


Figure 1.009: Modelled (shaded) and unmodelled (un-shaded) calibrated age probability distributions, grouped by periods (II-VI) and transition between periods (II/III, III/IV and IV/V) (after Hornstrup *et al.* 2012: 21).

undoubtedly is aware of the Nordic character of the same material and the close connection to the material of NBA II.[3] Following the transitional phase or initial NBA II, which he equates with several finds from Lomborg´s Løve horizon (Lomborg 1968), including the woman's grave from the Staldhøj at Skrydstrup (Aner and Kersten 1984: 77, plate 37), might be equal to the Løve horizon and later than Valsømagle (Vandkilde 1996: 223-252), meaning Ba C1, Göggenhofen. The Skrydstrup burial indicates a connection to the grave find from Sønder Onlev 8 (Randsborg 2006: 8). C-14 dates from the oak-coffin burial of Sønder Onlev 8 result in a very old age, however, they should be treated with caution.[4] A further burial, which supports the early date of the Skrydstrup main burial, is within the Diverhøj in Jutland (Asingh 1987: 139). The grave can be dated, with help of the two fibulas, to around 1500 BCE and might lie within this transition to NBA II (Vandkilde 1996: 241). In northwestern Germany, NBA 1B roughly corresponds to the *Sögel-Wöhlde Grabsittenkreis* (i.e. Vandkilde 1996: 152-160; Jockenhövel 1994; Laux 1976; Hänsel 1997).

NBA II corresponds to the southern Tumulus culture with the levels C1 and C2. This, in contrast to earlier assumptions of quite late correlation, is based on the dendrochronological dating from the oak-coffin burials which created a much shorter NBA II (Randsborg 1996: 67). Similar dates are confirmed by the latest radiocarbon data (Olsen *et al.* 2011: 270). Interestingly, 25 of the 28 oak-coffin burials are dated within a period of only 50 years from 1391-1344 BC (Christensen 2006: 181; Christensen *et al.* 2007: 42). The archaeological material contained in the mentioned graves is characteristic for the end of the NBA II and is occasionally complemented by imported goods from the simultaneous phase Reinecke Ba C (Vandkilde *et al.* 1996: 191). Here, a simultaneity can be assumed between the early NBAII and Ba B2/C1. Thus, NBA II ranges from 1430/1470 BC to 1300/1290 BC, indicated by radiocarbon data (Vandkilde *et al.* 1996; Hornstrup *et al.* 2012; Olsen *et al.* 2011).

In northwest Germany within the area of the Lüneburg group an independent chronology was created by F. Laux, whose time-groups I and II, with the phases *Behringen-Bonstorf* and *Wardböhmen-Kolkhagen* (Laux 1976), are to be equated with NBA II.

The short time span in which the Danish oak-coffin burials are dated, in combination with an archaeological investigation, resulted in an assumption of a much longer transitional phase than previously assumed. This transitional phase is confirmed by the latest radiocarbon data (Figure 1.009) and should be placed

[3] In Randsborg's opinion (which should be seen with a critical eye), the Early Bronze Age material terminates in a transition horizon, which he equates with several finds from Lomborg´s Løve horizon (Lomborg 1968). Randsborg correlates the mentioned material with the help of *Petschaftkopfnadeln* with Reinecke C1 (Randsborg 2006: 17).
[4] 'The date of this grave is likely several decades – perhaps half a century (or even more) – lower than dendro scientifically indicated by the youngest tree ring recorded of ca. 1468 BC' (Randsborg 2006: 8).

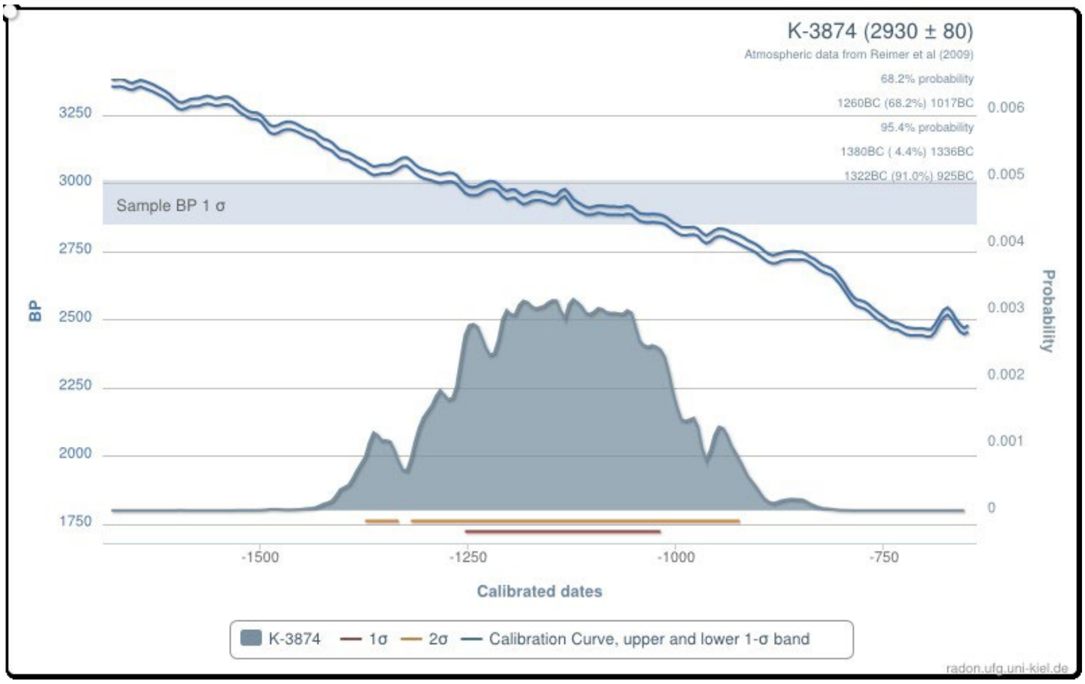


Figure 1.010: C-14 data from the oak-coffin burials of Melhøj
(taken from Kneisel et al. 2013: Jutta Kneisel/Martin Hinz/Christoph Rinne, Radon-B. In: http://radon-b.ufg.uni-kiel.de.).

around 1360 - 1290 BC (Hornstrup *et al.* 2012: 21; Olsen *et al.* 2011). The oak-coffin burials (dated to around 1300 BC) are mainly within this transitional phase (Randsborg 1996: 67; Hornstrup *et al.* 2012; Christensen 2006; Christensen *et al.* 2007: 43).

Using the oak-coffin burials, a definitive start of NBA III will be set at 1300 BC.[5] However, nationally an imbalance in development can be considered, so a number of researchers see a regional shift in the spread of NBA III. As a result, in Jutland and Schleswig-Holstein the material culture of NBA III can be observed much earlier, as for example on Bornholm (Hornstrup *et al.* 2012: 10; Randsborg 1968).

The latest radiocarbon data contributes significantly to the absolute chronological extension of NBA III (Hornstrup *et al.* 2012; Olsen *et al.* 2011). NBA III, about 1300 - 1100 BC, corresponds in its first phase with the Tumulus culture Ba D (Riegsee). The developed NBA III is equivalent to the southern central European Urnfield culture Ha A1 (Randsborg 2006: 15; Kristiansen and Larsson 2005: Figure 13; Hornstrup *et al.* 2012: 11, 21) and can be correlated with time group level III *Fuhrhop* in Lower Saxony (Laux 1976). The C-14 data from the oak-coffin burials of Melhøj and Skrydstrup (female burials) show, with an absolute date of 1100 BC (Figure 1.010), the decline of NBA III and the transition to NBA IV.

With respect to the examined material in this work, some pieces can be placed very precisely into the existing chronology based on the radiocarbon and dendrochronological data. Randsborg placed the Skrydstrup burial in the initial phase II on the basis of an archaeological comparison with the dendrochronologically dated grave from Sønder Onlev 8 (Randsborg 2006: 8). The Skrydstrup burial contains, in addition to the chronologically relevant fibula, a neck collar and a belt plate (Figure 1.011). Similar fibulas are found in Divershøj, Jutland and the early date seems to be correct (Asingh 1987: 139; Vandkilde 1996: 241; Bergerbrant 2007: 26). The collar is to be considered within the Nordic Bronze Age as a special object and most likely comparable with the neck collars of Drage type, which is mainly distributed in Jutland (Nørgaard 2011: 48ff.). A similar form (Rehlingen type), which is also characterised by the broad ribs and enclosing hems, occurs in Lower Saxony at the beginning of NBA II (Nørgaard 2011). Representatives of the Lower Saxon collars are dated by Laux in his time group I, which is equal to the beginning of NBA II. Thus, the discussed form (ribbed collar with accompanying hems) can be clearly placed at the beginning of NBA II,

[5] At this point a short excurse to the Kivik grave is necessary. Randsborg assumes that the Kivik grave in Scania should be placed at the beginning of NBA III and therefore can be dated to 1300 BC (Randsborg 2006: 6). In contrast, Kristiansen sees the Kivik grave as the first evidence of a Nordic Bronze Age and correlates the grave from Scania with the grave from Anderlingen in Lower Saxony. Both finds he thus dates in the transition from NBA I to II, around 1500 BC (Kristiansen and Larsson 2005: 189-194; Willroth 1997: 4; Kristiansen 2004; Goldhahn 2005: 97). Latest research and scientific dating (C14) of animal bones from the Kivik burial, place them at 1500 BC and following the start of NBA II (Goldhahn 2013: 566). However, due to this obvious discrepancy the Kivik grave is not included in the chronological discussion in this study.

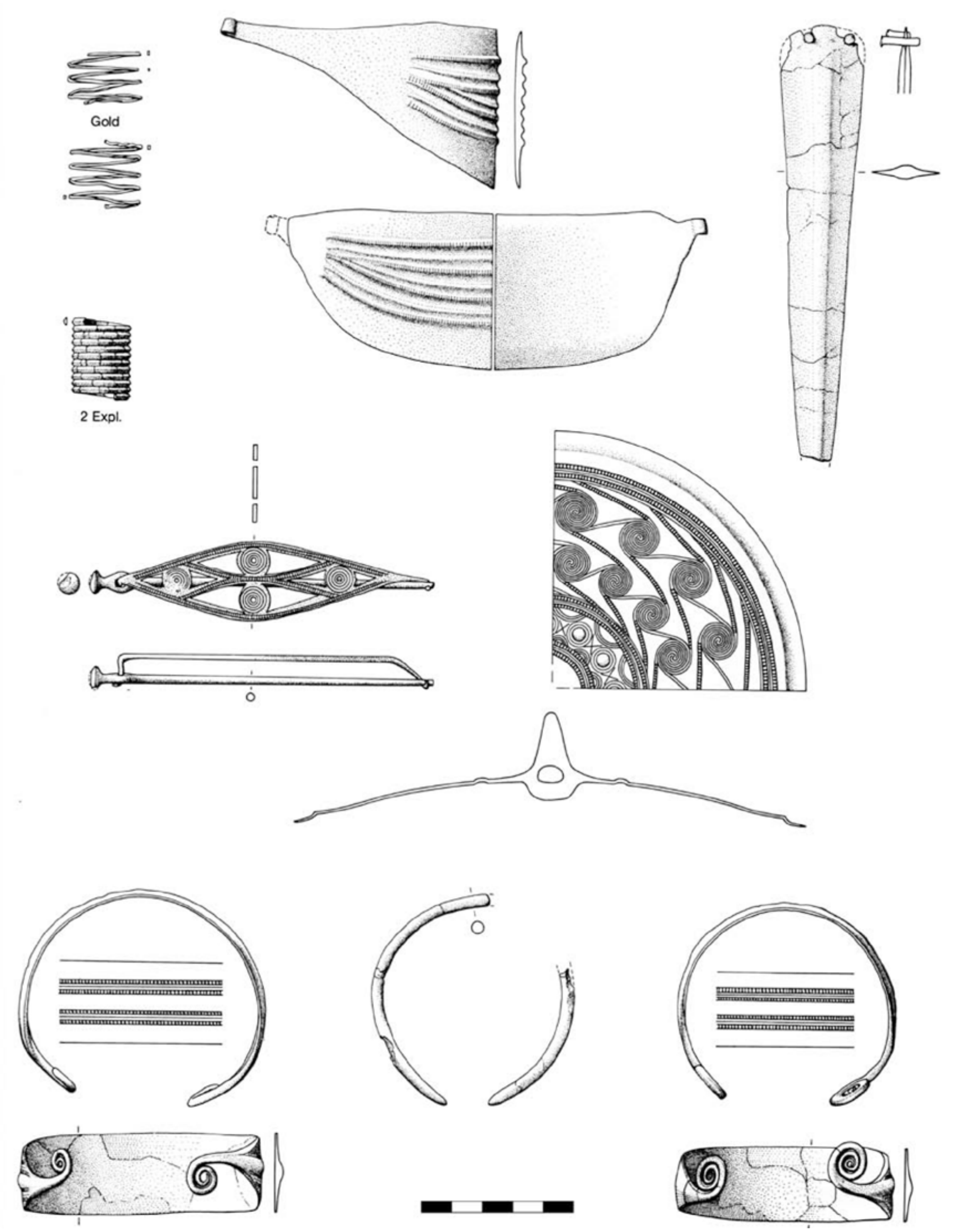


Figure 1.011: The grave goods of the Skrydstrup burial, Haderslev Amt
(after Aner and Kersten 1984: Nr. 3530A).

and furthermore can be seen as one of the origins of the later richly decorated collars. By this means not only Lower Saxony but also central Jutland should be seen as the area of origin for the rib-decorated collars (see Chapter 1.3.1).

However, the Skrydstrup grave also contained a further relevant bronze, namely the spiral-decorated belt plate. Similar to the collar, the belt plate from the Skrydstrup burial is difficult to assign to a formal group (see Chapter 1.3.2). The humpback row surrounding the spike is rather rare in the Nordic region and occurs mainly on Lower Saxony plates, which may well date to the early NBA II (humpback rows can be seen as Únětician-influenced details). However, the hump shown here is framed in concentric-circle groups and

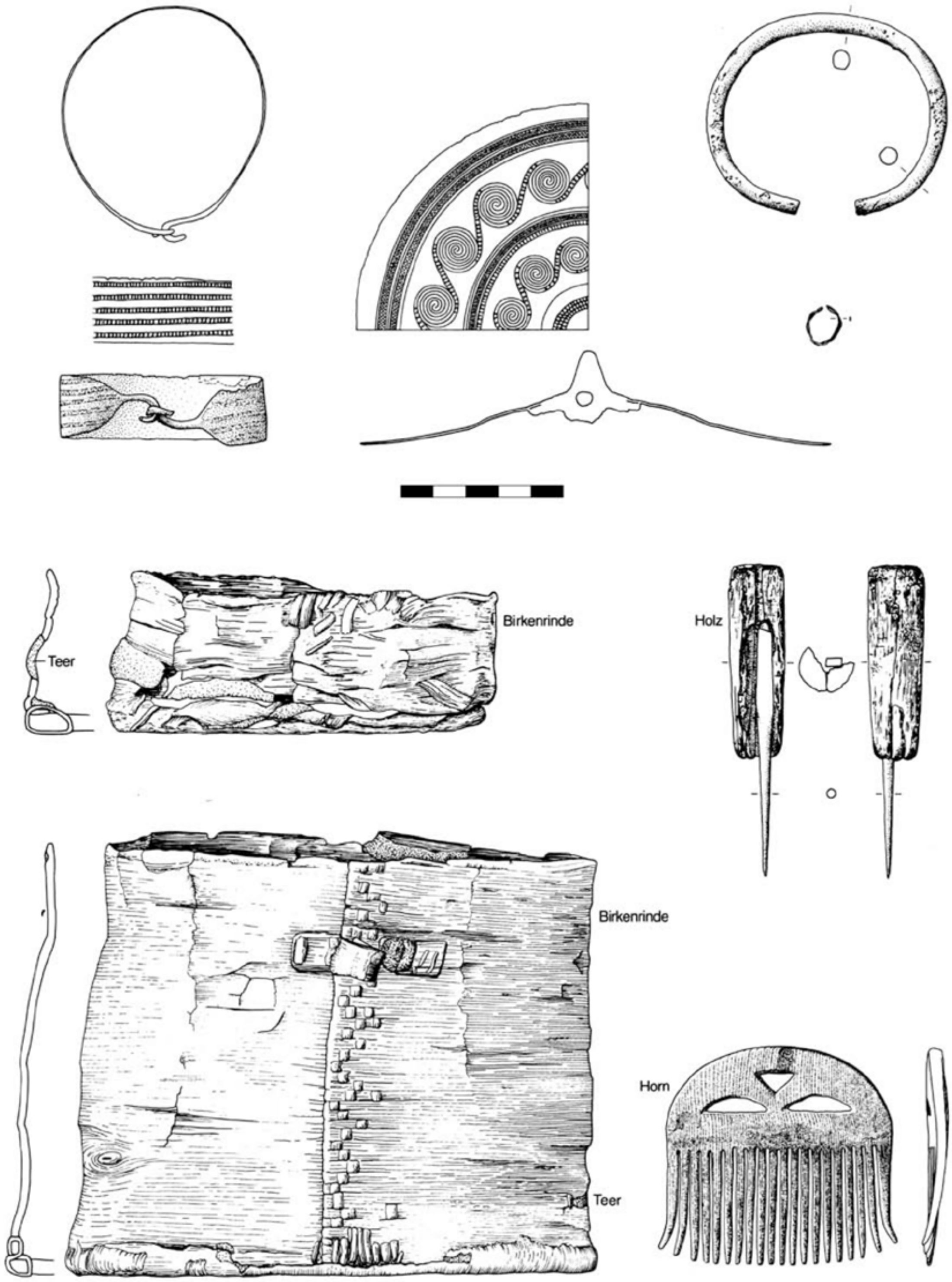


Figure 1.012: The grave goods of the Egtved burial, Vejle Amt
(after Aner and Kersten 1990: Nr.4357A).

accompanied by two spiral rows. Even if the belt plate is unique, the hump series are clearly a feature of the oldest belt plates.

A characteristic of NBA II design can be seen in the double-spiral series separated by a decorative band mostly applied on belt plates. This decorative element could be dated absolutely chronologically within NBA II due to the Egtved burial (Figure 1.012). The dendrochronological date of 1370 BC (Randsborg and Christensen 2006: 116) clarified the occurrence of this typical Scandinavian plate decoration in the developed

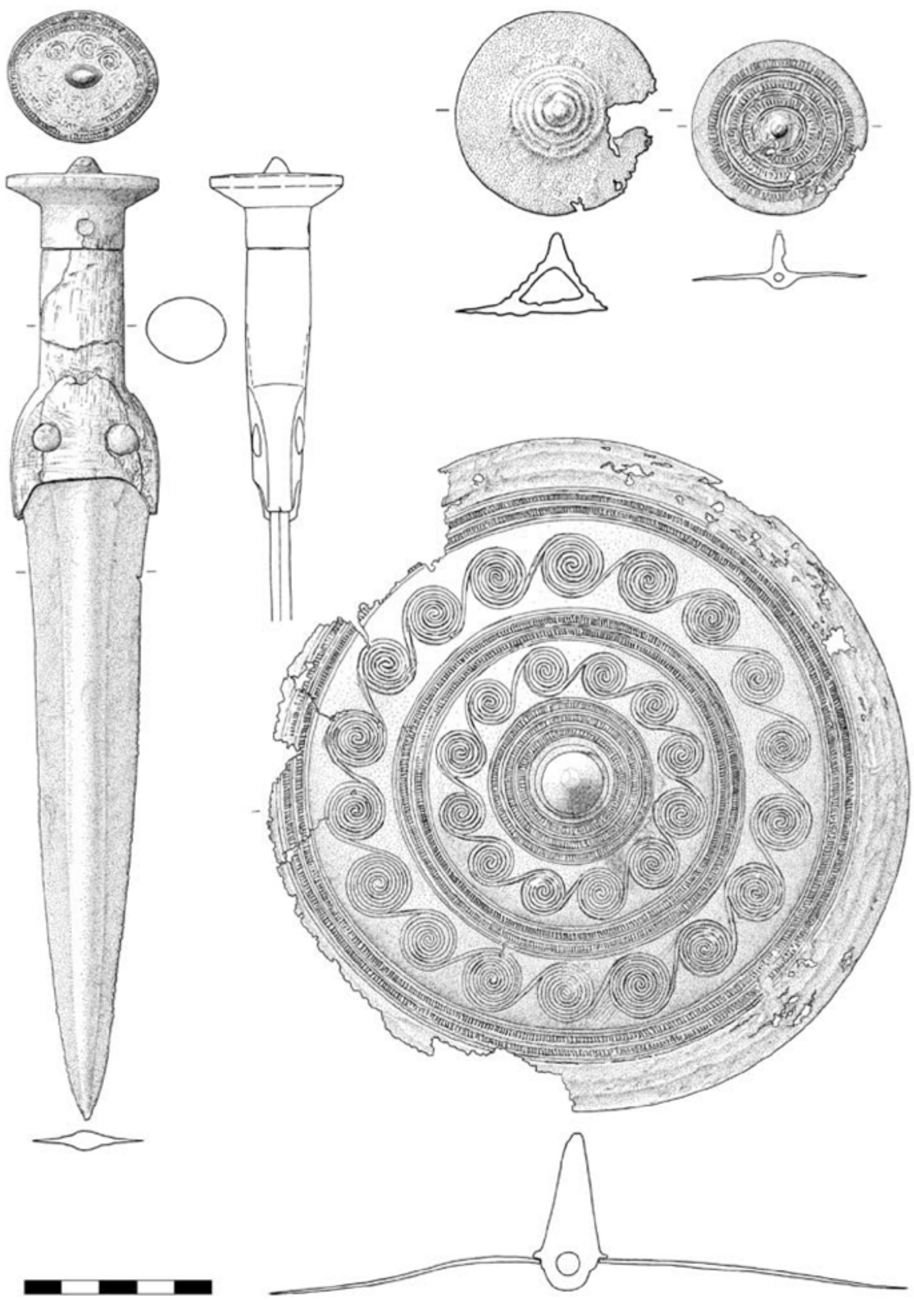


Figure 1.013: The grave goods from the female burial in Borum Eshøj, Aarhus Amt (after Randsborg 2006: 159).

NBA II. An additional date (1353 BC) of a similar belt plate from the old woman buried within the Borum Eshøj mound (Randsborg 1996: 66) defines a time span from the beginning of NBA II to its decline, in which this double-spiral ornament occurs (Figure 1.013).

From a purely typological perspective, the grave of Borum Eshøj would rather indicate the beginning of NBA II. For example, the tutuli with step-like spike-foot and clearly separated transitions (see Chapter 1.3.3) should, after Schubart, be regarded as the beginning of their formal development (1972: 74). However, the absolute data of 1353 BC shows a much longer existence of this form and a parallel existence with the more developed tutuli. Additionally, the data from Borum Eshøj (1353 BC) and Muldbjerg (1376 BC, after Randsborg 1996: 66) indicates a continuous occurrence of the small line-decorated belt discs during NBA II (see Chapter 1.3.2).

Thus, many bronze ornaments which can be examined in the course of this study are already part of the material culture during the beginning of NBA II. In addition, many forms prove to be almost typical for the entire NBA II (belt plates with double-spiral ornamentation) and others must now be considered, despite formal developmental series, as simultaneous phenomena. The lack of scientifically dated archaeological material of NBA III does not allow a reliable delineation of the period in which, among other things, the very large belt plates occur. Thus, only the traditional stratigraphic or typological methods can be used to indicate the approximate time span in which these objects were of importance, a point that will be addressed in the respective chapters.

1.1.2 The geographical extension of the Nordic Bronze Age and the material under investigation

The most important requirement for the independent study of the Bronze Age in northern Europe was the chronological system created by Montelius (1843-1921) as described above (Rassmann 2004: 39). Due to the independent chronological system, with its own characteristic material culture in northern Germany and southern Scandinavia, which stood out from the central German chronology created by Reinecke, Müller and then Kersten were able to define a separate 'culture' in the north (Randsborg 1996: 63; Jockenhövel 2000: 11; Kersten 1936; Müller 1884; Hornstrup *et al.* 2012, 10). However, it was Worsaae who already in the first half of the 19th century defined an independent style within this area based on the burials (Worsaae and Bertelsen 1844). The following material culture group addressed in research and literature as being of Nordic Circle or Nordic Bronze Age was by around 1500 BC fully formed. During NBA IB, the Nordic style gained the upper hand and at the same time the influence from southern tumulus cultures (Br A2c) decreased (Vandkilde *et al.* 1996: 189). A southern or Mycenaean influence in the shaping of the Nordic Bronze Age is not only visible through imported goods, but also by a similar iconography (Kristiansen and Larsson 2005: 249). It seems as if only 'in Scandinavia the religious Mycenaean symbolism was adopted, a conscious signal of powerful foreign origins transformed into a new Nordic identity' (Kristiansen and Larsson 2005: 249).[6]

Kersten defined a core zone of the northern area, in which the most magnificent and richest findings occur, and which he called a 'cultural centre' (Kersten 1936: 2). This area (Zone I) includes Scania (southern Sweden), the Danish islands and Bornholm, as well as the major part of Jutland (except the southern part). The adjacent regions in the south are included in Kersten's Zone II, namely the southern part of Jutland, Schleswig-Holstein and the area above the Weser in Lower Saxony, Pomerania. In NBA III Mecklenburg also is included in this zone (Kersten 1936). Within this area, the typical Nordic material is less decorated, and the quantity decreases further to the south. Kersten was influenced in its zoning by the former boundary lines (Randsborg 1996: 63-64). However, the geographical distribution, as well as the occurrences of Nordic influenced artefacts, make a similar definition of the Nordic Bronze Age possible (see e.g. Nørgaard 2011: 113ff.). Additionally, modern studies underline intensive contacts between the described Zone I and the adjacent southern regions (in both directions), in which the 'Nordic style' seems dominant. The Nordic influence decreases rapidly further to the south, possibly due to the central German mountains acting as a natural barrier to any significant amount of direct exchange.

In the area described above, there are, despite some similarities in social habits and material culture, many regionally distributed groupings. These differ between the adjacent regions in aspects of material culture, and partially in their burial customs and costume preferences.

Even within the core zone of the Nordic Bronze Age, several studies have revealed regional peculiarities already within NBA II (Rønne 1987; Rønne 1989; Asingh and Rasmussen 1989; Larsson 1986; Olausson 1989). Especially in the Danish area several stylistic regions were defined on the basis of a combination of patterns and stylistic differences. On Zealand, Rønne defined eight different regional groups during NBA II (Figure 1.014) in which different ornaments dominated (Ronne

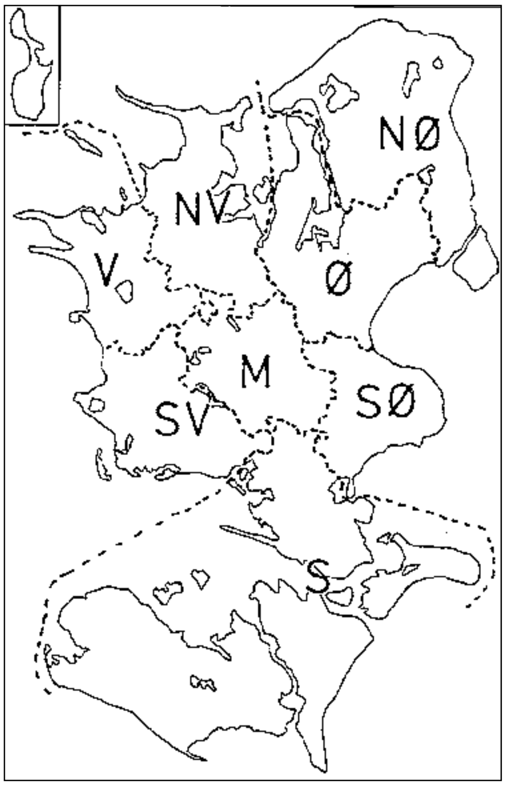


Figure 1.014: Regional groupings on Zealand during NBA II (after Rønne 1986).

[6] Here Kristiansen especially names the Kivik burial in Scania and the Anderlingen burial in Lower Saxony (Kristiansen and Larsson 2005: 189-194; Willroth 1997: 4; Kristiansen 2004).

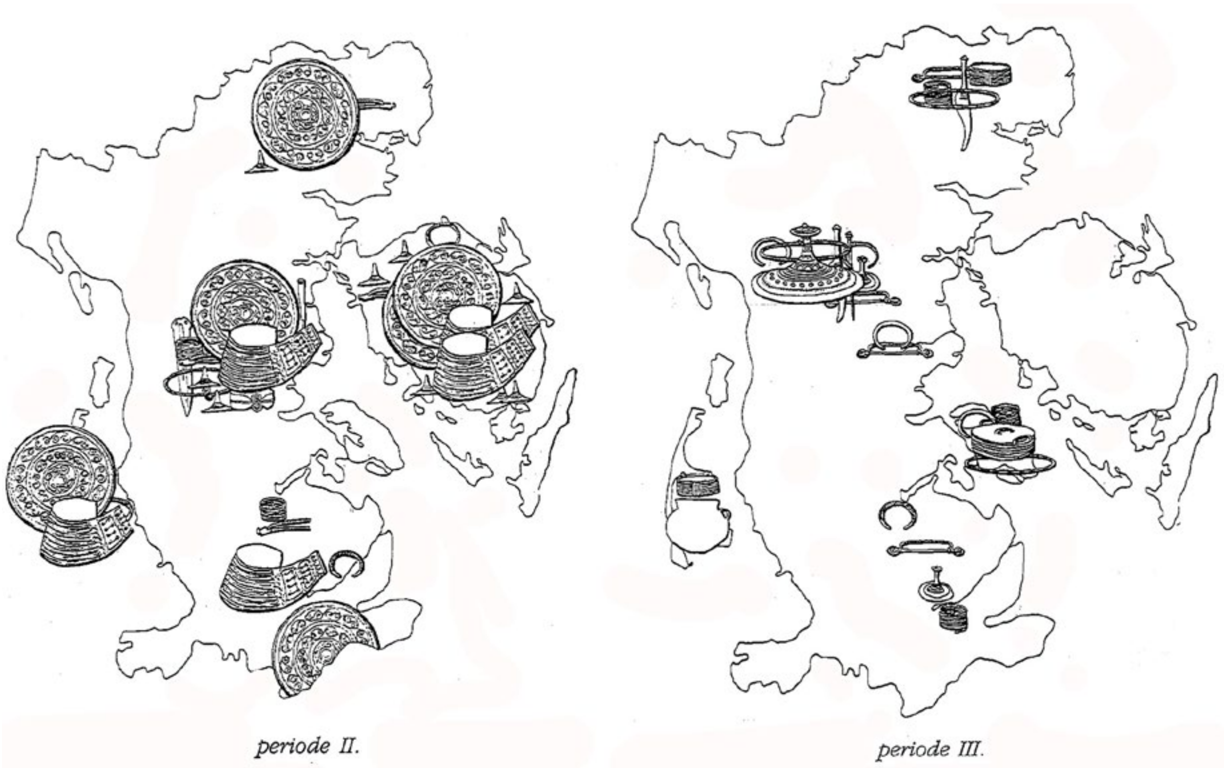


Figure 1.015: Regional groupings on Jutland and the Island Fyn during NBA II and III
(after Asingh and Rassmussen 1989).

1987: 80-99; Ronne 1989: 69-71). Within NBA III the wealth displayed through ornaments decreases and the stylistic regions seem to grow larger. Also, on Funen and the Danish mainland, similar groupings have been found based on combination studies (see Asingh and Rasmussen 1989) (Figure 1.015). The change from NBA II to III within these groupings is shown very clearly within the work of Asingh and Rasmussen. Similarly to the Danish islands, the amount and richness of the artefacts decreased and it seems that larger regions with similar patterns emerged (Asingh and Rasmussen 1989: 80-82). Furthermore, the material culture on Bornholm should be considered at all times (NBA II-III) as independent, offset in time and influenced by the surrounding areas.

Scania (southern Sweden) is characterised, on the basis of hoard equipment and different costume traditions displayed in burials, by a coastal distribution of several regional groups during NBA II (Larsson 1986: 103ff.). Larsson divides the southern part of Scania into three major groups, differing by their settlement patterns and artefact groups. Within these three zones the intensively used settlement areas, partly over centuries,[7] suggest a division into tribal areas (Larsson 1986: 105). Also, Scania is characterised towards NBA III through a change in the size of each region and the formation of larger centres with similar social structures (Larsson 1986: 112ff.).

Within Schleswig-Holstein in north Germany one or two independent groups can be assumed during NBA II and III, which were influenced by the north and south alike. The two groups developed presumably due to the different focus of this influence. In the *Elbe-Weser-Winkel* and the Stader Geest, influences coming from the north can clearly be noticed. Additionally, in Dithmarschen a group influenced by the north and west can be detected. In contrast, the southern part of Lauenburg is in close contact with the Lüneburg group, which is particularly reflected within the burials (Willroth 1997: 13). However, firstly at the end of the NBA III and then within NBA IV, the stylistic group located in Dithmarschen is clearly separated from the adjacent regions through the distinct material culture. A special find density in this area, with a strong presence of gold and imported objects, emphasises contact with the British Isles (Kneisel 2013: 48). Based on various studies (Asingh and Rasmussen 1989), which rarely deal directly with the area of Schleswig-Holstein, the intensive influence on this region from different areas, and possibly even coming from the British Isles, becomes clear.

The areas south and east of Schleswig-Holstein are summarized by Kersten in his Zone II. Here various regional phenomena are primarily evident in the early periods (Figure 1.016).

Lower Saxony was in the late Neolithic period strongly under Únětician influence and developed with the

[7] For the Neolithic settlement concentrations, see Maulers 1957.

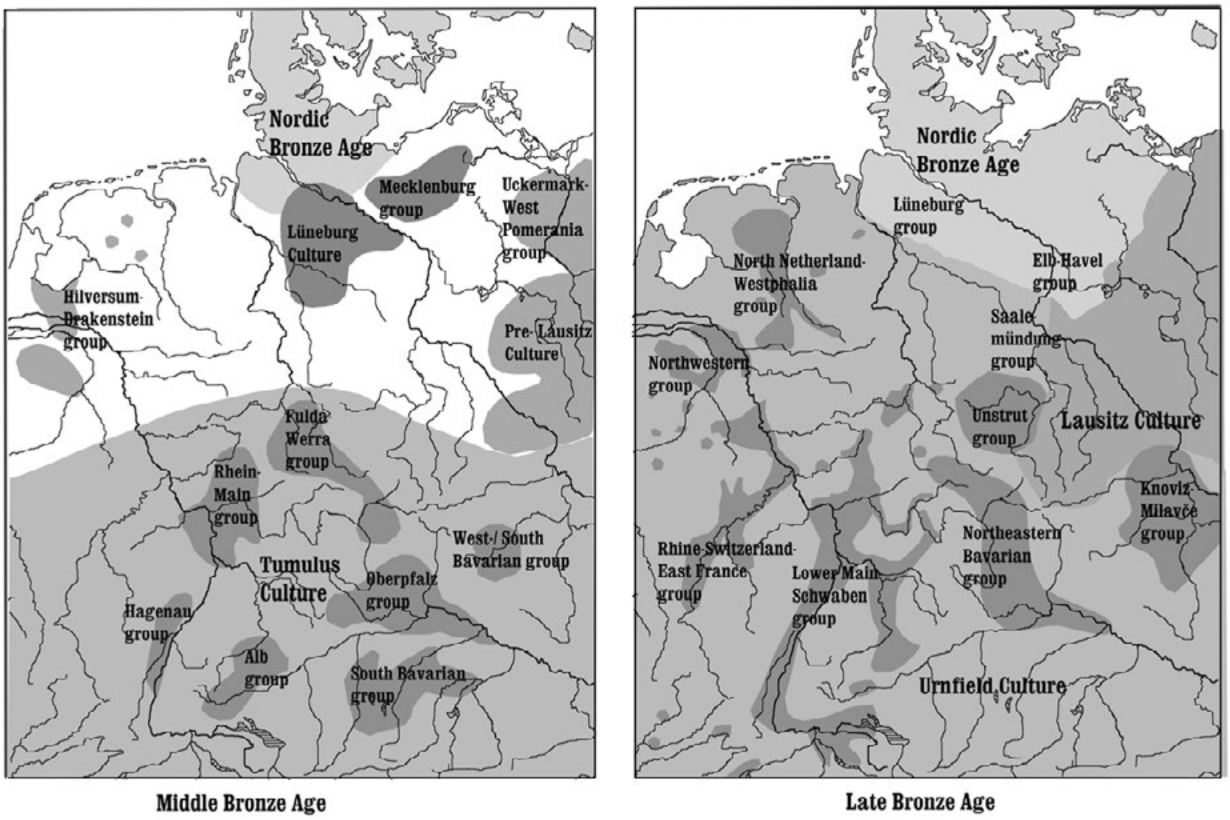


Figure 1.016: Regional groupings of the Early and Middle Bronze Age in Germany (after Jockenhövel 2000:14).

Sögel-Wohlde-Kreis its '*erste einheimische Bronzekultur*'[8] around NBA 1B. (Müller and Geschwinde 2013: 17; Willroth 1997: 13). This material culture group can be separated from the surrounding areas due to special weapons and a stronger Nordic influence. The Sögel-Wohlde-Kreis extends to the north to Jutland and thus includes *Schleswig-Holstein*. Only the Ilmenau area maintained the strong Únětician influence within its material culture, and here a possible local group can be assumed (Laux 1997: 147ff.). At the transition to NBA II in the territory of the Lüneburg Heath a unique culture developed that was less dependent on the influences from the south, rather serving as an inspiration centre for the surrounding areas (see Laux 1971; Holste 1953). One of the reasons why this region held such a central role from the beginning of the Bronze Age, where it served for decades as the periphery of the south, is its geographical mediating position between the Scandinavian and southern German Bronze Age (Müller and Geschwinde 2013: 18). Characteristic for the Lüneburg Bronze Age is its burial mounds, with their extensive fortifications (Geschwinde 2000; 1996) and the rich furnishing of the tombs (Fendel 2006; Laux 1996b; 1996a). The amount of foreign goods underlines the importance of the Lüneburg area as a transportation hub within the Bronze Age exchange network (Laux 1995; Jockenhövel 1991; Sprockhoff 1941). However, this grouping, which appears so uniform, and is visible in the archaeological across several centuries (about 1600-900 BC), also displayed regional specialities (see Laux 1997: 147-152; 1971), which might be of interest within this work.

West of the Elbe, in Ostfriesland, the *Elb-Kultur* can be detected. This cultural group clearly emerged within the Middle Bronze Age and is strongly influenced by the Tumulus Culture (Willroth 1997: 13).

The area of Mecklenburg can be divided into several stylistic and cultural areas during NBA II. The main cultural areas are western Pomerania, eastern and northwestern Mecklenburg (Rassmann 2004: 46). With the beginning of NBA III the transition from inhumation to cremation gives rise to the establishment of the Mecklenburg group, a cultural and material unit placed in the centre of Mecklenburg around the Mecklenburg lake area.

Western Pomerania and the easterly adjoining areas were under strong influences from the Vorlausitzer-Kultur, which was disseminated southeast of Mecklenburg. The material culture is related to Mecklenburg,

[8] The first local cultural group using bronze.

however it clearly shows southern influences which became prominent from NBA III (see Nørgaard 2011: 115ff.). This grouping is commonly known under the name Uckermärkisch-Westpommersche-Gruppe and differs mainly from the Mecklenburg group through its southern influences (Jockenhövel 2000: 13-14).

The cultural groups south of the area of research will be mentioned only marginally. During the early Bronze Age, the Únětician culture played a prominent role. This widespread cultural group, with various smaller centres in eastern Germany, Bohemia, Moravia, Lower Austria, southern Slovakia and western Poland, initiated the Metal Age and parallels can be drawn with the Sögel-Wohlde-Kreis (Jockenhövel 2000: 13; see Figure 1.016). However, only a few of the regional groups in south Germany are important for the material examined and all of them can be assigned to the Tumulus Culture. Of importance to the Bronze Age in northern Germany, due to their influence on the technological traditions, are the Fulda-Werra-group and the Rhine-Main-group which appeared within the Middle Bronze Age (Jockenhövel 2000: 13).

In summary, the research area from which the material for the present investigation is taken includes Kersten´s Zones I and II: that is to say the entirety of Denmark with Bornholm, southern Sweden (mainly Scania), Schleswig-Holstein, Lower Saxony, northern parts of Saxony-Anhalt, Brandenburg and Mecklenburg, and the adjoining Polish regions along the Oder. Within this area, which can be grouped under the term 'Nordic Circle', many regional groups occur during NBA II and III.

Chapter 2

Presentation and interpretation of the examined material culture

This section is devoted to a close examination of the material under investigation, i.e. neck collars, belt discs and plates, pins, rings and tutuli. It is undisputed that the majority of these ornaments are part of the female costume. The neck collars of NBA II and III, formally arranged into four large groups, present in the find assemblage of the NBA only a small percentage. Thus, their appearance in burial mounds and oak-coffin burials indicates that neck collars are to be seen as some kind of status symbol. They probably originate from the replica of the golden lunulae and the neck ring sets. Today, the origin of the small belt discs, a comparable important part of the costume, within the central European Únětician culture cannot be denied. The opposite seems the case for the large plates, which appear first in NBA III and are, very likely, of Nordic design. Tutuli, especially the cone-shaped and hemispherical pieces, are in a similar way typical for the material culture of the North, whereas the various pin types are often imports or specific north German creations. It seems, that these kind of elaborately decorated bronzes are more than just parts of a costume. These objects were reserved for a small number of people, as they commonly appear in rich burials or depositions, and often occur in combination. Moreover, they seem to hold a specific meaning in combination with characteristic Bronze Age garments throughout the Nordic Bronze Age and act here as part of an information system, through which social connections were visualised. A Bronze Age costume displayed several kinds of information in parallel, such as the age of the person, their social status and regional affiliation, as well as their personal situation and position in the family, depending on the visibility of the artefacts. Within this Chapter some suggestions are made concerning specific female costume-ornament combinations and how far they might symbolize the different stages within a female's life.

1.2.0 Symbol or costume-fitting: magnificent decorated ornaments within the socio-cultural discussion

That the source-critical neck collars were chosen as the starting point of the investigation (Nørgaard 2011) proved to be beneficial, as around 80% of large bronzes were deposited in direct relationship to one another. 153 neck collars, 106 belt plates and belt discs, 16 needles, 29 tutuli, 2 fibulas and 17 arm or leg rings were examined (Figure 1.017), all of Nordic origin and with known find contexts. However, these objects represent just a small number of the known bronzes from NBA II and III (see Figure 1.006). As an example, the investigated neck collars represent 2% of the overall findings within NBA II. However, they are, in addition to belt plates, one of only a few object groups with such magnificent decoration.

What is the meaning behind such elaborately crafted bronzes? Are they a permanent element of the common costume of a Bronze Age woman, and can they be seen as an information carrier in the sense of Wobst (1977)? Are bronzes as part of a person's identity of such importance, because they could change shape in the same ways as life can change shape (Sofaer-Derevenski 2000: 390)?

It is undisputed that neck collars, belt plates and discs, as well as wheel-headed pins and disc-head pins, are part of the female costume. The same can be said for the vast amount of tutuli. Furthermore, the elevated status

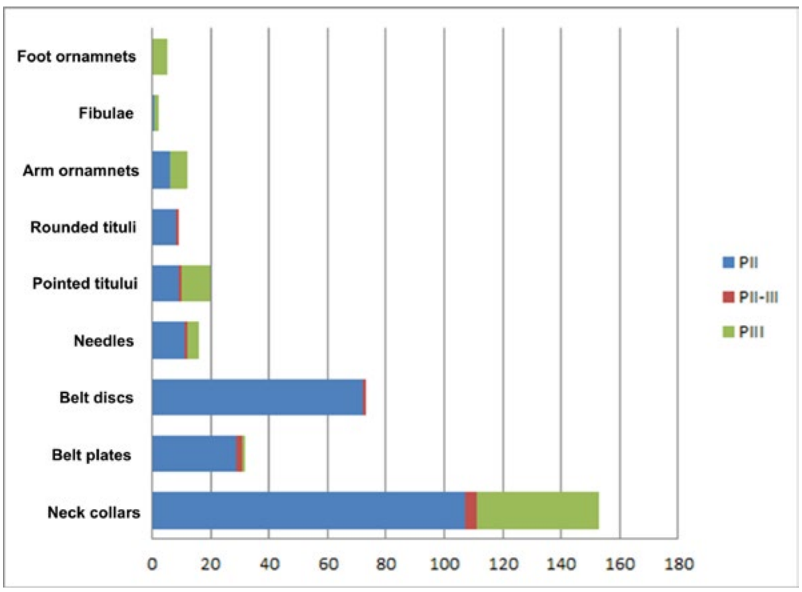


Figure 1.017: The distribution of the examined object groups within the Bronze Age periods.

of the persons who were buried with such a volume of elaborately crafted bronzes cannot be doubted. Thus, it is safe to say about the objects discussed in this work that they represent: A) components of a female costume; B) were reserved for a small number of people (probably high-status females); and C) often occur in combination. Therefore, an accumulation of the largest bronze ornaments within NBA II and III seems to be regular and supports the assumption that they were connected to status.

However, only in combination with clothes and the people that unite both parts do the objects mentioned above gain meaning: 'clothes are activated by the wearing of them as bodies are actualized by the clothes they wear' (Craig 1994: 16; Bergerbrant *et al.* 2013: 250).

Sørensen presented four categories in which objects and people connect (Sørensen 2010: 56ff.; 1997). Within the investigated material, attached objects – meaning objects that are connected to the body and thus can grow with the person – are not included. Due to the fact that these objects are firmly connected with the person, they must therefore have a meaning that does not change through the life course. Associated objects on the other hand are, after Sørensen (2010), owned by a person and are part of their appearance. This includes neck collars, belt plates and smaller belt discs, as well as some leg rings. The tutuli and possibly also the needles are, however, to be included in the group of objects that are applied to clothes and likely constitute a part of this as they are tied to the person. Sorensen's fourth category includes the objects that represent extensions of the body, like swords and axes, as extensions of the upper limbs (Sørensen 2010: 57). These object categories are of importance for the understanding of the bronzes insofar as they show the unity of persons, clothing and objects as elements of an identity. Such an overall picture, named in research 'appearance', displays the information in a conscious combination of individual information carriers (Bergerbrant *et al.* 2013: 249-250; Sørensen 1997; Sofaer-Derevenski 2000: 400; Wobst 1977).

Using preserved textiles, particularly from the common Scandinavian oak-coffin burials, three different female Bronze Age costumes could be reconstructed and have been revised by Bergerbrant (2007; Bergerbrant *et al.* 2012; Bergerbrant *et al.* 2013; also Broholm and Hald 1935a; 1935b; 1948; Broholm 1961). One of these costumes consisted of a long folded skirt, held in place by a cord, and a short blouse. Additionally, a hood or a kind of hairnet seems to belong to this dress (like Skrydstrup, Denmark, after Bergerbrant 2007: 53; Broholm and Hald 1948: 13-20; Aner and Kersten 1984: 77-79). What is striking is the reconstruction made by Bergerbrant without any kind of ornaments. A similar garment is assumed in Borum Eshøj (Jytland), however, this costume includes a big belt plate attached to a belt and a more elaborate collection of bronze ornaments such as necklaces, bracelets and body ornaments (Borum Eshøj, grave C in Bergerbrant 2007: 54; Broholm and Hald 1948: 22-29). Furthermore, a fairly widespread dress seems to be a short skirt, which is made up of several cords and held together at the hem and on the abdomen by a transverse cord. The cords of the skirt are decorated with bronze rolls. Several burials show that the upper body was covered by a short blouse. The hair was bound by bands, a net or otherwise (like Egtved, Denmark, in Bergerbrant 2007: 55; Broholm and Hald 1948: 30-36; Aner and Kersten 1990: 40). Also in combination with this dress bracelets and some necklaces are found, more seldom large belt plates. Another dress was reconstructed on the basis of the findings in Lower Saxony, slightly different from the previous examples. Again, it consists of a short blouse, a long skirt (only to the knee) and a coat or cape. This costume is complemented by extensive leg ornaments, neck collars, belt plates and an embroidered cap. The coat is decorated with several bronze cones (like Wardböhmen, Lower Saxony, in Bergerbrant 2007: 56; Piesker 1958; Laux 1971).

The garments described above seem to have been represented in their basic features throughout the Nordic Bronze Age. The literature is rich with suggestions concerning the design of the long skirt and possible combinations with capes or coats (i.e. Kristiansen 2013). Particularly striking are the obvious regional differences within the details, i.e. the additional coat, which occurs mainly in northern Germany, and the difference in the length of the skirts (i.e. Bergerbrant 2007: 44ff.).

Taking up again the definition of costume, cloth and appearance as discussed above, it seems that the garments should not only be seen as protection against environmental influences, but (especially in combination with the objects) also as part of an information system, through which social connections were visualised (Sørensen 2010: 55; Sørensen 1997: 96).

The costume of the 'Egtved girl' (Figure 1.018), for instance, is often interpreted as priestly. This is mainly due to the big belt plate and the fact that such a short skirt is considered impractical for everyday use, and even 'immoral' (i.e. Kristiansen and Larsson 2005; Thomsen 1929; Randsborg and Christensen 2006: 32). However, Bergerbrant has in this regard pointed to the similar belt plate in the Borum Eshøj burial, and towards the fact that the buried individual differs significantly from the Egtved girl not only in age but also in dress (Bergerbrant 2007: 59-60). Apparently, a Bronze Age costume displayed several kinds of information in parallel, such as the age of the person (Thomsen 1929), their social status and regional affiliation (Bergerbrant 2007: 65ff.), as well as their

Figure 1.018: The Egtved burial (after Aner and Kersten 1990: 40).

personal situation and position in the family (Eskildsen and Lomborg 1976; Bergerbrant 2003; Sørensen 1997). Additionally, the burial itself, its construction and position in the landscape contains information (i.e. Holst and Rasmussen 2013; Johansen *et al.* 2004).

Thus, the age is possibly displayed in the amount of ornaments connected to the garment. When comparing the dress of the Skydstrup woman (18-20 years) more closely with the similar dress of the woman from Borum Eshøj (50-60 years) a possible age-related difference attracts attention. This difference is within the large repertoire of ornaments the older woman is buried with compared to the younger woman. The reconstructed dress of an old woman in northern Germany (Bergerbrant 2007) differs slightly from the Scandinavian form, especially with regard to the skirt length and the additional cape. This might be explained due to regional customs or temperature. However, the difference in the ornaments is decisive. The ensemble from Wardböhmen emphasises the upper body and head (Wels-Weyrauch 1989). If one looks at how the different costumes act with regard to the effect that they could have on others, an emphasis on different parts of the body becomes evident. Wobst wrote:

> '[The] less an artifact is visible to members of a given group, the less appropriate it is to carry stylistic messages of any kind ...on the other hand, those sets of material culture which potentially are visible to all members of a given social group are more likely to show a society specific expression of stylistic form' (Wobst 1977: 328-329).

Assuming the ornaments acted as an information carrier (Wobst 1977: 320; Sørensen 1997: 93), or at least represented more than just possession (Sørensen 2004: 167; Renfrew 1974), and similar clothes probably showed a similar 'family situation', then different ornament sets might have included another level of information. In this way, different patterns in the above-mentioned costumes can be recognised. The costume of the older women (Borum Eshøj – long skirt and blouse with hairnet) would address different groups of recipients in the different regions (Figure 1.019). The Scandinavian woman was wearing a notable belt plate combined with less conspicuous neck and arm ornaments. A woman of similar age in north Germany was wearing an embroidered cap and a neck collar. Her upper body part is highlighted with a large wheel-headed pin and bronze discs. Wobst's (1977) theory of information carrier and information receiver is based on the fact that an artefact sends out information to different groups of recipients by its shape and decoration but also through its position on the body. The higher the position of the ornament on the body the further it can be seen and the information read. In the same way as the set of possible receiver increases, so the probability that the artefacts are carriers of social-specific information increases (Wobst 1977: 332-329). Consequently, the differences in the two costumes under investigation may lie in the differing social status of the dead. The north German woman signalled by the collar (a highly visible piece, even if coat and cap are worn) her position in society. The amount of neck collars found[9] suggests that these

[9] During NBA II neck collars are found in 2-10% of all known burials,

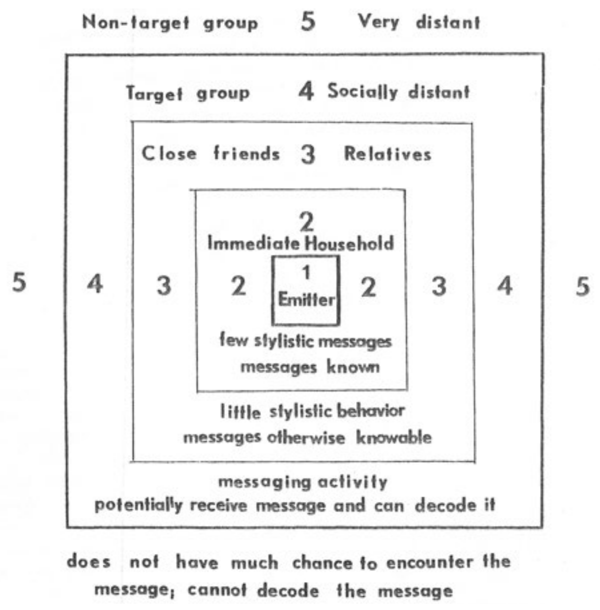


Figure 1.019: Wobst´s target groups of stylistic messages (after Wobst 1977: 325).

items do not represent the top of society, but their owner might be found near to it.[10]

Belt plates seem to have a similar function as information carrier. However, this ornament is visible only when the robe is removed and the receiver is located in the immediate vicinity of the person. Consequently, the information contained may reach fewer people and would, therefore, have to be of a different nature. The possibility exists that belt discs especially are expressions of the family situation. This is mainly due to the fact that they focus on the 'centre' of the woman´s body (see Sørensen 2010: 59) and are recognisable only in close contact or when presented.[11] Based on this hypothesis, the Egtved costume could be interpreted otherwise than as purely ritualistic. Suppose the belt plate carried on the waist symbolised the 'mother', the combination with the long skirt might inform about the carrier's family situation – the married mother. In contrast, the combination with the cord skirt may have been regarded as a signal that the person was of marriageable age (or was within this process). Relevant in this case would be the arguments put forward by Bergerbrant that the bronze tube skirt would cause noise (Bergerbrant 2007: 55). This would direct the attention towards the specific woman not only by visual values such as the differing clothing and the striking belt plate, but also by auditory values, such as the ringing of the skirt.

> '[The] modes of reception include at least the senses of vision, hearing, smell, taste, and touch, while the modes of emission range from verbal behaviour through a variety of non-verbal behaviours' (Wobst 1977: 322).

The number of cord skirts[12] within the archaeological record allows such an interpretation, probably rather than the ritual variant. Another point is that in other burials with cord skirts no belt plate is present, such as occurs at Ginderup, Thy municipality (Bergerbrant *et al.* 2012). The belt plate is, however, apparently crucial for the ritual interpretation used by many researchers. On the other hand, the Egtved burial contains a further burial that should be considered here as an important indicator to the discussed topic. The cremated bones of a five/six-year-old child, placed at the head and feet of the female, indicate in their strontium value ($^{87}Sr/^{86}Sr$) a close relationship to the Egtved girl. Both isotopic values, the values measured in the tooth enamel of the girl and the ones measured in the occipital bone of the cremated child, seem to be indistinguishable from each other and indicate an origin of both individuals outside Denmark (Frei *et al.*: 2015). Thus, even if the Egtved girl´s dress might indicate marriageable age, the belt plate might have signified the mother. This would also explain why the other corded skirts are not accompanied by belt plates.

A widespread assumption regarding the combinations of clothes and ornaments buried with the dead is that they are to be regarded as dead costumes rather than actively used costumes of a living person (Pearson 1999; Barrett 1994; Müller and Geschwinde 2013: 19). However, especially with regard to the Nordic Bronze Age, intense wear and tear marks on the clothes and artefacts bear witness that these were worn in life (Bergerbrant 2007: 44ff.; Kristiansen 2013; Sørensen 1997: 101). Furthermore, the above-mentioned attached objects (Sørensen 2010; 1997) testify to the importance of the ornaments. Thus, the costume can be seen as an integral part of life and will surely have been worn in representative situations. The probability that a complete costume was worn in field work or hard physical work is rather unlikely. To what extent the costume in the graves reflects the person, her personal conception of identity, or should be regarded as a collection of attributes that have been selected by the relatives and thus represents an applied identity (see

depending on the region (Nørgaard 2011: 105ff.)

[10] Svend Hansen was able to present in his analysis of extraordinary Bronze Age grave equipment ('Überausstattungen') within the Early Bronze Age the existing stratigraphy (Hansen 2002; see also Vandkilde 2007: 92). Regarding the burials with neck collar and belt plate another interpretation than that of 'Überausstattungen' is assumable. These pieces are quite likely part of a costume, and thus the possessions of a person. A possible duplication of objects seldom occurs and is related to costume tradition.

[11] This study concentrates on the natural way of interpreting these costumes. However, a supernatural explanation might easily be found and can perhaps be supplementary.

[12] Clear evidence of cord skirts comes from Gjedsted, Holbæk amt; Ols Kirke, Bornholm amt; Kirkedrup, Odense amt; Rye Holbæk amt; Nellikehøj, København amt; Tjornehøj, Frederiksborg amt; Nordhøj, Odense amt; Vognserup Mose, Holbæk amt (Aner and Kersten 1973; 1976; 1977) und Ginderup, Thy amt (Bergerbrant *et al.* 2012).

'I-dentity' versus 'eye-dentity' in Reiter 2014a: 53-66; 2014b), cannot be illuminated within this work. It might, however, be of great importance for an understanding of such complex jewellery equipment.

To conclude, neck collars are presumably an indicator of the social status (hierarchy/range) of women within the community. Justified by the different amount of recipients the artefacts, which are regarded as an information carrier, could attract, the belt plates may indicate rather a social statement. As discussed above, the focus on the female's body centre might stress female qualities, like motherhood or marriage. The combination of clothes and equipment is thus to be interpreted at different levels. In other words, 'the general growing awareness [is] that individuals have many overlapping identities' (Sørensen 1997: 93). Therefore, the costume (with an emphasis on the garment and the amount of ornaments) displays the personal status of the owner, such as married or unmarried (long skirt and short skirt), and mother or willing to become a mother (belt plate and short skirt with belt plate). This is especially likely in regions where fixed combinations could be detected. Furthermore, regional differences could be expressed in the choice of material, the kind of clothes, the combination and preference of certain objects, and in the object group (Bergerbrant 2007; Sørensen 1997: 96-98; Bender Jørgensen 1991: 117; Wels-Weyrauch 1989). In addition, amongst other artefacts, the neck collar might display a ranging significance. Their high position on the body allowed communication of the symbolic information contained in the artefact over a large distance, and identified the owner as a higher ranking personality.

1.2.1 Neck collars within the Nordic Bronze Age

Around NBA 1B, the first flat D-shaped collars appear within hoards (Gedl 2002: 37; Schubart 1972: 128; Schanz 2006: 383; Blajer 1990).[13] Similar objects could be identified through *in situ* burials as neck ornaments (Aner and Kersten 1973; 1976; 1977; 1978; 1979; 1986; 1984; 1981; 1990; 1991; 1995; 1993; 2001; 2008; Schubart 1972; Laux 1971; Piesker 1958 (Figure 1.020). Formally, these artefacts might have originated in the neck ring collars, and in the reproductions of golden lunulae. They developed in NBA II and III to become an important hoard and grave good within the entire north European and Scandinavian area (MAP 02). With the beginning of the Late Bronze Age the collars changed in form and consist of single neck plates combined to neck ring-sets. These 'new' neck collars spread from Scandinavia to Pomerania and represent a high proportion of the Late Bronze Age

Figure 1.020: Burial from Wardböhmen 'Hengstberg' (after Piesker 1958).
Figure 1.021: Classification chart of neck collar 1 (based on Nørgaard 2011).

material culture. With the end of NBA V these objects disappear from the archaeological record.

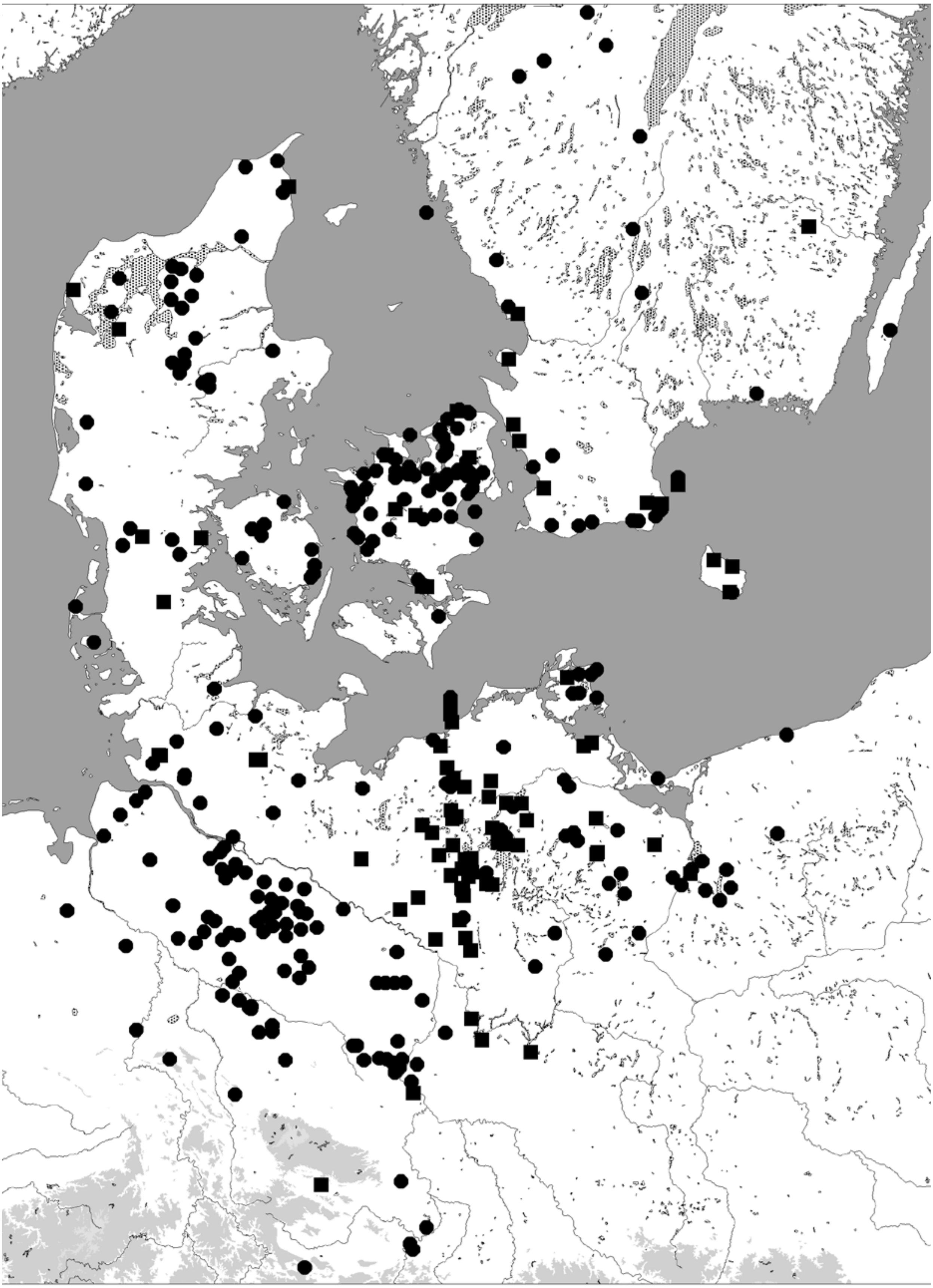
The neck collars of NBA II and III can be arranged on the basis of their formal characteristics into four large groups. The first group consists of 'Ösenhalsringkragen'. They can be determined during the NBA 1B mostly in north Germany and appear again within NBA III, predominantly in hoards spread over the whole area.

The second group consists of horizontal ribbed neck collars. They could be divided into five groups of formal types, with fine arrangements, on the basis of decorative elements.

The third group of collars is formed by the neck collars with smooth fields placed beneath groups of ribs. The wide valley (smooth space) between the ribs is a decorative element that appears with the transition from NBA II to III, with the most well-known representative being the 'Mecklenburg type' and which continues into NBA III. The representatives of the first two groups are only represented in northern Germany, Poland and Scandinavia. In contrast the third kind was found also in central Germany (Thuringia).

The fourth large group consists of the smooth neck collars, the earliest representatives of which might be the bronze reproductions of Irish gold lunulae. The more complex decorated objects (with spiral-decoration) appear within NBA II and III.

[13] The oldest neck collars are dating to NBA 1B (Br. A2c) and are known from: Kurcewo, Szczecin (Gedl 2002: Nr, 260-261), Mistorf, Kr. Güstrow (Schubart 1972: 128), Babin, Szczecin (Gedl 2002: Nr. 257) and probably Klempenow, Kr. Demmin (Schanz 2006: 383).



Map 02: Distribution of neck collars in NBA II (dots) and III (squares) (after Nørgaard 2011).

Several ribbed neck collars occur in find complexes spread over the entire research area, namely: the undecorated type, the Mistorf and Zealand type (mainly NBA II (Nørgaard 2011: 28-35; Figure 1.021), and the Pisede type (beginning of NBA III (Nørgaard 2011: 64-65; Figure 1.023). In contrast, the vast majority of these ornaments show a regional distribution. The Danish islands display the greatest variety of neck collar forms. Here seven different types were found, almost exclusively distributed on Zealand and Funen during

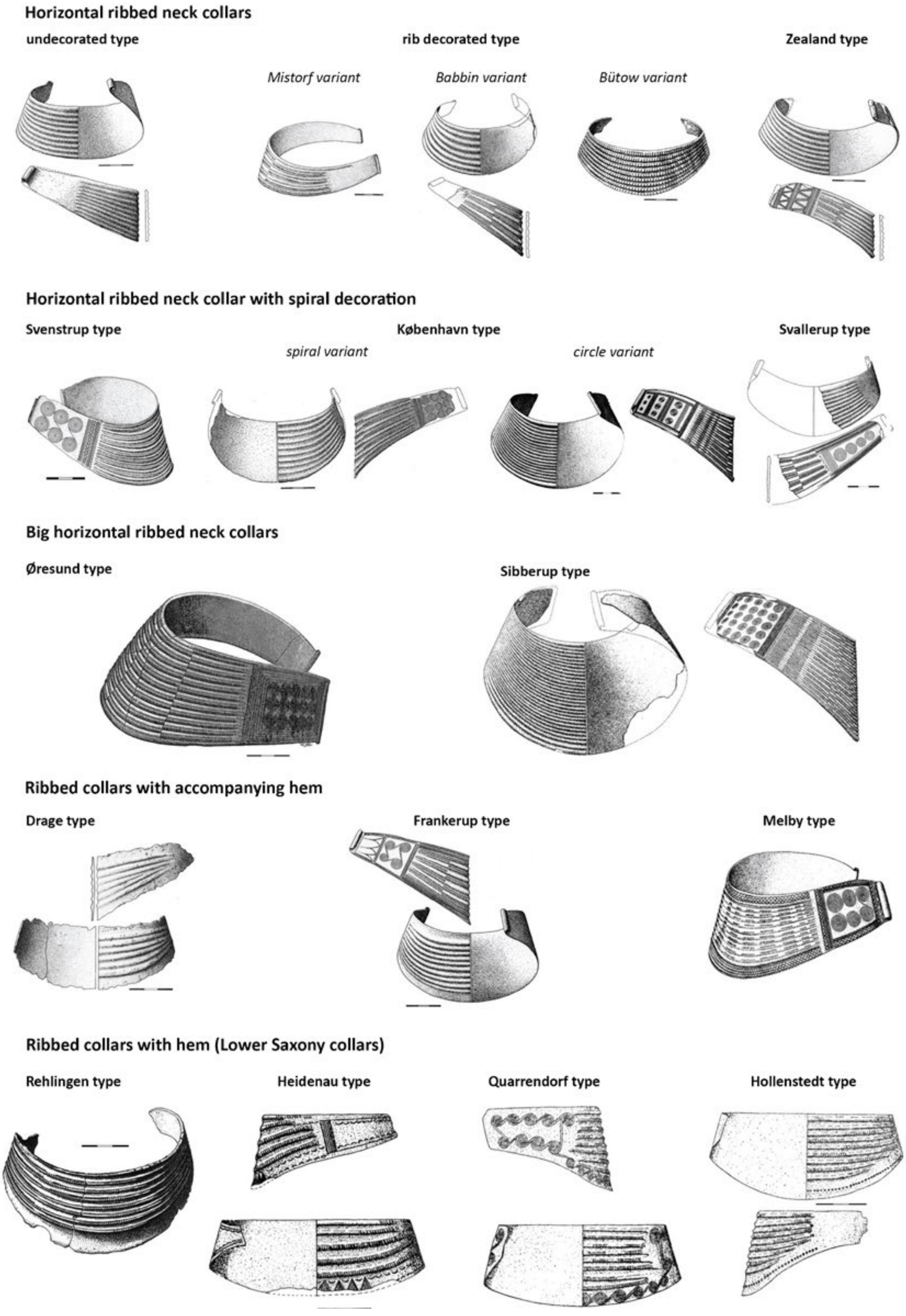


Figure 1.021: Classification chart of neck collar 1 (based on Nørgaard 2011).

NBA II and III (Nørgaard 2011: 39-51): the Svenstrup type, København and Svallerup type, Øresund type, Sibberup type, Frankerup type, and Melby type (Figure 1.021). Also on the Danish mainland, regional types can be detected, such as the Drage type, Vilsund and Krasmose type. The named forms belong to the ribbed Drage type, Figure 1.021) and the smooth collars (Vilsund and Krasmose type, Figure 1.021). Especially

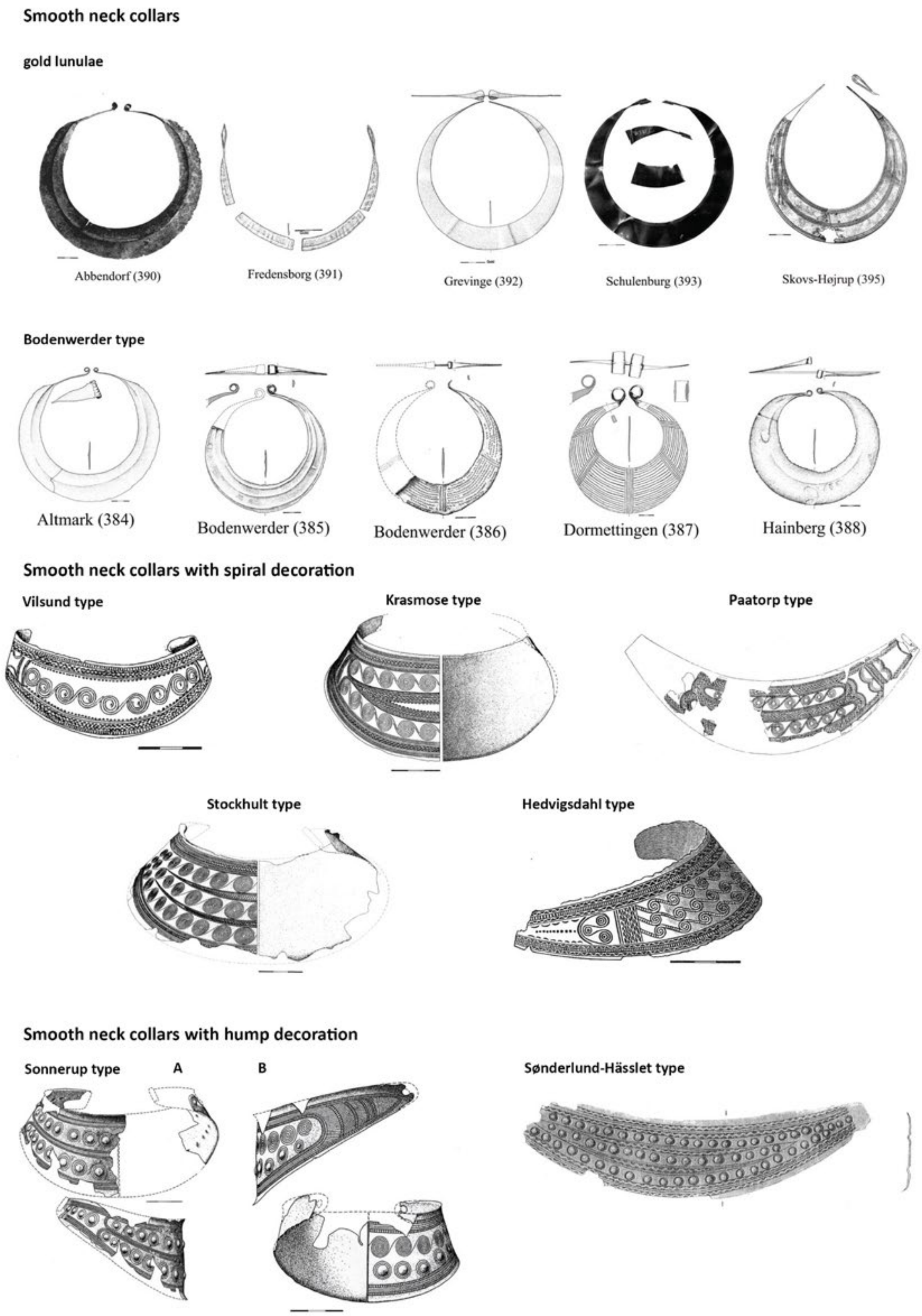


Figure 1.022: Classification chart of neck collar 2 (based on Nørgaard 2011).

striking in terms of the collars distributed on the Danish mainland is their connection to the artefacts in southern Sweden and Bornholm. In contrast, exchange relationships with the Danish island area are only rarely visible in the distribution of these types. Also, the south of Sweden has its own formal variations of neck collars within NBA II. Here the smooth collars of the Påtorp type, Stockhult and Hedvigsdahl type (Figure 1.022) are commonly distributed, which also occasionally occurs on Jutland (Nørgaard 2011: 83-87).

The neck collar types, which are mainly distributed between the rivers Elbe, Weser and Aller (area of the Lüneburg group), show in addition formal peculiarities, i.e. the Rehlingen type, Heidenau type, and Quarrendorf and Hollenstedt types (Nørgaard 2011: 52-57). Formally, they belong to the group of horizontally ribbed collars

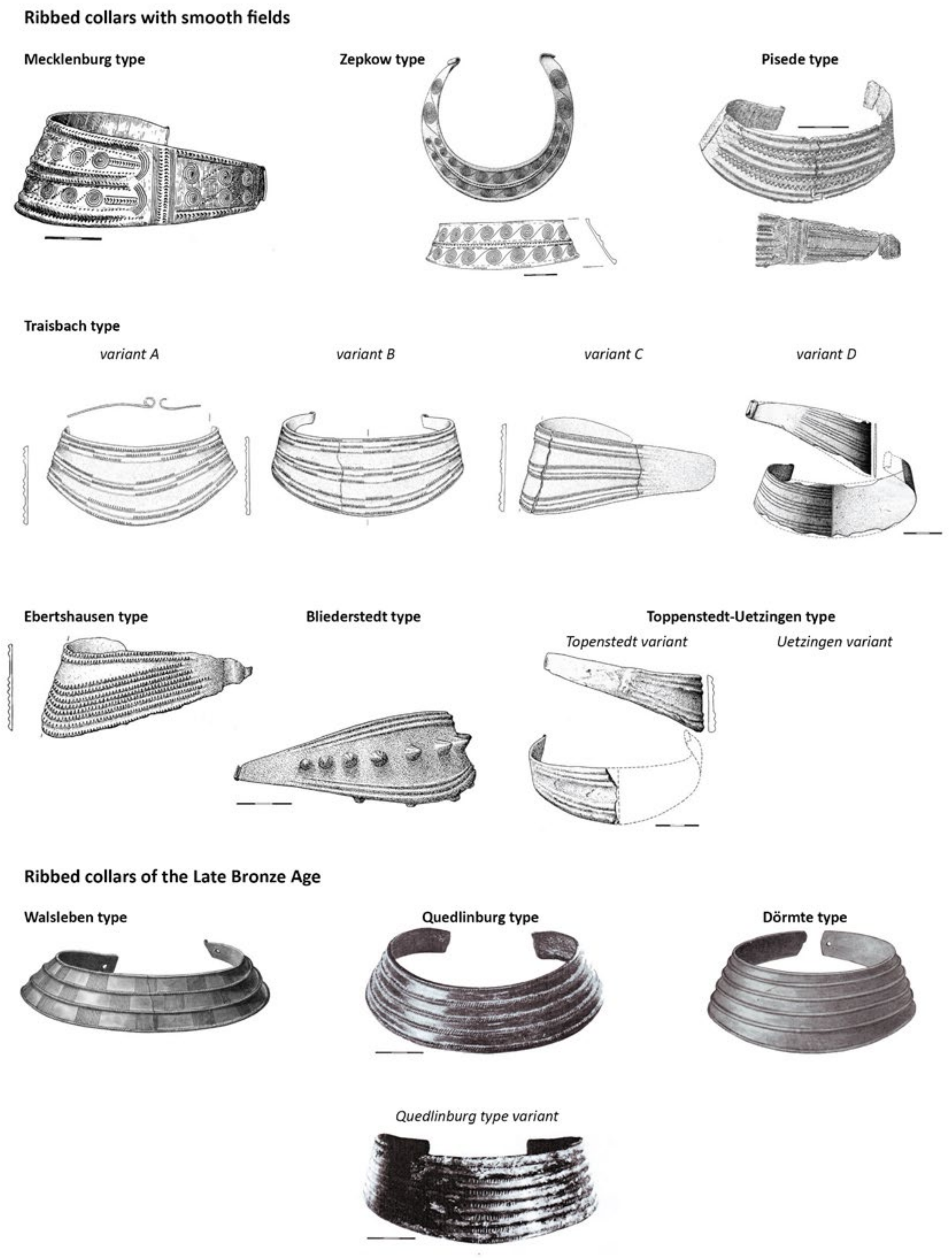
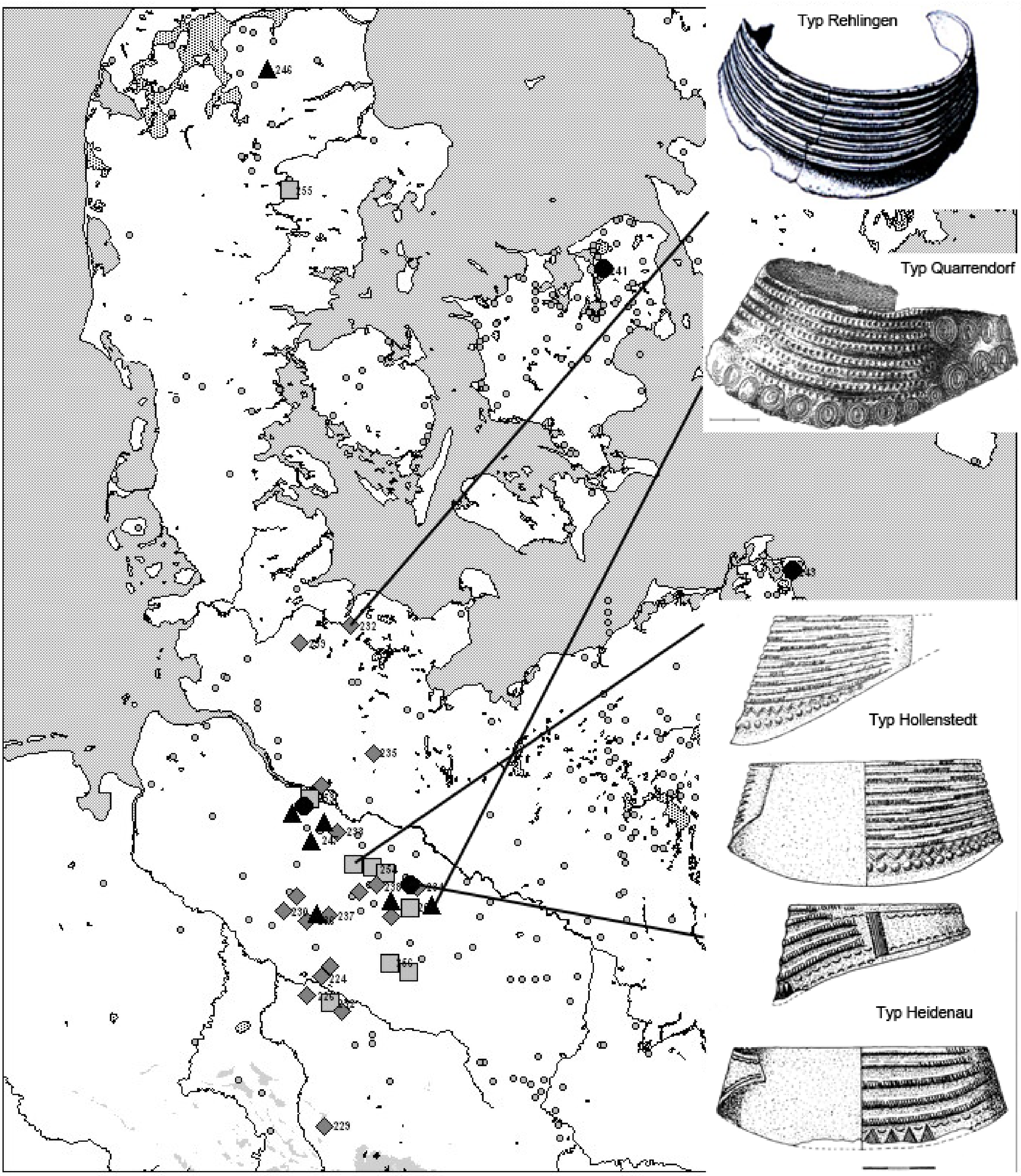


Figure 1.023: Classification chart of neck collar 3 (based on Nørgaard 2011).



Map 03: Distribution of the neck collar-types in central Lower Saxony with examples (after Nørgaard 2011).

(Figure 1.021), but have a smooth hem at the bottom. This characteristic feature, only occurring on Lower Saxony collars (MAP 03), can be seen as a distinctive sign for their origin and thus traced back.

The Hessian neck collars – Traisbach type, Ebertshausen type, Bliederstedt type and Toppenstedt-Uetzingen type – have already been associated to regional forms by Wels-Weyrauch (1978; Nørgaard 2011: 66-71). An influence of the north in the formal development is very likely and supported by the scattered distribution up to Jutland. The vast majority of these regionally distributed types occur within NBA II.

With their first representatives appearing in the transition from NBA II to III, the region-specific form in the Mecklenburg area (Mecklenburg and Zepkow types) reaches a peak in NBA III (Nørgaard 2011: 58-62).

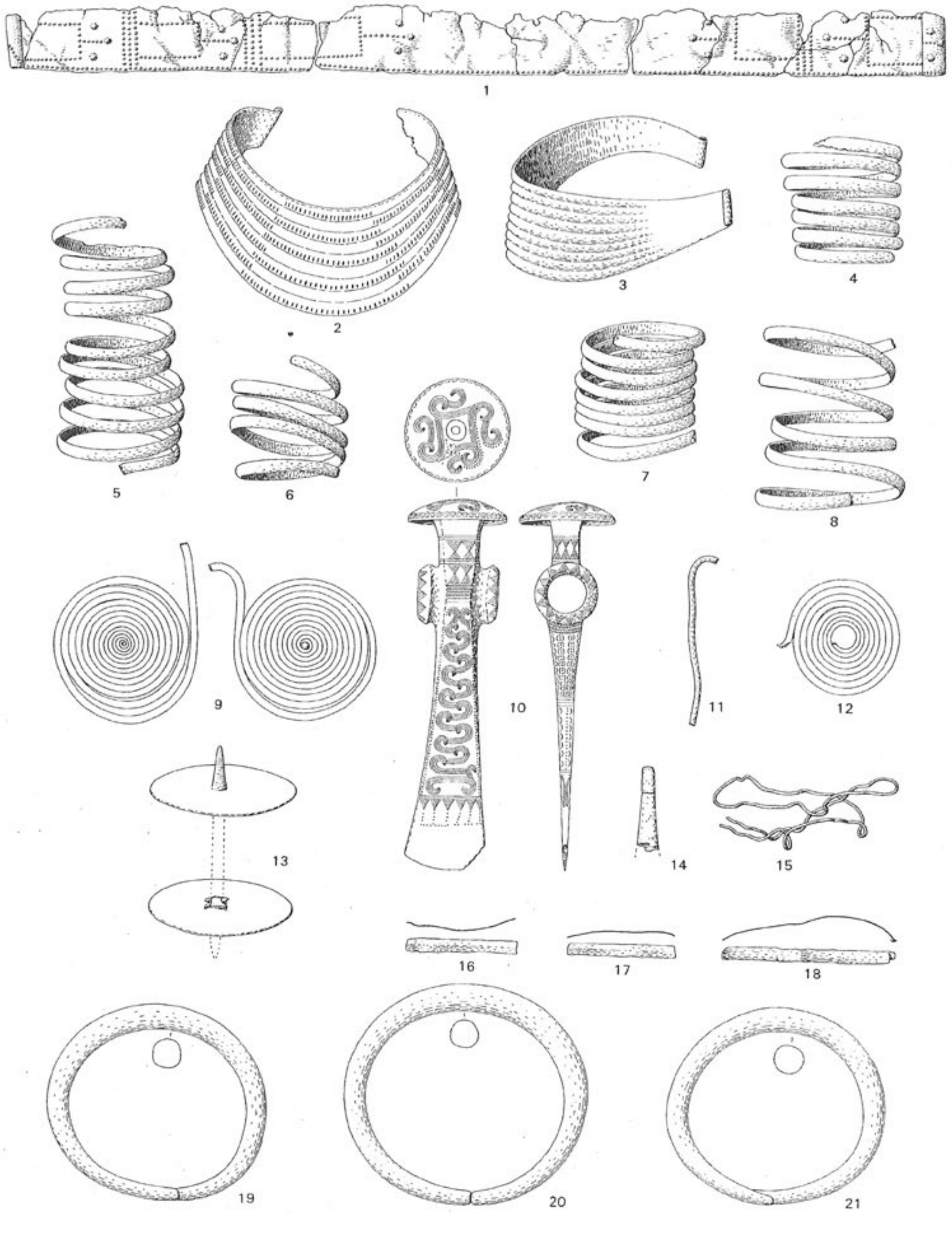
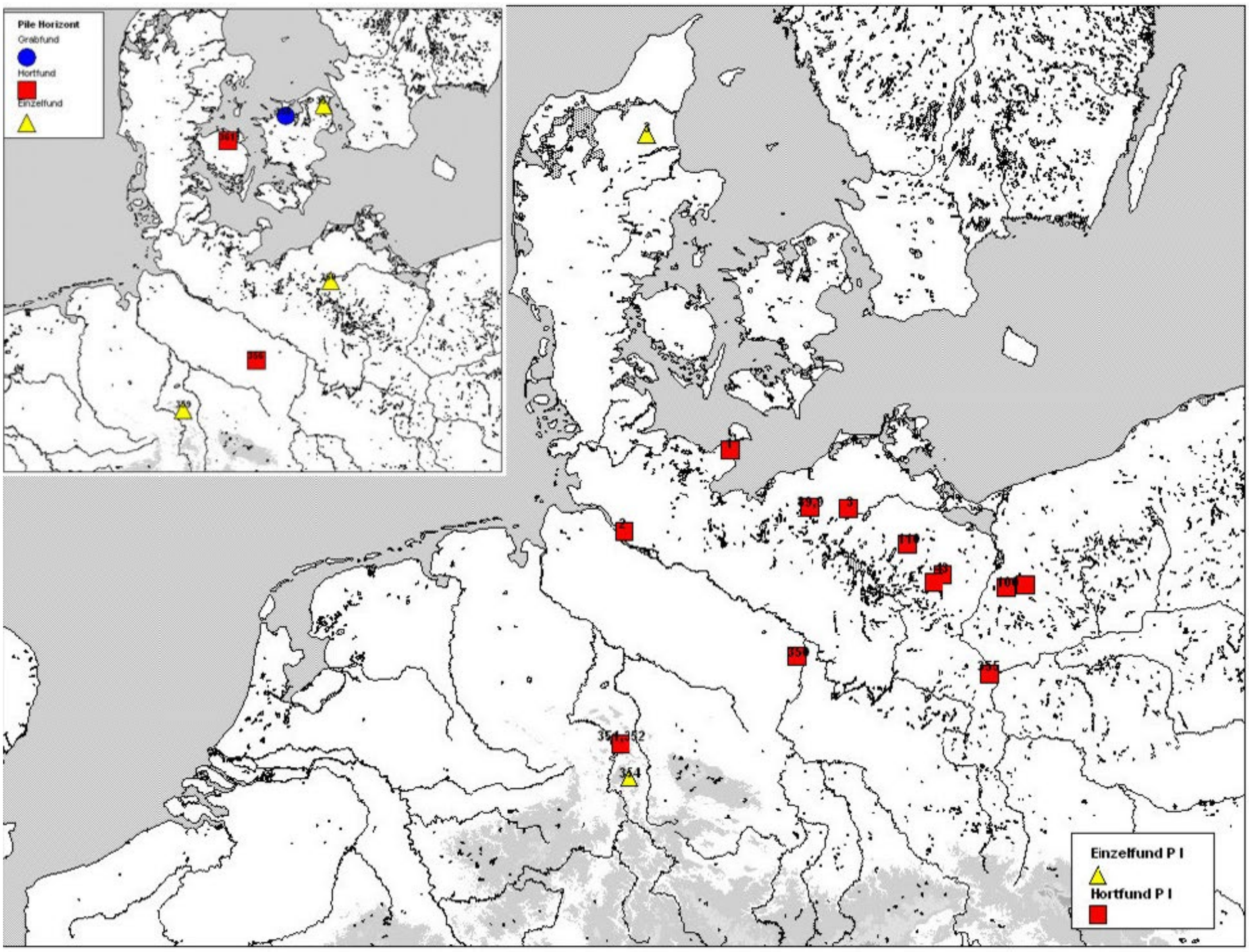


Figure 1.024: The NBA IB collar from Kurcewo with the additional hoard ensemble (after Gedl 2002: Taf.72).

It seems that the neck collars derived their origin from two centres of inspiration (see Nørgaard 2001: 113ff.). In the western part of northern Germany bronze reproductions of Irish gold lunulae (Bodenwerder type) can be found during the Pile-Horizon. In Mecklenburg and Schleswig-Holstein, however, necklace sets, similar to the first collars, occur. With NBA 1B, early horizontal ribbed neck collars (Figure 1.024) appear in hoards on the border between Mecklenburg and Brandenburg (MAP 04). It seems that the depositional method in hoards precludes the early appearance of the pieces in northwest Germany. Different deposition habits in the Lower Saxony area allow an appearance of collars within the graves initially in NBA II. Already at the commencement of this period, a centre in Lower Saxony was emerging. 25% of the NBA II neck collars were found in burials related to the Lüneburg group. On Zealand a second centre appears at the same time. The collars were deposited predominantly in the graves, however in the western part of the island several hoards could be documented. The formation of a hoard circle near the Oder River was already occurring in NBA 1B and continued its development in NBA II; in 71% of those hoards neck collars were deposited. With the onset of NBA III, the main ranges of collars had nearly disappeared on Zealand and in Niedersachsen. Scattered



Map 04: The NBA 1B neck collars in northern Europe, displayed as grave-, hoard- and single-finds (after Nørgaard 2011).

barrows with neck collars were now found only in the northern part of Zealand. A new main range of neck collars developed concomitantly in Mecklenburg (Figure 1.023) with influences from the north and west. Around 50% of the neck collars of NBA III are found in the region occupied by the 'Mecklenburger Gruppe'. Different types appear along the borderlands of this region.

It thus appears, that the small percentage of neck collars in the material culture of NBA II and III (2.6% of all bronzes, partly up to 10%), and their appearance in burial mounds and oak-coffin burials, are to be seen as some kind of status symbol (see Chapter 1.3.0). Thanks to organic remains on the back of several collars (Figure 1.025), we can infer that they were probably worn above the garment (Schmidt 2007; Nørgaard 2011: 104), and were visible over a long distance (see Wobst 1977). The probable golden colour and the impressive size of up to 7 cm in belly height increased the likelihood that they were used as a symbol of social power and affiliation.

1.2.2 Belt plates and belt discs in the Nordic Bronze Age

The plate ornaments of the Nordic Bronze Age are known primarily for their impressive spiral-decorated representatives The most elaborated discs and plates date to the developed NBA II at the transition to the Middle Bronze Age and appear to be a Scandinavian phenomenon, as Kersten assumed in his study of the Early Bronze Age assemblage (Kersten 1936: 11). However, a closer examination of the plate ornaments in northern Europe creates a different picture. The basis of Kersten's interpretation was just a few examples of the artefacts today often referred to as belt plates and belt discs.[14] Already Sprockhoff could add several new finds, especially discs of the Bohemian and south erman Únětician culture (Sprockhoff 1940). Today's distribution map (MAP 05) shows a high concentration of belt plates and discs in Denmark and northern

[14] The used term derives without doubt from the position within the burial, namely on the abdomen, where these artefacts were often found. Occasionally the discs were found in combination with belts or attached to a belt.

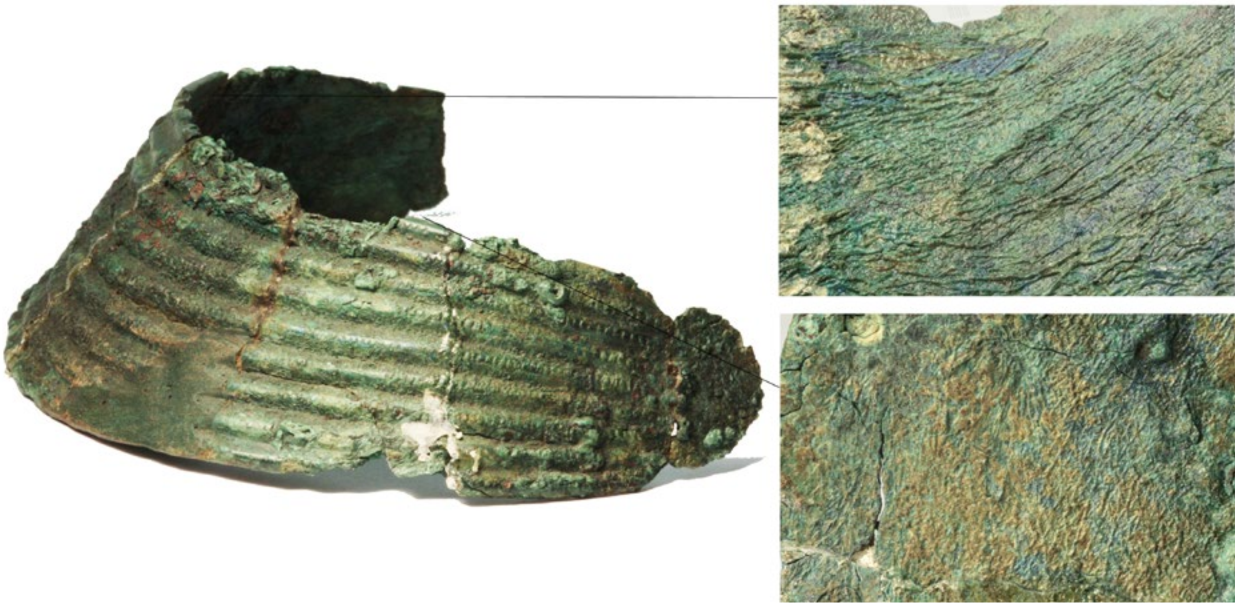


Figure 1.025: Remains of organic material on the reverse side of the neck collar from Kværkeby, København Amt (NM B 3348).

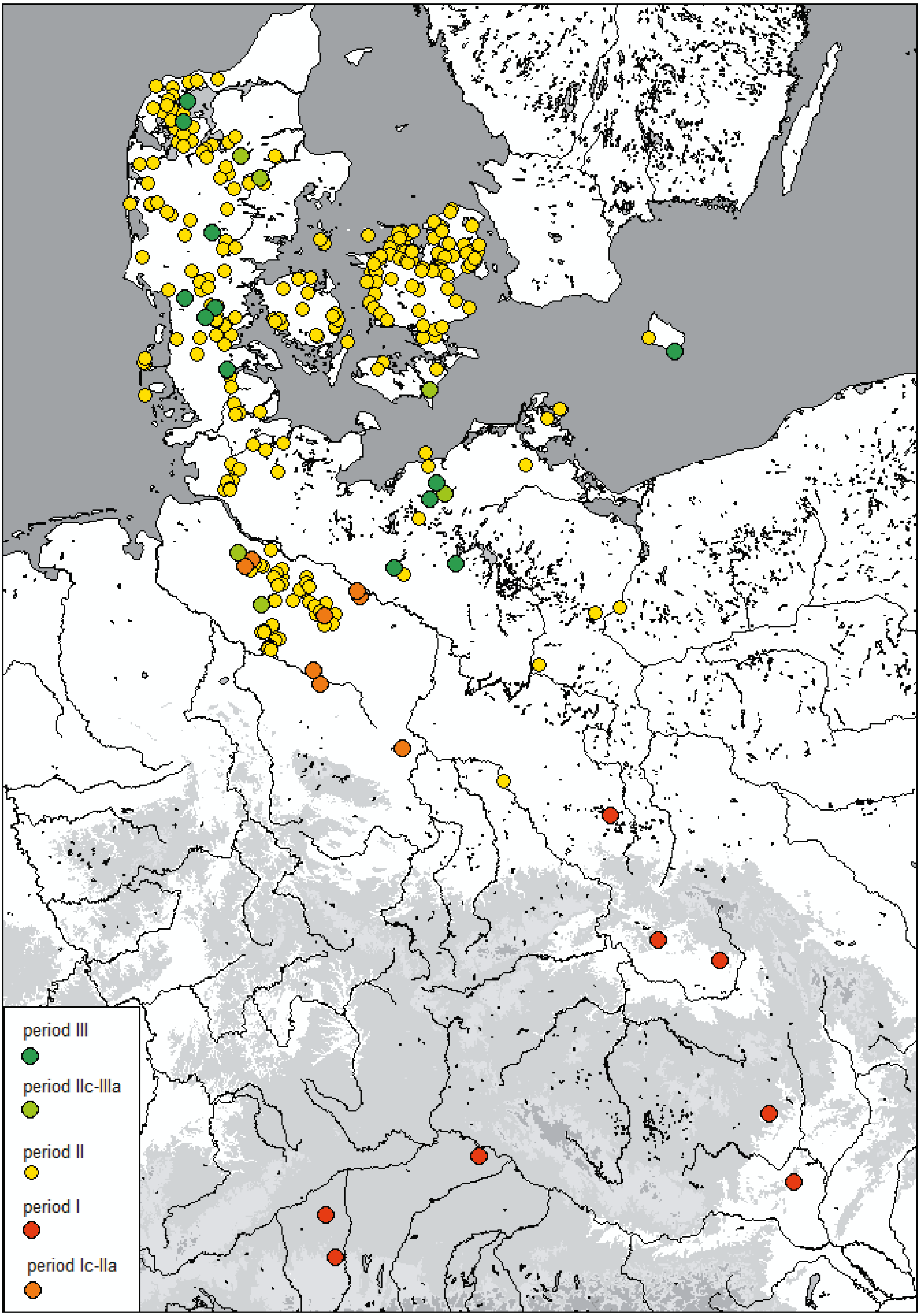
Germany. The Swedish examples are not listed in the mapping provided, however, as Oldeberg shows, during the NBA II and beginning of NBA III belt plates and discs were an especially regularly deposited item (Oldeberg 1974).[15]

Concluding, the origin of the small belt discs was in the 1940s a point of great controversy within German archaeology, and resulted in an approximate alignment of opinions (Kossina 1936; Bohm 1935; Kersten 1936; Sprockhoff 1940; Müller 1921). Today, the origin of the smaller belt discs within the central European Únětician culture cannot be denied. Únětician discs are characterised by a flat disc without backward eyelet, a diameter of 10 cm and a mid-disc hump attached to the disc by means of two rivets. These discs were probably attached to the costume via the rivets or through additional holes (Sprockhoff 1940: 29). Examples of this kind of early disc, recognisable especially through the central hump, could also be found in Scania (Oldeberg 1974: 15). The disc decoration, especially, supports their appearance within NBA I, with hatched bands, triangles and diamonds composed of lines, and small hump rows all divided into zones (see Sprockhoff 1940: 29).

Another argument that should emphasise the central European origin of the Nordic belt ornaments was the technique used to craft these plates. Sprockhoff assumes that the fact that the north German discs are cold-worked (hammered) is especially evidence for their direct connection to the Únětician culture: 'der Norden die Hochburg der Bronzegießer war, während Mitteleuropa dem Hämmern und Treiben den Vorrang gab, dann müsste man schon aus diesem Grunde erwarten, dass die Heimat der Gürtelplatten in Mitteleuropa zu suchen ist' (Sprockhoff 1940: 28). However, for decisive proof of origins within the Únětician culture the crafting technique should not be used as the leading argument where decoration and shape seem to provide much clearer signs. Furthermore, if the decorative elements, e.g. the star pattern, the triangles composed of lines, as well as the small hump series, are indeed a direct connection to Únětician decorative elements (Sprockhoff 1940: 31; Kossina 1936: 64; Bohm 1935: 69-70), and thus confirming the origin of the discs in this cultural group, then a corresponding pattern within a formal typological classification should be visible.

Initially, it seemed necessary to define a (typological) border between small belt discs and tutuli and, furthermore, to separate the smaller discs from the larger plates. Oldeberg noted that 'it is a quest for words when it comes to separate these early belt discs from the ordinary tutuli' (Oldeberg 1974: 15). However, for the purposes of clarity such a separation will be introduced here. The decisive factor for the separation is the disc itself, which is mostly flat and decorated when the item should be named as a belt disc. Additionally, the eyelet on the reverse is usually placed onto the flat plate when talking about belt discs, whereas tutuli display an eyelet integrated in the hollow spike. Further division into belt discs (hereafter this term is used deliberately

[15] Overall, A. Oldeberg could register 46 plates, of which 20 were found in Scania, eight in Halland, five from Småland, seven from Vastergotland, and a single plate was found in Bohuslan, Södermanland, and Västerbotten, as well as the three plates that come from unknown localities (Oldeberg 1974: 15).



Map 05: Distribution of belt plates and belt discs in southern Scandinavia and Germany.

to address the smaller discs, usually less than 10 cm) and belt plates (over 13 cm) was based solely on their size. The largest of the plates has a diameter of 28 cm and was found in the Langstrup hoard.

Small belt discs can be divided into eight types based on their decoration (Figure 1.026). The first group (Type Ia) consists of the hump-decorated discs. Within the area of this research a total of ten pieces could be documented, the majority of which occurred in the Lüneburgian-Hanoveranian region. A few of these discs could be dated to NBA 1B, including the hump-series decorated plate from the hoard of Immensen, Burgdorf (Sprockhoff 1940: 30). An early appearance of the remaining discs within NBA II might therefore be suggested. However, the neatness with which the hump series are executed should be used as the main criteria, due to the fact that 'offenkundig einheimische Nachbildungen aus ungeübter Hand' (Sprockhoff 1940: 30) also appear, as seen in the Immensen hoard.

The second group (Type Ib) is formed by 37 spiral-decorated belt discs, which appear from the beginning of NBA II until NBA III. These small spiral-decorated discs are distributed in Lower Saxony, over the entirety of Denmark and in southern Sweden, and appear in hoards and grave contexts.

The third group (Type Ic) consists of discs with the combination of hump series and spirals or concentric circle groups.[16] The discs are quite uniform and display usually 6-10 rather large humps, surrounded by concentric circle groups or (more seldom) spirals. The single units are connected in a similar manner to the spiral series. Within the 12 pieces that can be added to this formal group a slight chronological differentiation can be documented between discs with humps and surrounding spirals (throughout the first half of NBA II) and humps with surrounding concentric circle groups (predominantly in the developed NBA II). Representatives of the early discs are found in the hoards of Thale and Molzen in Lower Saxony.[17] However, the discs from Type Ic appear in hoard and grave contexts loosely spread over the whole northern European region. The fourth group (Type Id) is subject to a similar chronological and distribution pattern and contains discs with concentric circle decoration. This form is distributed across the region but rare in Jutland.

[16] The first signs of spiral-decoration can be found on local replicas of hump decorated discs, here the spirals are applied around the humps. Representatives of these discs are found in the Immensen hoard; Kr. Burgdorf (see Sprockhoff 1940: Tafel 3).

[17] In the hoards of Thale, Kr. Aschersleben and Molzen, Kr. Ülzen (both Lower Saxony) are the oldest representatives of northern European belt discs. They display a close connection to the Únětician discs (Sprockhoff 1940: 35).

The fifth group comprises small discs with star-shaped dash-filled triangles (Type Ie). The triangles can be arranged in several rows, as the belt disc from Dabel in Mecklenburg shows (Schubart 1972). The distribution of these discs, which are decorated with an Úněticianinspired pattern (Sprockhoff 1940: 32), extends mainly to the northern part of Germany, with a focus in southern Lower Saxony. Of these 13 discs only one is found near Viborg (Jutland) in a burial mound. The north German hoards and graves containing such discs can be dated to the beginning of NBA II and continue within the whole period.

The undecorated discs (Type If) might also be regarded as bronze buttons (Aner and Kersten 1973; 1976; Laux 1971).

The seventh group (Type Ig) contains the small flat discs with line and notch design, as discussed in the introduction. These common and richly decorated flat discs are significantly smaller than the previous examples and are very well represented, with 70 pieces in the entire study region. Within NBA II, the small line-decorated discs appear occasionally in hoards (mostly bog finds) on Zealand and in Lower Saxony. The vast majority, however, are part of the rich equipment in female burials, as well as in male graves, already occurring from the beginning of NBA II.

The eighth group (Type Ij) consists of small discs which have a decorative arcade ornament of stacked arches as the main decorative element. The 18 discs (none larger than 10 cm) appeared mainly in burials on the Danish islands and Jutland. All Danish pieces can be dated to the developed NBA II. The disc within the hoard from Handorf (Lower Saxony) can solely be dated to the early part of the same period, and in addition is the only non-Danish find.

The development of small belt discs in northern Europe confirms the significant influence of southern Lower Saxony, as already assumed by Sprockhoff (MAP 06). The early discs decorated with hump series, and triangles composed of lines arranged in a star motif, are mainly distributed in Lower Saxony and only poorly represented in Scandinavia (see Oldeberg 1974: 15). Additionally, a relatively large number of these pieces appear in hoard contexts (Figure 1.027).

As presented in the following discussion, a similar picture occurs with the large belt plates, the early examples of which are concentrated exclusively in hoards and appear also within the Lower Saxony region with decorative hump series (Type IIa), and also occur only sporadically in Denmark (MAP 07). The variety of large belt plates increased significantly in the developed NBA II, however, with a focus on spiral-decorated plates (Figure 1.028). Even in the Swedish material the main

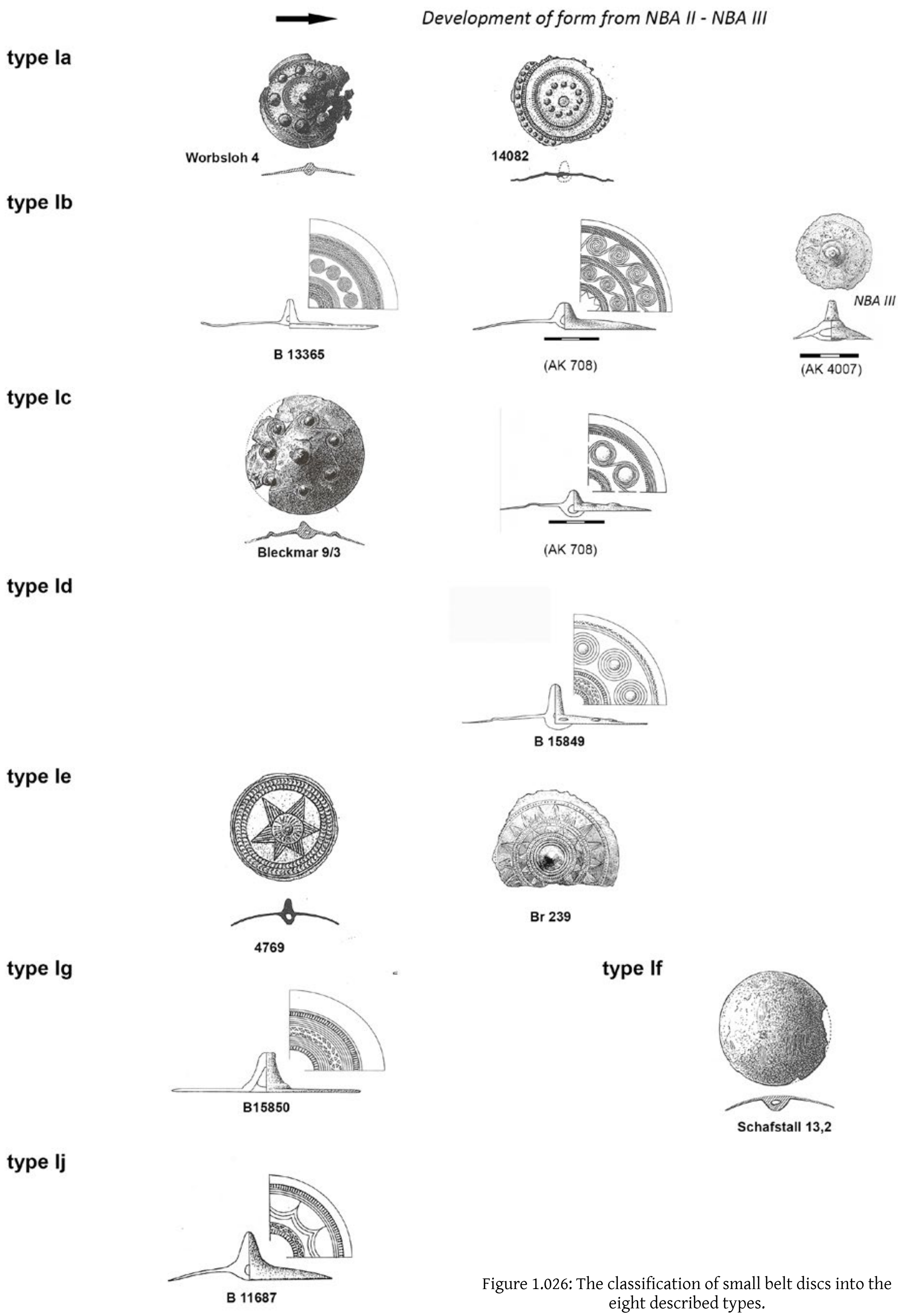
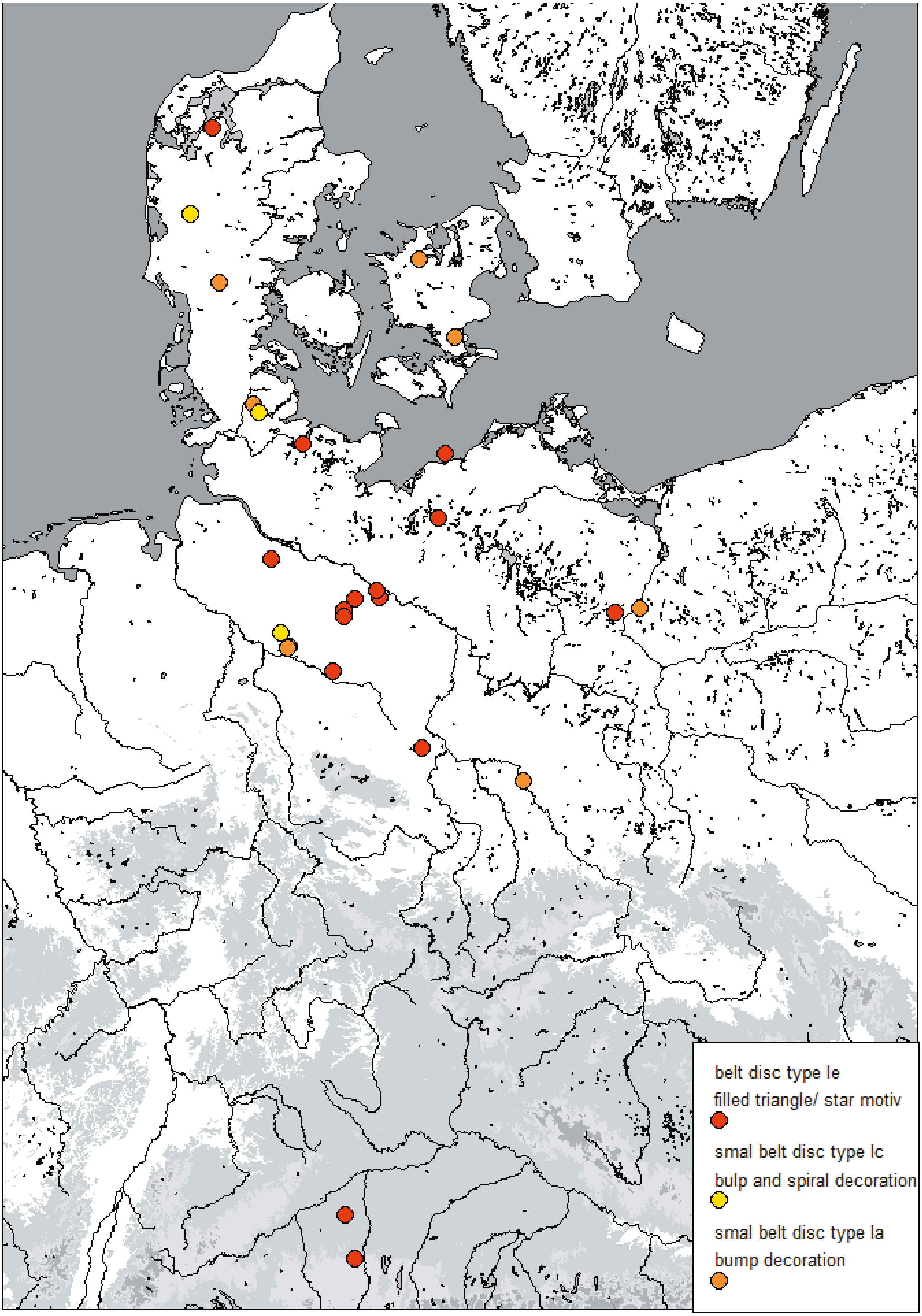


Figure 1.026: The classification of small belt discs into the eight described types.



Map 06: Distribution of the early belt discs decorated with hump series',
and triangles composed of lines arranged in a star motif.

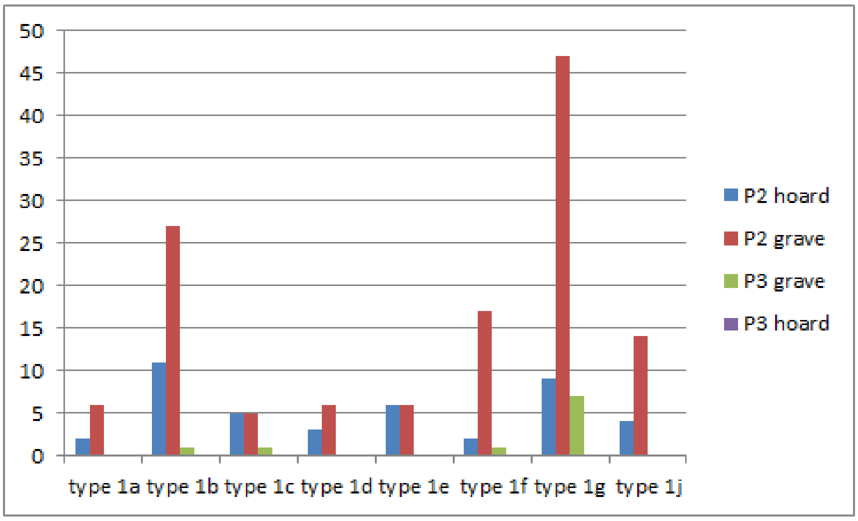


Figure 1.027: The diagram shows the different types of small belt discs and their type of deposition.

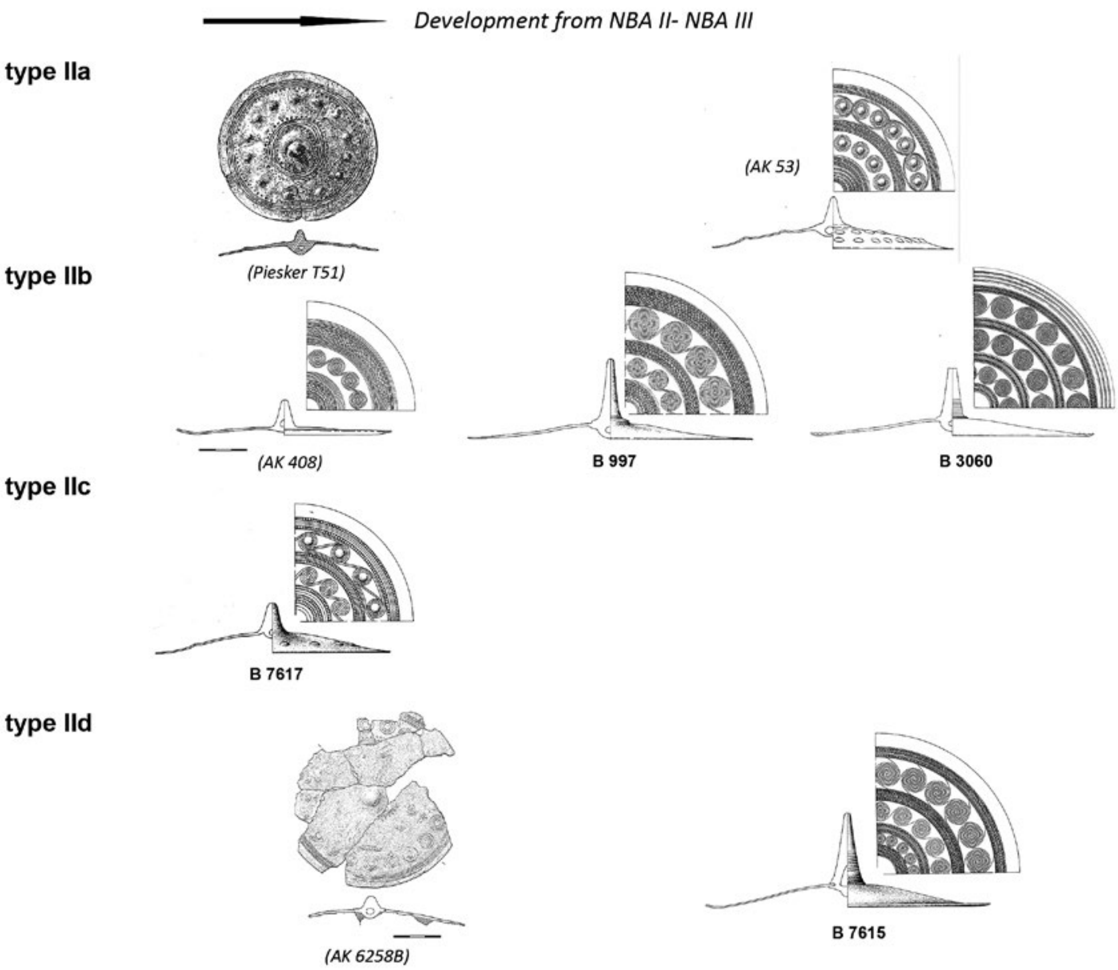
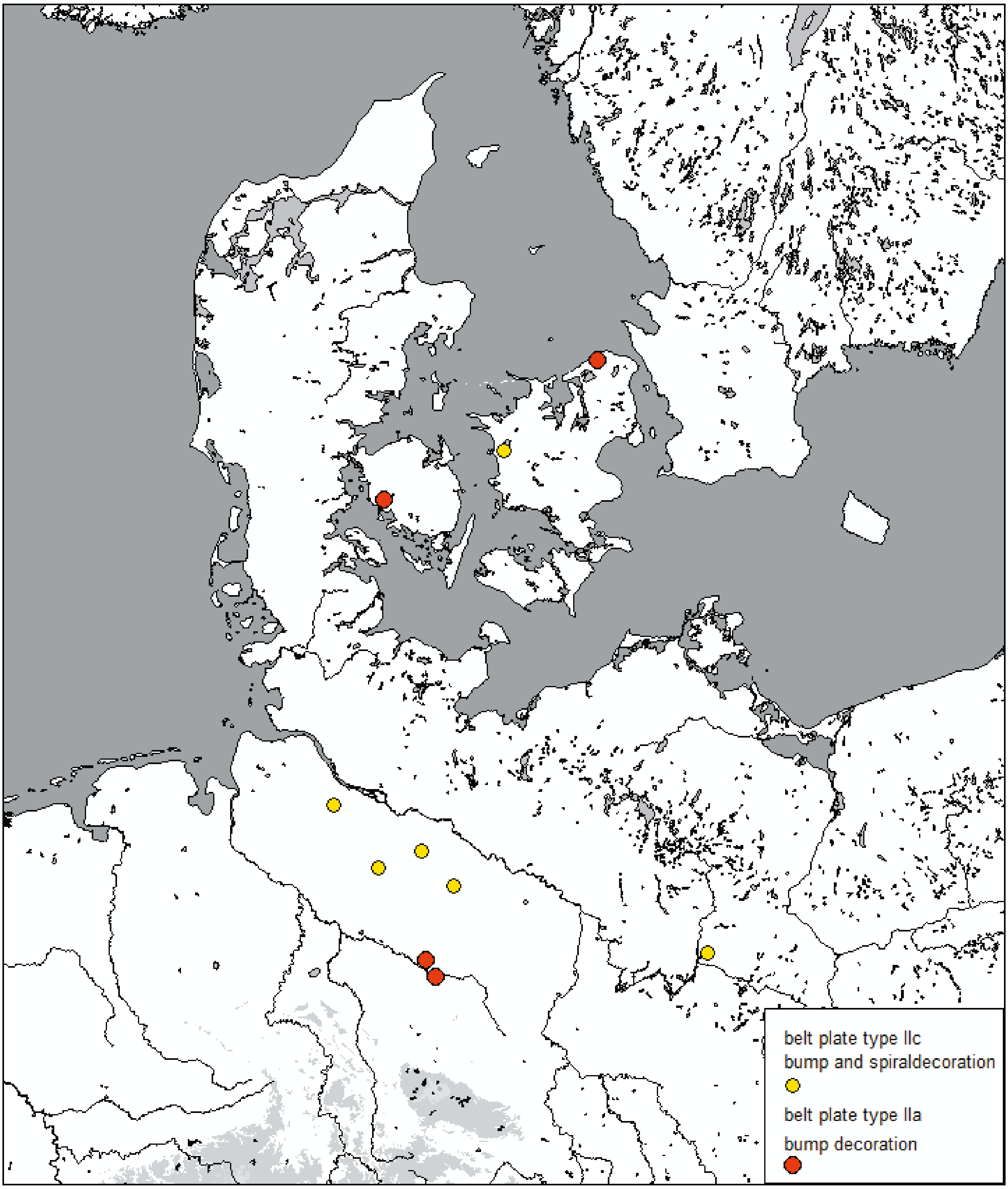


Figure 1.028: The typological classification of belt plates.

distribution of spiral-decorated plates is within NBA II (Oldeberg 1974: 15). The second formal group (Type IIb) of these 10-28 cm in diameter plates is made up of spiral-decorated examples (forming the majority) (MAP 08). The spiral series can be applied as a single row, connected with double or single lines or multiple rows. Most frequent are plates with two spiral series, each series slightly different in size (51 items), followed by plates with three spiral rows (39 items). These impressive pieces are occasionally components of very



Map 07: Distribution of the early belt plates decorated with hump series (see Map 06).

rich hoards (Figure 1.029), but mostly parts of female burial equipment, and dominate the NBA II.[18]

Three belt plates with four spiral rows are among the very special pieces, as they are not only of exceptional size, but also were crafted in two parts. These plates only occur on Zealand, and were found in hoards. Thus, they represent the only category which does not appear in a burial context.

[18] Three belt plates with three spiral series could be dated to beginning of NBA III. Additionally, many of the Swedish plates are probably from NBA III (see Aner and Kersten 1973; 1976; 1977; Oldeberg 1974a; 1974b).

Figure 1.029: The hoard from Svenstrup, Sorø Amt.

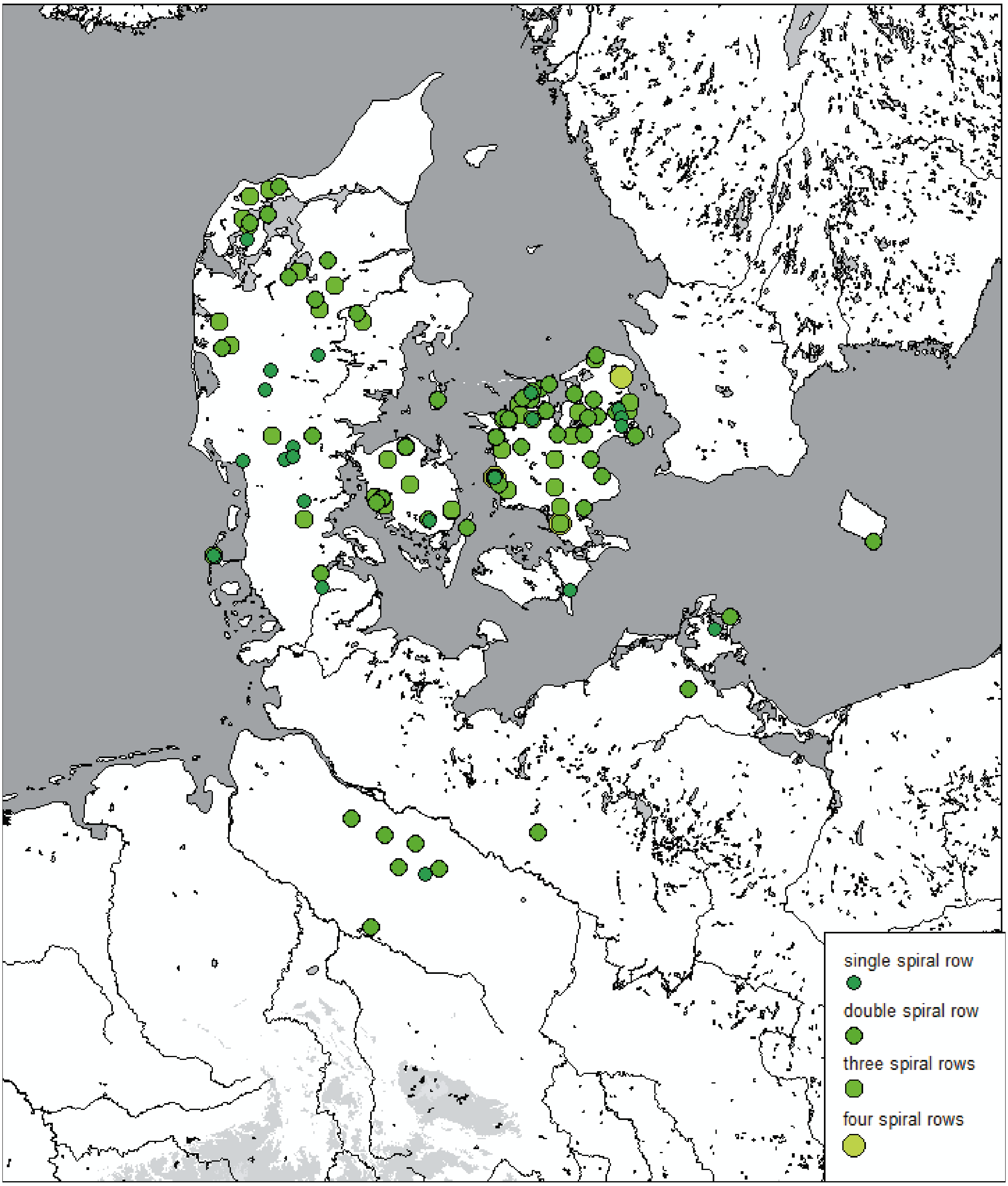
The third group (Type IIc) consists of plates that show a combination of hump and spiral series. These six known plates appear to have their main distribution area in Lower Saxony and thus fit into the familiar picture of hump-decorated discs. Unfortunately, a detailed chronology of these finds is not available (Laux 1971), and thus a definitive statement of their origin and chronological appearance cannot be made. However, the distribution of these plates makes a north German origin likely. The few Scandinavian pieces indicate an early date (in the initial Period II, Skrydstrup burial) of these hump and spiral-decorated plates, but a longer period of occurrence is to be expected.

The fourth group (Type IId) consists of the plates with concentric circle decoration, which always occur in combination with one to three spiral series. The six plates that meet the formal criteria of this type are found on the Danish islands in burial contexts from NBA II. Another form (Types IIe and IIf), exclusively dating to the developed NBA II, is designed with spirals, of which two are enclosed in oval frames and thus form a 'decorative eye'. In combination with this decorative element concentric circle and spiral series also appear. 12 plates were found, predominantly in female burials distributed in northern Jutland and the Danish islands. Single items could be found in Lower Saxony.

A form that shows decorative elements already known from the small discs with arcade decoration, but complemented by spiral rows, is represented in the seventh group (Type IIg). Only four plates could be documented, with similar distribution to the smaller discs, deposited in NBA II hoards as well as burials. Due to their uniqueness the few 'open-ornamented-plates' (Type IIh) are particularly important. This group consists of individually crafted pieces which display spiral rows, triangular series, or a combination of both. Interestingly, none of these quite large plates are found in hoards; they are exclusively known from Danish burials.

The classification of belt discs and plates within the northern European region could support the assumption that the precursors of the Nordic belt plates evolved from central European discs in the Harz region. Presumably, they were developed in the Lower Saxony area, demonstrable through qualitative differences of the first hump-decorated plates (Sprockhoff 1940: 30ff.). Clearly, the development of the decoration from hump series to hump and spiral-decorated pieces could be outlined above, as well as the spread into the Scandinavian region during the early NBA II (see also MAPS 07 and 08). Regarding the early date of the Skrydstrup burial (see Randsborg 2006: 8) an intensive contact and exchange between the Lower Saxony region and Jutland might have led to the development of spiral-decorated plates. Thus, the latter are purely Nordic products, which are limited to the northern German and Scandinavian regions and have hardly anything in common with the actual Úněticián predecessor.

Thanks to exceptionally well-preserved finds the large plates are interpreted as belt or, at least, centre-body ornaments (i.e. Aner and Kersten 1973; 1976; Brøndsted 1962: 74ff.; Piesker 1958: 31ff.; Oldeberg 1974: 15ff.).



Map 08: Distribution of the belt plates decorated with spiral series'.

The use of smaller plates seems more diverse, ranging from belt accessories and dress fittings to applications on cloaks or 'sashes' (Wels-Weyrauch 1989; Laux 1971; Piesker 1958). Concordantly, they are interpreted as associated objects, owned by an individual as a feature of their appearance (e.g. Bergerbrand *et al.* 2013; Sørensen 1997; Sofaer-Derevenski 2000).

1.2.3 A short presentation of tutuli within the Nordic Bronze Age

An important part of the northern European ornament set, as part of a costume, are small disc-shaped, conical belt or dress trimmings known as tutuli. Tutuli appear within the entire study region (from NBA II to the end

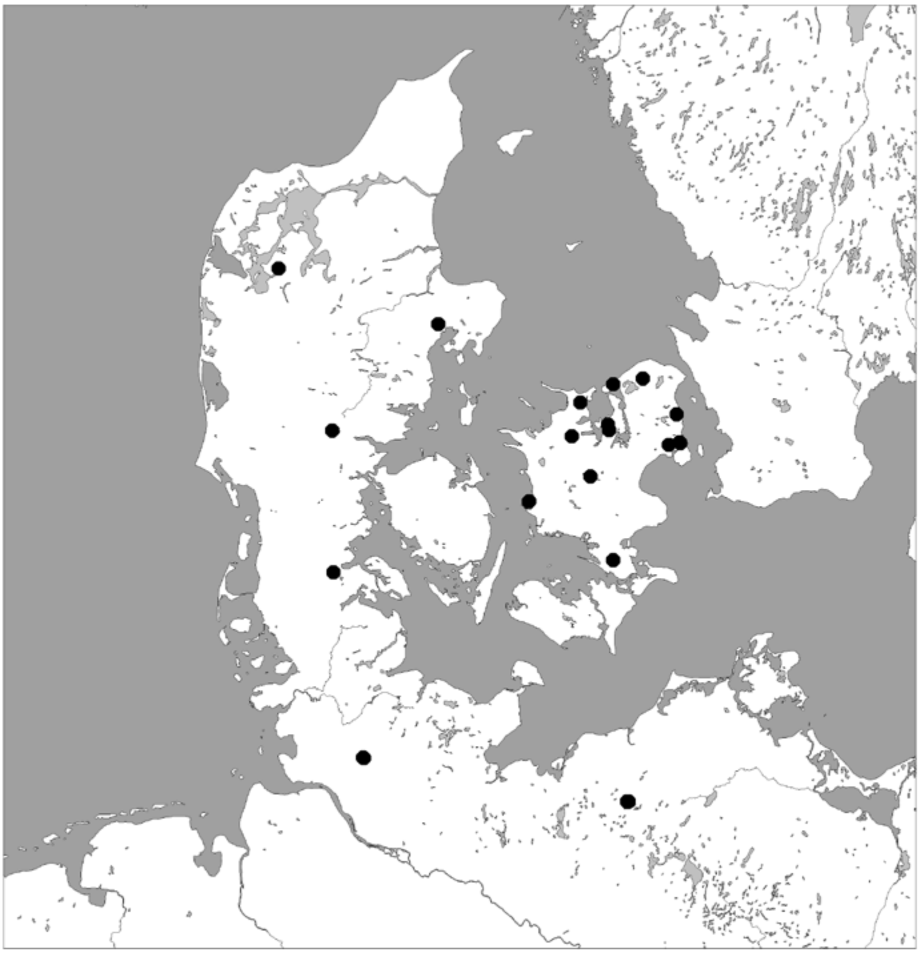


Figure 1.030: Distribution of tutuli examined within this study.

of NBA III)[19] and cannot be seen as strictly gender-specific as they occur in both male as well as female burials (Figure 1.030).

In previous research, tutuli have been subject to little attention and only Kersten (1936: 14-20) dealt with a short classification and chronological analysis of the bronzes.

A classification of the large number of tutuli is beyond the scope of this book.[20] However, a vast amount of objects, in the literature classified as tutuli, could here be characterised as small belt discs (mainly due to a flat and decorated disc) and have already been presented above. A rough overview of the remaining tutuli shapes and their chronological significance within the area of research is presented below.

Small bronze discs from which a conical step-like spike protrudes should be classified within this work as tutuli. Kersten referred to these objects as Nordic groove or rib-decorated belt humps (Kersten 1936: 14). The actual spike of the disc protrudes from the narrow conical ribbed base. On the back, mainly within the hollow spike, is a massive bar forming the eyelet. The eyelet of the tutuli does not extend beyond the disc and the small disc is mostly undecorated on the front.

In the study region four different formal versions of the ribbed tutuli occur. The first variant (Figure 1.031, A) has a narrow undecorated disc and only a slight step-like conical base, which ends partly in a long extended spike with rounded tip. The bar of the loop is mainly bent, however this does not appear on the surface. This form seemed to be limited to the NBA II, but this is to be regarded as an assumption based on only the six investigated examples in this study. Kersten mentioned a later occurrence of this form, especially within the Mecklenburg area (Kersten 1936: 15). The distinct transition from disc to ribbed base and to the spike is a characteristic of the early forms, as Schubart assumes, which occur even in Mecklenburg already during NBA II (Schubart 1972: 34).

[19] Sporadically belt humps also occur in the Late Bronze Age, with only slight formal changes, however their size increases significantly towards the Late Bronze Age.

[20] Kersten‘s statement should be mentioned here: ‚[Die] kleine Anzahl der ihm bekannten tutuli ermöglichen eine genauere Bestimmung und quellenkritische Untersuchung nicht‘ (Kersten 1936: 14ff.). To date, and especially due to the work that followed Kersten, a vast amount of belt humps are known and a classification would be worthwhile.

Figure 1.031: Classification of ribbed tutuli (based on Kersten 1936).

The second variant (Figure 1.031, B) shows a smooth transition from the ribbed base to the conical spike, which terminates in a rounded tip. Frequently, the spike is short and broad. The bar of the eyelet does not appear beyond the surface and the spike is hollow up to the tip. Occasionally these tutuli occur without the wound spiral-like step base. Based on their formal appearance a clear temporal sequence of the two forms introduced above cannot be reconstructed (Kersten 1936: 16; Schubart 1972: 34). However, an exclusive appearance within NBA II seems likely. Also, the distribution occurs almost exclusively in the Danish area (see Kersten 1936: 16).

The third variation (Figure 1.031, C) is bigger than the previous examples (up to 5 cm in diameter) with clean lines and transitions. The step-like base is hollow and on top of the base is placed a round spike that is narrow in cross-section, which terminates in a protuberance. This shape may have small recessed or large strap eyelets, which are attached to the sides of the hollow spike base. Often the narrow discs are decorated with lines of triangles or dots, parallel to the ribbed base. This kind of tutuli represents the beginning of the early line of Nordic belt humps (Kersten 1936, 16) and chronologically is placed within NBA III. Again, a slightly delayed occurrence is visible in Mecklenburg (Schubart 1972: 34).

The tutuli with lens-shaped top plates (fourth variant; Figure 1.031, D) usually measure 7-8 cm in diameter and are thus larger than the other forms. The top plate is commonly decorated with a star-shaped design, which may consist of sunken grooves or dotted lines. The step-like (ribbed) base of the spike is notably highlighted and lying in its extension is a round spike, narrow in diameter, ending in a flat disc. According to Kersten (1936: 15) these tutuli already occurred in northern Germany and Denmark at the start of NBA III. Here, the star ornament represents a common NBA III pattern and combined with the long extended spike indicates the final form of the typological series of tutuli (Kersten 1936: 14). Again, in Mecklenburg these forms more likely reflect the end of this period (Schubart 1972: 34).

As well as the conical ribbed tutuli, another form regularly appears in Denmark, northern Germany, and occasionally also in the adjacent regions. These belt humps consist of a small disc and a dome-like spike and the eyelet is attached inside the hollow dome. Kersten named this Form B and assumes an origin in the north, in Denmark and southern Sweden (Kersten 1936: 18-19). Kersten classified these tutuli in two formal variations. The 'prototype' shows a geometrical decoration on the narrow plate surrounding the flat dome-shaped spike. In particular the ornament of the broad disc is decisive for the dating in NBA IB, being supported by combinations with Sögel-type swords (Kersten 1936: 18). However, none of these early tutuli could be investigated within this study. Nonetheless, eight tutuli of the developed form were examined. These, in comparison with larger items, have a narrow disc around the high dome-shaped spike, which has complex decoration. Geometrical elements are dominant, although spirals were also used. The distinct dome-shaped spike can be flattened at the tip and is commonly decorated with a circulating or crossing line decoration.

The research area reveals two main variants of these large dome-shaped tutuli, with varying decoration consisting of lines and dots. One variant possesses at the rear a straight bar, round in diameter, placed at the transition from the hollow spike to the disc. The other possesses two crossing bars, placed in the hollow spike. The dome-shaped tutuli seems to be an exclusively NBA II phenomenon, whereby Kersten (1936) assumes a concentration at the end of this period. Particularly outside of Denmark the pieces are distributed at the end of NBA II.

In addition to the formal and chronological differences, differences in use and deposition context were also recognised. If the step-like tutuli described above showed a form-specific tendency for male or female burials, then these pieces seemed to be independent from any gender and appear in male and female burials. It is particularly remarkable that half of the dome-shaped tutuli examined in this work originate from hoard contexts. A tendency towards a male-related artefact (Kersten 1936: 19) could not be confirmed here. Four of the eight pieces are known from female burials (NBA II). However, the distribution emphasis on the Danish and southern Swedish area is remarkable.

Differences are also emerging concerning the use of tutuli. The smaller variants occur more often in large numbers and in combination with belt ornaments (Kersten 1936), or possibly as cloak fittings (Schubart 1972). The larger tutuli, on the other hand, seem to 'take the place of the great belt plates' (Kersten 1936: 15) and are mostly deposited singly.

Kersten supposed that the tutuli originated in the north and represented, in Lower Saxony and Mecklenburg, elements of direct contact or intense trading routes (Kersten 1936: 14). The recording of the discussed material presented in this chapter, however, shows that only a few tutuli occur in Lower Saxony in the archaeological record. Mistakenly, the conical costume trimmings, also mentioned as 'Hütchen' cones (Laux 1971: 44), are sometimes referred to as tutuli (Bergmann 1970b: 58). Only two pieces found in Bleckmar and Wardböhmen can be characterised by definition as tutuli (Laux 1971: 47). In Mecklenburg, the Nordic influence on the tutuli is apparent. Here, tutuli, from as early as NBA II, were deposited in hoard and burial contexts (Schubart 1972: 34-36). However, their appearance is strictly limited to the western and northern regions of Mecklenburg (Figure 1.032), which suggests influence from the north. In addition, the absence of tutuli in the richest graves, such as the burials of Alt-Sammit, Friedrichsruhe und Ruchow (Schubart 1972: 34), displays the limited acceptance of foreign elements.

In summary, it seems that the ribbed or step-like tutuli, as defined above, were, during NBA II and III, a Scandinavian phenomenon that clearly affected the surrounding areas, but without dominating them. The regional peculiarities concerning dress trimmings remained, such as the in part very numerous Lower Saxony 'Hütchen'. This becomes particularly clear in Mecklenburg by the absence of tutuli in the richly equipped funerals (Schubart 1972). Likewise, the dome-shaped tutuli have their origin in the north. Only two different formal variations of these tutuli

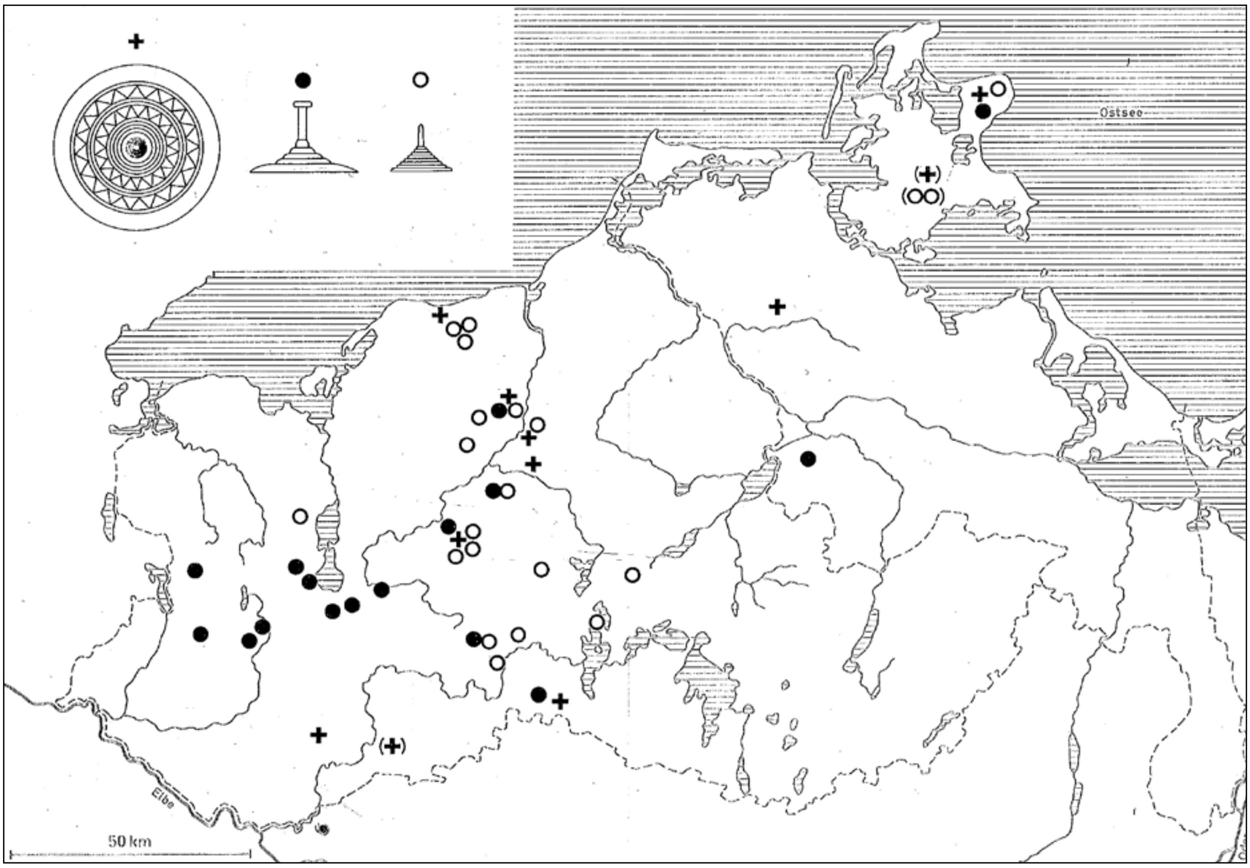


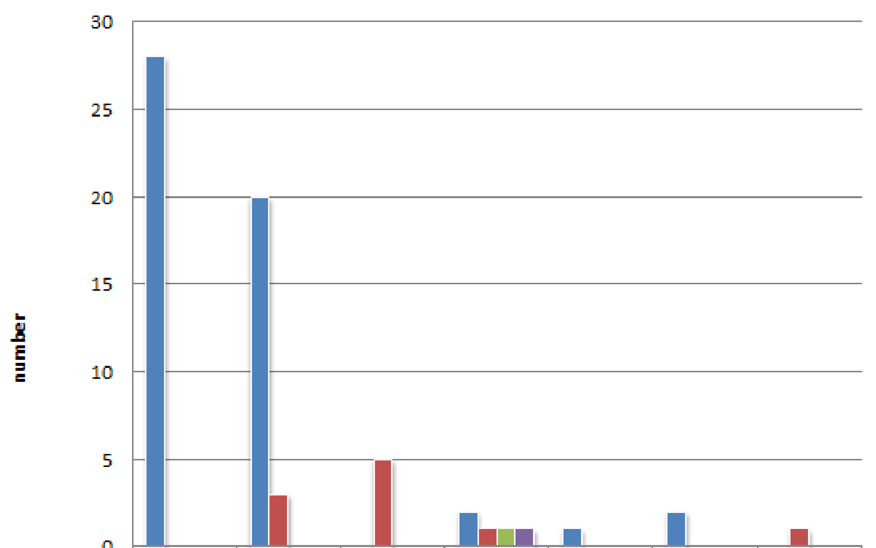
Figure 1.032: Distribution of tutuli in NBA III in Mecklenburg
(after Schubart 1972: K23).

could be classified, which can all be assigned to NBA II. Nevertheless regional differences in the decoration are visible. This form is particularly distributed in Kersten´s Zone I (Kersten 1936: 2-3) and displays an unusually complex decoration there compared to the other regions.

1.2.4 Highly decorated bronze pins in northern Germany and Scandinavia during the Early and Middle Bronze Age

During NBA II and III numerous pin types can be found in the Nordic region. Some detailed, predominantly classifying, investigations concerning pin types have been carried out by Laux (1976) for the Lower Saxony region and supplemented by Piesker (1958), Hoffmann (2004) and Bergmann (1970b). W. Kubach (1977) developed a similarly detailed arrangement for the Hessian and Rhine-Hessian region, alongside which the work by Hoffmann (2004) can be consulted. Marek Gedl (1983) classified the Early Bronze Age pins for the Polish area and R. Essen (1985) for the Middle Bronze Age. In addition, there are typological studies concerning Bronze Age pins in southern Germany and the Alpine region by Innerhofer (2000), in Thuringia by Ebner (2001: 78-90), Westphalia by Hoffmann (2004), Saxony-Anhalt by Stephan (1956) and V. Brunn (1959), Mecklenburg by Schubart (1972: 38-42), and in Brandenburg by Bohm (1935). In Schleswig-Holstein and Denmark the only source concerning Early Bronze Age material was the investigation in 1936 by Kersten (1936).

While working with such complex decorated bronzes as neck collars and belt plates it is important to note, however, that these bronzes are only occasionally combined with pins. The statistics (Figure 1.033) show the kinds of pins combined during the Bronze Age periods with neck collars. The data presented do not differentiate between hoard or burial contexts and additionally summarises the entire north German and Scandinavian areas. However, it becomes clear that such large bronzes, particularly during NBA II, were, if deposited with pins, deposited in combination with wheel- and disc-headed pins. Additionally, in NBA III predominantly disc-headed pins and those with transversely disc-shaped heads and profiled shafts (Weitgendorf-type pins) were found with neck collars (Nørgaard 2011). Simple pin types, such as globular-head pins, role-head pins, 'Petschaftkopfnadeln' and 'Schwellhalsnadeln', seem to have been limited to male burials during NBA II (Bergmann 1970b: 43ff). Wheel- and disc-headed pins, on the other hand, are commonly connected to female burials and appear here occasionally in combination with large bronzes. This statement is, however, only valid for the Scandinavian area in a much reduced form. Pins are rather a rarity in burial contexts (especially in female burials) in Denmark and Sweden (Broholm 1940: 130ff.; Oldeberg 1974). Occasionally, simple pins can be observed in male burials (i.e. Aner and Kersten 1973; 1976; 1977, also Oldeberg 1974). However, in some burials the influence of the north German regions is visible through wheel- or disc-headed pins which are associated with belt discs, as in Smidstrup Hovgård (Aner and Kersten 1976:



	wheel-headed pin	disc-headed pin	pin type "Weitgendorf"	contured-headed pin	plunger-head pin	roller-head pin	spiral-headed pin
Priode II	28	20		2	1	2	
Periode III		3	5	1			1
Periode IV				1			
Periode V				1			

Figure 1.033: Pin types associated with neck collars in the Bronze Age in northern Europe (based on Nørgaard 2011).

178). The burial mound contained several burials and in Grave A a female body was equipped with both kinds of pins and a hammered bronze-plate at head height, dated to the NBA II. With regard to the dissemination of the complex pin types a southern influence on the marginal areas of the Nordic region is likely. Through this distribution pattern, the here discussed pin groups can be seen as excellent indicators of exchange networks (i.e. Ruppenstein 2010; Jockenhövel 1991; Bergerbrant 2003; see also Sørensen 1997; 2000; Wels-Weyrauch 1998; Vandkilde 2007: 133ff.).

The above-mentioned pin types will be presented in more detail below. Occasionally, they are associated with the elaborately decorated bronzes investigated within this work (primarily the wheel- and disc-headed pins of NBA II). Thus, representatives of these forms could be studied in detail in the context of the present work.

Wheel-headed pins

Wheel-headed pins were classified by A. Lissauer (1904), F. Holste (1939), and in terms of their origin by K. Schumacher (1917) and H. Piesker (1958). A nearly complete and very detailed presentation of all wheel-headed pins in north Germany and the surrounding regions can be found Laux (1976), and a summary is shown below.

Formal classification was executed based on the items' wheel-spoke scheme (the number and shape of the spokes and rings in the wheel-head) and on the number of eyelets placed on the top (Figure 1.034; see Holste 1939: 53ff.; Laux 1976: 14ff.). Accordingly, a temporal sequence of wheel-headed pins could be created which runs approximately parallel in southern Germany and in the Lüneburg Heath region. It turns out that the simple forms, such as the single wheel cross and a single or double spoke scheme, already appear from the earliest Bronze Age. Within this group the one-side profiled wheel-headed pin (Mollberg type after Laux 1976: 26)[21] is the earliest form and may already be dated to the Søgel-Wohlde horizon (NBA 1B). However, the simple wheel-headed pin occurs definitely within the developed NBA II (Figure 1.035). Formal differences, especially with regard to their size, are detectable between the southwest German forms and the form spread in the Lüneburg Heath region (Laux 1976). Wheel-headed pins of this type are among the most common types and occur from Greece to Scandinavia.

Slightly offset in time to the first appearance of the simple wheel-headed pins, however, and dating to NBA II, are the pins with an unequal number of spokes, or eight spokes arranged in a star-shape, which are found in southern Germany and Bohemia. Occasionally this form is found in northern Germany (Laux 1976: 24-25). Wheel-headed pins with a three-ribbed-wheel and a simple spoke scheme are distributed only within the Lüneburg region during NBA II and occasionally in NBA IB (ZG I and II after Laux 1976: 27-33). The majority of the pieces have eyelets at the top. A development of this form seems to be the wheel-headed pin of Scheme E, which is also widespread in the Lüneburg area and almost simultaneously occurs with the pin form introduced above. It is apparent, however, that this form only occurs until the end of NBA II (Figure 1.036).

Further formal variations are the double-wheel-headed pins, which have a double rim and, in addition to the simple form, a further four wheels in the outer ring (Laux 1976: 18-22). They are distributed between the Elbe and Weser rivers, and occasionally also further west (Figure 1.037), and appear in small numbers

[21] This form is comparable to the Speyer type after Kubach (1971: 35ff.; also Bergmann 1970b: 56) and found, for example, in the Wildeshausenn hoard, dating to NBA IB (Vandkilde 1996: fig. 100).

Figure 1.034: Wheel-headed pin from Rehlingen, Lower Saxony (LMN5032).

Spät	Periode III
Stufe Deutsch-Evern	
Früh (Fuhrhop)	Periode III
Stufe Wardböhmen-Kolkenhagen	Periode II (b)
Stufe Behringen-Bonstorf	Perionde II (a)
Stufe Sögel-Wohlde	Periode I

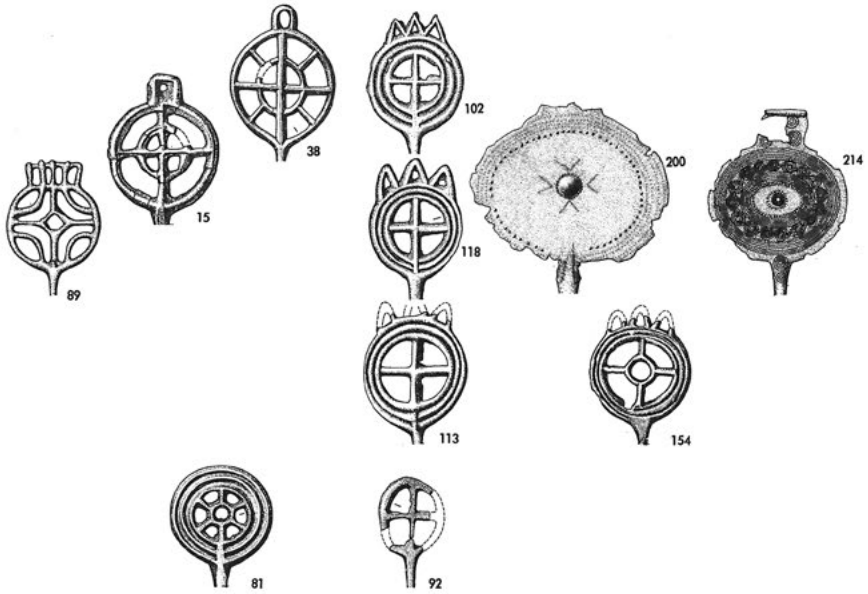


Figure 1.035: Classification of wheel-headed and disc-headed pins
(after Laux 1976).

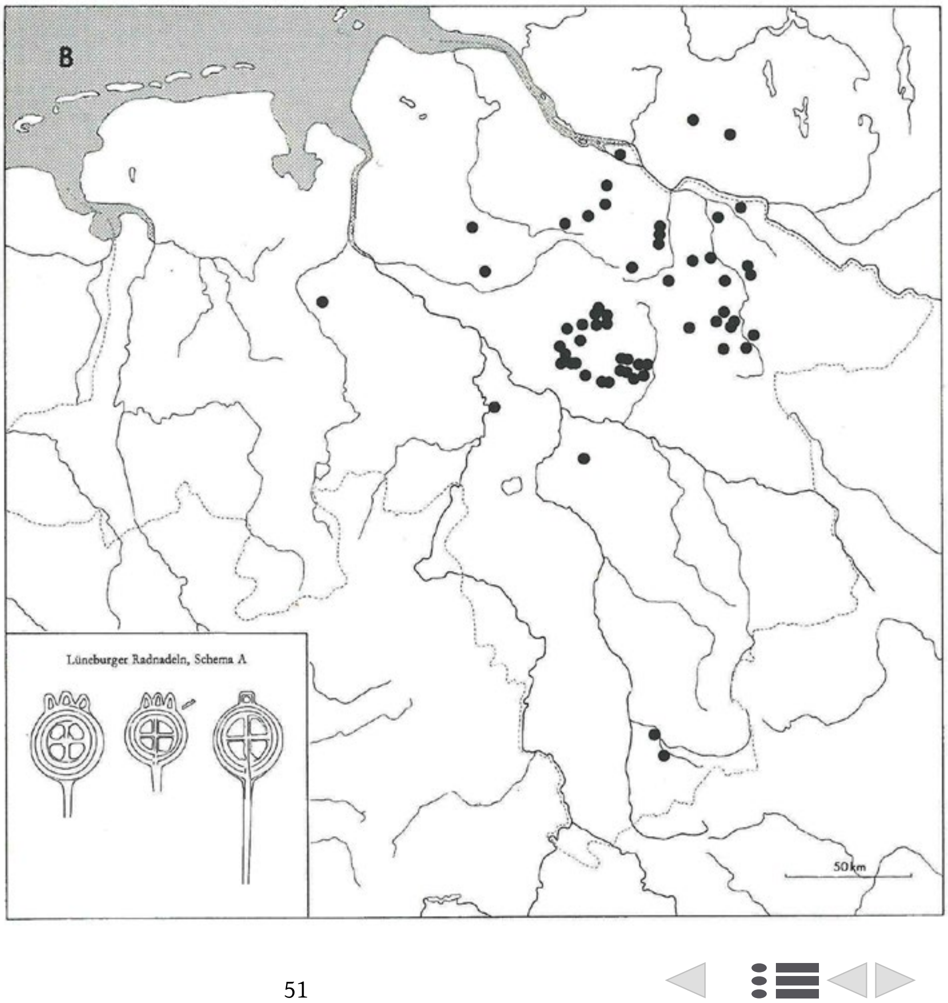


Figure 1.036: Distribution of wheel-headed pins Lüneburg-type (after Laux 1976: map 45).

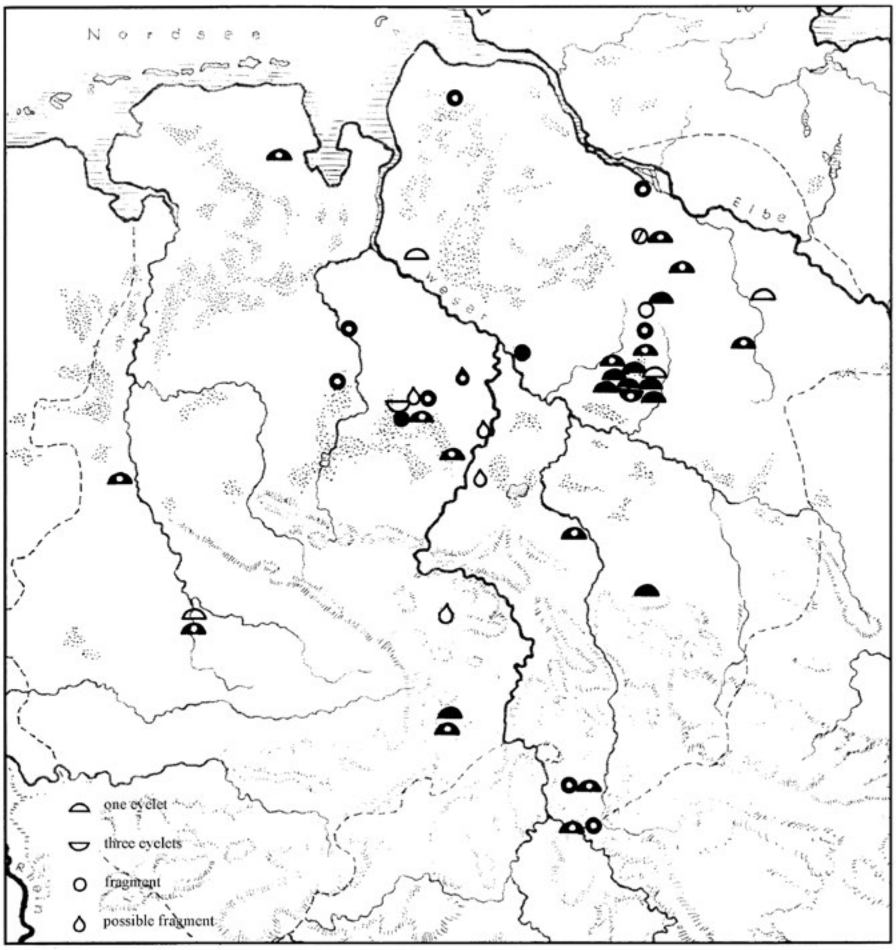


Figure 1.037: Distribution of wheel-headed pins southwest of the Elbe River (after Bergmann 1970: map 76).

throughout northern and southern Germany (Bergmann 1970b). Again, an enlargement of the wheel-head is characteristic for the items from further north. These pins are mainly related to the late tumulus culture and early NBA III respectively (Fuhrhop horizon, Laux 1976: 22). Thus the double-wheel-headed pins provide one of the few forms that occur even during NBA III within the archaeological record. Another equally late variant is the wheel-headed pin spoke Scheme D (Laux 1976: 23). Its main distribution is within the east Hessian region and only a few items are found in Lower Saxony.

The forms presented here are only a selection of the types created by Laux (1976) and others. However, these few types clearly show the area of distribution (mainly central Germany) as well as the chronological position of wheel-headed pins. Additionally, the importance of wheel-headed pins as an indicator of Bronze Age networks is outlined by its distribution, based on the latest research.

Laux (1976: 15), as well as Holste (1939: 54), grouped the pins due to their crafting in one or two side-profiled moulds (see also Chapter 2.4), with the result that a division appeared in southern German types and forms that spread in the Lüneburg Heath region. Additionally, several of the authors mentioned above also focused on clearly technical features while grouping these objects, and hence an approximate idea can be developed in which regional independent centres of production might have taken place. Concerning the Speyer-type simple wheel-headed pin (Kubach 1971: 35ff.), the distribution of which spreads over the whole of central Europe, several regions were identified that show all features related to technical peculiarities in the crafting of these pins.[22] This object group seems to have a concentrated appearance west of the Upper Rhine already during Br.B1, within the Middle Danube region during Br. A1b-A2a, and in the Upper Palatinate (Bavaria) and western Bohemia during the Middle Tumulus Culture (Br.B2/C1) (Ruppenstein 2010: 645). A formally very similar wheel-headed pin, which was, however, crafted in a fundamentally different technique, spread from NBA 1B in Lower Saxony (Laux 1976: 26). Each of these centres appears to produce in the succeeding periods several other variants of the wheel-headed pins and within each region technically-related differences could be found. Further research involving a comprehensive technical study of wheel-headed pins, in combination with their respective moulds, may well provide new insights on possible workshops.

22 A map showing these distribution centres of wheel-headed pins of Seyer-type is found in Ruppenstein 2010: 644.

Wheel-headed pins are, similar to the early ribbed collars (see Chapter 1.2.1), already found from NBA IB (Sögel-Wohlde horizon) in hoard contexts and appear in female burials from NBA II (Bergmann 1970b: 56; Laux 1976: 14ff.).

Disc-headed pins

Disc-headed pins are known within the archaeological record of southern Germany from Br.A2 (Lissauer 1904; Tackenberg 1949) and can also be found in northern Germany from NBA II (Laux 1976; Bergmann 1970b; Schubart 1972). Disc-headed pins are characterised by a large oval or round disc-shaped head, placed on top of a very long shaft. At the transition to the head the shaft usually widens and becomes a triangular flattened shape. There are undecorated pieces (Laux 1976: 39), but more common are the spiral-, circular group-, or hump-decorated discs (Figure 1.038). The early disc-headed pins from southern Germany and the later north German pieces terminate on the top in an attached rolled-up strip-like extension (Laux 1976). A detailed classification of the pins according to their disc decoration was made by Laux (1976), Bergmann (1970) and Tackenberg (1949). The three main groups will be introduced briefly below, but without going into detailed object descriptions. Knowledge regarding the main dissemination centre of these kinds of pins is important due to the appearance of several items in northern Germany.

Figure 1.038: Spiral-decorated disc-headed pin from Heitbrack, Lower Saxony (LMN 137:81).

The hump-decorated disc-headed pins all date to NBA II and are part of female burials throughout the north German area. Mainly, the pins are spread in the area between the Elbe and Aller rivers (Figure 1.039; see Laux 1976: 40-42), however they are occasionally represented in Mecklenburg, Brandenburg and Pomerania (Figure 1.040; see Bergmann 1970b; Bohm 1935). The disc head is decorated by a commonly bigger hump placed in the centre of the disc and several series of smaller humps which run along the edge.

A further variant is decorated with a series of connected double-spirals. They appear in the developed NBA II as well as at the beginning of NBA III (Laux 1976, 44), with a clear focus on the central Lower Saxony region. Only two pins are known outside that area in northern Germany,[23] thus the spiral-decorated disc-headed pin can be considered a northwestern German type (Figure 1.040). Often the centre of the disc displays a slight hump, which is surrounded by a decorative ribbon (line or notch decoration). Similar ribbons appear also accompanying the edge. In the Lüneburg Heath, Laux detected a regular combination pattern of spiral-decorated disc-headed pins, neck collars and hanging discs female burials (Laux 1976: 43).

The third version of disc-headed pins is decorated with a combination of hump and spiral series. These pins appear within NBA III, as supported by the Hohenbünstorf burial (Laux 1976: 45).

A different form, however, within the group of disc-headed pins are the Bohemian pins. Their head is cast-on and at right angles to the shaft (i.e. Reinecke 1935; Drescher 1958: 36-37). Their usually circular disc is elaborately decorated and the bent shaft is attached to the reverse of the disc (by flattening the shaft end and building a disc model around the same). The knowledge of this special variant is of importance because in northern Germany similar pins are also found. Therefore, the knowledge of this technique (cast-on in lost-wax) seems clearly to have been present.

[23] The disc-headed pins from Plau, Meckelnburg and Schrampe, Kr. Seehausen, Altmark (Laux 1976).

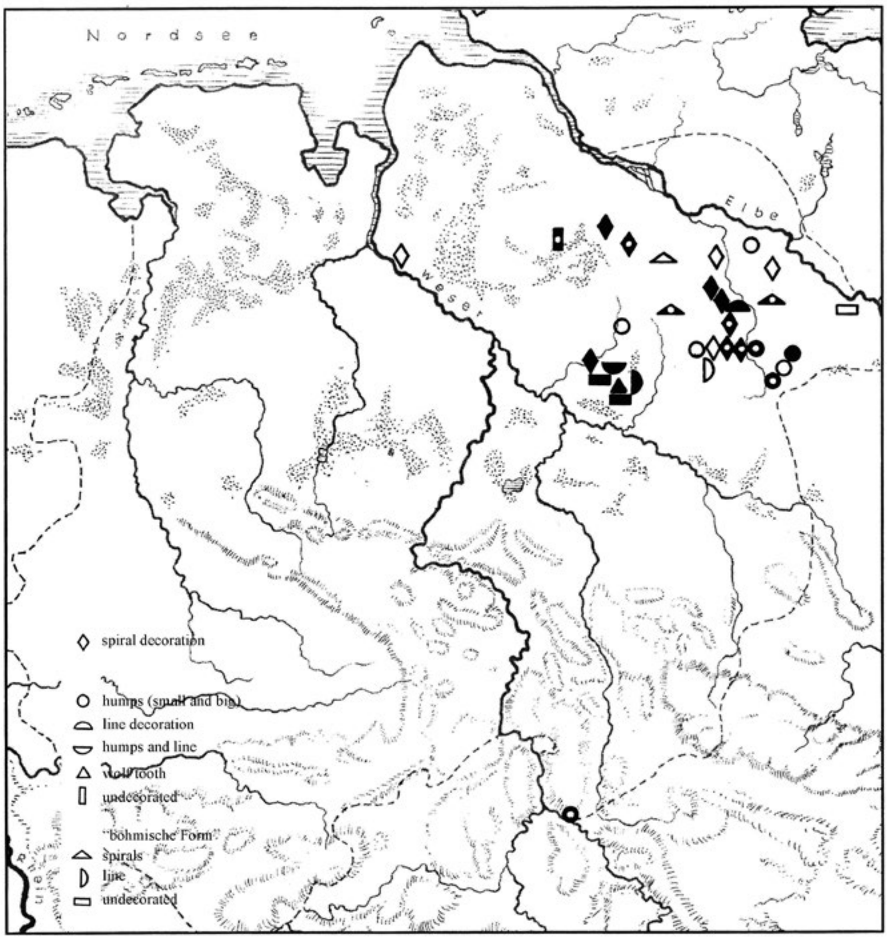


Figure 1.039: Distribution of disc-headed pins in regard to their decoration southwest of the Elbe River (after Bergmann 1970: map 80).

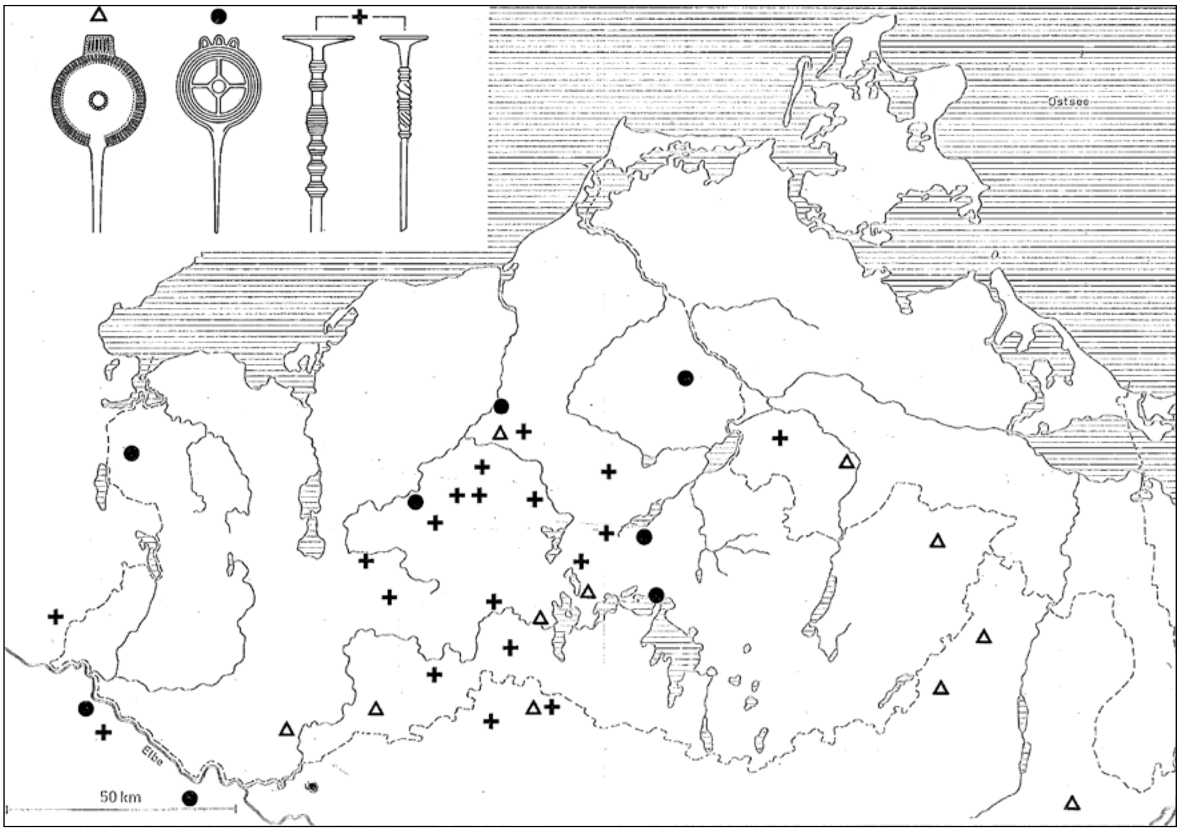


Figure 1.040: Distribution of disc-headed pins in regard to their decoration in Mecklenburg (after Schubart 1972: map 25).

Weitgendorf-type pins

Weitgendorf-type pins are regarded as one of the largest pin shapes in Mecklenburg and can reach up to 70 cm. In a way, these pins are a form of disc-headed pins, but their flat plate-head is horizontally placed on the shaft and decorated with lenticular thickenings (Figure 1.041). Schubart divided the pins into several variants according to the bulge decoration on the shaft (Schubart 1972: 40-41). However, since no more than 17 pieces were found in the Mecklenburg area, and Schubart himself mentions the variety of forms of this pin type, a further subdivision will not be presented. These aforementioned bulges on the shaft can be decorated with a notched trim, reminiscent of the decoration on the possible rolling wheel in the Murnau depot (see Nessel 2009), or have a pointed lenticular shape. Furthermore, a Weitgendorf-type pin was found with a head plate covered with gold metal foil (Schubart 1972: 41).

This kind of pin is limited to NBA III within the area around the Mecklenburg Lake district, where the Mecklenburg group is assumed (Figure 1.040). In northern Germany only a few examples of Weitgendorf-type pins are known west and east of the middle Elbe and upper Warnow rivers.[24] Further south, however, a further concentration can be detected. Although the quantity of pins found does not exceed the number of items found in Mecklenburg, another major dissemination area can clearly be detected in Upper Bavaria, Upper Palatinate and Bohemia. Interestingly, the dissemination of these pins results in 'einer völlig fundfreien Zone in Mitteldeutschland'[25] (Schubart 1972: 42).

To summarise, the Weitgendorf-type pin seems to originate in the southern region of central Europe. Amongst other things, the sharp disc profile is seen as an element of the late Tumulus Culture (Ba C/D) and underlines the origin of these objects (Schubart 1972; Holste 1953: 18-19).

Figure 1.041: The disc-head pin Weitgendorf-type from Weisin, Mecklenburg (ALM 2196a).

[24] As, for example, the pins from Barskamp, Kr. Bleckede; Witzeeze, Kr. Herzogtum Lauenburg and Vaale, Kr, Rendsburg (Schubart 1972: 41).

[25] An area with no known Weitgendorf-type pins in central Germany.

Chapter 3

Archaeological residues of metalcraft within the Nordic Bronze Age

References to metalworking activities in the Bronze Age are not only found in the form of moulds and related artefacts but also within settlements as features displaying actual working places. The artefacts related to metalworking activities vary though time and space. Stone tools, such as stone hammers, stone anvils and cushion stones are especially known from the Bell Beaker period, but however are also common during NBA II and III. The diversity of the tools that could comprise the repertoire of the Bronze Age metalcrafter, such as chisels, design punches and stamps and organic tools, is mainly known from Late Bronze Age hoards. These extensive tool ensembles from depositions like Génelard, Saône-et-Loire (France), Larnaud, Jura (France) or Murnau, Upper Bavaria (Germany) indicate how a metal-workplace might have been equipped in Europe. Within this chapter, reconstructions concerning the actual working places, based on excavated Bronze Age sites from Scandinavia to southeast Europe are presented. The archaeological evidence suggests simple constructions for northern Europe, consisting of both D- and U-shaped flat pits paved with stones, as well as rectangular stone settings and simple fireplaces at ground level, with no apparent stone constructions. Moreover, the metalworker is additionally detectable in burials through predominantly anvils and hammers of stone, and fewer casting moulds or cast ceramics. It seems that these graves, provided they contain items that are within the common range of equipment, should be regarded as craftsmen graves. However tools, contrastingly, are also found in very rich burials, for example the Leubingen burial mound. These tools, which are clearly attributable to metal-technical use, should be seen metaphorically, rather than arguing that they identify the owner as a craftsman.

1.3.0 Introducing the archaeological evidence of metalcraft

Our knowledge of metalcraft in the Bronze Age is based mainly on finds of finished products. Within the material culture of the Nordic Bronze Age, there is little evidence that points directly to the exerting of the craft. Nevertheless, to get an idea of the working environment of the metalcrafter and his tool repertoire, European (especially southeast European) findings can be used as informative sources. Here, a few well-documented working places related to metalcraft could be excavated. The information gained can be transferred to the northern European material and there be used as a comparative, thus enabling the interpretation of questionable findings. Within a closer examination of the metalworking crafts it becomes important to separate two basic find categories. Finds and features that show mining activity should be treated separately from those related to metal-forming activities (see Chapter 1.0.4). In a particularly impressive way, this claim is supported by the sophisticated metal technology of the Nordic Bronze Age, which has been proven to have imported the raw material completely (see Ling *et al.* 2012; Rowlands and Ling 2013; Ling *et al.* 2014).

In the present case, the working place of the metalcrafter, and the necessary tools, are particularly of interest in terms of ranking the metalworker, his position in society, and its occurrence within the Nordic Bronze Age.

1.3.1 Settlements

Well-equipped metalworking places are rarely excavated, but there is plenty of evidence of metalworking activities. However, scattered evidence for Bronze Age metalworking places can be found in eastern and southeastern Europe, dating from the end of the Early Bronze Age (Ba A2).

Exemplary among the findings is the 'foundry' in the fortified settlement of Feudvar (Hänsel and Medović 1991; 1998) placed on the Titel plateau near Mošorin in Vojvodina (Serbia). The settlement follows a regular constructed plan and consists of houses built in tracery technique and plastered with clay. Within its centre, a building could be determined that was constructed without the east wall and with a much larger open space. Other features, such as lack of hearths in the building, a particularly intense fire discoloration at the height of the missing east wall (probably a bigger furnace), and a lack of artefacts related to daily activities, highlighted the house construction. Additionally, the increased occurrence of casting equipment pointed towards a metal-workplace (Hänsel and Medović 2004: 88-135; Kienlin 2007: 2; Primas 2008). The site is dated to the Early Bronze Age (Reinecke Ba A2), which is comparable to the Hungarian Middle Bronze Age (Hänsel and Medović 2004: 86f.; 1998; 1992; 1991; Hänsel 2002: 79ff.). The excavated material culture displays a wide range of metalworking activities (Kienlin 2007: 4-5). Thus, a clay patrix, as well as the high quality of the clay, are evidence for the production of casting moulds. Scattered moulds probably related to lost-wax casting point towards casting activities, executed probably in the open southern area. Additionally, this is supported

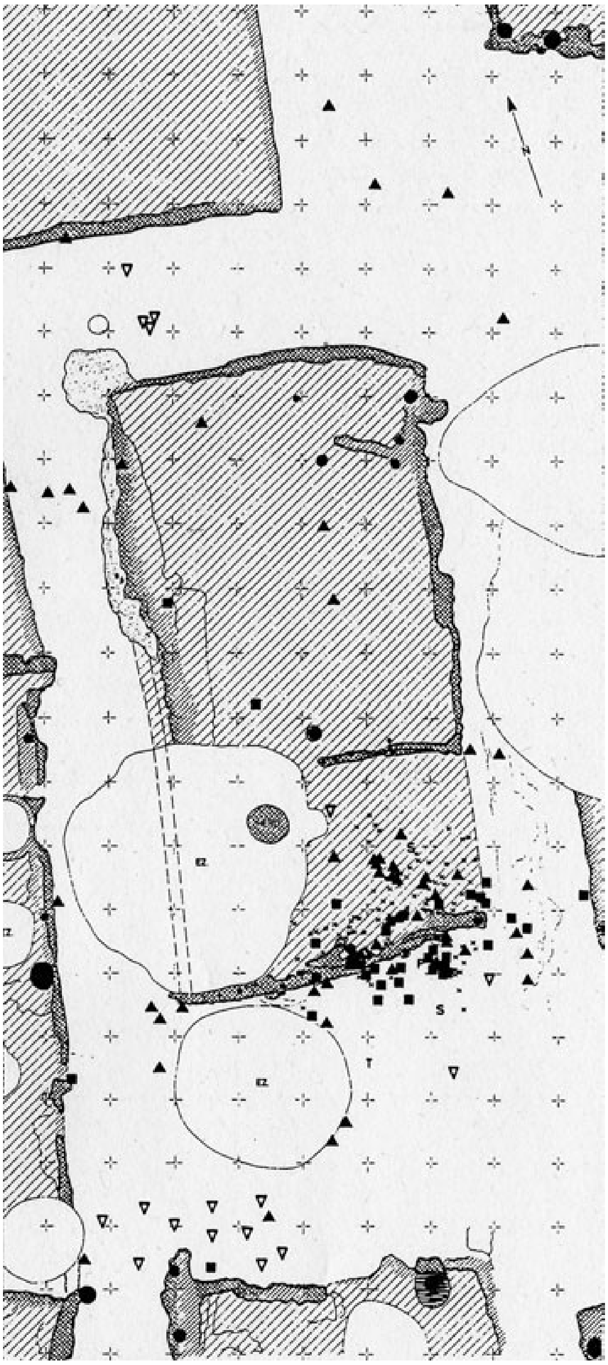


Figure 1.042: The workshop in Feudvar (after Hänsel and Medović 2004: 89).

by crucible fragments and slag residues, grinding stones and the bronze fragments that could also be detected in this area (Figure 1.042). Grinding stones also indicate that metal-forming activities took place alongside casting work. Furthermore, a mould used to cast thick bronze discs, which is interpreted as a blank disc and designed for further cold-working (forging) activities (Hansel and Medović 2004: 92), confirmed the variety of metalworking techniques within this workplace (Kienlin 2007: 5). The various mould residues, which were mainly found separated from the workplace area at the edge of the southern court (Hansel and Medović 2004: 91-93), and the diverse cast cores (Figure 1.043), suggest the production of shafted tools, spear heads and chisels (Hansel and Medović 2004: 101; Dietrich 2010: 359).

A distinct evidence for metal production has been found in the Early to Middle Bronze Age settlement of Bruszczewo in western Poland, which was excavated from the 1950s up until the present. Within the multi-period fortified settlement pits,metalworking debris connected to the 'Únětice culture environment' (Jaeger *et al.* 2015: 228) was detected in the southwestern area of the settlement (Czebreszuk *et al.* 2004a: 17; Silska 2012: 115-121; Kneisel 2013: 183-187; Czebreszuk *et al.* 2015). Direct evidence for the actual metalworking places, however, were not documented in the old excavations from the 1960s (see Pieczyński 1985: 167-168; Czebreszuk *et al.* 2004B: Abb.28). The metal-working ensemble found indicates large-scale production within the settlement. Here especially the mould of an open massive ring, also known as 'Thüringer rings', is of importance, as the construction of this stone mould revealed an advanced knowledge of casting skills. Furthermore, the wide distribution of this distinct ring type within the Kościan Group of the Únětice Culture indicates the range and size of metal production at Bruszczewo (Jaeger *et al.* 2015: 228-230).

Another well-excavated working place from Entre Águas 5 in Portugal could be related to metalcraft activities, based on the numerous finds of crucibles, moulds and bronze granules. Metallurgical artefacts found in House X point to several aspects of metalcraft executed within this site. Crucibles and bronze granules are not only evidence for the melting of metal and casting, but also point to the extraction of metal from the ores within this site (Valério *et al.* 2013: 441). In addition, particularly thin-walled and highly fragmented crucibles would have been used within the lost-wax casting which, on the Iberian Peninsula, is mainly related to the production of gold artefacts (Valério *et al.* 2013: 441; Armbruster 2000). House X is a located on the eastern edge of the Late Bronze Age settlement, situated on the River Enoxé. Within this settlement, which was excavated in several sections, was the named site where metallurgical activity could be confirmed (Rebelo *et al.* 2009; Valério *et al.* 2013).

Sporadic, well-excavated metal-workplaces in settlement contexts are also known in northern Europe. Jantzen collected in painstaking detail a total of 32 settlements of the older and younger Bronze Age in Denmark and northern Germany, where finds of crucibles, moulds or tools can be related to metalcraft activities within the settlement (Jantzen 2008; 260; see additionally Oldeberg 1942; 1943). This number can be supplemented by five other sites in Mecklenburg (Figure 1.044) that show metalworking activities close

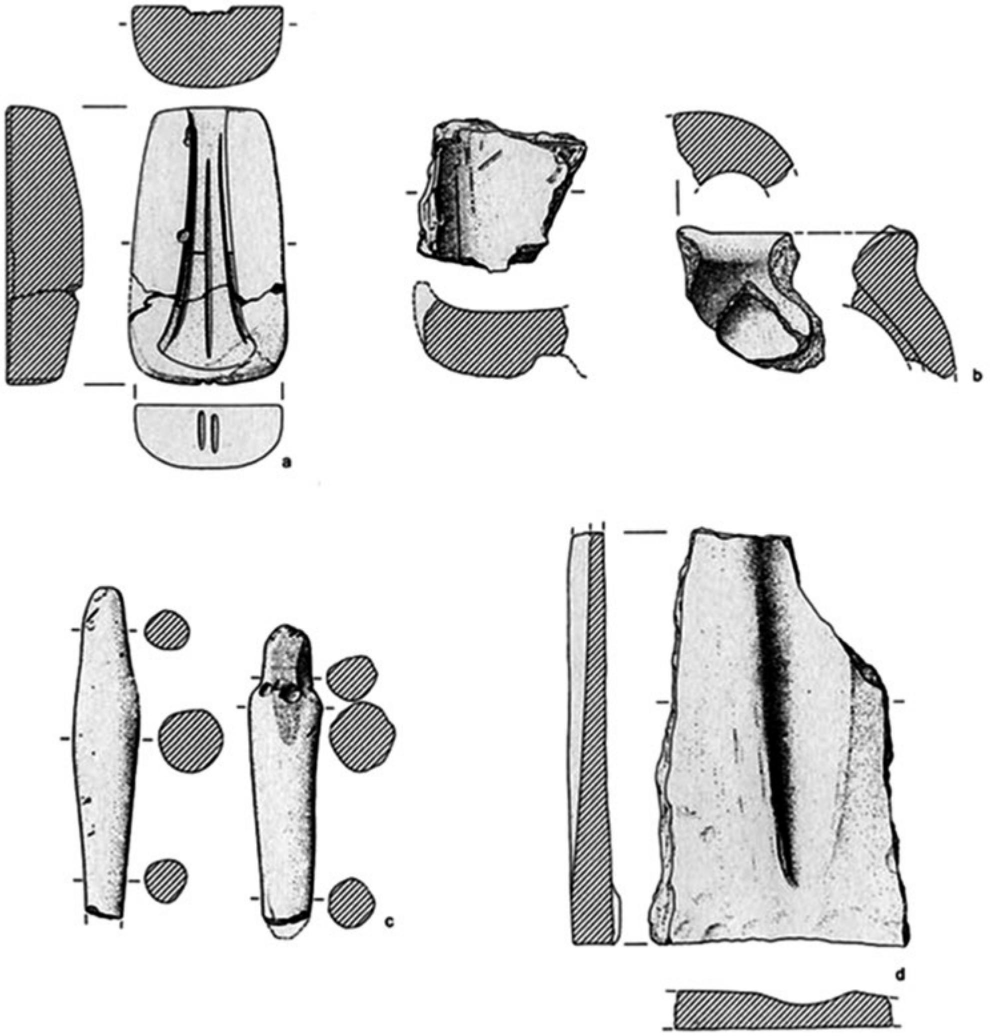


Figure 1.043: Crucibles and moulds from Feudvar (after Hänsel and Medović 2004).

to settlements (Jantzen 1999; also Goldhammer 2013; Willroth 2013). In Brandenburg five, and in Lower Saxony three settlements with metallurgical activity from the Late Bronze Age are also worth mentioning. Within the Danish region metal-workplaces are distributed in 6% of all known Bronze Age settlements (Jantzen 1999: 11). Especially in the municipalities of Copenhagen (18.6%) and Aalborg (22%), a significant concentration of settlements with metalwork activities can be detected (Jantzen 2008: 42). Northern Germany lacks a percentage figure, since the volume of excavated settlements cannot be determined due to the lack of publications. However, it can be considered a fairly small number, similar to the Danish region.

In Sweden, many settlement finds with references to metallurgical activities have been made, especially in recent years. Here, the topic of metallurgical activity areas within settlements is still under investigation, and more sites can be expected to contain workshop areas, taking the invisibility of many such places into account (see Sörman 2017, Nilsson and Sörman 2015). Lene Melheim increased in her study the number of settlement finds in which metalcrafts were certainly executed during the Bronze Age to 16 (+3) settlements (Melheim 2012; additionally Högberg 2011; Goldhahn 2007; Ling 2008; Hjärthner-Holdar *et al.* 2011; Hjärthner-Holdar 1993). However few sites dating to NBA II and II are excavated and documented in detail,[26] and thus our understanding of the working places of metalworkers in the north is only slightly expanded. Most finds related to metalcrafts came from pits within a settlement; as such, they could be ascribed more to a waste area than a working place.

[26] A very well-excavated and documented example is the site of Södra Kristineberg (Malmö). Here Anders Högberg focused on craft activities within the settlement (Högberg 2011) and the lately published Bronze Age casting workplace in Skeke, where metalcraft activities could be proved from the beginning of the Late Bronze Age (Hjärthner-Holdar *et al.* 2011). These settlements are perfectly excavated and documented, however the features are from the Late Bronze Age and both show additionally iron work activities.

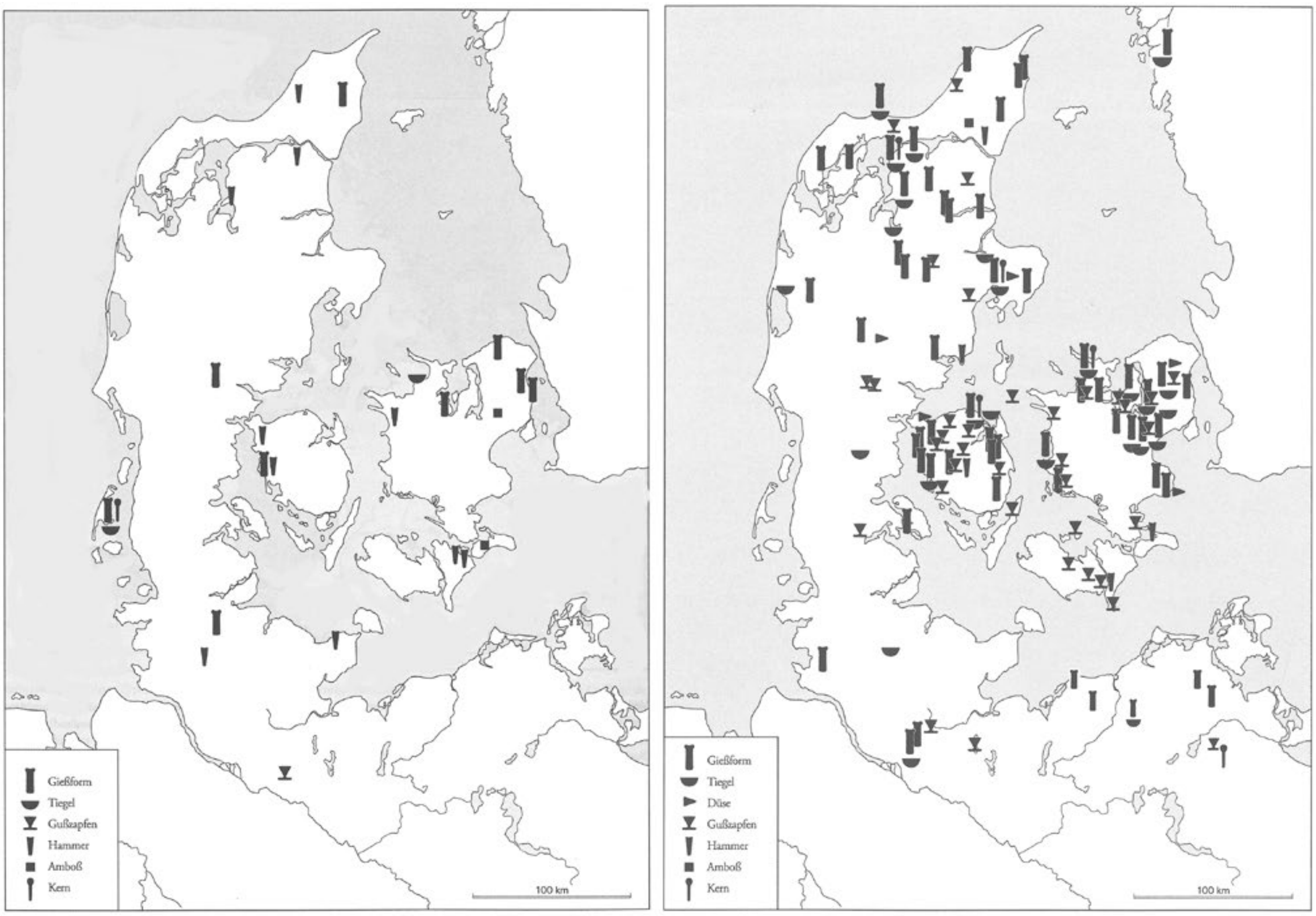


Figure 1.044: Metal working activities related to settlements during the early Bronze Age (left) and the younger Bronze Age (right) (after Jantzen 2008, supplemented with Jantzen 1999).

However, in Torslev,[27] within a three-aisled longhouse dated to the NBA II, a hoard was found with fragments of bronze socketed axes and palstaves, bronze ingots and scrap (Nilsson 1990; Nilsson 1996; Jantzen 2008). Most likely this hoard is related to a metal-workshop. The excavated fragment of a mould for socket-tools found in a post-hole pit of the house confirms the interpretation of the hoard. The post-hole located near the hearth contained in its uppermost fill layer the said object (Figure 1.045). The mentioned finds lead to the assumption that within this house metallurgical activities took place (Jantzen 2008: 271). A similar situation appears at Ferslev.[28] Within a 'cult building', identified by two parallel rows of stones arranged in rectangular shape, several fragments of moulds and crucibles were recovered from its southern half

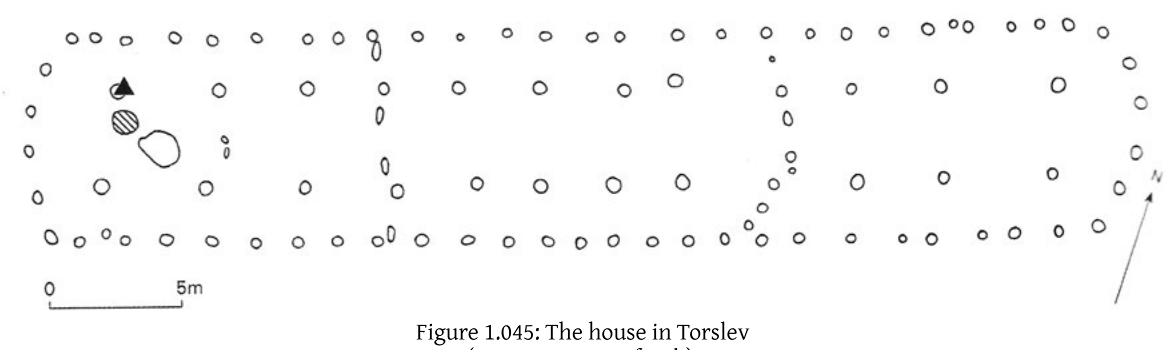


Figure 1.045: The house in Torslev (Jantzen 2008: Taf. 78b).

[27] Torslev, Dronninglund herred, Hjørring Amt (after Jantzen 2008: 63; Nilsson 1989: 26).

[28] Ferslev, Horns herred, Frederiksborg Amt (after Kaul 1987; Kaul 1985; Jantzen 2008).

(Kaul 1985; 1987a: 122; 1987b). The concentration of finds within the southern half of the building leads to the assumption that metalworking activity took place there, additionally supported by a presumably related oval stone setting (Jantzen 2008: 274; Goldhahn 2007: 48-50; Kaul 1987b).

Among the other settlement or settlement-related findings, the two hills of Vindblæs[29] and Thorsager[30] should be mentioned as they contained pits with metal-technical equipment and a fire pit within a stone setting. These hills are not interpreted by the excavators as grave sites (Nielsen 1956; Oldeberg 1943; Jantzen 2008) and display a significantly increased find density in comparison to most other settlements.

References to the metalworking activities within settlements are not only found in the form of moulds and related artefacts. In addition to the features displaying actual working places, more often stone tools, such as stone hammers, stone anvils and cushion stones are found. They are especially known from the Bell Beaker period and are also common during NBA II and III (Butler and van der Waals 1967). These stone tools are one of the few groups of tools that are present in a settlement context.

1.3.2. Hoards

The majority of metal-technical equipment (except ceramic devices) comes from depositions, especially the tools. Within these depositions, or hoards, two basic distinctions can be made. On the one hand there are hoards containing predominantly used materials, bun ingots and moulds (stone or bronze), and on the other they can contain tools, sometimes even whole tool ensembles. Combined compositions also occur, however Jantzen (2008: 285) suggests that tools and sprues are almost never found in combination. The so-called foundry hoards, which predominantly contain used materials, moulds and bun ingots (see Jantzen 2008: 281; Oldeberg 1943; Struve 1979), will not be in focus within the further discussion. Even if these hoards are of interest concerning the reuse of metal during the Bronze Age they contain less information concerning the working place of the metalworker.

Of greater interest for the present research are those depositions with tools. They present direct statements on the tool repertoire and the workshop of the Bronze Age metalcrafter. Respective hoards with tools show, 'eine starke Bindung an Hortfunde mit zerkleinertem Altmaterial ("Brucherzfunde"), auch wenn sie selbst innerhalb dieser Funde stets zu den unbeschädigten Stücken zählen'[31] (Jantzen 2008: 285).

For NBA II (Ba C), there is only sparse evidence of moulds or tools related to metalcraft. Worth mentioning is the occasional appearance of bronze casting moulds during NBA II in Danish, Swedish, north German, and Polish hoards. The southwestern European area only sporadically includes this type of casting mould in its archaeological record. However, the picture changes during the Bronze Age, and in the later periods bronze forms are represented mainly in southwest Europe and hardly any in northern Europe (Jantzen 2008: 170). NBA II tool finds are within the area of research mainly represented by stone tools, which (as mentioned) also occur in the settlement context. The durability of stone tools has so far not been clearly set out. However, stone anvils demonstrate the use of such equipment at least until NBA III (Ha A), for example the piece from the hoard near Auvernier, Canton of Neuchâtel (Switzerland) that was still connected to its wooden base (Armbruster 2010: 15). In addition to large-scale equipment, such as anvils or hammers, further stone tools occur, which were used as grinding stones or as touchstones.

Late Bronze Age hoards (central European chronology) with extensive tool ensembles are known, especially in southern Europe. These finds can contain complete workshop tool sets (Pernot 1998). However, finds of large equipment such as anvils or hammers are rare, they contain mostly punches, chisels, die and patrix, and occasionally various stamps. Primarily, these deposits contain tools that may be attributed to the hammering of gold plates and bronze plates (Armbruster 2012: 390; Kuijpers 2008). Among the most important finds, the deposit from Génelard, Saône-et-Loire, France (Figure 1.046) should be mentioned, as well as the deposit from Larnaud, Jura, France (Thévenot 1998; Armbruster 2010; 2012). Even the NBA III (Ha A) deposit from Murnau, Upper Bavaria, is of particular interest because the pieces were not only deposited completely preserved, but were also in very good shape (Nessel 2009).

A special feature of the above-mentioned depositions can be seen in the presence of bronze anvils. Tools like this are also known from Scandinavia and northern Germany, however, only a few bronze anvils (probably three pieces) are documented. In the north they are only known from hoards and represent just a small formative spectrum. Functionally, the three anvils are assigned to forming blocks. One of the most northern pieces has a horn-like extension. As such, all bronze anvils are designed to perform more than one task; they can be used as an even and clean surface, a tool to

[29] Vindblæs, Slet herred, Ålborg Amt (after Nielsen 1956; Jantzen 2008).

[30] Thorsager, Øster Lisbjerg herred, Randers Amt (after Neergaard 1908; Oldeberg 1943; Jantzen 2008).

[31] '...a close relationship with hoards with crushed waste material ("Brucherzfunde"), even if they are always deposited as undamaged pieces, within these finds...'

Figure 1.046: The deposit from Génelard, Saône-et-Loire, France (after Armbruster 2010).

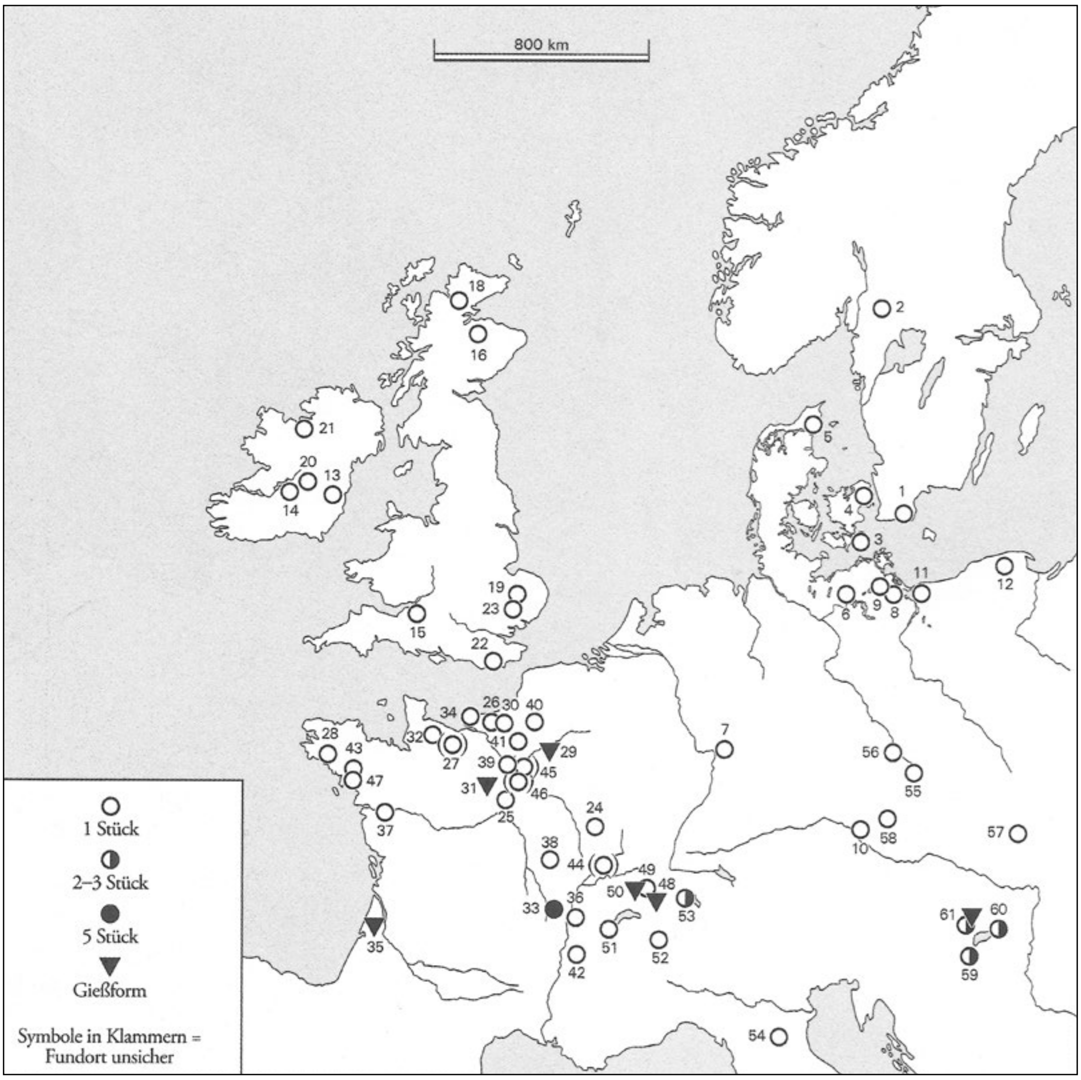


Figure 1.047: Distribution of bronze anvils in Europe (after Jantzen 2008: Taf. 125).

form wire, or as a core to shape metal sheets. Jantzen was able to collect, in all, 63 European bronze anvils and six moulds for anvils (Figure 1.047) which could be divided by Armbruster (2001) into four different categories with regard to their function (see Jantzen 2008; Kuijpers 2008: 97).

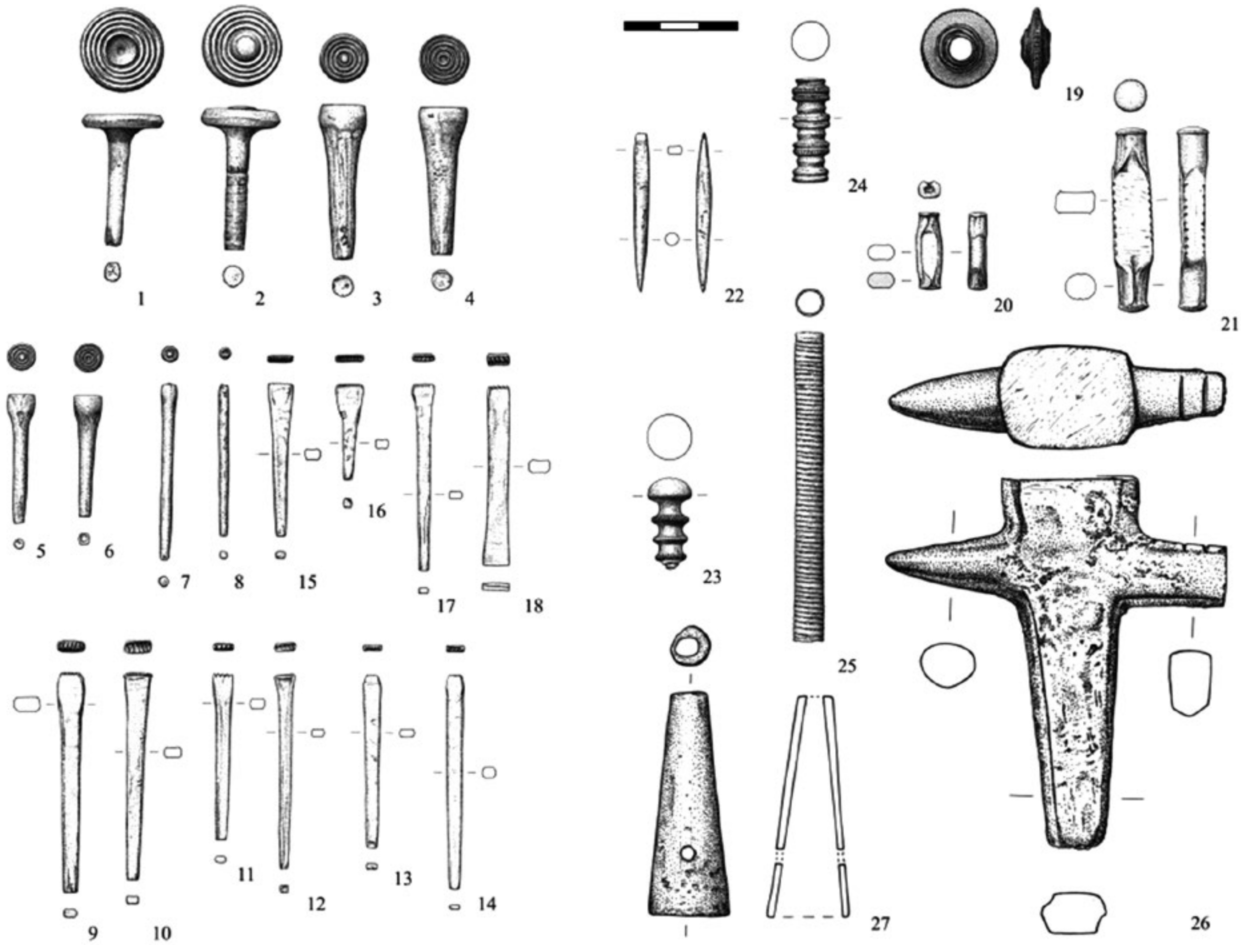


Figure 1.048: Tool deposit from Murnau, Upper Bavaria
(after Nessel 2009).

To gain an overview of the possible tools of a Bronze Age metalcrafter, the deposit from Murnau mentioned above will be presented here in detail.

The 27-piece deposit was described in 2009 for the first time, but was already, before 1995, part of a private collection. Due to the identified traces there can be no doubt that the objects are related to each other. Regarding the find context there is little information, however, a bog or water deposition is excluded (Nessel 2009: 38). The hoard consists of seven punches with concentric ribs,[32] a hollow design punch, ten design punches ('Faulenzerpunzen'), a small wheel-like tool (see Chapter 2. 5. 2), two miniature hammers, an awl, an anvil, needle fragments, a spearhead fragment, and several smaller bronze residues, including a sheet metal tube (Nessel 2009: 56-58).

All of these objects are in pristine condition and show few use wear traces (Figure 1.048). However, the anvil, a small hammer and the hollow punch suggest the use of the tools, as superficial abrasions and rounded edges are visible here. Grooves in the rib valleys of the concentric circle stamps are probably caused due to their crafting using rotating devices while forming the wax model (Nessel 2009: 38). Furthermore, the hoard contains ten design punches, meaning punches whose decorative tip is designed so that recurring ornaments can be made without much effort. In this case, they display the juxtaposition of slightly tilted notches in different widths (similar to the popular ribs decoration on Nordic neck collars). Almost all design punches within the deposit seemed unique, with the exception of punches 15 and 16 (Figure 1.048). These two tools probably produce the same pattern. The described hoard represents a comprehensive tool kit of a Bronze Age metalcrafter, similar to the hoard of Saône-et-Loire (see Pernot 1998). The presented tools are to be regarded as an extensive tool set of a skilled smith (Kuijpers 2008: 104). However, the tools seem little used and, consequently, this excludes their use for bronze working (Nessel 2009: 42). In addition to the proposed gold sheet-work, these devices could well have been used for the production of wax models. This is supported not only by the filigree elaborated design punches, which carry a common decorative element of northern and central German ornaments, but also by the wheel-like tool, a possible rolling wheel (Chapter 2.5.2).

[32] A further description of the tools is in Nessel 2009: 56-58.

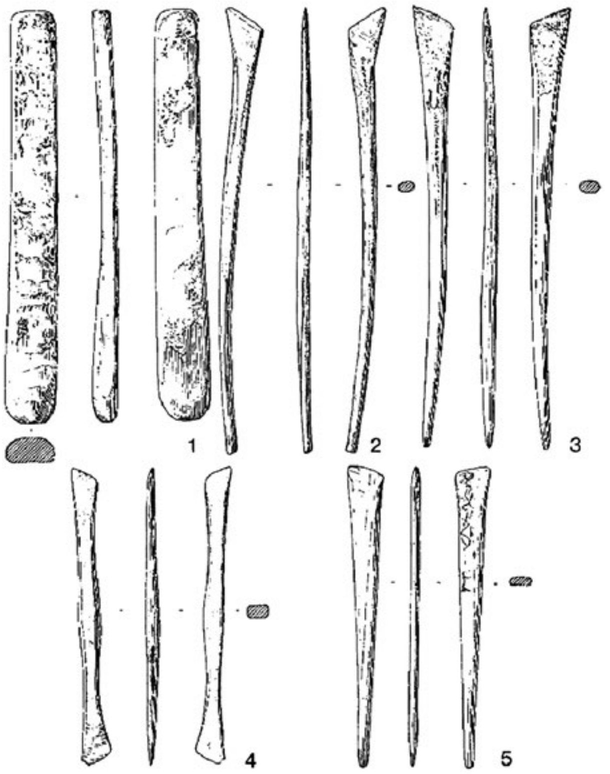


Figure 1.049: Deposit from Gussage All Saints, Dorset, with bone tools and bronze ingots (based on Wainwright 1979, picture taken from Rønne and Bredsdorff 2008: 69).

That bronze tools were used for shaping the models for the lost-wax process is obvious. However, an Early Iron Age feature from Gussage All Saints implies that the greater number of devices to shape models were probably of organic materials. The ensemble found in Dorset of bone tools and bronze ingots are interpreted as model-forming tools (Rønne and Bredsdorff 2008: 69). Each tool has a varying peak (Figure 1.049), and they can be assumed to be very effective tools in the design of wax models.

Due to the depositions discussed above we are able today to at least imagine the diversity of the tools that could comprise the repertoire of Bronze Age metalcrafters. In addition to stone tools and bronze hammers, anvils and punches as well as chisels were used. Detailed design punches and stamps display significant skill in tool manufacture. A similar diversity should also be applied to organic tools. Perhaps the relationship between the artefacts and the tools needed for their crafting would not seem quite so unbalanced in the archaeological record when we consider that many steps within an operational sequence could do without metal tools.

In addition to the known tool kits in hoards, grave finds can be documented since the Early Bronze Age, especially in central Europe, that are richly endowed with tool offerings.

1.3.3 Burials

This third category in which metalcraft related objects can be found provides a direct link between the material and the individual, even if this link should sometimes be seen more as a metaphor than as a visualisation of reality.[33] The scientific evaluation of burials with metallurgical inventories has advanced, especially in recent years, thanks to the Nebra project 'Aufbruch zu neuen Horizonten' (Bertemes *et al.* 2000; Bertemes and Heyd 2002; Bertemes 2004; 2010; see also Thrane 2009; Nessel 2012a; 2012b; Lauermann 2012; Butler and van der Waals 1967). Especially in central European Beaker and Early Bronze Age burials, persons with a direct relationship to metalcraft can be recognised due to the added tools. The majority were found in eastern central Europe (Nessel 2012b: 3; see also Harding 2000: 239; Jockenhövel 1982) with a temporal concentration during the Beaker Period (Bertemes and Heyd 2002: 215f.).

However, the tools found in burial contexts represent only a small portion of the presumable tools of a Bronze Age metalworker (Bertemes 2010: 134; Mohena 1991), in contrast to the ensembles in the hoards described above. The deposition of tools related to metalwork in graves speaks in itself for the elevated position of the buried individual(s) (Bertemes 2010: 134). In addition, some central European Early Bronze Age graves that contained equipment related to metalcraft were found, which displayed the dead in a deviating position and which were particularly richly furnished. Here especially the 'Princely Grave' of Leubingen should be mentioned (Zich 2004; Höfer 1906). This huge burial mound contained under a wooden roof the interment of an elderly man, who had golden costume components and weapons as well as three chisels, a rectangular anvil or touchstone and a perforated Neolithic stone wedge (Figure 1.050). The tools, which are clearly attributed to metal-technical use, should be seen metaphorically rather than arguing that they identify the owner as a craftsman (Bertemes 2010). In keeping with the quite common belief that metallurgy was controlled by the ruling class, these tools may be regarded as symbols of the power of the deceased. This theory of the symbolic character of metalcraft related tools (Bertemes 2010: 154), is supported by the grave finds from Sachsenburg in Saxony-Anhalt. Here a Sögel-type sword, a dagger, and 300 clay nozzles were buried together with the dead (Müller 1982: 117f.; Bertemes 2010: 154). The number of nozzles is far too high to represent the tools actually used by a craftsperson.

[33] However, every analysis of burial finds should be made with a critical eye. Burials can be metaphors of reality as well as the images of reality. They can present the person or the community, and artefacts can act as symbols as well as personal property.

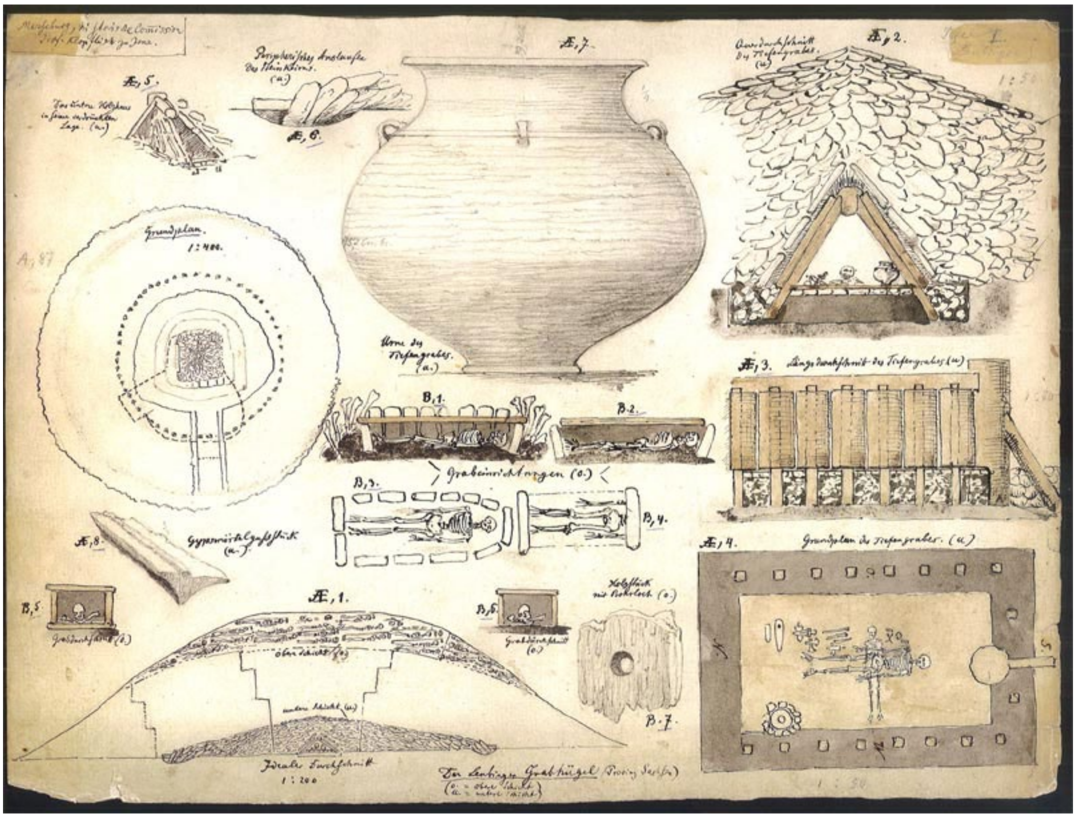


Figure 1.050: Excavation sketch from the Leubingen grave
(after Klopfleisch 1877).

Also of interest are some female burials with metal-technical equipment. These include the Bell Beaker Age grave from Tvožiharáz (Znoimo in southern Moravia), which was placed slightly away from the burial ground. The buried woman was equipped with a supposed cap with gold foil bands and several vessels, a silex scraper, and two anvil stones on the west wall (Bertemes 2010: 146-147; Dvořák 1993). Another grave is from the cemetery of Geitzendorf (Lower Austria). The Early Bronze Age female burial contained stud rings and spiral rolls near her head. In addition several vessels were placed around the skull and legs, as well as several stone tools, including an anvil, hammer, and cushion stones (Lauermann 2012). Likewise, the grave found in Erfurt-Gispersleben (Thuringia), where a woman was buried with clay nozzles, loom weights and probable anvil stones, is from the Early Bronze Age (Müller 1982; Nessek 2012b: 7). Furthermore, the tin beads found near the head of the dead woman of Buxheim, near Ingolstadt in Bavaria, can be interpreted as putative metal-technical accessories (Ottaway 2001: 99). This Early Bronze Age burial (Straubinger Kultur) is interesting due to the tin beads, which might have been units that enabled the precise alloying of bronze when added to a copper melt (Möslein and Rieder 1998; Ottaway 2001: 99).

In general, the mentioned studies indicate that predominantly anvils and hammers of stone and fewer casting moulds or cast ceramics are represented in graves (i.e. Bertemes 2010: 149). Occasionally stone tools are also identified in Nordic burials as belonging to metalcrafts. Here the *Galgehøj* on Funen presents an exceptional extensive stone tool kit with in all 10 different kinds of stone tool, partly with metal residues (Thrane 2009: 89-91). However, in the central European Early Bronze Age several clay nozzles also occur in grave contexts, as demonstrated within the burials of Sachsenburg and Erfurt-Gispersleben. Future studies of stone tools from grave contexts promise an increase in the metalcraft related findings. So, the x-ray microscopy examination of the stone anvils and embossing hammers from Grave 9 of the Künzig cemetery (see Schmotz 1992; Bertemes et al. 2000) could produce convincing evidence for the processing of gold and copper. Perhaps such a study would be of key interest to gain a balanced view of the number of craftsmen burials in the Bronze Age. Thereafter, an inference may be possible as to the extent to which the metalcraft related tools in burials might actually have been used by the buried individuals.

1.3.4 The metalworker in the archaeological record

Despite increased settlement excavations in northern Europe and, consequently, an increase in findings that provide evidence of metalworking within the settlements during the Bronze Age, analysis of the relationship between sites and artefacts is still clearly inclined towards the actual products of the metalwork activities.

Thanks to recent studies (see Jantzen 2008; Melheim 2012) however, a rough picture of a Bronze Age metal-workplace and how it might have been equipped in northern Europe can be drawn. Jantzen (2008) summarises three feature types, which he connects to metalcraft activities and which are found within settlement contexts, although mostly outside of buildings. Both D- and U-shaped flat pits paved with stones, as well as rectangular stone settings (1 x 1 m) and simple fireplaces on ground level with no apparent stone constructions, seem to be characteristic for a metalworker's working place (Jantzen 2008: 293-294). Moulds and core material of all types found near the described features point to a variety of artefacts produced within such a working place. For example, the working place in Grimeton (Broåsen, Halland) contains both moulds of weapons, tools and ornaments together (Melheim 2012: 458; Svenson 1940).[34] Many of the well excavated sites in the north clearly show the parallel existence of different aspects of metalcrafts within one working place, as was also found in the South within the jewels of settlement finds, such as in Feudvar, Vojvodina (Serbia). Here also the refining of ores (Entre Águas 5, Portugal) can be seen as part of the range of activities carried out in the workshop (Valério *et al.* 2013; Rebelo et al. 2009; Armbruster 2000). However, this should be excluded from the activities executed in a North European metal-workshop.

Otherwise, the combination of small pits and hearths seems to imply the use of different constructions for different activities. Thus, in Hallunda (Botkyrka, Sweden) a 60 cm pit, lined with stones, was used as a melting pit, while the laterally adjoining tongue-shaped hearth pit was used to warm up and prepare the mould (Jantzen 2008: 298; Melheim 2012; Jaanusson 1971; Jaanusson and Vahlne 1975). Jantzen concluded that the distance between these two features was not more than one metre, a distance that easily can be overcome when working. However, working space that was less intensively used than that described above might only be documented with difficulty in the archaeological record (Jantzen 2008: 298-299). Thus our rudimentary knowledge about the metalcraft-related working places in North Europe may be explained as a result of the 'invisible' constructions. Furthermore, it can be assumed that normal fireplaces were quite often used for casting and thus mobile workmen would have had no problems building their working areas again and again.

Additionally, the possible tool repertoire of a fine smith (goldsmith or metal artisan?) can be reconstructed due to the rich hoards from southern Europe. Elaborately designed punches seem to be equally part of the tools used in metalcraft, as well as bronze anvils and coarse to fine stone artefacts. However, due to the differences in their technological traditions, the tool sets might have differed a lot between the southern and northern European regions. Furthermore, the few tools actually found in correlation with the artefacts suggest that a large proportion of tools consisted of organic materials, as confirmed by the metalcraft hoard equipped with bone tools from Gussage All Saints in Dorset, England.

The few burials with metalwork-related equipment, in relation to the Bronze Age grave finds in North and Central Europe, can already be interpreted as being of a rich status by virtue of their very presence (Bertemes 2010; Nessel 2012b; Nessel 2011). However, within the Bronze Age grave finds these burials by no means stand out as well equipped and can be considered more of a 'normative' kind (Nessel 2012b: 5). Only a few of the extremely rich Bronze Age burials, which stand out not only by a particularly elaborate grave construction and equipment, but also by a display of different world views through the placement of the body within the burial, also show metalcraft-related goods.

An evaluation of the so-called smith-graves in terms of their social position ranges from the assumption that the deceased represent the highest social status (Bátora 2002; Pancikova 2008; Randsborg 1984) and show specialisation in crafts (Strahm 2010: 166), to the opinion that particularly high levels of metallurgical activity in the relevant community is expressed through burials (Olexa 1987). Additionally, the assumption is expressed that the burials actually represent the smith as being a fully accepted member of the society (Thrane 2009: 96), who is the last representative of their 'lineage' and is, therefore, buried with the tools (Nessel 2012b). Furthermore the simultaneous occurrence of cultural artefacts and metalcraft activities, as shown in the 'cult-house' in Ferslev, leads some researchers to think about the direct connection of the metalworker to the supernatural. Here the smith is seen as the master of fire and mediator between worlds (Goldhahn 2007: 55-56; Kaul 1988: 7-8; Kaul 1998: 44-45).

However, it seems that these graves, provided they contain items that are within the common range of equipment, should be regarded as craftsmen graves. They were equipped by the bereaved relatives with the insignia of their profession, possibly because they made an outstanding contribution within their craft or they held a special significance as metalcrafters. In contrast, within the rich graves metalcraft-related equipment probably should be seen in terms of metaphorical expression. Here the tools have a symbolic meaning, and identify their owner as the head of traditional activities.

[34] Especially in the Late Bronze Age the documented workplaces in Scandinavia display a great variety in forms and items produced. The most interesting sites are Håg (Thorsager, Jytland); Jyderup Skov (Vig, Zealand) and Ganløse (Zealand), where weapons and ornament are apparently produced together (see Melheim 2012: 453-460; Jantzen 2008: 57-61; Neergaard 1908; Thrane 1971).

PART 2
ARCHAEOLOGICAL AND SCIENTIFIC INVESTIGATION

Chapter 1

Bronze Age Metalwork of NBA II/III in northern Europe

At the end of the 4th millennium BC tin was consciously alloyed with copper to form bronze, which in most of Europe replaced the previous use of copper and copper arsenic alloys. This copper-tin alloy appeared in the 3rd millennium in Europe, however, in Scandinavia much later. Within the material culture of early Bronze Age Scandinavia, an influence from central Europe (Únětician culture) and southeast Europe is visible, not only in stylistic but also in technological development. In Scandinavia, the dominance of forging techniques in metal production was already being challenged within the late Neolithic. In LN II casting techniques seem to dominate the local Scandinavian production. Central Europe was, however, introduced through the Bell Beaker cultures and established with Únětician tradition, deeply rooted within the tradition of cold-working and sheet metal techniques. With the early periods of the Nordic Bronze Age (NBA IB and NBA II), a technical transfer took place and north of the Elbe artefacts of both technical traditions appear side by side in hoards. At around NBA IB (1600-1465 BC) a Scandinavian style was established, characterised by the very early, putative, use of a casting technique known as lost-wax-method or *cire perdue*. It seems that especially the use of wax as model material, within the *cire perdue* technique, resulted in an innovative handling of tools and technique to create an independent ornamentation that stood out in variety and execution from the southerly adjacent regions. This chapter introduces the technological development in northern Europe and the methodology to study prehistoric craft.

The difficulty while studying residues of the crafting processes on bronze ornaments lies mainly in their state of preservation due to corrosion. Furthermore, traces of the crafting process on bronzes are rare, thus, certain criteria must be fulfilled in order to achieve promising results, such as: the objects need to be in good condition; they need to have a specific amount of decoration to trace individual behaviour; and the object's stylistic origins need to be known.

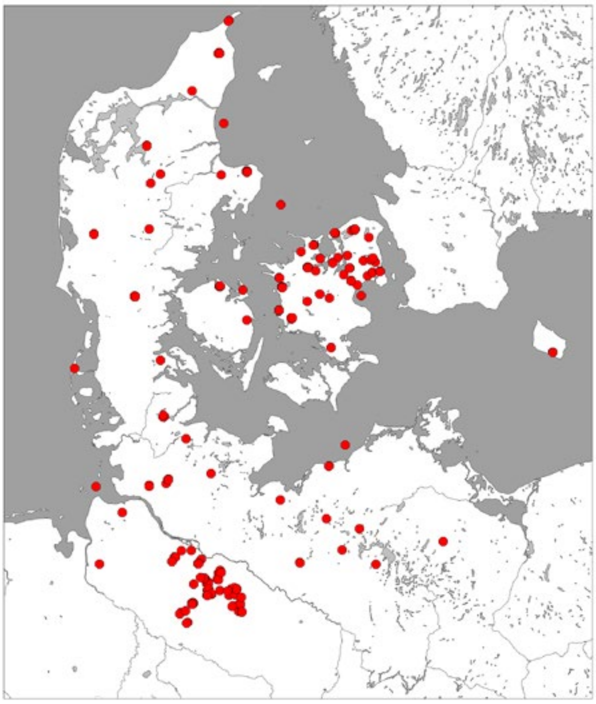
2.1.0 Introduction and method of the technical and investigative parts of the study

The second part of this study centres around the technical characteristics of the bronzes under investigation, those characteristics deriving from the visual, technical and scientific analyses conducted in this study. This is performed in two independent fields (technical and scientific), which at the end are compared with each other to gain a complex and realistic sequence for crafting NBA II and III bronze ornaments.

The basic technique used within this investigation is macro-photography executed by a Canon EOS 450D SLR camera and a Sigma EX 105mm1: 2.8 DG Macro lens. In order to achieve both best resolution and focus the camera is placed on a tripod and triggered by remote control. Focus and ISO are individually adjusted, depending on the detail of the motif and the surrounding conditions. The pictures are taken within the museum storage facilities of the respective collections (see Acknowledgements). In addition, all the photographically documented artefacts are drawn and the single decorative elements measured, which was especially important in terms of the spiral stamps (see Table 1). One comparative scientific study applied was the metallographic investigation of belt plates, neck collars and bronze pins stored at the national museum of Lower Saxony in Hannover. For the very first time it was possible to do metallographic observations of 33 bronze ornaments of the NBA II in north Germany. This investigation (described in Chapter 7) will allow a definitive determination of the techniques used in their crafting and the related visual traces. The sequences of the selected artefacts presented at the end of Part 2, therefore, reflect the latest research. The combination of archaeological documentation, technical analysis and scientific confirmation leads to the most realistic reconstructions of prehistoric craft in the Bronze Age.

In a study of prehistoric artefacts one needs to be aware of the material properties of the object in order to determine the kinds of tools and techniques used (Armbruster 2000: 19). A good knowledge of the material allows today's researchers to gain direct access to the prehistoric possibilities.[1] Thus, 'die Identifizierung und Interpretation von Werkzeugspuren und Verfahrensmerkmalen (ist) ... in der Regel keine Sache der Willkür, sondern ein konkreter Sachverhalt'

[1] Especially Armbruster (2000; 2012) but also Maryon (1949) repeatedly mention misinterpretations of the archaeological material and wrong technical allocations due to ignorance of the material or the metalworking techniques. There is no intention here to present these technical misinterpretations in detail (see Armbruster 2000), however, the mentioned studies are not included in this work as they are simply wrong.



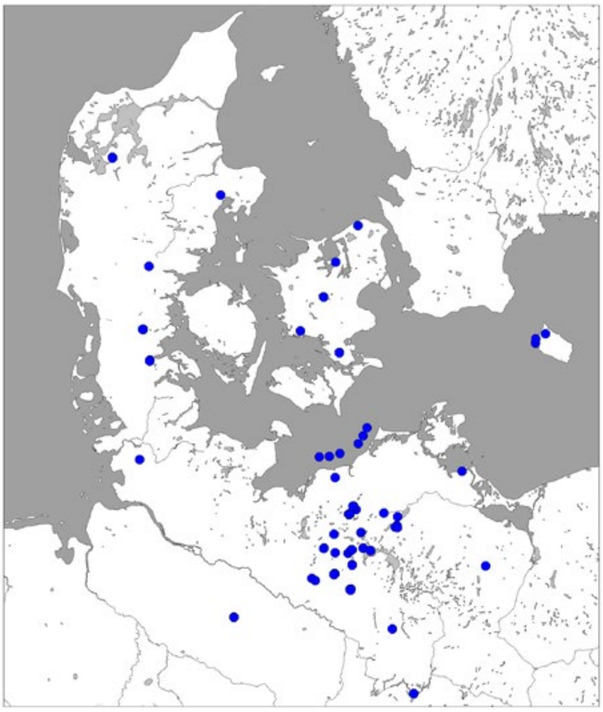


Figure 2.001: Distribution of the artefacts investigated within the present study chronologically separated; artefacts of NBA II (1450 BC to 1300 BC) (left) and artefacts of NBA III (1300 BC -1100 BC) (right).

(Armbruster 2000:19).[2] The difficulty while studying bronzes lies mainly in their state of preservation. Unlike gold, bronze builds a patina if it is exposed over a long period to acids, salts or gases contained in the air, in water or in the ground. Together with signs of wear (due to the storage in the ground), this patina makes the study of prehistoric craft traces more difficult. Additionally, as recent research revealed, due the transformation of the surface structure during the corrosion process the actual surface of the bronzes can have been changed greatly, as well as the traces of crafting (see Nørgaard 2017b; Mödlinger 2011).

Furthermore, it can be assumed that bronzes that were in use were repeatedly cleaned and polished (Lowery *et al.* 1971: 176) – provided that the golden colour of the bronze was one of the main reasons for their use - and, therefore, the profile of the surface might have been greatly changed. Thus, traces of the crafting process on bronzes are rare and only objects in good condition are useful for an investigation.

Thus, the studied artefacts (323 bronzes from 190 localities of period NBA II and III, see Figure 2.001), shall reveal through photographic documentation of macroscopic details of their ornamentation their craft technical characteristics. The severe documentation and evaluation of the traces in regard to the just described problems is intensively described in this second part of this book and will be supported by previous research and metal-technical studies as well as by experimental comparison of known metalworking techniques.

2.1.1 Differences in Nordic metalwork

In order to understand the unique position of the Nordic metalwork in northern Europe one needs to shortly touch the topic of the development of bronze, or better copper-alloy-technology.

Consensus seems to be that in the 6th millennium BC metallurgy seriously developed in the Near East. Whether this proceeded from a single centre, or took place independently in two different centres, is still under discussion (i.e Radivojević and Rehren 2016; Radivojević *et al.* 2010; Roberts *et al.* 2009; Golden 2009b; Pernicka 1995; 1998; Primas 2002; Shalev and Northover 1993). The first metal worked was copper in a more or less pure form. At the end of the 4th millennium BC tin was alloyed with copper (presumably first accidentally, and later purposefully) and appeared in the 3rd millennium in Europe (Roberts *et al.* 2009: 1015; Golden 2009a; Primas 2002; Thornton 2007; Tylecote 1991). In north Europe, however, this technology was introduced much later.[3]

From a technological point of view, distinct differences were observed between the early metal technologies of

[2] '...the identification and interpretation of tool marks and method (is) ... usually not arbitrary, but is based on facts...'

[3] An excellent summary of the research history concerning metal technology in northern Europe is presented in Jantzen's study on the research of Bronze Age metal technology and its origins (Jantzen 1992).

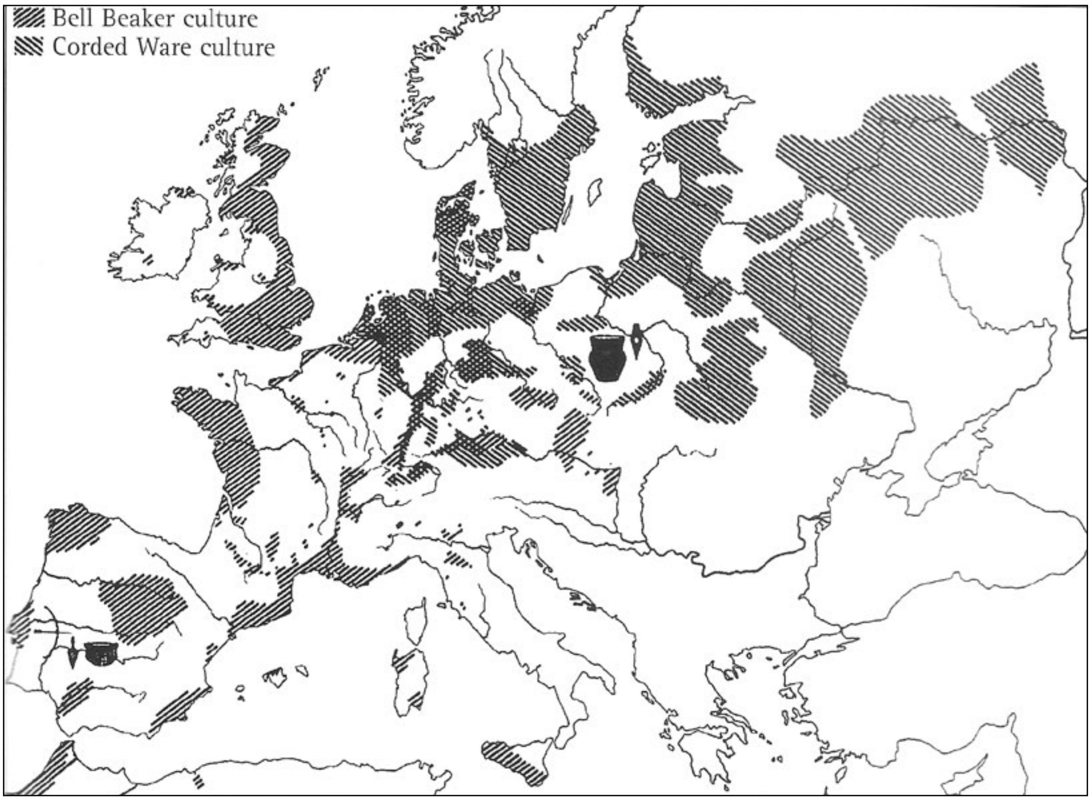


Figure 2.002: The Bell Beaker Cultures
(adapted from Gallay 2001).

the Bell Beaker cultures and the 'developed' metalwork of the Bronze Age (Taylor 1979; Vandkilde 1996: 263). Despite the knowledge of several basic techniques in metalwork, as seen in the use and crafting of cast copper flat axes, the Bell Beaker metal technology was based on cold-working (Taylor 1979: 27-29; 1994: 53; Renfrew 1986: 146; Buhl 1995; Vandkilde 1996: 262). It is assumed that the technical knowledge of the Beaker cultures (Figure 2.002) spread through the movement of specialised craftspeople (Taylor 1994: 49). Although trade and exchange may have played an important role in the spread of the technological knowledge, objects such as lunulae point towards the technology rather than the objects themselves being adopted in northern Europe. Taylor (1994) sees no direct relationship between the lunula-shaped artefacts in north Germany and Scandinavia, which appear[4] here in LN I, and the western lunulae, and assumes production by local artisans since neither the basic elements of geometric decoration nor the shape match the originals (Taylor 1994: 44; see also Taylor 1979: 27-31; 1994: 42). This assumption was confirmed by trace element analysis of the gold used in their production (Hartmann 1978).

However, an influence from central Europe (Únětician influence) and the southeast regions on the development of an independent technology in northern Europe is also visible. Again, it seems that cold-working techniques dominated in central Europe. Sprockhoff (1940: 28) noticed that in central Europe a predominance of 'Hämmern und Treibens' (cold-working techniques) is detectable while the north seems to concentrate on the development of casting techniques. Thus, especially in northwest Germany, NBA I artefacts with characteristic Únětician decoration based on cold-working techniques are common. With NBA IB and NBA II, a change can be detected and artefacts of both techniques appear side by side in hoards. The area in which this technical transfer took place seems to have been the east Hanoverian and Lower Saxon areas (Sprockhoff 1940: 30-31).

The first independent technology centres in Scandinavia are assumed to have occurred during the 4th millennium BC (Klassen 2000: 271-294). Distinct traces for locally produced metal artefacts are, however, present in the LN I in south Scandinavia. Already in LN II, casting techniques seem to have dominated local production and the first artefacts possibly cast through *cire perdue* can be detected (Vandkilde 1996: 170-190; 1998: 125; 2004/05: 93-96). The development of the local Scandinavian metal tradition is to be seen as a gradual process with a gradual establishment of forms (Vandkilde 1996: 264). Shortly after the complete adoption of metal technology in northern Europe, a separate Scandinavian style was established (Herner 1989: 129).

[4] For the chronological placement of the Scandinavian lunulæ, see Vandkilde 1996: 182-183.

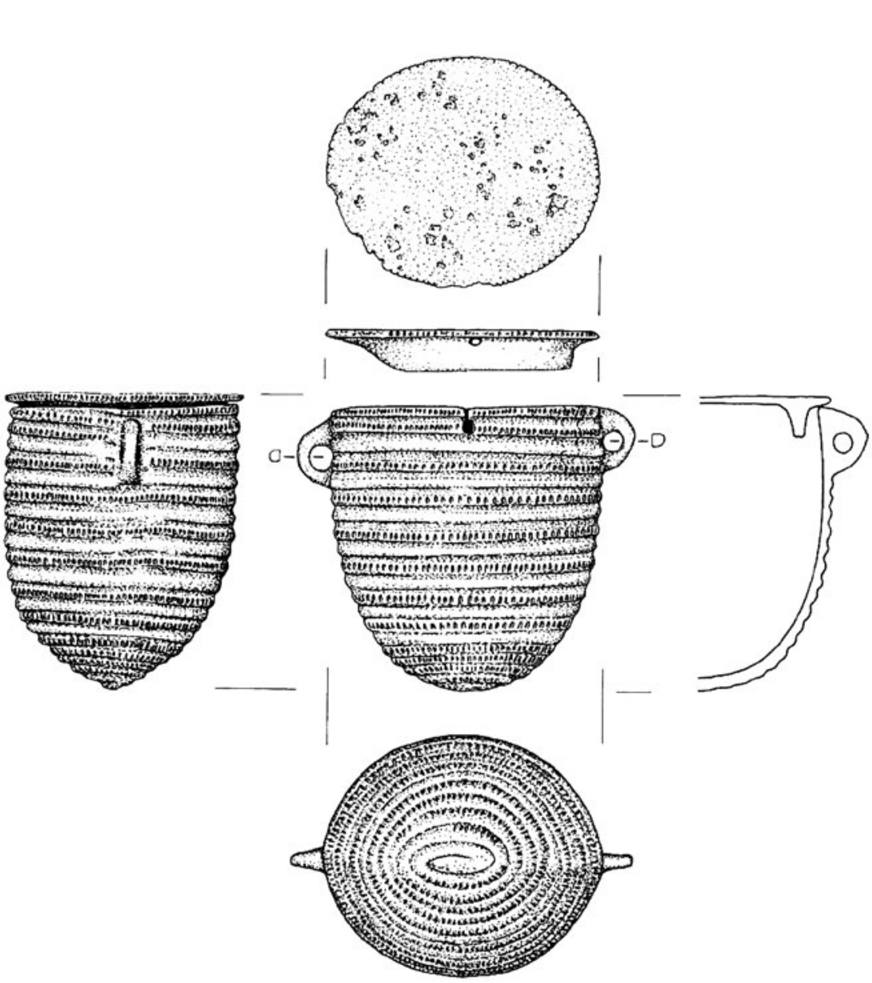


Figure 2.003: The beehive-shaped box from the hoard in Skeldal (after Vandkilde 1988).

Particularly of interest concerning the Scandinavian style, which was established around NBA IB (1600-1465 BC), is the very early, putative, use of a casting technique known as the lost-wax method or *cire perdue*. This technique seems to hardly have been known in the surrounding areas. This technique can without doubt be seen as the leading technique within the establishment of a distinctive Scandinavian style. One of the first bronzes produced via *cire perdue* technique comes from the Late Neolithic hoard of Skeldal (central Jutland) in Scandinavia. The beehive-shaped box from the hoard (Figure 2.003) is made without doubt via *cire perdue*, confirmed by the irregular wall thickness and the surface structure (Vandkilde 1988: 118). The origin of the vessel has been argued to be within the Únětician culture (Vandkilde 1988: 117-120; 1996: 206; Zich 1997: 237ff.). However, recent research has shed a different light on the origin of this box and the entire hoard content. A detailed comparison of the metal compositions of the hoard bronzes and morphologically similar objects from the nearby Únětician culture shows a clear deviation of the metal used. Furthermore, compared to locally produced metal objects, they are almost identical in signature (Mörtz 2009). Therefore, the Skeldal hoard could consist of mostly locally crafted artefacts, including the beehive box, which was quite likely crafted via *cire perdue.* Thus, here might be the earliest evidence of the lost-wax technique used in northern Europe.

It is possible that some LN II flanged axes were also cast via *cire perdue*, because their detailed and geometric ornament would make such a technique conceivable (Vandkilde 1996: 263; Rønne 1993). However, this assumption needs to be tested in further studies. Occasionally the decoration on Fårdrup axes was interpreted as being part of a model, and thus cast via *cire perdue*. However, the investigation of three axes of the Fårdrup-type[5] could prove that the geometric decoration of the objects is added post-casting using chisel-like punches (Figure 2.004). In particular, the contrast between the only weakly recognisable curved ornaments and the deep rectilinear lines is characteristic of post-casting decoration. In this context it should be noted that the decorative elements on this type of artefact could be part of a model without being crafted via *cire perdue*. As Chapter 2.5 discusses, two-

[5] Kept at the Copenhagen National Museum, NM 6115; NM 541 and NM B10104.

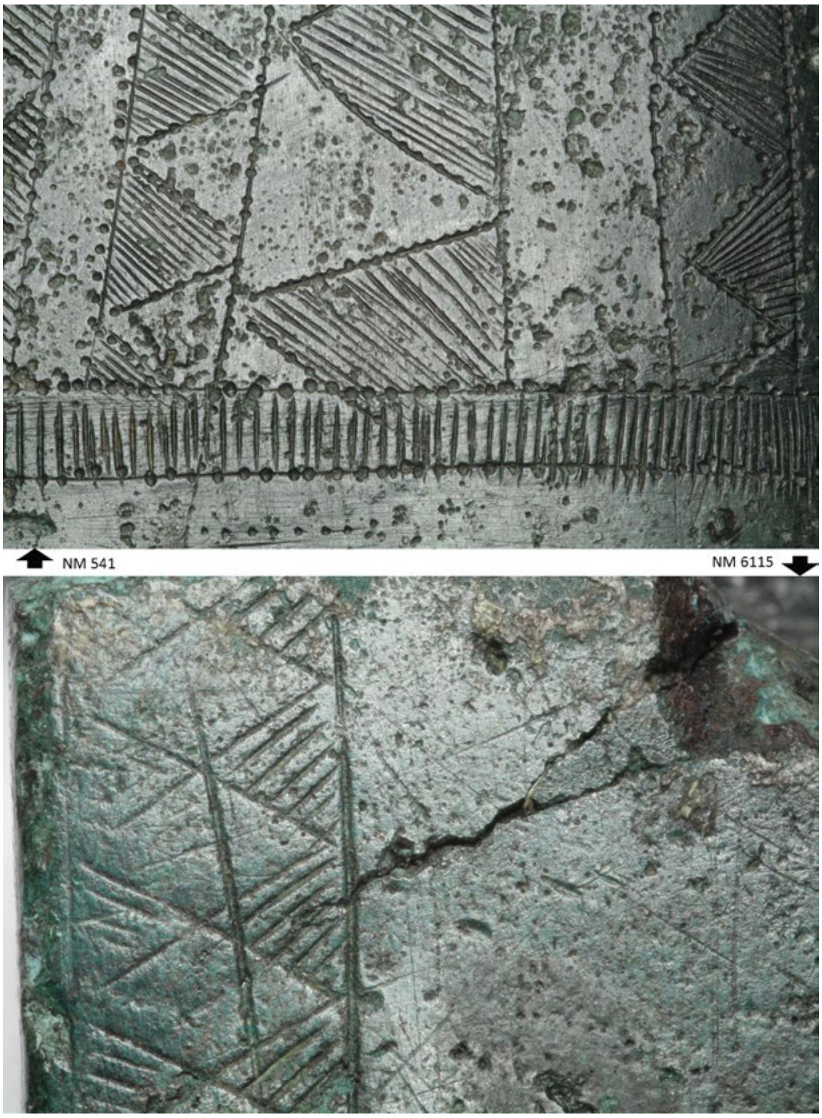


Figure 2.004: Geometric decoration of two Fårdrup Axes from the National Museum in Copenhagen.

part moulds of clay can be reworked and probably also decorated, or can reproduce already decorated wooden models.

Undisputed, however, is the importance of the *cire perdue* technique for the development of the outstanding metal technology of the Nordic Bronze Age. It seems that especially the use of wax as model material resulted in an innovative handling of the tools and techniques to create an independent ornamentation that stood out in variety and execution from the southerly adjacent regions.

Chapter 2

Bronze Age craftsmanship: a research history

This chapter deals with the research history of metalcraft. In northern Europe, metalcraft is strongly influenced by the work of Barbara Armbruster and Hans Drescher. By presenting visual recognisable crafting traces on artefacts, and explaining in detail possible and individual metal crafting techniques within prehistory, the foundation for later studies on metalcraft was established. Already in the 1950s and '60s detailed crafting sequences for cold-worked (hammered) neck rings, so called 'Ösenhalsringe', and ribbed neck collars were presented based on practical experiments by trained metalcrafters. Same experiments revealed that the tin content of the bronze is not decisive for the result. Regardless of whether the bronze contains less tin, and is thus more flexible, or contains a high tin percentage and thus more brittle, a good craftsman can achieve the same result. Thus, detailed technical knowledge was added to the archaeological research, allowing more reliable analyses. These first results inspired further researchers to combine craft technical knowledge with archaeological investigations, experimentations and detailed ethnological studies, resulting in today's advanced expertise in terms of Bronze Age metalcraft. Technological knowledge regarding repairs, achieved through soldering, melting, or 'cast-on' techniques were studied intensively, however mainly on weapons. The crafting of the specific spiral-focused decoration of the Nordic Bronze Age was long discussed before Rønne´s assumption that these decorations might have been stamped in the wax model changed the research direction drastically. The research mentioned in this chapter on the metalcraft of the Nordic Bronze Age has already achieved great results and has been the basis for lively discussions. However, not all questions are solved: the way in which the decoration is applied (wax model or post-casting) is still a topic of high controversy. Generally, the crafting of richly decorated bronze ornaments, especially in northern Europe, is still mainly based on assumptions.

2.2.0 Research concerning Bronze Age metalcraft

Research concerning metalcraft has always been popular and Bronze Age metalcrafting has especially been in focus since the turn of the millennium.[6] The pioneering work of Hans Drescher (1953; 1954; 1958) and Barbara Armbruster (2012; 2000; 1995) is in this regard seen as a foundation of metalcraft research.

Armbruster (2000) created with her analysis of the metalcraft of the Atlantic Bronze Age the necessary basis for future research on this topic; she explained in full detail not only individual techniques but also outlined the related crafting traces that can be found on artefacts. Based on facts like 'kleine abgeplattete Flächen...die ein Werkstück schuppig überziehen' or 'Schmiedefacetten an massiven Stäben'[7] she not only presented the characteristics of cold-worked artefacts but also compared the same with traces of different techniques, such as the rough and blistered surfaces of cast objects (Armbruster 2000: 20). In doing so, she introduced the majority of possible techniques used in Bronze Age metalcraft, presenting examples of the material on the Iberian Peninsula (i.e. Armbruster 1995b; 2000; 2001a).

On the other hand, Drescher described already in the 1960s the detailed crafting sequences for hammered Ösenhalsringe and ribbed neck collars based on practical experiments (Drescher 1953b: 67ff.). Both authors are trained in metalcrafts and add craft technical knowledge to archaeological research that allows for reliable analyses.

The techniques necessary for the crafting of spiral-decorated ornaments, a decorative element mainly occurring on neck collars and belt plates of NBA II and III, was intensively studied by Elizabeth Herner and updated by Preben Rønne. Rønne's (1989a; 1991) discoveries refuted long-standing theories of solely post-casting decorated artefacts (with chisels and punches) and resulted in a completely new way of looking at the characteristic spiral-decoration of the Nordic Bronze Age (Rønne 2010; 1991; 1989a: 126ff.; Rønne and Bredsdorff 2008). His ideas created an ongoing discussion in Bronze Age research, which will be further added to in the following chapter of this study (Rønne 1991: 36ff.).

Next to traditional archaeological research are studies that combine traces found on archaeological material with the results of a detailed ethnological study of particular interest. In this sense, the intensive study of the goldsmith in Africa allowed Armbruster to interpret neglected traces of crafting and to greatly expand the possible technical repertoire of the Bronze Age craftsmen (Armbruster 2005; 1995b; 1993b; 1991; 1990; Armbruster and Dillhöffer 1988). It is the traditional aspect of this craft that allowed direct insight into possible prehistoric methods and their traces on the material with the help of modern examples.

In regard to terminology, the subject-related work of Erhard Brepohl and Jochem Wolters (Brepohl 1996; Wolters 1991), as well as several archaeologically oriented works (Armbruster 2000; Armbruster *et al.* 2003; Bunte 1985; Foltz 1979) are taken as the standard.

[6] Especially with the 'Nebra Disc' and the connected DFG project FOR550 (*Aufbruch zu neuen Horizonten*) interest in Bronze Age metalwork increased considerably.

[7] '...small flattened areas ... that can cover an artefact like scales/flakes ... forging facets on massive rods...'

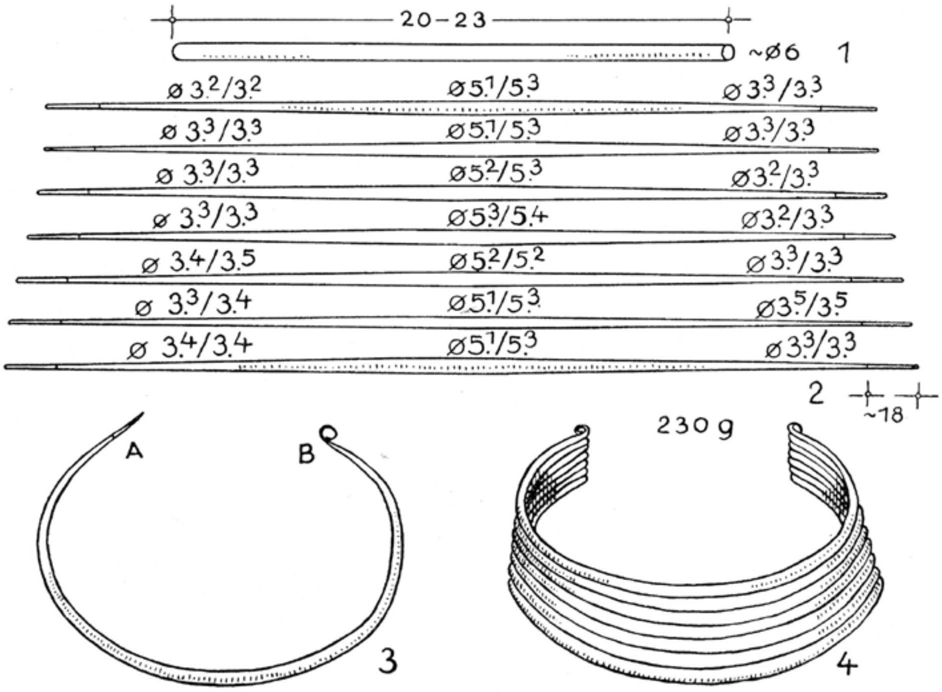


Figure 2.005: Individual steps in the production of the Tinsdahl neck-ring-set (after Drescher 1953b).

This is of importance because the terms specific to metalwork which are mentioned in this study are seldom explained in full length and could be further discussed upon request in the respective publications.

The increasing interest in Bronze Age metalcraft and the combination with the most modern scientific analysis allowed new insights into the possibilities of these craftsmen. In the following discussion, past as well as current research is presented to ultimately obtain a thorough knowledge of Bronze Age metalcrafting techniques.

2.2.1 Research concerning the crafting of 'Nordic' ornaments

Based on two experiments, Hans Drescher (Drescher 1953b) attempted to work out the differences between the crafting of hammered neck ring sets and cast neck collars (see Part 1, Chapter 1.2.1). Here, the specific techniques and the degree of necessary specialisation were the focus of his research, as well as possible differing economic factors.

With the awareness that, for the production of an ornament based on cold-working, highly skilled craftsmen were needed, he tried to reconstruct such an artefact using the inventory of the Tinsdahl hoard (Nørgaard 2011; Hachmann 1954: 196; Splieth 1900), the neck ring set,[8] with the aim of gaining knowledge of the distinct steps needed for the crafting. The good preservation of the ring collar allowed him not only to make accurate measurements, but also to reconstruct the toolset used, based on tool traces.

The results of Drescher's investigations were as follows (Figure 2.005): A neck ring set is crafted in seven steps, which all require high-precision craftsmanship. (1) First, bronze rods are cast with a diameter of 6 mm and a length of 20-23 cm, and the cast seams are removed thoroughly. Then, (2) the rods are hammered (cold) until the desired length and thickness, as well as the final shape (round to oval), is achieved. The individual rods are tapered evenly towards the ends. The last 18 mm[9] are beaten flat to be subsequently bent to form loops. If the rod starts to show signs of stiffness or increasing hardness, identifiable through the use of more power to deform the material, it is annealed and quenched.[10] For more malleable bronze, often tin-reduced alloys were

[8] Whether the neck ring sets (Ösenhalsringsätze) are a product of Únětician culture (Drescher 1953: 67) or should rather be related to a workshop area in southeast Bavaria (Wels-Weyrauch 1978: 142), is not fully understood. It should however be noted that within the Únětician area of influence virtually no sets of Ösenhalsringen occur. However, they occur as single objects and in greater numbers in the Únětician influenced areas and up to the east German Sea coast area (Zich 1996: 206). Ösenhalsringe originate in the Danubian Early Bronze Age and the vast majority of rings that occur in the area of the Únětician culture come from the eastern Alps or the Danubian region (i.e. Vandkilde 2005).The distribution area of the neck ring sets (Ösenhalsringsätze), on the other hand, extends 'from the Danube to the edge of the Alps and of the Isar to the Salzach' (Wels-Weyrauch 1978) and should be assigned to the Danubian FBZ, which is parallel to the Únětician culture (Bartelheim 1998: 143ff.). The combination of the individually widespread rings to Ösenhalsringkragen occurs in the primary contact zone of the Bohemian Únětician culture. Within the contact area of the Danubian FBZ, as well as in the Italian region, such neck ring sets develop.

[9] Here, regarding the Tinsdahl neck ring set.

[10] The metal (in this case the bronze) is heated to red heat and then immersed in a water bath (quench). This process results in an expansion or relaxation of the structure and makes the material soft and workable again.

used. After hammering, the rods are carefully reworked. Especially on the Tinsdahl neck ring set, similarities in the measurements were found that were not possible to accomplish without a gauge or a measuring unit, as Drescher could confirm in further studies (Drescher 1954). Again, the bronze rods are annealed and quenched to relax the metal for further crafting. Now the rods can be manually bent into form. For this purpose, a model made of wood is usually required, around which the rods can be bent. After the loops at the end of each ring are completed, the various rings are adjusted. It can be assumed that this step will have taken place occasionally with the neck of the user as the model, since deviations in the form lead to a poor fit and thus less comfort. The individual rings slightly increase in diameter from the top to the bottom ring; however, the loops are exactly above the other, and, as such, a tremendous amount of skill is required to execute this step (Drescher 1953b: 67-69). The size-grading of the individual rings and the conditional exact fit results in an appearance of the single rings as a closed neck ornament. The ornament is closed by means of pegs, wire, or a cord which is pulled through the eyelets.

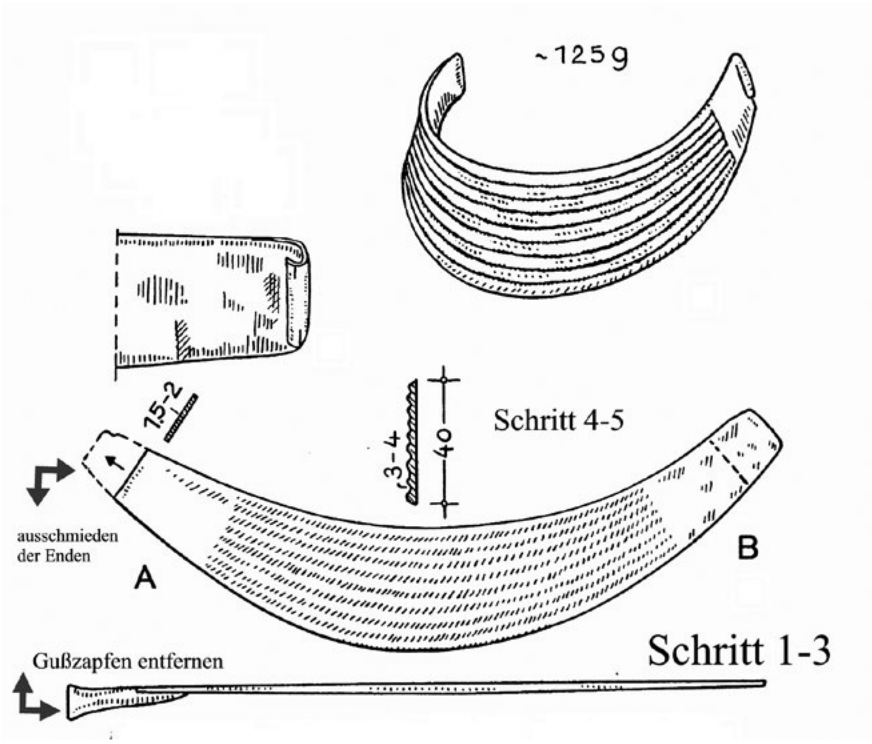


Figure 2.006: Individual steps in the production of the cast neck collar from Hohenlockstedt (Schleswig) in northwest Germany (after Drescher 1953b).

The ribbed neck collar from Hohenlockstedt (Schleswig) in northwest Germany, found in a NBA II burial (Aner and Kersten 1993: 34-35), is the model that Drescher aims to reproduce in his casting experiment. Compared to the above-executed experiment he observed that fundamentally different techniques are used in the crafting of this artefact (Figure 2.006): The first step within crafting a ribbed collar is the modelling of a wax model of the straight collar. The model is made by hand, so it starts with the kneading or rolling of the wax until the desired shape is achieved. All superficial ornaments can be introduced by using wood, bone or metal tools, simply through pressing them into the wax, although Drescher sees a subsequent decoration with bronze punches as more likely (Drescher 1953b: 70). However, such simple wax models can also be produced in two-part ceramic moulds. When the model is completed to the satisfaction of the craftsman and the sprue and any ventilation ducts made of wax are attached, then it is embedded in moulding loam. Normally the moulding loam used to create moulds for lost-form casting is applied in two or more layers. After several days of drying the mould in the air, it is heated upside-down in a charcoal fire to melt out the wax. The outgoing wax is collected and reused, and the mould is heated again and baked at 600-700 °C. Thus, the collapse of the now hollow body is prevented (Born and Hansen 2001: 182). In the finished perpendicular form,which is dug into the ground for protection from bursting, the liquid bronze can be poured. Additionally to this sequence, Drescher also discovered several possibilities to execute a single step. For example, another way to prevent damage to the mould in the casting process would be a thorough heating of the clay mould. However, the same may not be ‘burned hard’, otherwise it will break during preparation. After cooling, the mould is broken.

As one of the next steps the sprue is removed and the collar slightly reworked. Artefacts crafted with the lost-wax method have no casting seams (Drescher 1953b) due to the completely enclosed mould. However, so-called ‘pseudo seams’ may occur; these drying cracks or shrinkage cracks of the unfired clay mould can leave traces on the cast artefact (Born and Hansen 2001: 183). Such remnants of this casting method can be easily removed afterwards if they affect the appearance of the piece.

The post-casting bending of the collar around a model was probably done with a mallet. The ends are slightly hammered and then bent to the vertical end rolls using a mallet (Drescher 1953b: 69-70). The use of a wooden or skin hammer for finer reworking on the finished metal object is still relevant today in the modern goldsmith's craft. The significantly softer tool, compared to a stone or metal hammer, leaves more shallow traces and can be used knowingly without damage to the artefact. As a final step Drescher (1953b: 70) assumes the decoration of the collar with metal punches.

Drescher found out in his experiments that the tin content of the bronze is not decisive for the result. Regardless of whether the bronze contains less tin and is thus more flexible or contains a high tin percentage and is thus more brittle, a good craftsman can achieve the same result (Drescher 1953b: 69).

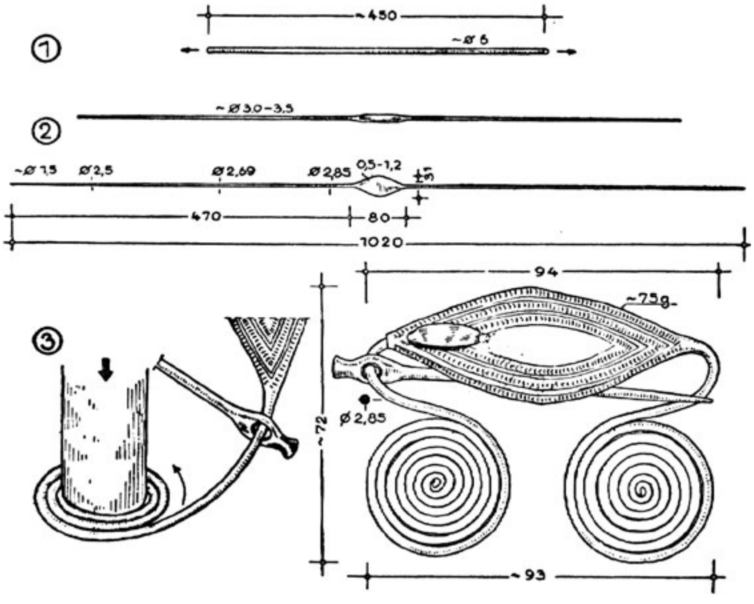


Figure 2.007: Individual steps in crafting a fibula Lüneburg-type (after Drescher 1953a: 25).

2.2.2 Drescher's experiments in the light of modern research

Considering the state of research today, there is little doubt that the Bronze Age metal craftsmen were able to make precise castings via lost-wax and also were able to reproduce 'komplizierte Verzierungen im Wachsmodell nicht nur...präziser, sondern auch zeitsparender'[11] (Born and Hansen 2001: 183; Rønne and Bredsdorff 2008: 69; Uhlig 2004; Armbruster 2000; Koch 2000a; 2000b). Again and again, objects were detected which provide clear evidence for the decoration of the model prior to casting (Born and Hansen 2001: 187; Uhlig 2004). In contrast to this research opinion supported in northern Europe, in the central European region several researchers reject the intensive use of the lost-wax method, in particular for already ornamented wax models (Schwab *et al.* 2007; Savage *et al.* 1982). This rejection is primarily based on the assumption that such fine decoration cannot be achieved by prehistoric casting techniques in which the metal would fill the mould only aided by gravity (Schwab *et al.* 2007: 243).

Primarily, information regarding the technological knowledge of Bronze Age metalcraft derives mainly from studies of individual artefacts or object groups. Of these, only a few studies deal with the crafting of ornaments, i.e. Drescher´s further investigations concerning fibulae, belt boxes and rings, in addition to those presented above. Among other things, the investigation of the Lüneburg-type fibula from Tangendorf, Harburg, could show that this piece and related fibulae were cold-worked from a single rod with repeated annealing. The spiral ends were wound using holding tools made of wood after the hammering of the main part (Figure 2.007). The needle on the fibula is cast via lost-wax (Drescher 1953a: 24; 1955: 135). However, the late Bronze Age fibulae with rhombic plates are not, like their predecessors, fully cold-worked but instead have a cast-on decorative plate (Drescher 1953a: 27). Furthermore the belt boxes (commonly in NBA III-IV) are made via the lost-wax method. Such hollow bodies were very likely modelled over a core made of clay, which reflects the shape of the belt box, through the application of thin wax strips (Drescher 1955: 131; Rønne and Bredsdorff 2008).[12] Interestingly, Drescher accepts here the possibility that parts of the decoration are, in contrast to the otherwise post-cast added decoration, inserted in the model using a stamp that is pressed into the wax. He writes:

'Es zeigt sich, dass die Strahlen durch Eindrücken eines Stempels entstanden sind und deshalb sehr gleichmäßig geworden sind. Auf dem Boden dieser Vertiefungen lassen sich vielfach aus Nachbesserungen herrührende Spuren des Spachtels finden.' (Drescher 1955: 131)

Nevertheless, Drescher favours the decoration of most of the bronzes post-casting, since, in the case of the investigated belt box from Bargfeld, wear traces of bronze tools are often visible. In this instance he found particularly strong use-wear from punches and attributed this to the thin wall-thickness of the belt box. Due to its instability under heating the box could not be annealed several times, and, therefore, the hardness increased with every strike of the tool (Drescher 1955: 133). A possible completion of the decoration

[11] '...complicated ornaments in the wax model are not only ... more accurate but also more time-saving...'

[12] Drescher experimented with the crafting of the Late Bronze Age belt box from Bargfeld, Kr Harburg (Drescher 1955).

in the model would, however, make the annealing unnecessary and also the high difficulty in applying the decoration and the additional work of sharpening the punch/chisels would not occur.

While examining the arm rings of the Bargfeld Hoard, Drescher (1955) found clear evidence of decorations that were added in the ready formed metal. The tool with which the line decoration was inserted in the U-shaped bracelet was so sharp that it cut through the metal. In contrast, massive rings, whether closed or open, are mainly produced via *cire perdue*, as modulated parts of the rings indicate (Drescher 1955: 137). These rings were usually cast as a closed form, to be opened after casting with chisels. In the developed periods of the Bronze Age this was done partly with saws. This analysis is supported by several artefacts which display separation notches already inserted in the model, as seen on the rings from Bahrendorf, Dannenberg and Bargfeld, Harburg (Bath 1953/55; Drescher 1955).

Furthermore, due to the investigation of the neck collar of Kyritz in Brandenburg, the first definite proof for the casting of decorated wax models could be made (Uhlig 2004). The same collar was not only repaired using a rather carelessly executed cast-on technique, but Uhlig was also able to prove that even the ornament of the ribs has a uniform fine-cast skin and that there are no traces of post-casting reworking.

The vast majority of craft technical studies, however, focused on the intensive study of weapons and their crafting techniques (Driehaus 1961; 1968; Anker 1977; Hansen and Born 1991; Born and Hansen 1992; Wüstemann 1999; Mödlinger 2007; 2011; Mödlinger and Ntaflos 2009; Bunnefeld and Schwenzer 2011; Binggeli 2011).

Hermann Born investigated the crafting of sword types of the central European Bronze Age. He was able to demonstrate that to craft the handles of the 'Schalenknaufschwerter' (Ha B1) an already decorated wax model was used for completion. The specific crafting sequence is as follows: (1) the pommel is moulded by hand in wax and placed on the hilt (the decoration should cover the resulting seam); (2) the necessary openings are incorporated into the model, partly with the help of cores; (3) hilt and pommel are brought together in the model and are attached to the blade, which is crafted separately in the model and cast before combining. Additionally, the studies of Marianne Mödlinger added chronological and functional differences in the casting direction of the swords (Mödlinger and Ntaflos 2009: 193; Bunnefeld and Schwenzer 2011: 209).

In contrast, the making the hilts of Möringen-type swords involved bronze folding moulds and the decoration of the hilt added post-casting (Born and Hansen 2001: 189-191; also Drescher 1958; Mödlinger and Ntaflos 2009; Bunnefeld and Schwenzer 2011). Furthermore, using various leaf-blade swords Born was able to show the different alternatives in placing and making rivet holes in the handle tangs. For some blades, holes that were already embedded in the wax model and sealed by thin clay layers could be documented, while other blades just had small indentations where the holes should be, which were subsequently punctured. However, blades with clean drilled holes could also be documented (Born and Hansen 2001: 205; also Born and Hansen 1992: 342; Born 1989; Bunnefeld and Schwenzer 2011: 211). Traces of drilling using rotary instruments, especially in connection with the lost-wax technique, but also while reworking cast objects, could also be documented for the Atlantic Late Bronze Age (Armbruster 2000: 61). Additionally of interest for the present study is Born´s (2001) examination of different weights and dimensions of mass-produced axes. Here, apparently wooden models were used which were pressed into the one- or two-part clay moulds in order to obtain an accurate impression, which was then used to cast the artefact. In his opinion, the use of organic models in preparing clay moulds is very likely supported by a difference in the sizes and weights of mass-produced weapons (Born and Hansen 2001: 181).

Increasingly, metallographic examinations are used for support (see Chapter 2.7.0), which could provide important insights into metalcrafts (Drescher 1958; Oldeberg 1974a; 1974b; Levy 1991; Schwab *et al.* 2007; Kienlin 2007; 2008a; 2006; Mödlinger and Ntaflos 2009; Mödlinger 2011; Mehofer 2011). Mödlinger (2011) underlined the close connection between casting and cold-working techniques in her study of Early Bronze Age daggers with middle ribs, predominantly cast in two-part moulds. Similarly, Kienlin (2007; 2008) could also demonstrate this regarding the Early Bronze Age flanged axes of central Europe. Mödlinger´s (2011: 47) metallographic images showed that the weapons were hammered once, predominately at the edges to increase their hardness. Thereafter, the subsequent hammering (reworking) of the bronzes is a common part of the crafting sequence and should not be underestimated within the crafting of bronze artefacts, as Müller in 1876 assumed and Oldeberg (1943) confirmed for the Swedish material (Müller 1877; Oldeberg 1943; see also Born and Hansen 2001: 181; Mödlinger and Ntaflos 2009; Armbruster 2000). Of particular importance concerning the results of the above-mentioned studies is, however, that bronze is not forged hot, but can only be hammered (cold-worked) when cold due to its increased brittleness when heated (Kienlin 2008a; Armbruster 2000: 91; Holdermann and Trommer 2010: 798).

Furthermore, the above-mentioned intensive investigations could clarify the Bronze Age possibilities regarding repair or composition of weapons or ornaments in bronze. Thus, a merging of different parts can be achieved through soldering, melting, or 'cast-on' techniques. Here, soldering is a method for joining metallic materials that can first be documented in the Iron Age, as seen in the combination of iron pieces through soldering with copper or bronze (Armbruster 2000: 105; Fries-Knoblach 1999: 27). Bronze Age metalworkers used other methods, such as cast-on techniques (Drescher 1958; following Born and Hansen 1992; Armbruster 2000). In addition to this very effective and well-used technique, other ways of combining artefact parts occurred frequently, such as riveting and folding. One of the most common compounds is the riveting of two superposed sheet metals. Here, holes are inserted at the position where the sheets should be connected (possibly using chisels) in which a rivet is placed. Then the rivets' ends are beaten flat. The rivet was usually made from a softer alloy to prevent damage to the object (Armbruster 2000: 122; Drescher 1957b: 24). Such a technique was mostly used in repair, whereas the folding was used commonly in the Late Bronze Age in the making of vessels (Armbruster 2000: 123).

In summary, the majority of all these investigations and their results related to mass-produced bronzes, such as weapons and tools. However, the crafting of richly decorated bronze ornaments, especially in northern Europe, is still mainly based on assumptions (apart from the early studies of Drescher). It seems as though the variety of techniques used ranged from model building to casting and hammering, and should commonly be seen as a combination of the above-mentioned techniques. Still, in regard to metalcrafting in northern Europe during the Nordic Bronze Age (NBA II and III) there does seem to be a large gap in our knowledge which this present study seeks to remedy.

2.2.3 Methods for the preparation of individual decorative elements

The question of how the decorative elements on the Nordic bronzes were made, be they simple notches and impressions on the ribs of the neck collars, line decoration, geometric patterns or even spiral rows, seems to be the one question most debated in craft archaeology even today. The present study deals in detail with the decoration of bronzes; therefore, a basic knowledge of the possibilities in which such decoration is applied is particularly important.[13]

Inspired by the increasingly frequent questions about the accuracy and limits of the *cire perdue* method, the 'Bronze Casting Workshop' held at Wilhelminaoord, Netherlands engaged with the issues raised.

Using the example of a detailed Merovingian die[14] the boundaries of the *cire perdue* method were tested under prehistoric parameters while replicating the artefact (Meeks *et al.* 2001). The results highlighted the importance of the actual clay mould and its construction. Defective castings enabled an intensive examination of the mould and demonstrated that the mould held every detail of the wax model. Here, the grain size of the clay dictated the limit of the details. The balance between the temperature of the mould and the metal proved to be crucial for the success of the casting. This experiment aimed to end the discussion about the possibility to cast the decoration of the ornaments of Scandinavian bronzes. It seems to have succeeded insofar as it could be clearly demonstrated how accurately the clay moulds reproduce the model (Meeks *et al.* 2001: 65). However, successful castings could be achieved first in the laboratory, and that leads to the statement that the knowledge of the Bronze Age craftsman must not be underestimated. A definite result of this experiment is that absolute statements that deny or favour a particular technique should not be based on modern experiments without involving the skill and years of experience of master bronze casters (as the Bronze Age smith may be argued to be).

Why, however, this issue arises in the first instance will be presented below.

Drescher´s studies concerning the techniques used to apply the decoration on metal artefacts were based on the assumption that the notch pattern on the ribs of the neck collar was added post-casting using bronze chisels (Figure 2.008). He could define wear traces of the chisel on the notches of the neck collar from Hohenlocksted (Drescher 1953b: 70). Similarly, he documented such traces on the Lüneburg-type fibula from Salzhausen, Harburg. On the fibula from Tangendorf he described the used tool as a: '4-5 mm breite Meißelpunze mit leicht gewölbter Schneide, sowie eine weitere, 1,2 mm breite mit c-förmigen Profil' (Drescher 1953a: 24-25).[15]

His thesis that the bronze ornaments were decorated after casting with metal tools (Drescher 1953a; 1955; 1957b; 1968) was taken up and developed by many

[13] Despite the fact that experimental research has a dedicated chapter in this study, some selected experiments will be referenced here due to their potential to change considerably the discussions based on divergent views between central and northern European researchers concerning decoration on bronze artefacts.

[14] The die with a line width of the decoration of 0.2 mm, and a detail of the ornament that was hard to see with the naked eye, was found in Tjitsma and was used for the production of pressed gold foils. Comparable gold foils were found at Sutton Hoo on the grenade ornaments. Similar dies are also known from medieval Denmark (Tulp and Meeks 2000).

[15] '...4-5 mm wide chisel with a slightly curved profile, as well as another 1.2 mm wide chisel with c-shaped profile...'

Figure 2.008: A chisel-like tool similar to the pictured one could, after Drescher have caused the decorative notches on the neck collar from Hohenlockstedt (Drescher 1953b: 70).

researchers (Foltz 1979; Herner 1987; Krausse-Steinberger 1990; Schwab *et al.* 2007; Savage *et al.* 1982).

An opposite direction was proposed by individual researchers, among them Preben Rønne, whose research dealt with the techniques used to apply the prominent NBA II and III spiral-decoration (Rønne 1989a; 1991; Uhlig 2004). His results are contrary to Drescher's statements because he was able to prove an application of the decoration, especially the spirals, in the wax model through recurring features in the decorative elements. This assumption that these decorations might have been stamped in the wax model changed the research regarding the metalcraft of the Nordic Bronze Age considerably and has been the basis for lively discussions, although, before Rønne's assumptions some researchers expressed the idea that the decoration was created in the model and the finished object was cast (Müller 1877; Knudsen 1978; Jensen 1979a; Horn 1874). However, until the end of the 1980s the opinion in archaeological research was that the spirals were applied to the cast piece using metal punches (Herner 1987: 126). Nevertheless, the amount and uniformity of the spirals made the assumption less likely that each spiral could have been applied individually and free-hand (Oldeberg 1943: 46; Broholm 1944: 208; Drescher 1954: 47). Various ideas for the creation of such spirals were in circulation, such as the sketching by means of pins and cords (Ringbom 1933) or with a compass-like tool[16] (Strzygowski 1925; Thrane 1977; Lenerz de Wilde 1977; Lowery *et al.* 1976), or through the gradual construction of opposed semi-circles (Savage *et al.* 1982: 472), but it was suspected that a different technique was used for the production of matched spirals, as known from the NBA II belt plates. The hypothesis developed by Rønne (1989) that said spirals were applied using a punch in spiral shape, which is pressed into the wax model, would allow that a number of uniform spirals can be produced. This assumption could be confirmed by observation of spiral-decorated ornaments. Here, recurring errors, as seen on the belt plate of Langstrup (Rønne 1991: 38), and in the small notches within the connections between the spirals, as documented on the Vognserup plate (Rønne 1993), clearly showed the use of a spiral-shaped tool that was pressed without much effort into the deformable material of the model, resulting in similar imprints.

By means of a stamp, it becomes possible to leave a sharp and uniform imprint in a soft material, in this case the moulding wax. Rønne refers to a grave near Jaegerspris, Frederiksborg (Aner and Kersten 1973: 31-32), in which a spiral chain of gold wire was found. A similar tool could be used to create the impressed spiral series.[17] The 'real spirals' as known from the majority of Nordic artefacts only arise when mutually twisting two wires. After several experiments performed by Rønne he describes the production of a spiral punch as follows (Figure 2.009).

> 'First, a hole was made in a small piece of wood.
> Then the wire was bent double and pushed into the hole.
> In this way one wire becomes two and both wires disappear
> out of the centre of the ornament. Then both wires are laid on the wood block and wound up to form a spiral.'
>
> (Rønne 1989a: 134)

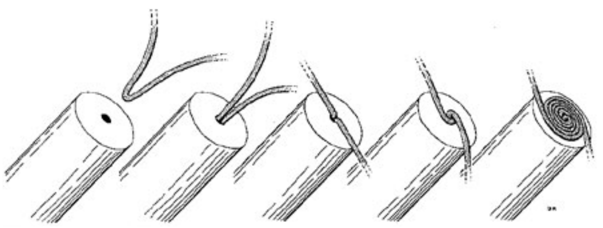


Figure 2.009: The copper wire of the spiral punch is coiled, as illustrated in the drawing by J. Kraglund (after Rønne 1989a).

It is the scores that appear while assembling the individual stamps that Rønne (1993) interprets as characteristics for the application of the spirals through stamps, which are elsewhere used as a supporting argument for the application of spirals by stamps (Savage *et al.* 1982). Nevertheless, damage to the spiral that occurred through casting, and which is visible on the finished piece, supports the stamp theory and might be considered as reliable evidence for introduction of the decoration already in the model. Here, porosity, or

[16] The use of compasses or similar measuring tools is proved for the Bronze Age in northern and central Europe (Drescher 1954). Additionally, the Late Bronze Age deposit of Drouwen, Drenthe, contains a compass-like device (Butler 1979), and circle traces were detected on Bronze Age artefacts (Jockenhövel 1974: 19ff.).

[17] This raises the question of whether gold was used to make a tool or whether this spiral chain was used otherwise, i.e. for decorating a sword scabard.

even holes in the spiral pattern, can be cited as well as shrinkage cracks. These traces appear when the cast is not properly done and the spiral was placed before the object was cast, otherwise this casting defect would not be visible in the decoration.

In the last 20 years, studies to verify the credibility of Rønne's model have been presented. Here, a basic argument of the 'stamp theory representatives' was the assumption that bronze cannot be worked with bronze. This question was, however, in a different research area, not aligned to the craft, of great importance. Namely, during the discussion concerning the three-period system and the question of whether there has actually been a pure Bronze Age (Hostmann 1874; Müller 1876a; 1876b; Hostmann 1877: 42-45; Jantzen 1992: 94-95; Rønne 2010: 44-46). A subsequent experiment initiated by Müller and executed by the goldsmith Boas,[18] could not only answer the question and demonstrated that bronze could be worked with bronze, but also ended the highly debated question of a pure Bronze Age (Jantzen 1992: 97). At the present stage of research a unified belief prevails that bronze can be deformed plastically with bronze (Voß *et al.* 1998: 164; Schwab *et al.* 2007: 244; Rønne 2010: 45; Lowery *et al.* 1971; Holdermann and Trommer 2010: 797ff.), although not in a chip removing process as needed for engraving; for this, a high-quality steel is needed (Drescher 1957b: 56; Rønne 1989a: 129; Herner 1989: 129; Lowery *et al.* 1971: 170; Armbruster 2000: 32).[19] However, the bronze tools should be of a different and harder alloy, with up to 14-16% tin, as Schwab and colleagues suggest, for the bronze that should be worked (Schwab *et al.* 2007: 245).

However, this did not end the discussion. Müller himself, as a representative of the model theory, now proved in return that a similarly superior finish can also be made with casting in lost-wax (Müller 1878: 38; 1877: 40; 1876a; Rønne 2010). Thus, the discussion was ready for another round, and next the most important arguments concerning the debate for the particular groupings are briefly compared .

Modern experiments regarding the making of spirals by plastic deformation of the metal (punching) could not achieve spirals that were comparable to the known, very uniform and relatively small in diameter spirals.[20] As such, the production of uniform spirals and lines with the help of U-shaped punches or chisels was thus classified as 'not possible' (Rønne 1991: 45). Nevertheless, as the already indicated experiment clarified, a sufficiently skilled craftsman *can* easily produce such uniform and high quality spirals and thus the disc made by Boas could stand up to the criticism of the greatest opponents of this theory (Hostmann 1877: 45; Müller 1876a; 1876b). However, Savage and colleagues found another way to apply the decoration as evenly. The firm belief that the spirals of the Nordic belt plates were punched, caused them to assume that a thin layer of wax, grease or similar was spread over the cold-worked (hammered) disc and into this layer the decoration was sketched with a graver. In this way possible errors could be corrected before the decoration was inserted with the help of bronze punches and chisels (Savage *et al.* 1982: 464; also Benner Larsen 1984: 171).

Another argument for the stamp theory was the lack of negative impressions that would arise on the rear side of the artefact if the decoration was introduced by plastic deformation (such as the impact of the punches). Admittedly, these can seldom be detected on the large spiral-decorated belt plates of the NBA II. Nevertheless, such negative impressions can be documented on bronzes that were clearly decorated as a wax model (especially on very thin-walled artefacts).

Furthermore, the small fan-like lines ('fans') which occur in the centres of the spirals (Figure 2.010) are interpreted by Rønne (1989a: 139) as traces of spiral-stamping caused through a twisting of the wires while preparing the stamp. These fan-like traces are often used exactly as a supporting argument for the making of spirals with the help of chisels (Herner 1989: 129; Savage *et al.* 1982: 464). Such elongated notches could be a result of many consecutive hits, due to the size of the spirals and the fact that punches must have a certain minimum size to be effectively manageable. Thus, it seems that these fan-like traces cannot be avoided while punching spirals (Savage *et al.* 1982: 464). However, it should be considered that the centres of the individual spirals decrease in diameter and that chisels, with always the same width, would cut into the adjoining turns. Although, there are hardly any such traces in these so flawless centres of the spirals.

[18] In this experiment, Boas, under the supervision of J. J. A. Worsaae and other archaeologists, crafted a bronze disc with tools that had the same alloy as the bronze plate to be processed and confirmed Mueller's assumption that bronze is workable with bronze (Müller 1877: 33ff.; Rønne 1991: 33ff.; Jantzen 1992: 96ff.).

[19] The possible use of very small amounts of iron for the production of engraving tools is, for the Early and Middle Bronze Age, pure speculation (Charles 1984; Hundt 1965; Bunnefeld 2011), but is quite possible for the Late Bronze Age, especially in central Europe. Here it might be that the first iron tools were used for engraving bronze objects (Mödlinger 2007 and 2011).

[20] Here once again the question is raised regarding the qualification of the implementing actors. Rønne himself executed many experiments concerning the crafting of bronze ornaments and ultimately had to admit to himself that casting is a difficult craft that must be learned through many years of practice before such a high quality of work could be achieved. 'Støbning er så vanskeligt et håndværk, at det må læres gennem års fultidsarbejde' (Rønne 2008: 69; also Lowery *et al.* 1971: 168).

Figure 2.010: The fan-like structures in the centre of the spirals of several examined artefacts, like Rye on Zealand (B7612 and B7618), Karow in Mecklenburg (ALM Br.88); Weitgendorf in Brandenburg (MM II8302).

Therefore, a third possibility should be considered. It is equally possible to decorate a wax model with bronze tools as it is possible with a bronze surface. Assuming, that the wax model is of such hardness as described by Meeks and colleagues (Meeks *et al.* 2001: 61),[21] then applying the spirals in the wax model with a chisel-like tool would be quite conceivable. Meanwhile, on many richly decorated belt plates and collars, finely crafted spirals occur without this fan structure in the centre. Thus, the construction of the spirals still seems thus far an insolvable riddle.

Furthermore, Müller assumed that, in addition to the spirals, the geometric decoration was also already applied to the model (Müller 1878: 38), and especially the hump decorations. In contrast, the overlaps and significant boundaries of individual impressions are interpreted as hit marks and were used as evidence for the exclusive crafting of humps in cast metal (Herner 1989: 132).

[21] 'It was surprising how hard the punch had to be struck using a single blow with a 1 kg hammer to fully impress the die faces into the wax to take all the details' (Meeks *et al.* 2001: 61).

However, these mentioned traces seem to support the application of humps in the model. Straight, uniform edges and uniformly deep impressions suggest a controlled operation which was not too power consuming and which cannot, or can only rarely, be achieved with a blow of a metal punch onto metal. The use of punches (whether made of metal, wood or ceramics) to create impressions, however, seems very likely to have been also used on wax.

Inspired by the stamp theory, the fine lines and depressions of similarly decorated artefacts were under investigation. While examining the decoration on the Schalenknaufschwerter of the Axel Guttmann Collection, Born could confirm the decoration of the sword in the wax model – the clear signs were soft edges, some easily recognisable individual tool marks, and extraordinarily fine lines. He suggested the use of fish bones for the application of such lines (due to the restricted material width for metal tools), in addition to wood, bone and metal punches (Born and Hansen 2001: 187). Opponents of the 'ornamented cast'[22] like to indicate that the extra fine lines cannot be reproduced in the cast (Schwab *et al.* 2007: 243).

Traces as discussed are used as a supporting argument for both sides. Thus, overlaps, disorders or interruptions within lines are characterised as signs of unfocused guided tools or even as traces of specific tools. Such traces can speak for the work done on the bronze object (Schwab *et al.* 2007: 245), or might be interpreted as a result of the model working (Rønne and Bredsdorff 2008: 66-67). The gradual change of specific impressions is interpreted as wear marks of the tool (Drescher 1957b; 1955; Savage *et al.* 1982), or as wax adhesive on the tool (Rønne 2010; Rønne and Bredsdorff 2008).

However, concerning the application of the decoration and related traces, several studies could add important information without a research-influencing focus. Thus, the use of specific shaped tools ('Formpunzen') used in several ways could be documented by Herner (1989). Her study underlined the variety of tool shapes and highlighted that hourglass punch marks are occasionally introduced from two directions and thus are an assembled form (Herner 1989: 130). Assuming that the majority of ornaments were decorated post-casting then such specifically shaped punches should be visible in the material culture,[23] however, these do not appear in northern Europe (Fabian 2006). If, on the contrary, the material is malleable and its hardness is significantly lower than bronze, then diverse tools of wood or other easily adapted materials could have been used. In the material culture, therefore, a variety of individually shaped decorative elements would then be visible (see also Chapter 2.6).

Finally, to gain an insight into the extent of technological knowledge of Bronze Age craftspeople, another research area should be taken into account. A small group of researchers have been engaged in the examination of crafting traces of gold objects, in particular ritual objects and vessels (Foltz 1979; Fecht 1986; Nagy 1992; Fries-Knoblach 1999; Born 2003; Koch 2003; Schmidt 2012; Armbruster 2000; 2003; 2004; 2012; 2013). Even if the material properties and preservation conditions of gold cannot be compared with those of bronze objects, technical investigation can help to understand documented traces, techniques, and possible tools (Fecht 1986: 83; Armbruster 2012: 382). Detailed studies displayed sketched decorative elements, which can be seen as measuring aids for the placement of decoration (Koch 2003: 101; Fecht 1986: 94; see also Drescher 1954), as well as the use of dies, punches and rolling wheels (Born 2003: 93; Nessel 2009: 46; Fecht 1986: 92). Additionally, the advanced goldsmithing and padding skills could be highlighted (Schmidt 2012; Armbruster 2012; Fecht 1986: 84; Pietzsch 1952; 1968; Fries-Knoblach 1999).

Many of the tools used in processing gold could be adopted for the production of wax models. The skills needed for successfully working such thin-walled objects (mainly placed on a ceramic core) would also be helpful for model building. Especially, the idea that recurrent ornaments are applied using *Faulenzerpunzen* or wheels (see Chapter 2.6.2) opens up the door for new possibilities when transferred to the making of wax models.

When considering all the research concerning the techniques used to decorate bronze ornaments, a very important point has been addressed in many studies but, however, has never been clearly explained. Within the Nordic Bronze Age, in the majority of the highly decorated bronze ornaments it was not possible to define identical pieces; almost all studies also documented various differences in pieces addressed as identical (see Herner 1989: 130). This simple, but important, insight allows firm conclusions on the method of production, or rather makes it possible to exclude various techniques. Only from multiple re-usable moulds can identical pieces be obtained, which can contain only a small amount of subsequently added decoration in order to be identical. Pieces made with the casting in lost-wax are, however, originals. In general, it can be stated that artefacts crafted in this manner are never identical down to the smallest detail, as every piece must be created again from scratch. Admittedly, it is possible to produce models with wax casting in re-usable moulds. The similarity to the original is very high, but the piece probably needs to

[22] Meaning the cast of fully decorated wax models.
[23] 'Formpunzen' or specific-shaped punches occur in the late Bronze Age in the Aegean (Armbruster 2000: 390; Nessel 2009).

be greatly reworked before it can be cast via lost-form and will recognisably differ in size from the original. This simple observation thus restricts the possibilities for the crafting of the investigated highly decorated bronzes to two basic methods – they are crafted in a model and cast using lost-form, or are hammered. The above-mentioned tool marks alone proved to be of little help in identifying the technology used when the investigator is not fully trained in this craft. Here, with the help of metallographic studies it could be shown that the application of the decoration was done using many different techniques. Therefore, for definitive answers concerning the techniques used only a comparative study will give insight into the technological knowledge of Bronze Age craftspeople. Accordingly, and based on the results of the scientific studies executed in recent years, it can be stated that in the Nordic Bronze Age everything seems to be possible – from the 'ornamented cast' to fully cold-worked artefacts. The extent to which the individual techniques display regional differences and whether a chronological factor plays a role in favouring certain techniques will be examined in the technical investigation in the following sections.

Chapter 3

Experimental and ethnological research

Experimental research and ethnographic studies concerning metalworking techniques play an important role in the understanding of Bronze Age technology. This present chapter discusses and explains why experimentally achieved results should not be directly compared with the events in prehistory. Technical experiments expand the horizon of the observer, reveal the technical possibilities and allow allocating or excluding techniques. However, when a direct comparison with archaeological sources, as well as the reconstruction of prehistoric procedures, is desired, the experiments need to be based on archaeological evidence. In this case, the results allow a correlation between techniques and use-wear of tool traces. The following discussion introduces several levels of experiments and aims to grade their usefulness in relation to the archaeological question. Thoroughly executed experiments can advance research hugely. One of the many examples discussed in this chapter has, for instance, shown that the estimated time per person needed to craft the 'Nebra Disc' was at least 160 hours, when two individuals were permanently active. Additionally, the idea of a spiral-shaped stamp with which similarly shaped imprints can be placed in wax, as needed for the spiral-decorated bronzes in northern Europe, is the result of several experiments. Furthermore, ethnographic examples allow us to define the skills that were needed to craft the magnificent artefacts we know from the Bronze Age. Furthermore, with the help of ethnographic parallels we are able to think out of the box and might be able to trace better and more appropriate methods of crafting, as a variant of the lost-wax cast, where crucible and form are part of the same mould. First, this interdisciplinary approach gets the archaeologist closer to the sensitive aspects of craft and allows an understanding of the evidences of perfect familiarity with the material, which in turn lead to the understanding of qualification and skill. These aspects, discussed within this chapter, allow the scientist to draw conclusions regarding the craftsman's position in society.

2.3.0 Experimental research and its significance for the knowledge of prehistoric metalcraft

To this day, the experimental research concerning metalworking techniques plays an important role in the understanding of Bronze Age technology. Experimental archaeology makes it possible to monitor technical processes, document the occurring traces and leftovers, and check hypotheses. As also addressed in this study, many operational sequences, connections between tool traces and techniques, as well as possibilities, have their roots in experiments which could be afterwards used to interpret prehistoric traces.

Ideally, experiments should be based on archaeological finds, because only then do useful results materialise (Jantzen 2008: 24ff.). Unfortunately, this cannot be said about all the experiments which find their way into research.

Additionally, when using experimental research one should also be aware before, during, and after the evaluation that an experimentally achieved result cannot be directly compared with the events in prehistory, and thus an unsuccessful experiment is not equal to a non-existing action in prehistoric craft. From this point of view also, experiments executed under modern conditions can expand the horizon of the observer (as with the experiment concerning the possibilities of lost-wax casting by Meeks and colleagues), provided that the question does not seek an answer concerning the reconstructions of the operations, but rather the technical *possibilities*.

In the following discussion, outstanding experiments and their results are to be presented. It is primarily the effect of the experiment on the subsequent research that is in focus, and not the detail in replicating prehistoric conditions or the qualifications of the experimenter, for, as Rønne states: 'Støbning er så vanskeligt et håndværk, at det må læres gennem års fultidsarbejde' (Rønne and Bredsdorff 2008: 69).

For a successful application of information gained from experiments, the experiment should first be critically examined so that the modern view is not transmitted unfiltered to prehistory. With respect to their information potential, the published experiments can be divided into several categories. First-category experiments should be counted as those that aim to reconstruct prehistoric work processes based on the archaeological evidence. Here, a direct comparison with archaeological sources is possible, as well as the reconstruction of prehistoric procedures and the correlation between techniques and use-wear of tool traces. An excellent example is Jantzen's reconstruction of Bronze Age melting processes on the basis of nozzles found in the Nordic Bronze Age (Jantzen 2008; 1991). This experiment allowed the conclusion that within the Nordic Bronze Age the use of simple, possibly edged hearths in which the crucible was placed, was probably preferred in contrast to the more elaborate kilns (see additionally Fasnacht 1995a: 240). A reducing atmosphere was achieved by coating the charcoal over the crucible and the needed temperature was achieved through nozzles that kindled the fire from above (Jantzen 2008: 27-29). The information from this experiment can be used to explain the lack of documented workshops within northern Europe and might help to identify the sparse traces.

The working group 'Prehistoric Metal Technology',[24] with its numerous experiments regarding bronze handicraft carried out by skilled craftspeople, made a great contribution to the understanding of Bronze Age technologies. Among other things, Claus Stephan Holdermann and Frank Trommer aimed, while reproducing the 'Nebra Disc', to understand the single steps within its working sequence. Their experimental sequence was based on the documented tool marks and the information taken from the metallographic images (Holdermann and Trommer 2010; 2006). To understand the order of steps within the crafting sequence the plate was cold-worked (hammered) with modern tools. Here, additionally, the various tools and techniques were determined. In a second step, the process was repeated under prehistoric conditions and the information needed concerning possible crucible form and size was taken from examples from the south, due to a lack of examples from northern Europe (Holdermann and Trommer 2010: 791-794). The results were revealing in many ways also in regard to this investigation, as several methods to cast a usable ingot could be presented, such as using open, one-sided moulds (offener Herdguss), through gravity die casting (Kokillenguss), and via *cire perdue*. Furthermore, the disc ingot was successfully worked with higher alloyed bronze tools, of which the different possible alloys were documented. However, of particular importance within this reconstructed working sequence was the knowledge that such a disc can only be produced with a permanent intermediate annealing of up to 70 times (Holdermann and Trommer 2010: 799): The estimated time per person needed was at least 160 hours, with two individuals permanently active (Holdermann and Trommer 2010: 802). Such a statement is of particular importance for social, organisational and economic studies in archaeology.

Similar experiments that demonstrated the qualifications and skills of Bronze Age craftsmen could be carried out on bronze wheels. As used during the 'Nebra Disc' experiment, also while reproducing the Late Bronze Age wheel from Cortaillod,[25] the executed sequence is based on modern work (Binggeli 2007). Besides the difficulty of reconstructing a crucible that could handle the 10 kg of liquid bronze, the clay core in the wax model (the bronze wheel was a hollow cast with clay core) was a particular challenge that could only be solved by using a wooden skeleton (Binggeli 2007: 177).

A second category comprises experiments that try to understand the use, benefits, crafting, and durability of a specific artefact or tool. The information taken from these experiments can explain techniques and give an insight into the metalworker's knowledge. Within this group, a connection between modern experimental facilities and archaeological sources commonly appears. This is justifiable when not affecting the question, as for example, the function of each layer of a clay mould. Here, the metal to be cast can be melted in a modern oven and the temperature measured with modern equipment if just the form (as the object of investigation) is based on archaeological finds. Especially with regard to the nature and design of the ceramic moulds, and the possibilities of the lost-wax method, outstanding results could be achieved with any such combination. In this manner, Jantzen succeeded in understanding the nature of ceramic two-piece moulds for socketed axes (Jantzen 2008). The innermost black separation layers documented on several prehistoric moulds were interpreted as crucial for a good surface of the cast artefact. The attempts to reconstruct this layer with a wax mixture, which was burnt down after being applied in a thin layer, and then polished to ensure the finest possible surface, were not crowned with success. The casts of the socketed axes failed, as the large amount of air in the mould could not escape, presumably due to the compacted wax from the surface (Jantzen 2008: 33ff.). As a result, Jantzen summarises that the layer of fine ashes and clay might be part of the often perfect surfaces, but, however, the balance between casting temperature and mould temperature was one of the most decisive factors for the success of the cast.[26]

A similar statement was the result of the experiments undertaken by Meeks and colleagues concerning the possibilities of the *cire perdue* method (Meeks *et al.* 2001; see also Chapter 2.2.3). While trying to replicate a Merovingian die through lost-wax casting, the experimenter concluded that the main problem lies in the balance between the casting temperature of the metal and the mould temperature (Meeks *et al.* 2001: 66).

Through experimenting, Rønne and Bredsdorff (2008) developed a way in which the wax models needed to cast NBA II and III belt plates via *cire perdue* were shaped and decorated (Rønne and Bredsdorff 2008). The information achieved is crucial to define and develop operational sequences of the investigated bronze ornaments. Accordingly, a disc-shaped model was created by pouring liquid wax into a vessel filled with 90 °C hot water. Due to the relatively high water temperature, which was just above the melting temperature of the wax, a uniformly thick wax plate was obtained. The decoration of the wax plate was carried out using a centrally placed compass construction

[24] The advantage for carrying out experiments within such a working group is the simultaneous documentation and publication of the same, and thus the ability to make the results available for research.
[25] Concerning the site and find conditions, see Keller 1863; regarding the position of the wheel within the different wheel types, see Pare 2004: 360ff.

[26] Additionally, Jantzen mentions that more experiments are needed regarding the construction of clay moulds (Jantzen 2008: 33).

(stick and string) for the division of the decoration and the prepared wooden stamps (Rønne and Bredsdorff 2008: 59-61). The experiment was adapted to Bronze Age conditions and the results were quite comparable. The inspiration for the construction of the wooden punches and pricks was taken from known finds (e.g. Gussage All Saints in Dorset). However, this attempt to replicate Bronze Age ornaments also ended with faulty castings, mainly due to the lack of skills needed by the experimenters to cast under prehistoric conditions; an attempt by a trained craftsman under workshop conditions succeeded (Rønne and Bredsdorff 2008: 69).

The third category of experimental research includes experiments where the materials and conditions used are based on the prehistoric materials, but, however, in many details do not comply with one another. Such experiments serve in the first place to broaden the horizons of the researcher and are usually adapted to the technical skills of the experimenter or changed for economic reasons. The results are, however, striking and also regarding the topic of the present study influenced the research highly.

One important result concerning the crafting of the magnificently decorated bronze ornaments in northern Europe was achieved in the several experiments aimed at understanding how the similar spirals might have been crafted (Rønne 1991: 45). The answer was a spiral-shaped stamp developed by Rønne (see Figure 2.009), with which similar spiral-shaped imprints can be placed in wax similar to the known spiral-decorated bronzes from northern Europe (Rønne 1989a; 1993; 2010). However, the materials used by Rønne were not chosen on the basis of prehistoric finds and a direct transfer of the traces obtained in the experiment, including the fan-like notches in the spiral centre, should not be assumed lightly. Rønne constructed the spiral stamp from a wooden stick (quite realistic) and two inter-twisted copper wires with a circular cross-section. The production of bronze wire is, under Bronze Age conditions, both a time-consuming and strenuous procedure, and this particularly with copper or bronze as the raw material. Gold wires are known during NBA II and II however (Aner and Kersten 1973: 31-33; Rønne 1989a: 136; 1991: 38). Gold can be hammered significantly better than bronze, but still little evidence of round wire is known. In the Bronze Age wire was produced using forming blocks or anvils with grooves[27] (Figure 2.012), on which the cast ingot was first extended and finally brought into the required form (see Armbruster 2000: 104; Pietzsch 1964: 54). This process is accompanied by repeated intermediate annealing, otherwise after a short time the metal would become brittle and break. As convincing as the use of a spiral-shaped stamp might be, they were not constructed using round wires (especially copper). Rather, the present author would like to propose the use of organic materials, such as horse hair. Greased and rotated they form stable 'wires' of sufficient strength to imprint model wax. Additionally, plant fibres, leather or even wood could be used as basic materials for such spiral stamps. A stamp made as such can be customised when needed, and the fanning of the individual hairs at the centre would be quite comparable with the documented fan-like structures in some spiral centres.

2.3.1 Experiments based on ethnographic parallels

On the previous pages, only a small part of the experiments regarding metalcraft were presented. All these attempts made contributions to the cognitive process of archaeological research (see Fasnacht 1995a: 238).

A particularly clear result from all experiments is the fact that the Bronze Age metalworker had high technical skills and a wide-reaching knowledge of the material and its conditions: the difficulties for reproducing this technical performance by modern researchers attest to this. A researcher may extract information concerning use and chronological position from an archaeological object, but the piece itself does not show the skills that were needed to craft it. Here, archaeological experiments and ethnographic examples fill the gap. To hear and feel the point at which a workpiece needs relaxation (Holdermann and Trommer 2010: 799) is evidence of perfect familiarity with the material. For the modern scientists this information is important to understand the qualification of the craftsman, and his amount of skill, in order to draw conclusions regarding the craftsman's position in society.

Experiments based on ethnographic parallels can be important to archaeological research due to the fact that through the knowledge of 'pre-industrial' societies forgotten techniques can be recovered. However, the results of such experiments should not be taken as evidence for their appearance in prehistory. In other words, through ethnographic examples 'werden vielmehr Hypothesen überprüft und Modelle entwickelt' (Armbruster 1995a).[28]

As an example, inspired by the filming of brass casting in Java (Mullens 1974), an interdisciplinary investigation was launched which should deal with the use of rotating tools within the lost-wax process in prehistory. As a result, Armbruster was able to detect similar tool marks on gold bracelets from the Iberian Peninsula, and consequently could prove the use of a lathe and

[27] In the area of the Nordic Bronze Age, three bronze anvils with grooves were found, of which the piece from Damsholte, Praesto, is dated to NBA II, and the piece from Sengeløse, København, dated to NBA III (Jantzen 2008: 256-258).

[28] '...are rather hypotheses reviewed and models developed...'

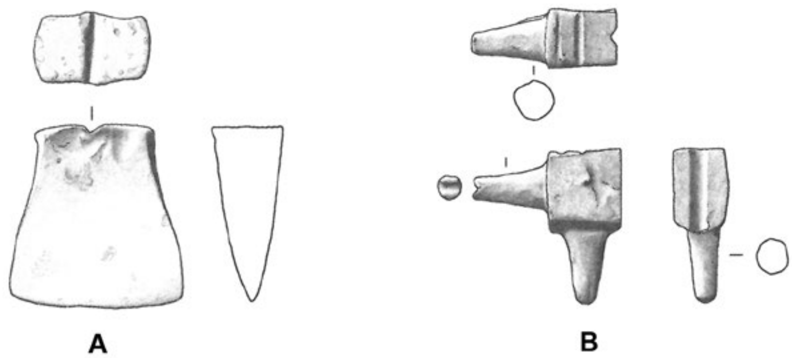


Figure 2.011: Bronze anvils with grooves found in the Nordic Bronze Age (after Jantzen 2008: T68).

drill during the late Atlantic Bronze Age (Armbruster 1993a; 1995a: 350; 2000: 77; 2005). Additionally, the experiments concerning lost-wax cast in a closed mould (Chapter 2.5.0) were based on ethnographic parallels and can be considered as an alternative to the usual lost-wax method used in northern Europe (Armbruster 1995a: 355-359; 2000: 78ff.).

Finally, there is yet another category of experiments, which is often unconsciously used by researchers. This category can be introduced by the term 'exclusion experiments' and examples are provided below. This type of experiment is performed in order to gain clarity about the consequences of an action. Most often this is in terms of tool traces, or traces of actions, imprints or breaks. Such experiments usually happen spontaneously and aim to rule out possible actions and favour others. Since such a process of elimination, however, is rarely published, the following section will show such a process and present the characteristic traces of embossing metal sheets using the example of Bronze Age forms and ornaments.

2.3.2 Embossing – an 'exclusion experiment': NBA III ornaments embossed on a copper sheet

Archaeological material displays only the traces that specific techniques leave on the material. These traces can be used to define the technique that was utilised. One technique, possibly used on gold-sheet work during the Bronze Age, is called embossing. Within this technique, sheet metal is worked with differently formed tools to create hollow, pressed and decorative patterns.

The results of the experiment presented here allowed this technique to be excluded as one that was used to craft the ornaments investigated. However, as negative results are also results, and the traces documented on the material will help future studies to securely exclude this technique, the experiment is presented in outline.

As a template for the embossing, common decorative elements of NBA II and III in northeast Germany were used and, therefore, direct comparisons are possible.

This experiment was carried out using a 0.3 mm thick copper sheet (modern walsed copper sheet),[29] in which the decoration was embossed using domed punches. The punches were pressed onto the surface of the metal sheet and the decoration was thus visible as grooves, the rest of the surface being straightened with wooden tools (Figure 2.012). During the single steps within the operational chain, various wooden tools with different tips were used, as well as domed punches of different sizes.

In a first step the pattern and shape of the collar (Figure 2.013, A) was sketched on the copper sheet using a pointed tool. The accuracy of the pattern was secondary in this experiment, primarily because the focus was on the differences in the tool marks. With a rounded domed punch (2 mm), the basic shape of the pattern was imprinted by moving the tool, which was moved with a slight pressure over the metal. The sheet was then turned (to the face side of the collar) and on both sides of this groove the surface was straightened using a flat modelling tool (Figure 2.013, B-C). The objective of this working step is to break the smooth transition of the groove and to work out an edge. Curved parts of the sheet metal, which can be documented between the decorative units, are smoothed with a modelling tool. By the alternating processing of the front surface and reverse side of the sheet a three-dimensional pattern arises. The horizontal ribs, a typical decorative element on neck collar types of the middle Bronze Age, are formed from the back with domed punches, which are 2-3 mm in diameter depending on the rib thickness. Here, too, the face side must be subsequently reworked with a modelling tool. The notches of the ribs are pressed from the face side using modelling wood (C) (see Figure 2.012). In the same way the arrow bands of the end plates were imprinted. Finally, the collar was cut out with a sharp-edged instrument from the sheet (in this case a chisel) and the edges were folded.

The described operational chain resulted in technique-specific features, i.e. the positive and negative

[29] The selected copper sheet was similar in thickness to gold sheets known from the Bronze Age.

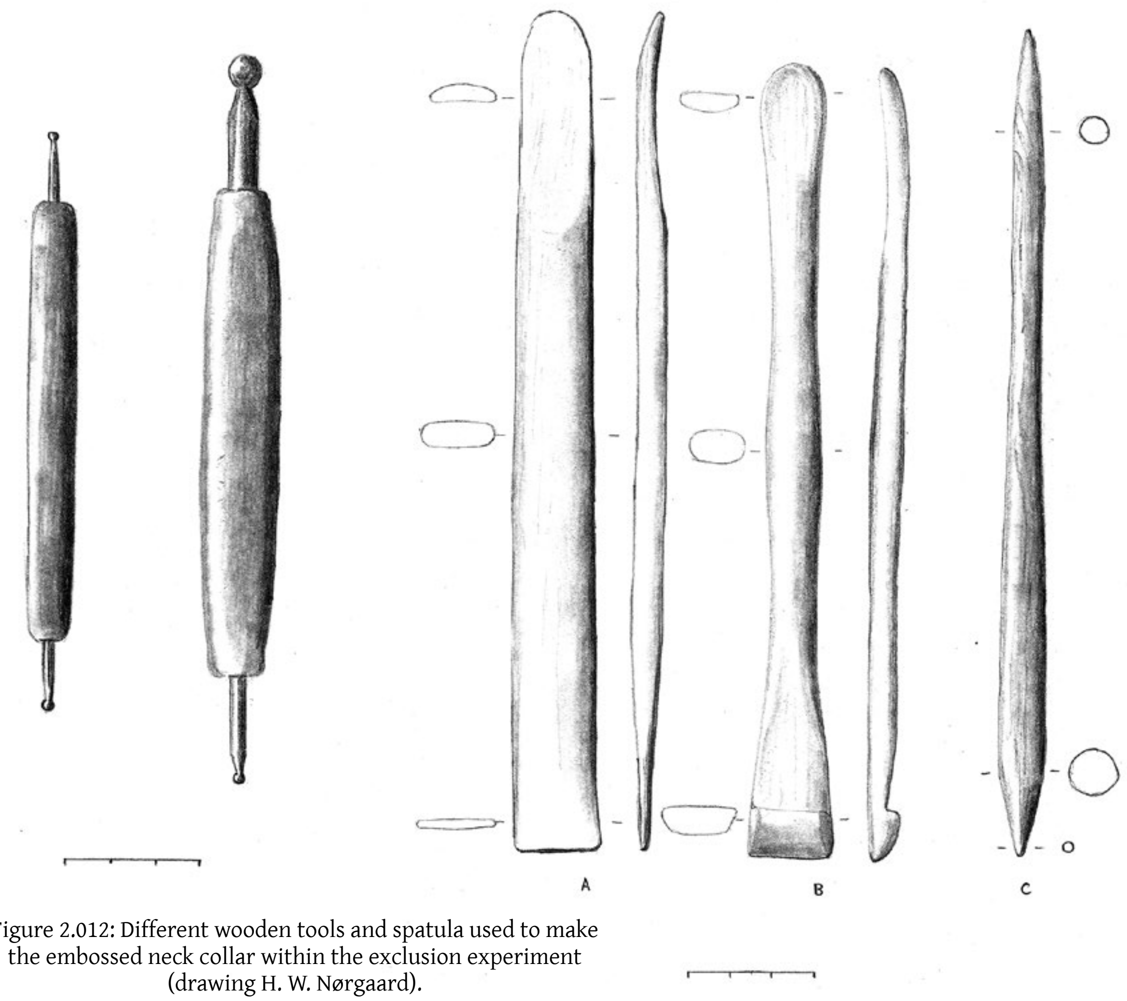


Figure 2.012: Different wooden tools and spatula used to make the embossed neck collar within the exclusion experiment (drawing H. W. Nørgaard).

impression of the pattern on the front and reverse sides and the folding of the material at collection points in the ornament. Compared to similar decorative details on Bronze Age collars, significant differences in the tool traces were detected, such as folded or curved metal within the spiral centres and at the meeting points of the connecting lines of the embossed collar (Figure 2.014a). This typical characteristic for embossed material is due to a thinning of the metal at the place where the tool hits, while the excess material gets moved to the sides. Especially when the surface right and left of a groove is compared to that of the prehistoric bronze collar, the difference in the visible traces becomes clear. On the bronze collar none of these 'displacement traces' can be detected (Figure 2.014b). Consequently, the surface of the Bronze Age artefact was deformed in a way that resulted not in a significant displacement of the material but rather in a compression.

Interestingly, signs of material displacement can be recognised on the Bronze Age neck collar. The dotted connection line shows signs of selective bulging of the material. However, these are highly localised, which allows assumptions concerning the material hardness, because only with a soft material will such a directed bulge appear.[30] Accordingly, rather than metal, a soft material like wax probably was deformed.

On the embossed collar soft bulging edges appear at the transition from the surface to the groove. Compared with the impressions of the spirals on the collar from Rye (Figure 2.015) the edge is sharp and the semi-circular cross-section of the groove is clearly visible. The cross-section of the embossed groove is irregular in width and depth. Additionally, the spaces between the grooves are not arched, as between the single turns of the spiral on the embossed piece, but straight. Finally, the ribs display the clearest difference. In addition to the fact that they are hollow, which was recognised in none of the documented bronzes, repeated displacement markers and bulges of the metal are visible at the embossed piece (Figure 2.016). On the investigated collars, the ribs and also the imprints of the punches show a uniform surface without a visible compression of the material.

[30] For a better visualisation, the impressions of a blunt object in wax should be imagined here. In this process, the excess material is displaced in the compression direction, so that a bulge is formed.

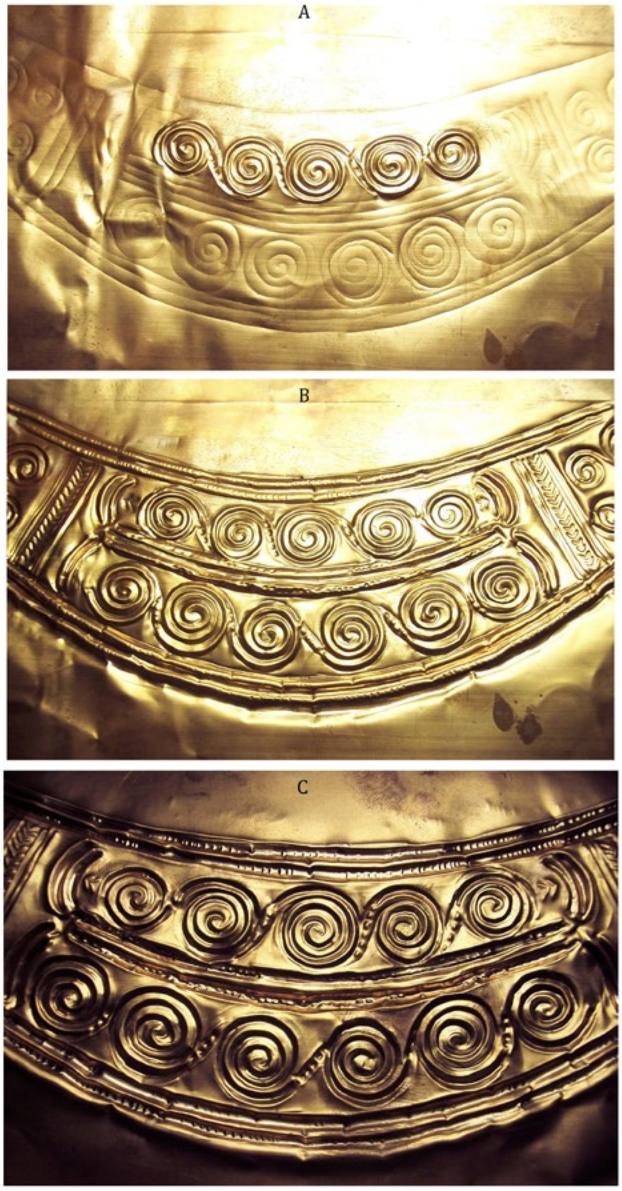


Figure 2.013: Production steps of an embossed neck collar: the outlined pattern of the collar with the first spiral series (A), the finished embossed face side of the neck collar (B) and traces of post-processing on the reverse side (C).

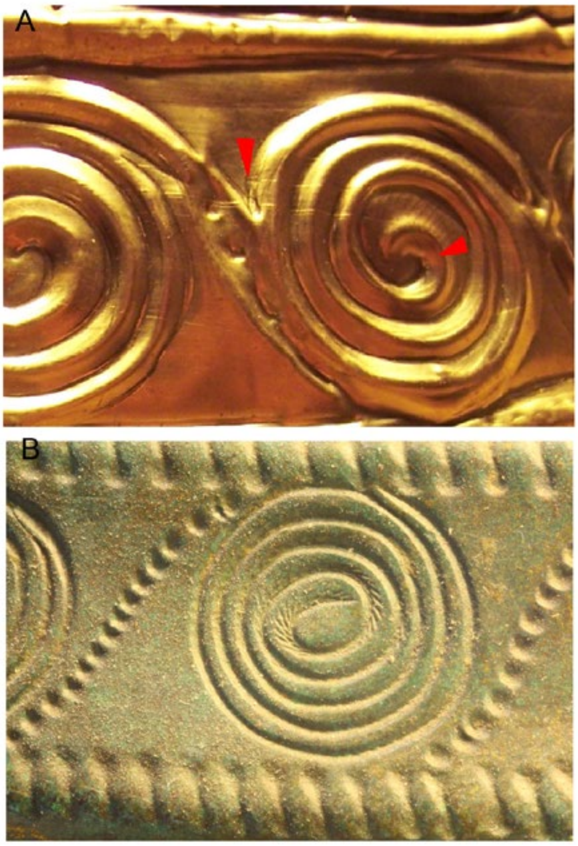


Figure 2.014: Comparison of the spirals on the embossed collar and the neck collar from Weitgendorf, Kr. Prignitz (MM II8269).

Figure 2.015: Comparison of the spirals of the embossed neck collar (A) and a neck collar from Rye, Holbæk (B7612).

The documented traces and the differences occurring concerning the majority of the artefacts under investigation support the statement that the embossing technique can be excluded as a possible method for the crafting of the Nordic bronze ornaments. However, the known crafted gold sheet metal artefacts (see Armbruster 2012) show some characteristic traces of this technique. Here, second experiments that are based on the archaeological finds (in terms of tools, material properties and forms) would be quite fruitful.

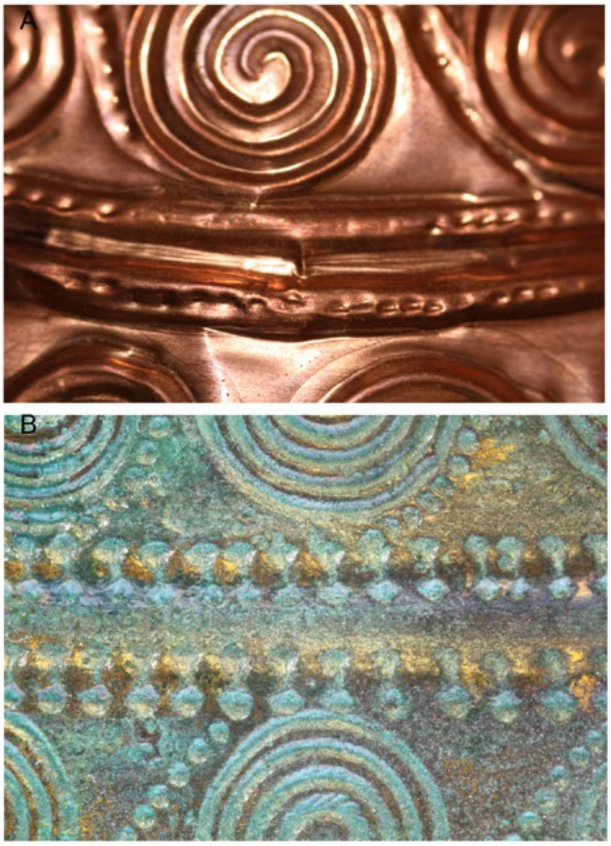


Figure 2.016: Comparison of the rib-group of the embossed collar (A) and the collar of Weitgendorf II, Kr. Prignitz (MM II8302).

Chapter 4

The difference within metalworking techniques

Metalworking techniques leave characteristic traces on the material, which help, when known, to reconstruct parts of the operational sequence in artefact production. Within this chapter common Bronze Age metalworking techniques are compared, resulting in a trace catalogue allowing the allocation of a specific technique to an artefact solely through a superficial examination. Here, a comparative detailed study of the belt plate manufactured by the goldsmith Boas in the 1890s, and a corresponding disc, which was crafted via *cire perdue*, revealed important technique-related differences. Among the most striking differences are not staged and interrupted lines, as one might assume, but rather the sharpness of edges and impressions, which are more blurred in the model-decorated cast artefacts.

With the above-mentioned disc it was not only proved that bronze can be worked with bronze, but also the idea of crafting spirals using spiral stamps was born. The uniformity of the spirals on prehistoric artefacts has always attracted the attention of archaeologists. As no 'fan-like' structure was visible in the centre of the spirals of this experimentally punched artefact, the discussions around this characteristic of punched decorative elements was to be reopened, ending in a schism of science, where one part supports the punch theory and the other defends the idea of decorating wax models with stamp-like tools. With this experiment in 1890, new insights concerning the preservation of crafting traces were gained.

In the following, the detail to which one can separate both techniques is described in the working sequence needed to create spiral series. Attention will also be paid to the reverse side of the ornaments, as they also can be used for identification. This is based on experience gained from errors, which remain in the finished piece from working the metal, as well as from creating the model. However, working with a model has some advantages, such as making certain repairs without leaving distinct traces on the finished piece.

2.4.0 Traces of crafting and comparing techniques

Through intensive research and various experiments we have today a very accurate insight into the different techniques used for the crafting of bronze artefacts (e.g. Rønne 1989; Drescher 1953b; 1954; Goldmann 1985). However, the archaeological collections today mostly present artefacts without visible failures and as such without the direct traces of the applied techniques. Even if the trained craftsperson's eye might be able to clearly define the technique used, the archaeologist will not solve the mysteries of production without knowledge of the traces left by specific techniques.

Similarly, the casting of artefacts, as well as the working with bronze tools on bronze, leaves distinct marks. First, the knowledge of the specific traces left by a specific technique will allow a secure definition of the artefact's crafting.

There are several almost unconsidered sources which may significantly improve our knowledge for distinguishing the techniques used. In the 1890s Sophus Müller published a test by the goldsmith Boas to prove that bronze can be worked with bronze. The named goldsmith, inspired by an exhibition at the National Museum, Copenhagen, crafted a spiral-decorated belt plate.[31] As already shown, Boas could prove that bronze can be deformed in detail with the help of bronze tools and the necessary handicraft knowledge (Müller 1897: 257-258; Rønne 1989: 129). A subsequent experiment showed that a result of equal quality (Boas' belt plate was good enough to satisfy the greatest critics), in terms of the spiral and geometric decoration, can also be made in wax and then cast via *cire perdue* (Müller 1877: 40). The bronze plates from the two experiments (the latter experiment via *cire perdue* was executed several times and the chosen object is definitely from one of these) could be investigated intensively during the current research and it was then possible to compare the two most widely used techniques of the Middle and Late Bronze Age in direct comparison with each other.[32]

2.4.1 The methodology

The craft technical comparison is based on macro images taken by a Canon EOS 450D SLR camera and a Sigma EX 105mm1: 2.8 DG Macro lens. The evaluation of the images is based on the author's craft technical

[31] 'It was a Copenhagen craftsman, the goldsmith Boas, who solved the problem. He often visited the National Museum, and the curators were not slow to notice that he had a good eye for ancient metal technique. He was asked about the execution of Bronze Age ornaments and urged to discover how they could be produced without using steel, only bronze tools. On the following day goldsmith Boas brought a piece of brass on which he had with a punch of the same metal executed the spiral ornament described. This answered the question posed by both proponents and opponents of the Bronze Age theory: the ornaments have been punched. Bronze can be chased with bronze.' (Müller 1897: 257-58)

[32] Next to the probable belt plate made by the goldsmith Boas in the 1880s, several belt plates crafted through *cire perdue* were discovered in the archives of the National Museum in Copenhagen. A critical examination and comparison of these items is a long-overdue task. Knowing the different traces left by the different production methods, an investigation such as that within this project, will allow the differences in crafting during the Nordic Bronze Age to be revealed

knowledge gained over a period of three and a half years as an apprentice goldsmith.

The images aimed to focus on specific details, as single spirals or decorative ribbons. Nonetheless, every part of the artefact was photographed in a precise sequence and the photo numbers were noted on a specific arc in order to reconstruct the position of any section on the artefact afterwards. The focus was in the general range of F25-32, with ISO 800, as the majority of the imaging took place within the storage facilities (dark rooms) of various museum collections (mostly within the National Museum, Copenhagen). Of interest for the examination were:

- surface textures
- failures within the decorative elements, such as interruptions and damaged shapes
- interruptions in flow
- irregular line width and depth

The artefacts were additionally sketched and the exact measurements were added to every sketch. This step was of huge interest when comparing single decorative imprints to detect similar tools, or when comparing the suspected stamped spirals in order to identify a specific stamp. All data was entered into a database (Table 1, morphological data). As occasionally museum collections allow only restricted access to stored artefacts (especially very fragile artefacts), not all of the documented traces could be shown in this current work. However, every attempt was made to describe the traces and depict them with help of comparable artefacts.

2.4.2 A trace-catalogue for the technical examination of the bronze ornaments

The comparative detailed study of the belt plate manufactured by Boas and a corresponding disc, which was crafted via *cire perdue* (Figure 2.017a-b), yielded several technically related differences. A record of these differences resulted in a comprehensive catalogue of crafting traces which will clearly facilitate craft/technical investigation of Bronze Age metal artefacts.

Typical characteristics of each technique, as well as different results of comparable crafting units, were recorded and are set out below.

One of the crucial differences, visible to the naked eye, is the surface structure of the piece and the nature of the decorative borders (Figure 2.018a). The edges of the inserted decoration are sharp and occasionally show tool attempts, such as small offsets in the grooves when crafted with punches in metal. As such, the decoration of the cast disc consists mostly of soft, flowing lines without significant breaks. In particular, the gentle transition from the surface to the wide, edge-accompanying grooves with clearly visible pores (cast skin), is a characteristic feature of cast objects (Figure 2.018b). Here, it must be noted that this characteristic is subject to strong variations due to the quality of the cast. The investigated piece, found in the archives of the *Nationalmuseet København* is, at best, of medium quality; several errors such as the faulty application of the moulding material (the various ash and clay layers of the mould) could be documented on the basis of interruptions in decoration (Figure 2.019). The partly washed-out contours of the decoration suggest that the liquid metal did not fill the mould completely. These features can be considered as unique for the casting of decorated objects, and do not occur in plastically

Figure 2.017: Two belt plates experimentally produced: made via cire perdue cast (A) and punched by the goldsmith Boas (B).

Figure 2.018: Characteristic differences between cast- and cold-worked bronze ornaments.

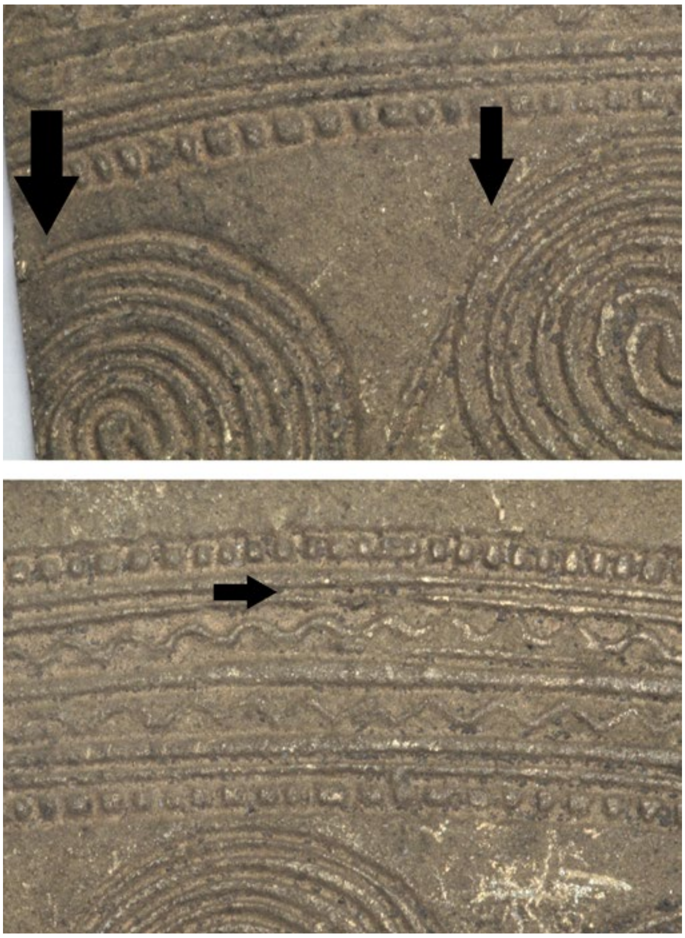


Figure 2.019: Several errors, such as interruptions in decoration, assign the bronze plate as a medium quality cast.

deformed pieces. In contrast, the incised grooves and protruding ridges are clearly identifiable on the metal-decorated piece (Figure 2.018b). Especially, the triangle-ribbon displays clearly the characteristics of decoration applied using metal form-punches: a variable line width of the ridge; punch marks which are slightly offset and partly at different depths; and a different degree of rounded corners due to the use-wear of the tool (Figure 2.020). Here, through an exact documentation of the variations in shape of such triangle-shaped punches, it would be possible to reconstruct the sequence of work and the work direction.

Rønne (1991) suggested that the uniformity of the spirals, especially, serves as a determining factor for the possible use of a stamp. The direct comparison of the cast disc and the one that was punched supports this (Figure 2.018c). However, it also shows that generalisations are not appropriate. Only on closer inspection can the irregularities in the line width, deviations in the spacing between the single turns, and the ridge width, be seen on the handmade spiral from Boas. Specific markers are, here, small displacements and tapered points within the turns, which act as evidence for interruptions in the workflow (Figure 2.021). When the optimal fluid movement of the hand that held the tool was interrupted and had to be re-recorded, the position of the tool will have slightly changed and consequently the impression altered. Compared to the imprint of a spiral stamp, no such interruptions occur.

Interestingly, no 'fan-like' structure is visible in the centre of the spiral of the punched artefact. This feature (the fan structure) has been considered a characteristic of punched decorative elements (Herner 1987; Drescher 1953b). However, there are changes in line widths towards the centre of the spiral, due to the width of the punches (Figure 2.021). As can be seen in the comparison (Figure 2.018c), the spirals applied in the model are significantly more regular, which is why the use of a stamp-like tool is assumed. On closer inspection, also, this spiral-decoration shows detailed differences between the spirals, mostly deformations of the spirals (in horizontal or vertical oval), or individual areas not properly reproduced while casting. Additionally, differences in size are frequently observed.

Another criterion, by which the distinction between the two techniques is facilitated, is the way in which the spirals are connected. Each technique has its own specific characteristics. Within the creation of models that should be cast in lost-forms, it can be assumed that errors made while creating the model remain in the finished piece. Inadequate connections or defects in the connection points are thus already made during the preparation of the model. However, making a model has some advantages, such as making certain repairs without leaving distinct traces on the finished piece. The trained eye will nevertheless see such repairs, i.e. accumulations of material where a decorative element was filled out. Distinct features to determine crafting via model making include regularly occurring offsets in the grooves between the spiral end and the connective line, and overlapping within the grooves, as arrow-like impressions (Figure 2.018d).

Since, however, a different working sequence is needed for the crafting of a punched spiral-decorated disc, the documentable traces will also differ. According to the discretion of the craftsman an ongoing spiral series can be made in two ways: (a) all spirals are individually, and in one fluid motion, punched, and the connective lines attached after the completion of the spirals; (b) the spiral series is made in a continuous movement, wherein the connective lines are applied as part of each spiral. Both of these explained 'ways of doing'

Figure 2.020: Characteristic markers of punched decorative elements.

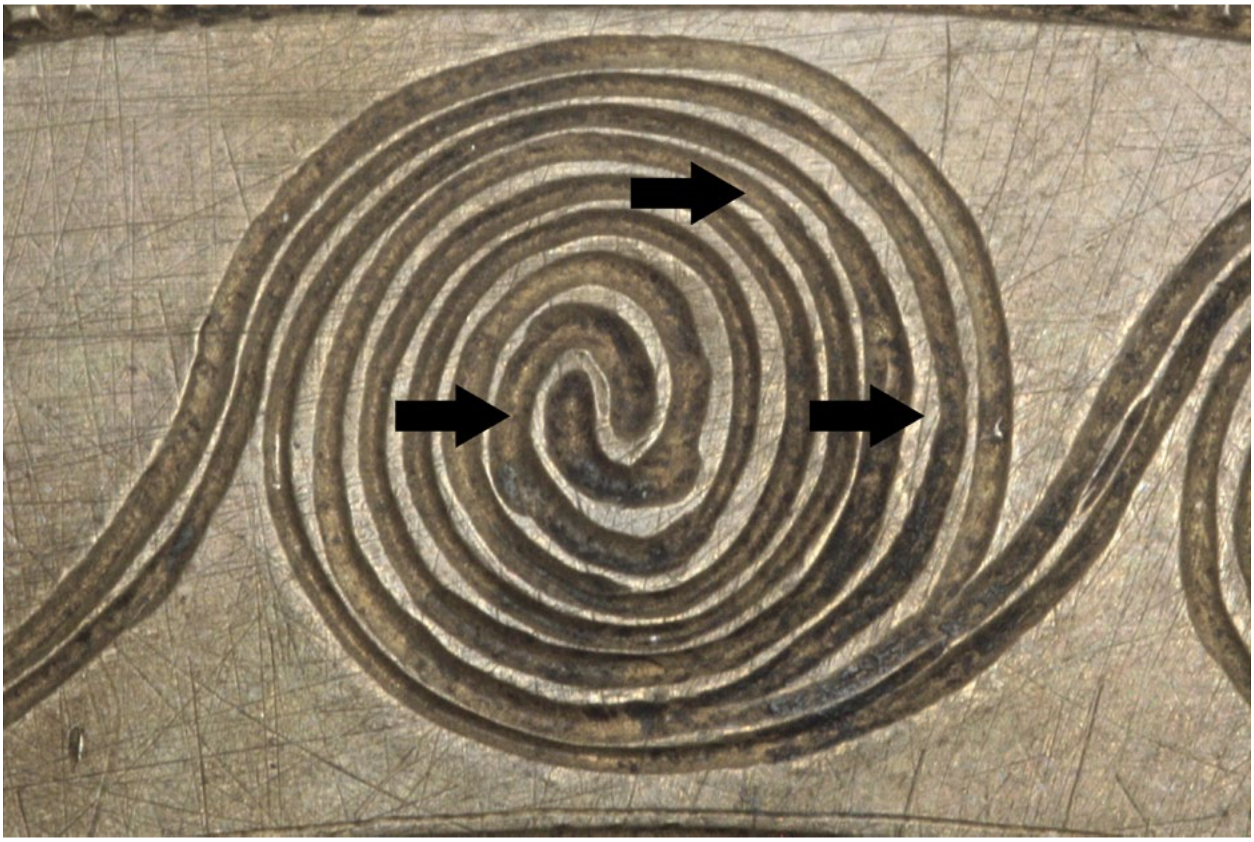


Figure 2.021: Characteristic markers of hand-applied spirals.

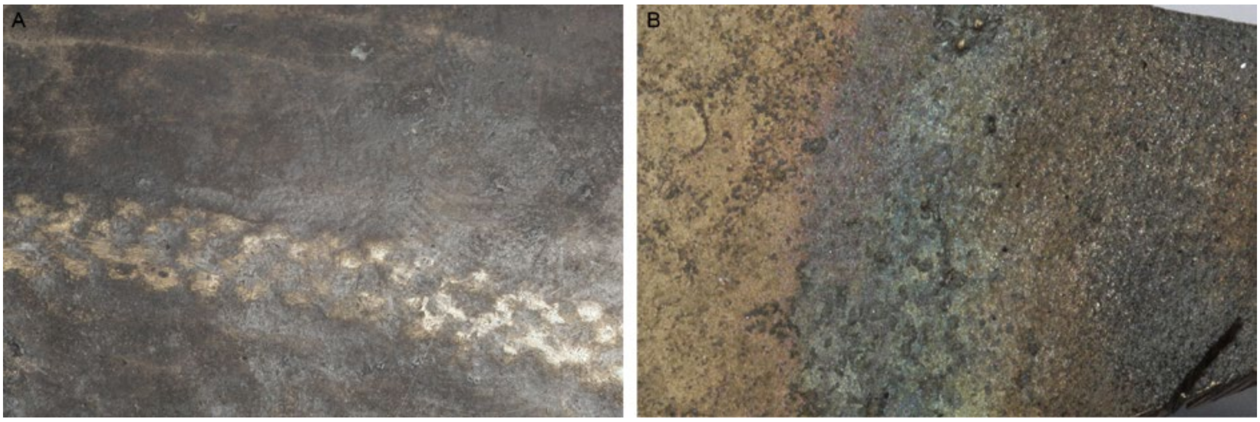


Figure 2.022: Negative pattern is recognisable on the reverse side of the hammered plate (A) and not on the cast plate (B).

have distinct features that are mainly due to the different movements. While crafting a spiral series in two steps (example a) the point where the connective line and the spiral meet can easily become visible as a thickening or an offset in the grooves. Additionally, deviations in the line style (line width, bending and depth of each groove) are to be expected between the single spirals (Figure 2.018d). When applied in one fluid motion variations in the distance between two parallel connecting lines can also occur if one line is applied from right to left and the other is made left to right. The distance between the spirals, and thus the length of the connective lines, will likely be more uniform in this variant than in version (b), since significantly more pronounced skills related to units of measurement are needed here.

As already mentioned at the beginning of this chapter, the slightly grainy cast skin is often an especially recognisable sign of casting. Since this surface structure is preserved in the wells of the decoration, even if the surface is, post-casting, reworked and smooth, here impurities or traces of mould material can easily remain, which leave the impression of an incrustation. This might be intentional, however, but usually the difference to a truly conscious replenishment of the decoration is detectable and can be recognised in the amount and uneven distribution of the material. In addition, discolourations of the material can be used as distinctive features of the casting technique (Figure 2.022b). Here it should be noted, however, that the corrosion process of bronze causes colour changes, which can be easily confused with those related to the cast.

In addition to the features previously mentioned, the reverse side of the ornaments can be used for identification of the crafting technique. Depending on the material strength, the negative forms of the applied decorations are notable when produced by plastic deformation, meaning with help of punches (Figure 2.022a). The changes in the surface structure are particularly clear even if the material is as thick as the examined piece. The back of the cast disc reveals typical features for cast items (Figure 2.022b): a porous structure, discolouration, scares and shrink-holes. Weak negative forms can also be recognisable on the reverse side of a cast artefact, but only when they occurred while crafting the wax model and have not been reworked. Whether negative imprints of the decoration occur depends primarily on the material thickness and the force from the introduction of the decoration in the model as well as in the metal.

In summary, it could be shown that using two experimentally crafted belt diss, with a typical NBA II and III decoration of northern Europe, the basic crafting techniques can be compared and the occurring traces described. It is now possible to define the technique which was used to craft a Bronze Age ornament based on the developed characteristics. There were several characteristics for artefacts cast via *cire perdue*: a porous and partly coloured cast skin; impurities in the grooves of the applied decoration; interruptions in the decoration; uniform spirals whose deviation from each other is limited to horizontal or vertical deformations; recognisable attachment points between the connecting lines and the spirals. In contrast, artefacts created through the application of the decoration in metal, using punches and chisels, display different characteristic features, such as: very pronounced and sharp contrasting decorative borders; variable line widths; a variation in the shape of the imprints caused through use-wear; many individual errors and features in the spirals and the connecting lines.

Taking the information from the previously described experiment, characteristic features for embossing are: the embossed grooves are irregular in width and depth; the grooves are hollow; and folded or curved metal occurs at the connection points of the decoration.

Chapter 5

Casting techniques and casting moulds

Several casting techniques were in use within the early and middle Nordic Bronze Age and it can be ascertained that metalwork, especially in the north, is dependent on casting. The variety of techniques used in the NBA, presented within this chapter, extends from complex techniques, such as casting in lost-form, to two-part moulds, and simple techniques such as open mould casts. It is shown that regionally restricted behaviour occurs, e.g. the use of specific mould material, such as stone moulds for the production of wheel-headed pins. Complex casts were executed in multiple steps in regionally restricted areas, for example the implicit use of the cast-on technique for the production of large belt plates on Zealand. This chapter aims not solely to explain the known bronze (copper-tin-alloy) casting techniques, based on the investigated artefacts, but also to compare the techniques used in the Atlantic region and those in northern Europe. Through such a juxtaposition of the known techniques between 1470 BC-1100 BC, it is possible to capture the range of technical methods, visualise the characteristic features, highlight new discoveries, and define regional peculiarities. As the cast-accompanying processes are relatively familiar to us, due to general physical laws, ethnographic parallels and material culture studies, it can be assumed that the melting of the metal probably did not happen in an oven, rather in a shallow fire place. We also know that specific knowledge was used to achieve the best results, 'tricks' probably still applied in modern goldsmithing. Results of the craft/technical investigations are directly compared to the knowledge of the discussed casting techniques, with astonishing discoveries. This chapter presents evidence for the casting of complete decorated wax models in *cire perdue*, regionally specific techniques to create eyelets on belt plates, the different use of cast-on techniques, and the preference of porous mould material instead of the much more complex method of using artefact-attached cast pipes and air channels.

2.5.0 Casting techniques used to craft ornaments of the Nordic Bronze Age

The casting of metals can be seen as one of the most used techniques in Bronze Age metal technology, due to the fact that 'jede Goldschmiedearbeit ... folglich mit dem Gießen eines Barrens oder Grundkörpers beginnt' (Armbruster 2000: 67).[33] Metal casting is a much-used technique, also in our modern world, which is based on unchanged physical parameters of the metals used. Consequently, with the present knowledge of the necessary technical requirements, suitable fuel, furnaces, blowers, cast ceramics and deoxidising agents (Armbruster 2000: 67), a prehistoric casting process is relatively easy to reconstruct. It is more difficult, in return, to exclude techniques which are used today, because the lack of proof for a technique does not have to mean a given technique was not used.

A profound knowledge of the different casting techniques is crucial for the interpretation of work traces and an important factor for identifying regional behaviour.

The present work deals with bronzes; accordingly, the casting techniques presented are focused on this metal. Such a remark may seem unnecessary, but it is of utmost importance. As each metal has its characteristic properties, so too has the alloy bronze properties which carry with them particular quirks. Under today's conditions a bronze alloy is considered to consist of copper and nickel, aluminium, silver, manganese, silicon, and, especially, tin, and is named according to its components. The so-called tin bronze has at least 6% tin to copper; bronze used for casting can have up to 20% tin (Brepohl 1996: 88-91). In prehistory, a different, significantly simplified, definition of bronze is applied. Here, tin is the decisive alloying partner for the metal called bronze, and, additionally, many different admixtures occur in different ratios (see Jantzen 2008: 7). In the present work, the term bronze is used for a copper alloy whose alloying partner is tin, regardless of its amount and any other alloying constituents. The characteristic of bronzes is the relatively rapid change in its properties when the elements additionally contained in the alloy are changed. A colour change from reddish to golden is attained by the increased addition of tin, however arsenic and lead also have a colour-changing effect. A lowering of the melting temperature is caused by arsenic and antimony, whereas bismuth makes the alloy brittle. The casting potential is increased by, among other things, the presence of antimony and lead (see Wolters 1991: 78ff; Junk 2003).

The crucial step that precedes each casting process is the smelting and refining of the metal used. Our knowledge of these processes can only be reconstructed from the archaeological record. Nevertheless, through experiments based on the remains of Bronze Age casting workshops (Jantzen 2008; 1991) and ethnographic studies (Armbruster 1995b; 1990; Fröhlich 1979), the cast-accompanying processes are relatively familiar to us. The melting of the metal in northern Europe probably did not happen in an oven (Armbruster 2000: 67; Jensen 1979b: 83), but in a rather shallow fireplace (Figure 2.023), with the crucible placed on the bottom of the hearth and above it the charcoal fire, fanned by a curved fan nozzle (Jantzen 2008: 29). The tools needed for this procedure can be summarised under the term casting equipment and consist mainly of ceramic

[33] ...any goldsmithing... hence begins with the casting of an 'ingot' ...'

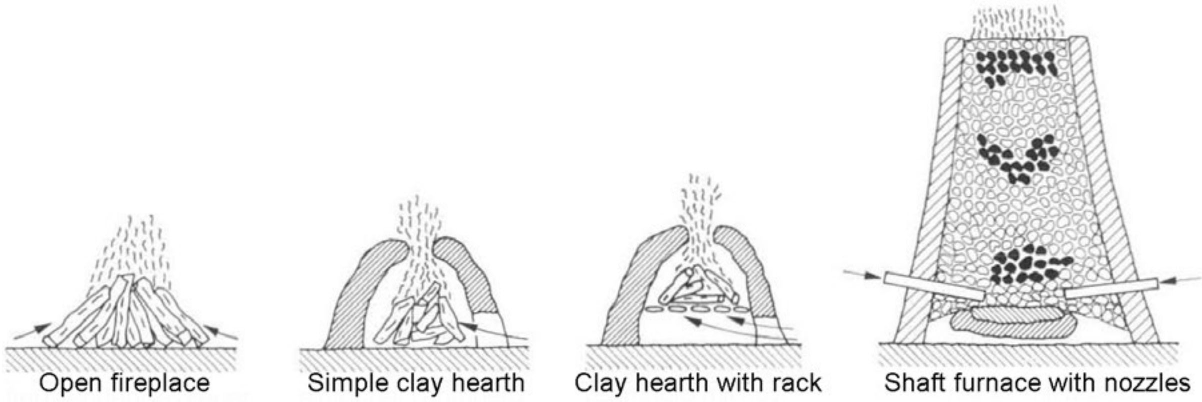


Figure 2.023: Different hearth constructions, from a simple fire place to a melting oven (after Armbruster 2000).

crucibles and wooden tongs (Jantzen 2008; Armbruster 2000: 67), although wall-paintings (Figure 2.024) in some tombs of the Old Kingdom also display crossed wooden sticks, or two stones for holding the crucible (Armbruster 2000: 23; Garenne-Marot 1985: 86).

Since prehistoric casting was based solely on the force of gravity, modern methods which use, for example, centrifugal force (centrifugal casting), through which the metal can be transported to all cavities of the mould, should be excluded (Jantzen 2008; Armbruster 2000). Since defective castings seem rare in the material found (also due to the possible re-melting of the material), the prehistoric metal craftsmen must have been able to overcome this difficulty. Many experiments (Chapter 2.3) emphasise the importance of a balance between mould temperature and the temperature of the liquid metal. Furthermore, it was found that an innermost layer of soot, oil, or a wax mixture in the mould, improves the surface finish and possibly the filling of the form (Jantzen 2008; Armbruster 2000; Meeks *et al.* 2001). However, there is a high possibility that certain tricks were used to achieve the best results. As Armbruster (2000: 70) shows, a complete filling of the mould can be achieved through a sheet of absorbent material placed on the sprue, a trick that still applies in modern goldsmithing. The metal is poured through a hole in the middle of the wet paper (it should have the dimensions of the sprue-former) and then the mould is closed with a heavy object. Between the slowly solidifying metal and the lid of the mould water vapour emerges, which pushes the still liquid metal into all the intricacies of the form (see also Hawley 1953).

Furthermore, the usual procedure in a modern cast to add cast-pipes seems to have been rarely used, due to the fact there are hardly any moulds with such cast-pipes. In contrast, the oblique posture of a mould, which facilitates the escape of air during casting, is documented more frequently on recovered sprues. In addition, the choice of porous materials for moulds seems common (Jantzen 2008: 314; Armbruster 2000: 68; Monteagudo

Figure 2.024: Wall paintings of the Old Kingdom show workers carrying crucibles with wooden sticks (after Garenne-Marot 1985: 86).

1977). Based on the material culture (cast equipment) of the Nordic Bronze Age, Jantzen (2008) was able to present a clear picture of the techniques used. At the first glance, this technical repertoire is not very different to the techniques used in the Atlantic Bronze Age (Armbruster 2000). Within both areas a predominance of bronzes produced in two-part moulds is visible, especially weapons and equipment. Ornaments, except bracelets, on the other hand, seem to be mainly produced in lost-form and this apparently occurred in the north much earlier than in the south. Special attention is given to soapstone forms, which are apparently only used in Scandinavia (Jantzen 2008: 314).

However, as has been shown already in the Atlantic region, some techniques are only detectable by looking at the artefacts themselves.

2.5.1 Lost-form casting

Lost-form casting has been mostly related in the literature to the *cire perdue* technique (the lost-wax cast). As Jantzen (2008) could clearly show in his study, however, a large number of ceramic forms should also be described as 'lost-forms'. In this sense not only does the lost-wax process belongs to casting in lost-forms, in which the model is embedded in mould material and both parts are destroyed after casting, but also the highly controversial method of sand-casting. In addition, two-piece moulds, which cannot be opened without destruction, should be regarded as lost-forms (Jantzen 2008: 96). These two-part lost-forms are at the moment of particular interest, where the model used for reproduction of the artefact is not to be destroyed. Both techniques have their characteristics and can thus be traced in the material.

For the majority of the highly-decorated ornaments in NBA II and III, the crafting via *cire perdue* or similar methods where no residues of the process are obtained can be accepted. Accordingly, the amounts of mould fragments that can be associated to such an ornament are very low. For example, clearly identified moulds for neck collars, belt plates, tutuli or pins are rare, especially for NBA II. A reasonable explanation may be the recycling of the mould material for the production of other forms or equipment (Born and Hansen 2001: 185; Jantzen 2008). Nevertheless some traces indicate the use of the discussed techniques and will be highlighted in the following section.

Casting via 'cire perdue' or the lost-wax cast

The *cire perdue* technique, also called lost-wax technique, 'Wachsauschmelzverfahren' or commonly known as lost-form casting, is a method used for the casting of single pieces, based on the almost complete formation of the artefacts in a wax model (Figure 2.025). This technique is especially useful for creating complex shapes, shapes with undercuts, and rich ornamentation. The main component of the malleable material to create the models is beeswax. However, since pure beeswax is very sticky and probably the stamp or other tools (like the hands) would have adhered to the wax and would thus have destroyed the surface,[34] it is inferable that various additives were added to the wax. Several attempts have been made to describe those mixtures, for example Jackson states that the wax was a mixture of beeswax with mineral and vegetable oils (Jackson 1972: 24; also Armbruster 2000: 75; Grassmann 1983; Büll 1977). Born suggests a mixture of wax, talc, rosin and grease (Born and Hansen 2001: 182), and also Hundt argues for an incorporation of talc, chalk or rosin (Hundt 1980).

With the assistance of various metal, wood or horn tools, as well as the hands and fingers, the wax is formed. Once the model is completed the sprue is attached. Armbruster (2000) underlines the importance of the size, position and thickness of the sprue for the success of the finished piece, as the amount of metal in the sprue serves as storage. During cooling the still liquid metal in the sprue is by gravity feed transported into the centre of the artefact, where the volume shrinkage would else result in shrink-holes (Brepohl 1996: 150-152). In the same manner the pressure on the liquid metal in the form is increased by the weight of the sprue material, and the mould can be filled more efficiently. However, the attachment points of the sprue on the artefacts are rarely documented (Armbruster 2000: 75), and our only sources that shed light on the position of the piece under casting, and the eventual size of each sprue, are from X-ray analyses or the rarely preserved sprues themselves.

The finished model was then embedded in a multi-layered clay mould, dried and heated. The liquid wax flowed out while heating, leaving the hollow form of the ornament in the clay mould. The construction of the clay mould makes a significant contribution to the success of the casting. The innermost layer that is applied directly to the model should consist of a mixture of ground charcoal and the finest clays,[35] because the grain size of this first layer determined the fineness of the decoration (Meeks *et al.* 2001; Armbruster 2000: 84; 1995a: 356). Presumably, before the sludge is applied to the model, straw or grass is connected to the model, which should serve as air ducts. However, channels of this kind cannot be confirmed in the remains of the forms received. The next layer of mould consists of a fine tone followed by coarser layers. Jantzen reported

[34] For further discussion about the need for a less sticky modelling material, see the experiments of Rønne and others (Rønne and Bredsdorff 2008: 68-69; Meeks *et al.* 2001).

[35] Further investigations suggest the addition of cow dung so that the innermost layer is as fine as possible (Davey 2009: 153).

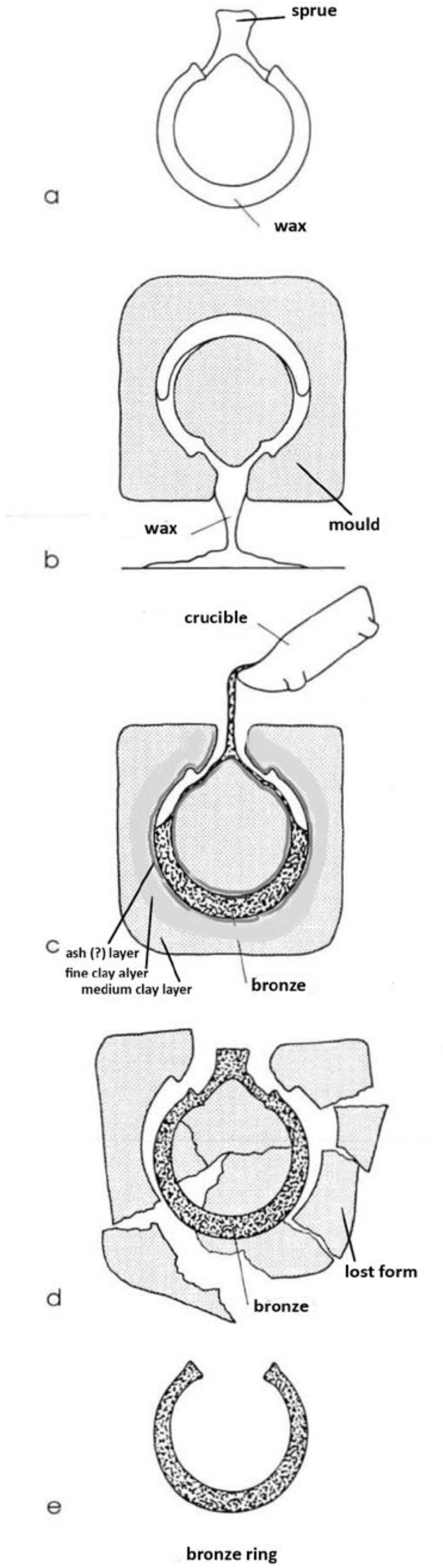


Figure 2.025: Single steps of the lost wax-method (based on Wübbenhorst and Engels 1989).

predominantly two to three layers of differently grained clays (Jantzen 2008: 61ff.), in which case probably the innermost layer was not preserved.

Among the pieces investigated in this work one displayed striking differences in the surface texture. The neck collar from found in a bog near Vellinge on the Danish Island of Fyn (NM 25787) has a beautiful golden-brown bog patina, with a partially strongly advanced corrosion of the surface. It is this difference in the surface structure that is surprising. Additionally, the collar has a partly blackish layer, that is unlikely to be bog patina (Figure 2.026), which has survived mainly in the indentations of the decoration and could be a silt layer. Where the same was not carefully applied, the decoration is not reproduced error free and the surface is very porous.[36]

The multi-layered clay mould is then dried. Concerning the time to dry the mould, Drescher mentions no specific time period (Drescher 1953b), whereas Meeks suggests a slow drying at room temperature for several days (Meeks *et al.* 2001: 61), and Armbruster (2000; 1995b) waits until the previous layer is dried before applying a new clay one. However, the mould must be dry prior to casting, as residual moisture can cause a violent reaction during the pouring of the molten metal and this could break the mould. The professionalism of the craftsman can now be seen in the casting process, because the form is only completely filled when the temperature of the mould and the molten metal are in a delicate balance (see Rønne and Bredsdorff 2008; Meeks *et al.* 2001; Schwab *et al.* 2007).

After casting, the mould was destroyed and the finished cast recovered (Born and Hansen 2001: 182; Hundt 1980: 63-79). While casting, parts of the mould material can be burned into the surface of bronze and must be removed after cooling – a time-consuming activity.

Ethnographic studies of the Brazier in West Africa (Armbruster 2000; 1990; 2005; 1993b) made it possible to add another possible method for casting objects using lost-wax to the one described above. This casting technique was previously unconsidered in the international literature, but is presented here in order to demonstrate the variety within one technique.

The special feature here is the connection between mould and crucible. After melting out the wax from the mould part of a carefully designed form, a sprue, is scraped into the ceramic extension of the mould. Then, the sprue is sealed with a thin wax plate in order to prevent contamination of the cavity (Figure 2.027,1-4). The metal (carefully matched and weighed in terms of the size of the form) can then be put into a crucible that is covered with a wet paper. Crucible and mould are now joined with an extra layer of moulding material (Figure 2.027,5). This mould, consisting of two-pieces, is covered after drying again with clay, and during heating the crucible part of the mould is placed downwards (Figure 2.027,6). The hollow form and the crucibles are, therefore, simultaneously heated until the metal is melted. However,

[36] A full examination of this artefact and the obtained patina was, unfortunately, not possible during this project, since this piece would ideally have to be re-examined with the aid of a binocular loupe or via electron microscopy. If the assumption was confirmed that the blackish layer is silt, the Vellinge collar would prove the casting of complete decorated ornaments via *cire perdue* and could answer the questions concerning the innermost layer of the lost-moulds.

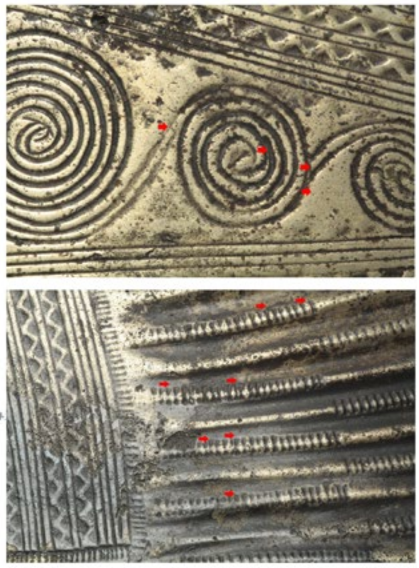


Figure 2.026: Different surface structures of the neck collar from the Vellinge Mose hoard on the Danish Island Fyn (NM 25787).

NM 25787

the temperature differs greatly due to the different position of the mould parts to the hottest point of the furnace. After checking the state of the melt, the mould is inverted to allow the molten metal to flow into the hollow form part (Armbruster 2000: 84-85; 1995a: 351f.). Thus, the form/mould in this method is also completely destroyed post-casting, as is the corresponding end of the crucible. A proof that the latter sequence was preferred while casting *cire perdue* cannot be given, however, the described and demonstrated method by Armbruster can be considered as a possible variation for prehistoric lost-wax casting.

Both working sequences presented in this section are known through ethnographic parallels and experiments, and can give the modern observer evidence of possible tools and resources. Neither process should be regarded as the ultimate, but the material evidence of the Bronze Age points towards casting processes with lost-forms and models of easily formable materials, which correspond to the described techniques.

On many artefacts studied within this work, clear traces of a production in a soft, deformable material could be documented. Additionally, it

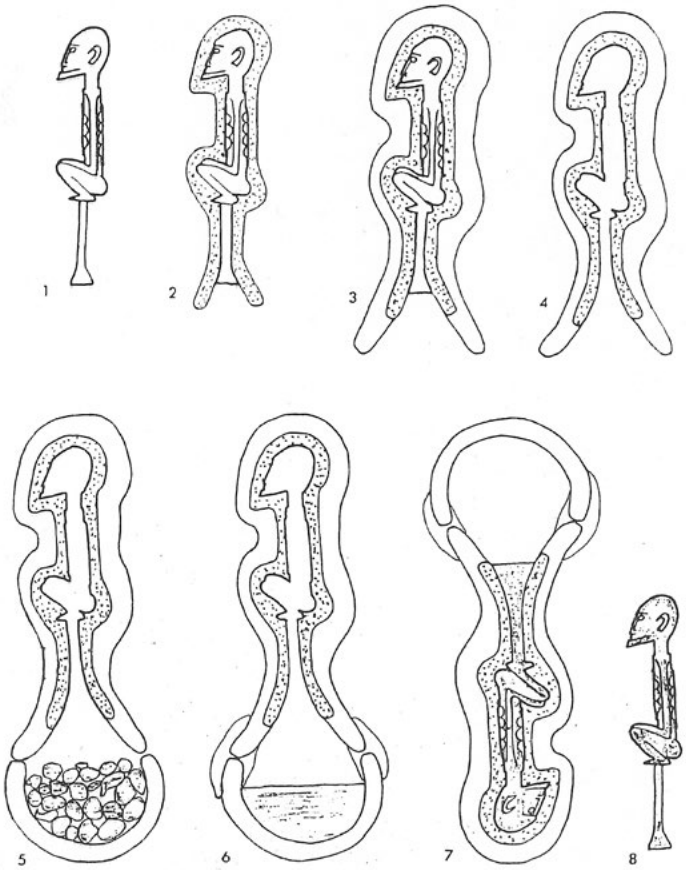


Figure 2.027: Variation of the cire perdue cast used in West Africa (after Armbruster 1995a).

was also possible to provide clear evidence of the cast of completely decorated models. On some belt discs and tutuli from the hoard in Vognserup Enge, the cleaning techniques of the farmers who found the hoard (Frost 2011: 8) have left stunning traces. On the surface of the tutulus (VM1680P) and the belt disc (VM1680KJ) fine dendritic (tree-like) structures are visible, also in the grooves of the decoration (Figure 2.028). Such a tree-like structure (dendritic) develops due to the segregation of the metals copper and tin, contained in the melt, during slow cooling. This structure is a definite proof for the casting of a decorated model. Within plastic deformation, as indicated by a working of the disc or adding the decoration with punches, the microstructure of the metal would be subjected to a conversion, and, instead of dendritic cast structure, crystal grains would

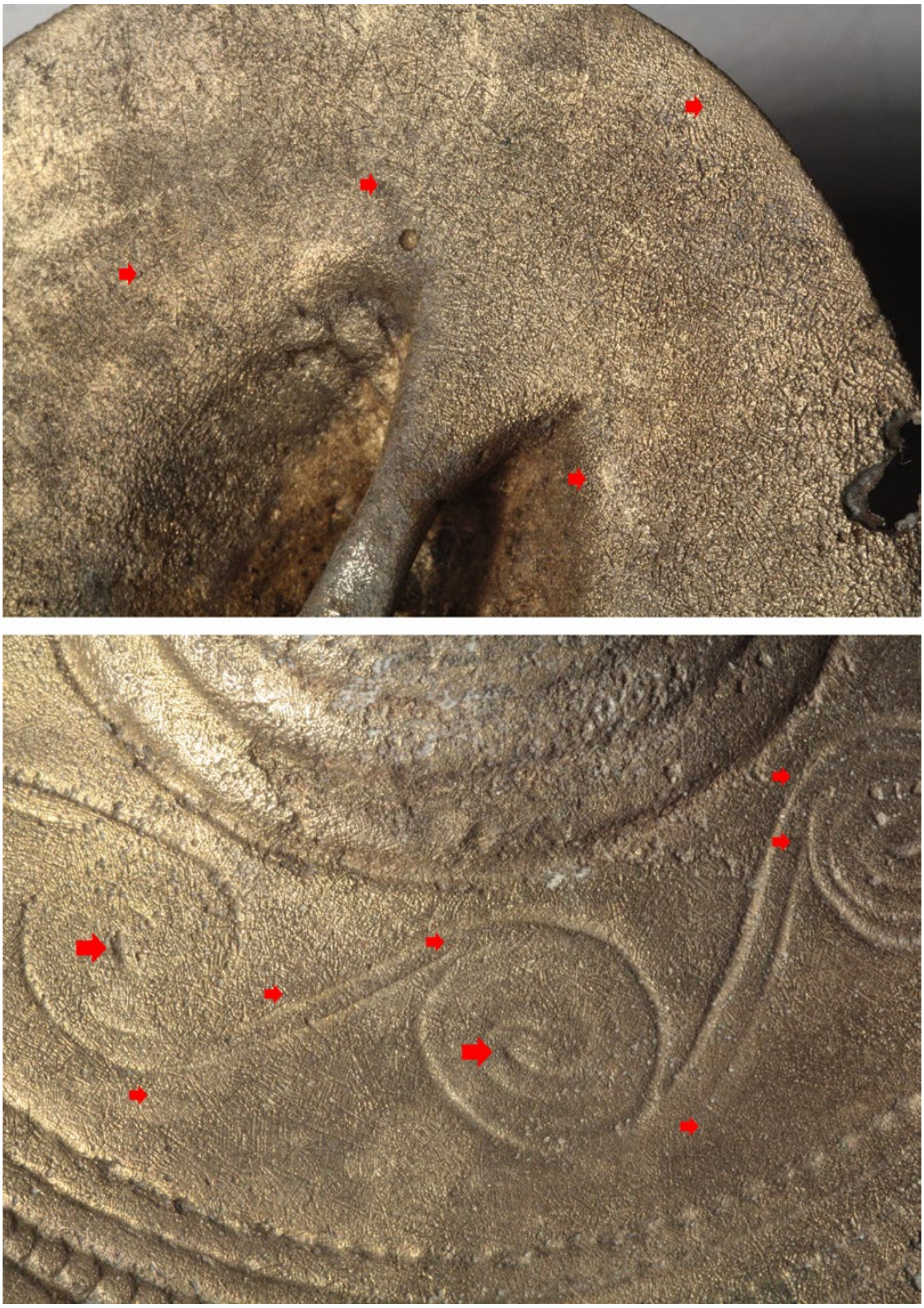


Figure 2.028: Dendritic structures visible on the surface of the belt disc VM 1680KJ.

Figure 2.029: Cast skin on the small belt discs from Vognserup Enge (VM 1680 AD and AH).

be visible with strain lines. Due to a chemical reaction on the surface of the above-mentioned artefacts, which probably happened while using acid fluids for cleaning, this otherwise invisible microstructure on the surface is an irrefutable proof for the casting of fully decorated models via *cire perdue*.[37] Also, the remaining bronzes of the Vognserup deposit show clear signs of pure castings when examined closely. Several discs display a very fine cast skin, which also appears unchanged in the indentations of the decoration (Figure 2.029), and others show the difference of reworked decorative lines next to those with a still intact cast skin (Figure 2.030).

Furthermore, the application of the humps already in the model could be detected on the belt disc VM 1680KL and a further disc belonging to the Molzen hoard in Lower Saxony (ML 242:84 g). The first disc

[37] See for the discussion about the possibility to cast decorated objects, those in favour: Rønne 1989; Rønne and Bredsdorff 2008; Koch 2000a; 2000b, and those against: Schwab *et al.* 2007; Savage *et al.* 1982.

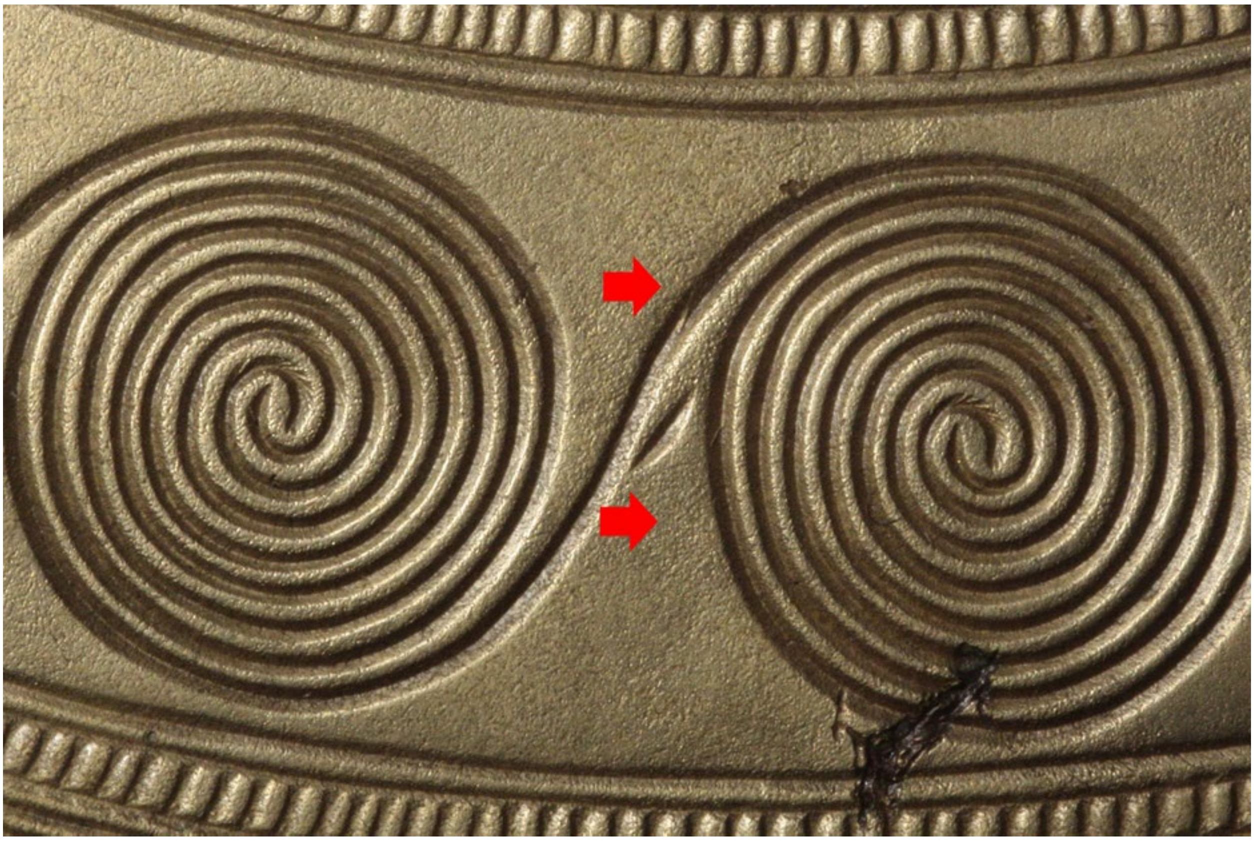


Figure 2.030: Difference between reworked and cast decoration on the a plate (VM1680KC) from the Vognserup hoard.

shows that the hump was pressed into the model as a large depression, roughly in the same way as one might imagine in metal. After casting, the weak indentations were then reworked with metal punches (Figure 2.031). This reworking is seen particularly clearly on the second disc from Molzen. The weak depression has a fairly porous casting skin, while the impression left by the punch, which was used for the deepening of the hump, is clearly distinguishable and partly caused stress cracks on the front (Figure 2.032). Thus, there are, while examining the ornaments closely, various evidences for the application of the decoration already to the wax model. In the same way, also, distinct traces of post-casting reworking can be detected.

Isolated fragments of moulds related to *cire perdue* cast could be occasionally recovered despite the reusability of the mould material and the almost complete destruction of the used forms. From an Early Bronze Age settlement in Grimeton, Halland (Oldeberg 1974: 196) the remains of a neck collar mould[38] are known, and in Denmark two fragments of moulds for the casting of tutuli[39] are preserved; however, the latter are from rather later in the Bronze Age (Jantzen 2008: 71).

Besides this, the material examined showed multiple direct references to the moulds, their construction and the tools used. Thus, on the small belt discs from Appel, Harburg in Lower Saxony (LMN 4769, 4770 and 4771) the use of a presumably bony or wooden cotter could be documented, which was incorporated into the model in order to stabilise the loop and secure the perforation during casting (Figure 2.033). On the figures the rounded edge of the auxiliary, and at the edges the accumulated material, is clearly visible. A similar implement was used to model the eyelet of disc NM 25789a from the Vellinge hoard (Figure 2.034). A small disc found in Molzen shows a cotter that was struck too far into the model and thus damaged it (Figure 2.035). The finished artefact thus has a perforated spike. On the basis of this error, the use of a cotter of organic material can almost be assured, since a similar ceramic placeholder would not have left so sharp-edged a perforation as seen on the Molzen disc. Another method frequently documented uses a rod-like implement that pierced a modelled torus, and was probably fixed in the mould in

[38] Another mould, which was described as the form of a neck collar (see Jantzen 2008: 63), can be determined after further investigation as a Late Bronze Age sickle mould.

[39] A fragment comes from a hoard near Kerte, Odense (NM B11288), another from a settlement area near Vindblæs, Aalborg (Års 542), within a stone ring (Jantzen 2008: 71).

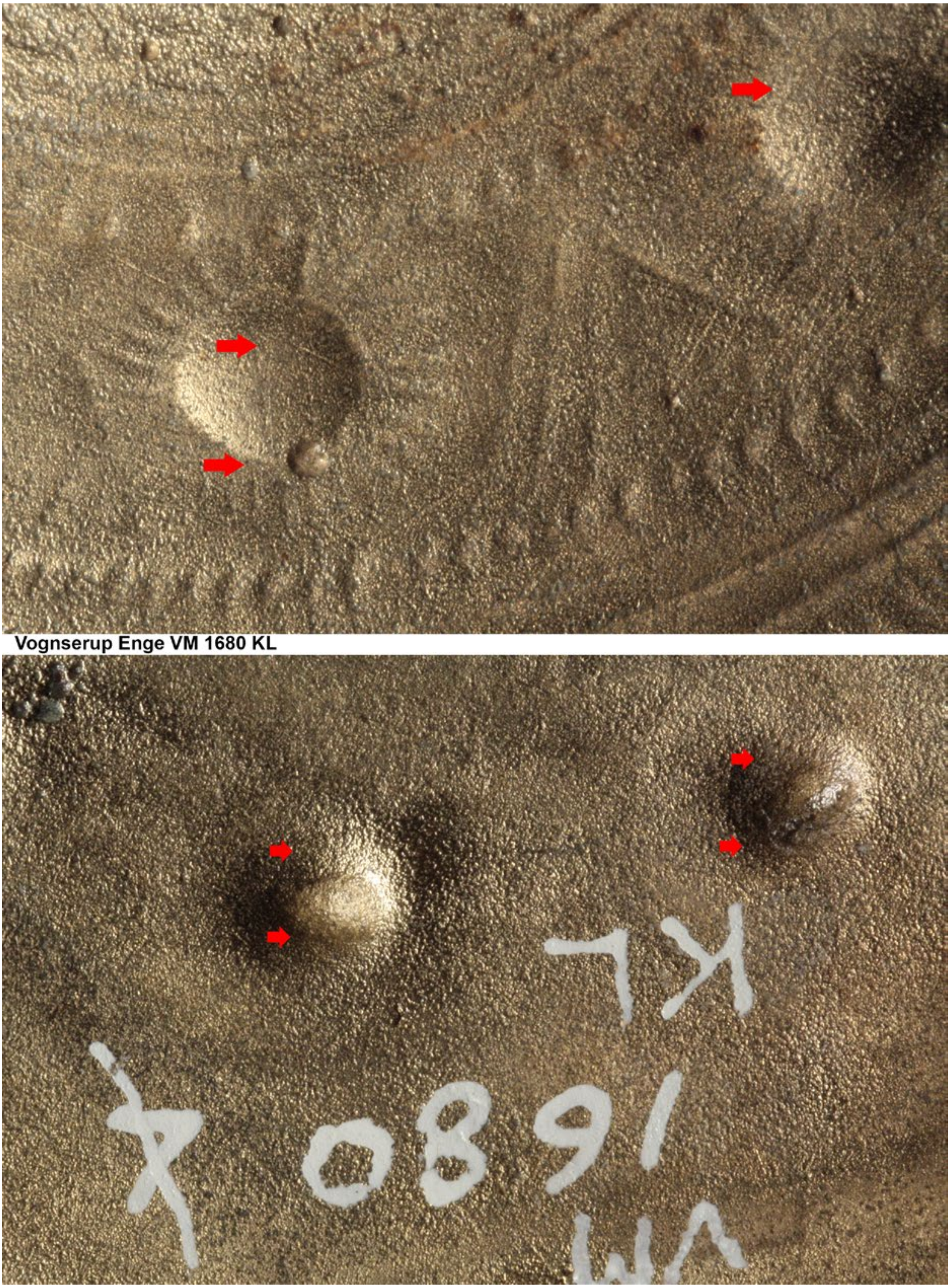


Figure 2.031: Cast (top) and reworked (bottom) humps of the belt disc (VM 1680KL) from the Vognserup hoard.

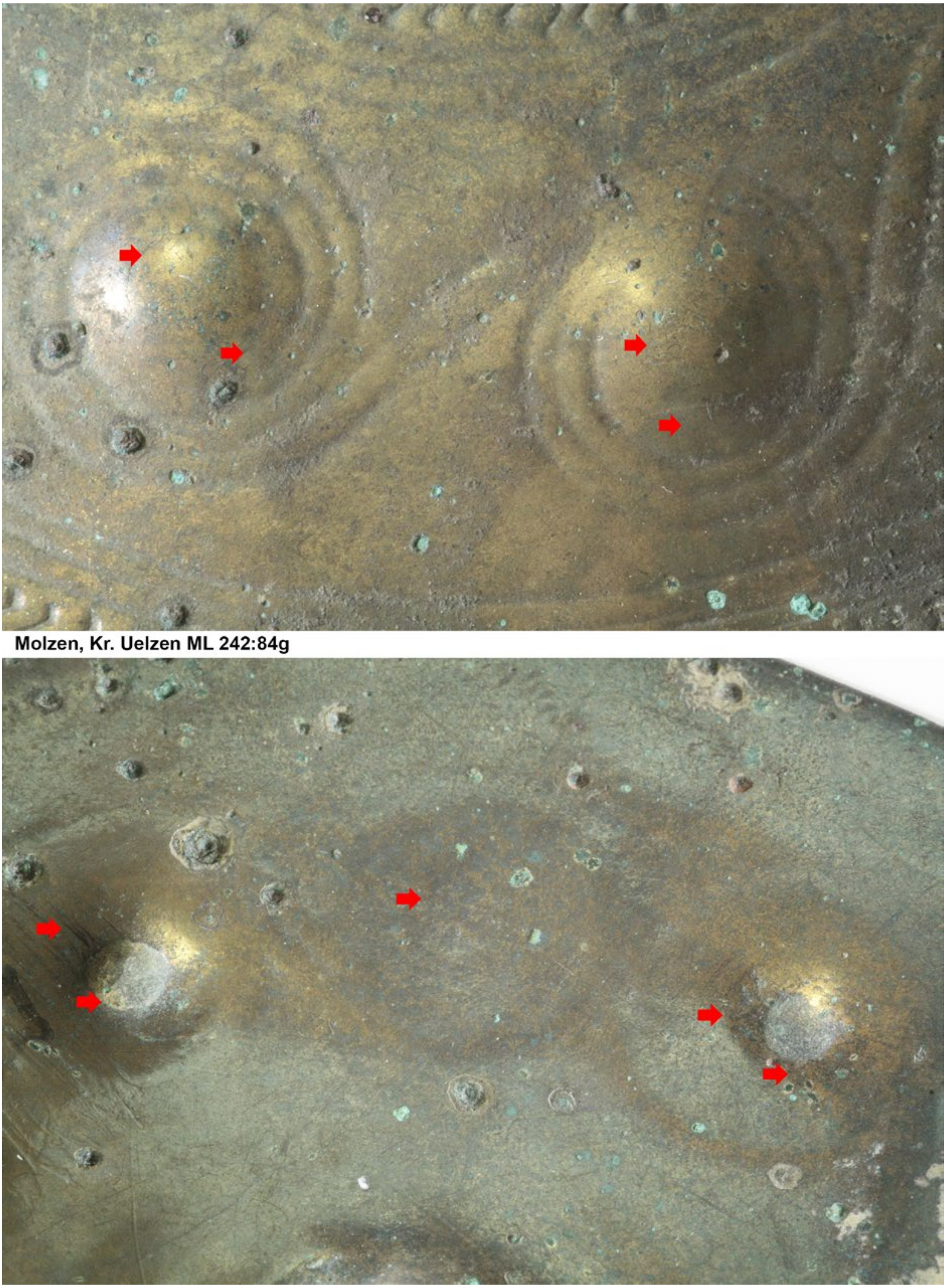
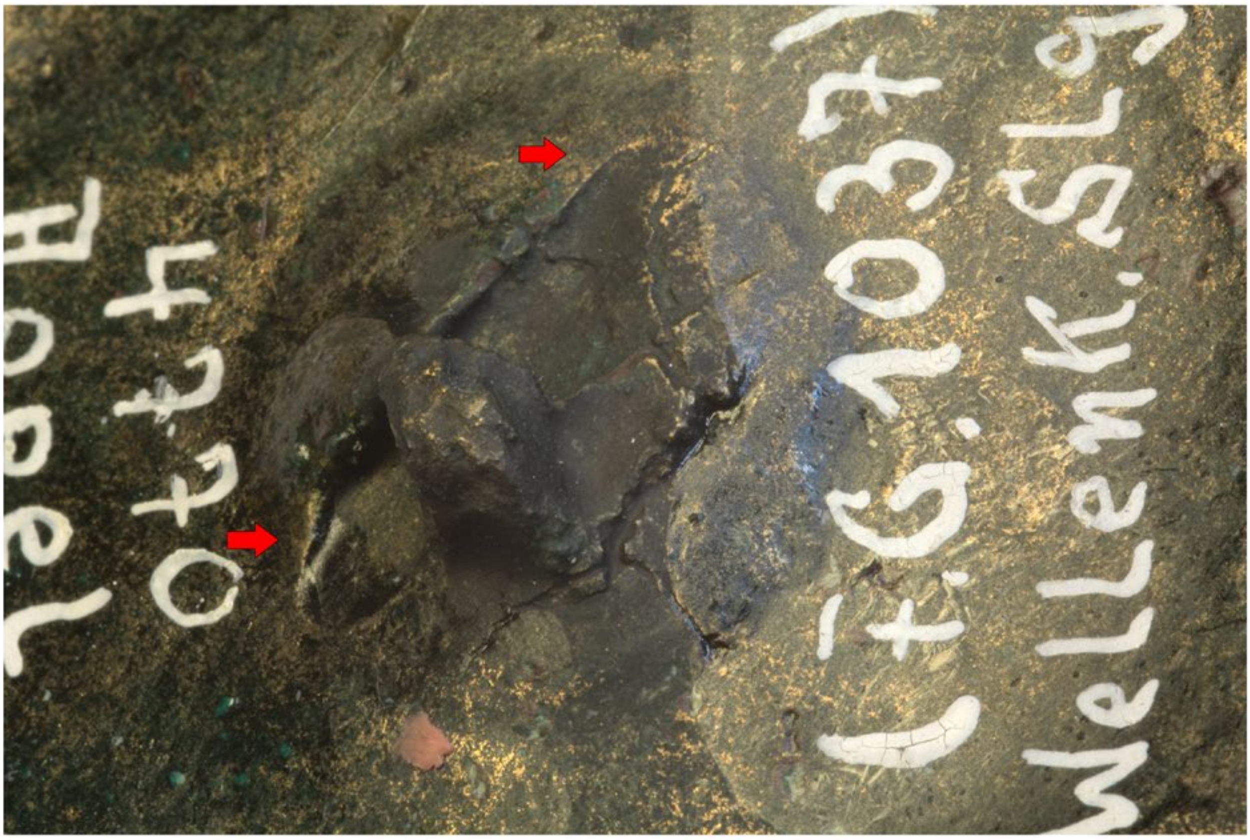


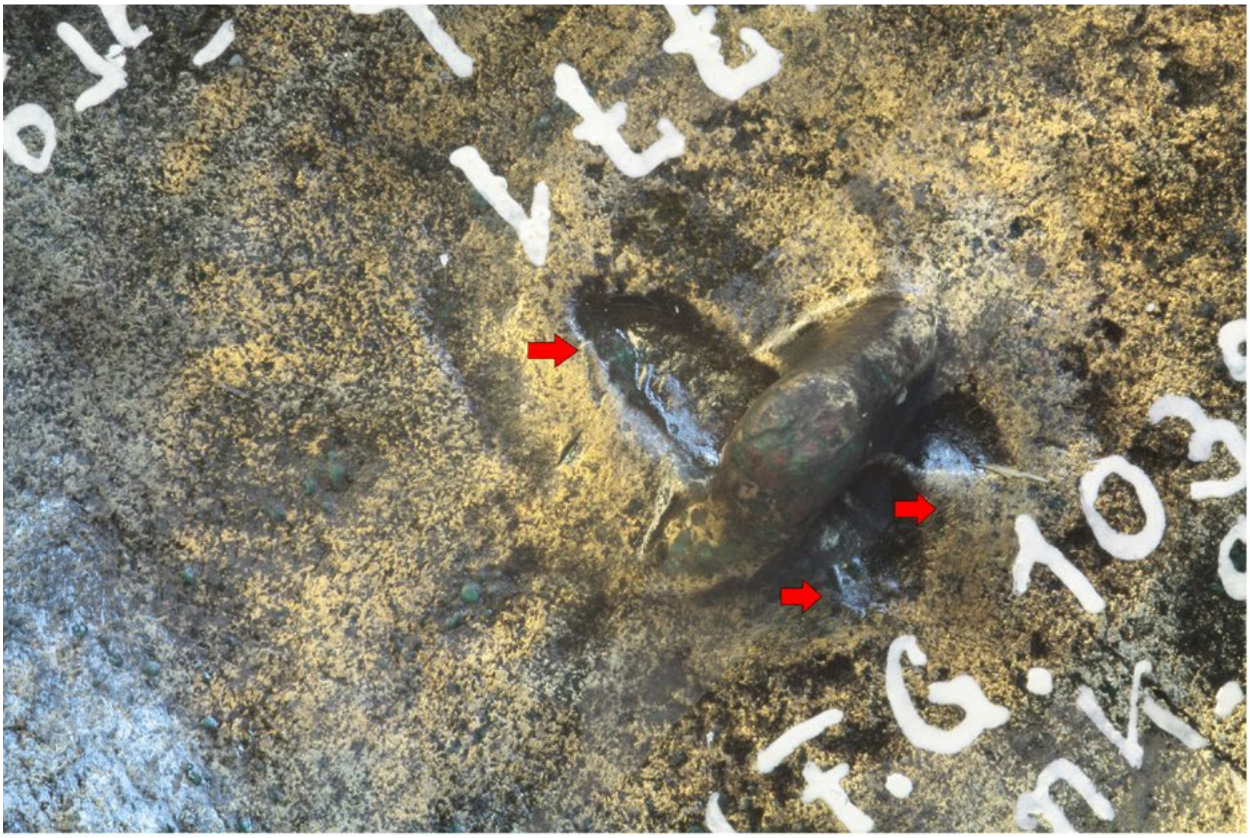
Figure 2.032: Difference between the weak hump impression with cast skin and the deep post-casting reworking of the belt disc from Molzen (242:84g).

Appel LMN 4769



Appel LMH 4770

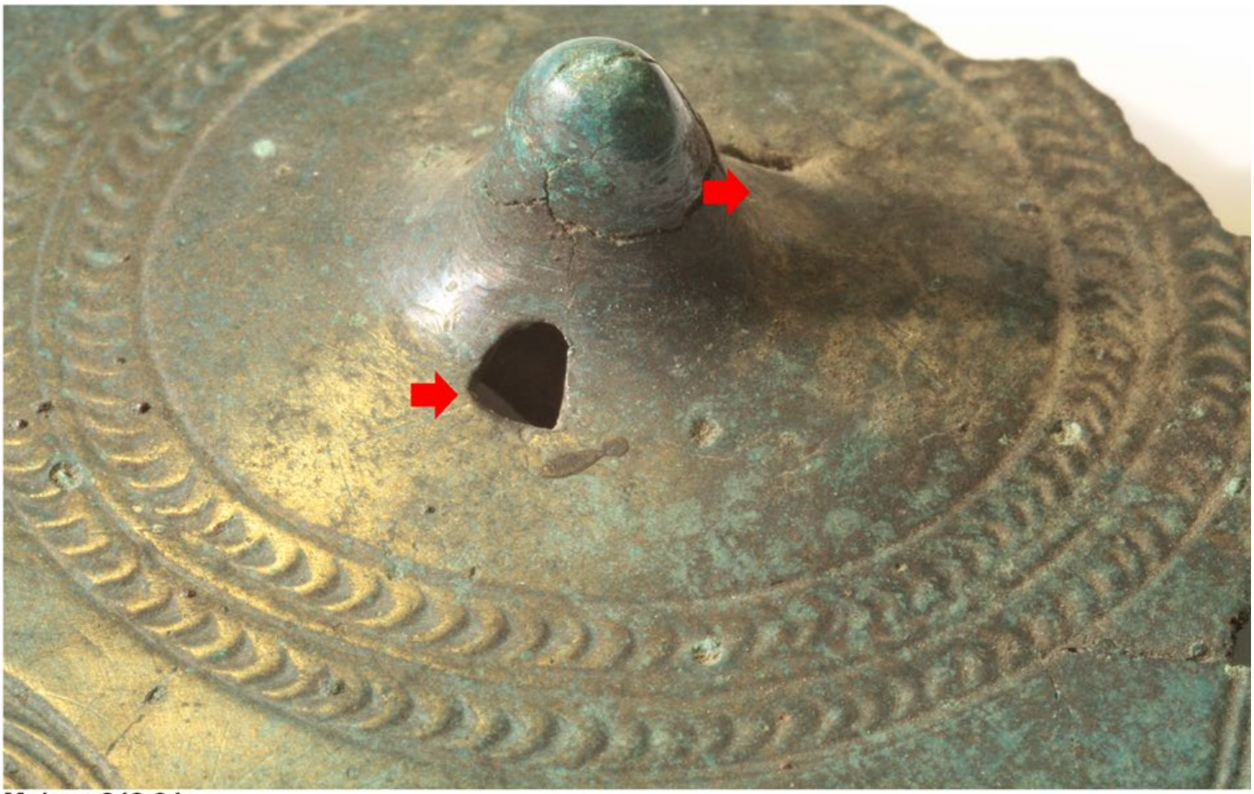
Figure 2.033: Use of organic cotter in making eyelets demonstrated on the belt disc from Appel, Kr. Harburg (LMN 4769 (top) and LMN 4770 (bottom)).



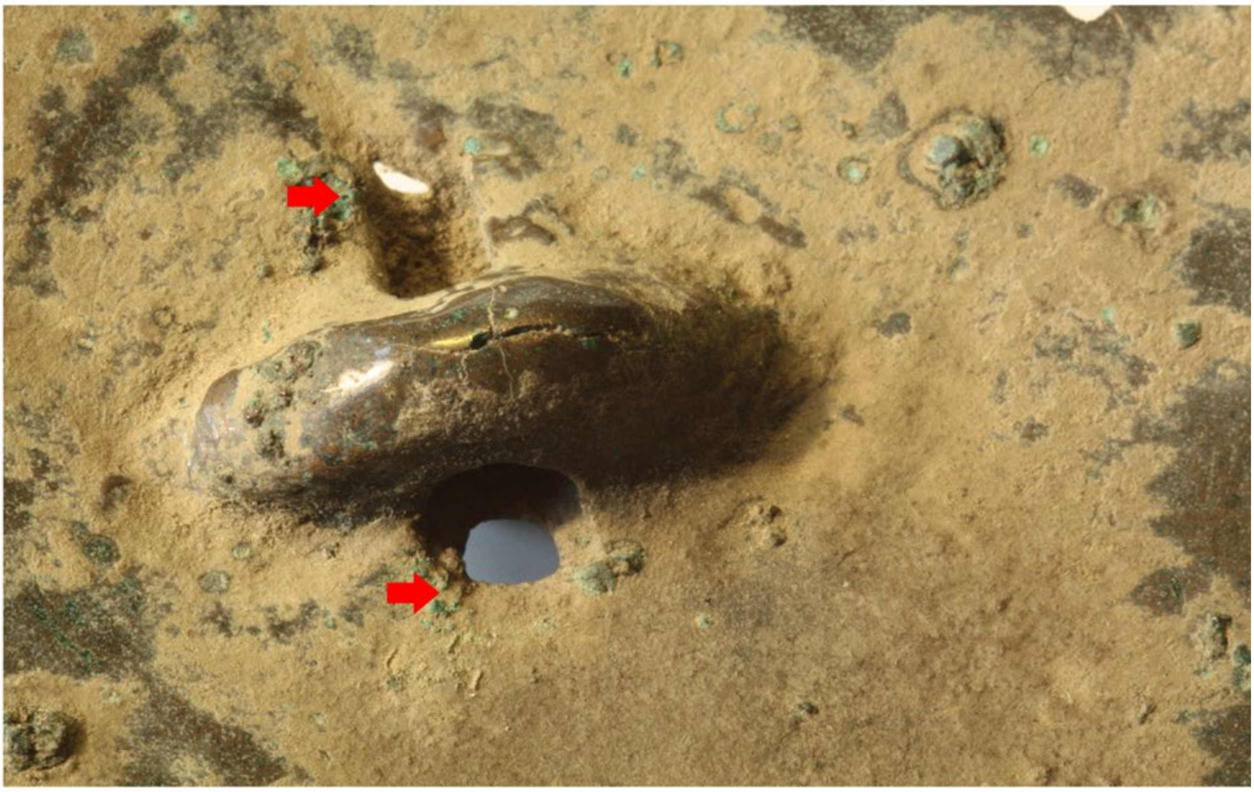
Appel LMH 4771

Vellinge Mose NM 25789a

Figure 2.034: Use of organic cotter in making eyelets demonstrated on the belt disc from Appel, Kr. Harburg (LMN 4771 (top)) and Vellinge Mose near Odense (NM 25789a (bottom)).



Molzen 242:84e



Molzen 242:84e (reverse)

Figure 2.035: Use of organic cotter in making eyelets demonstrated on the belt disc from Molzen (242:84e).

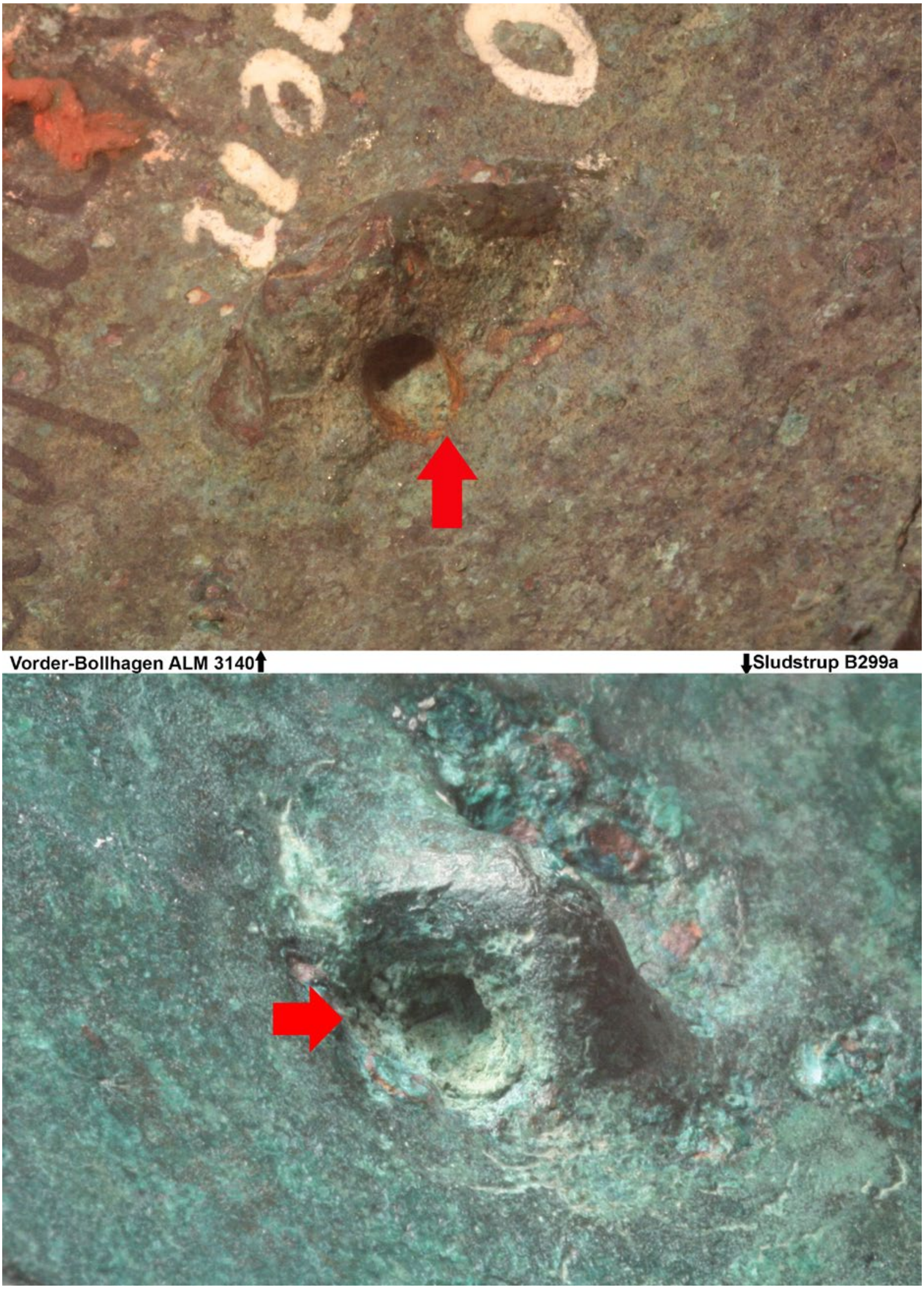


Figure 2.036: Use of a rod-like implement in making eyelets demonstrated on the belt discs from Vorder-Bollhagen in Mecklenburg (ALM3140) and Sludstrup, Jutland (NM B299a).

Svenstrup, Sorø Amt NM 10935a

Svenstrup, Sorø Amt NM 10938a

Figure 2.037: Residues of ceramic core material in the spike's interior of discs NM 10935a and NM 10938a from the Svenstrup hoard.

Svenstrup, Sorø Amt NM 10938b

Svenstrup, Sorø Amt NM 10938c

Figure 2.038: Residues of ceramic core material in the spike's interior of the NM 10938b and NM 10938c from the Svenstrup hoard.

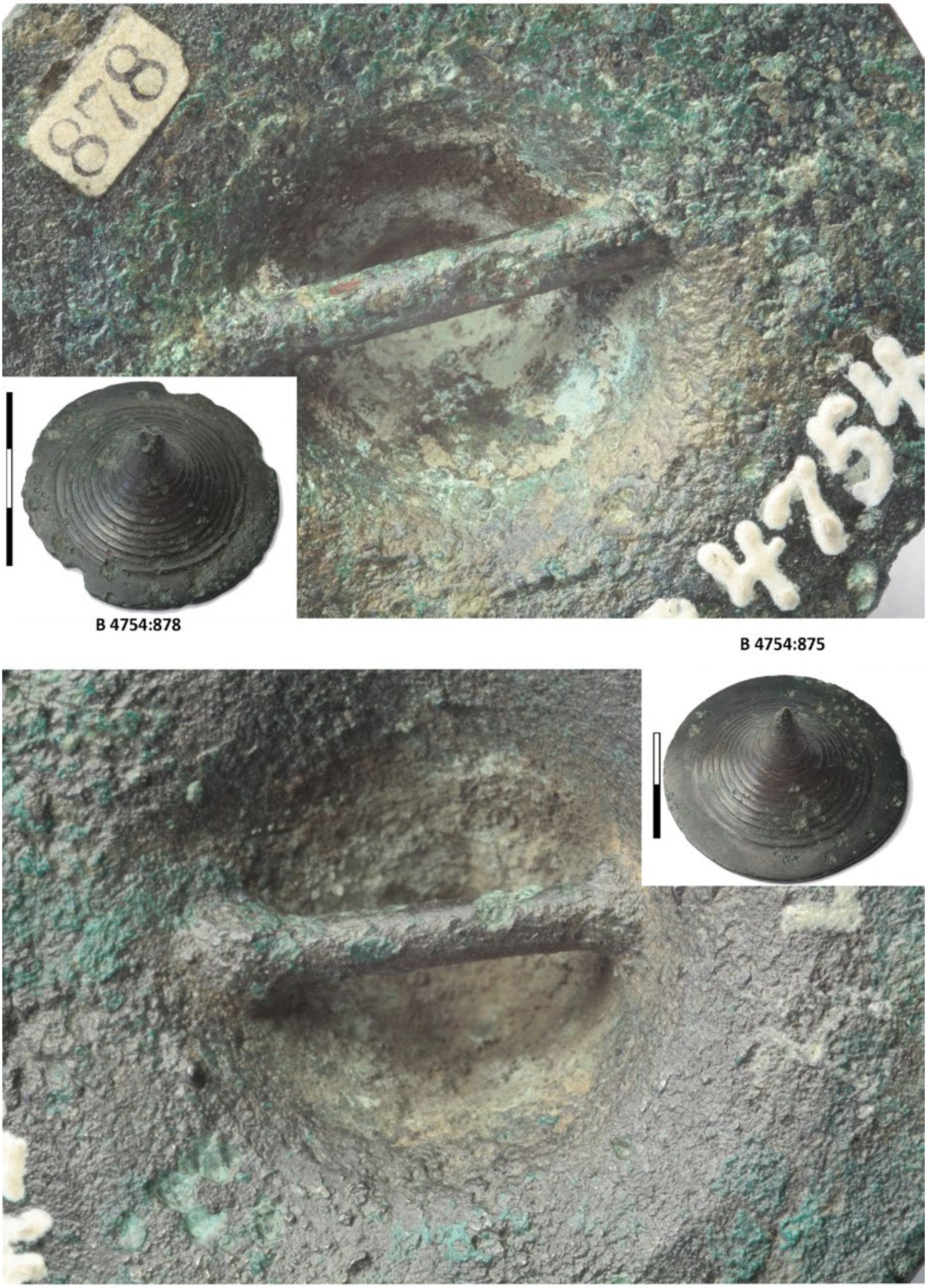


Figure 2.039: Characteristic traces for the use of ceramic cores in making eyelets shown on tuluti from the Vendsyssel hoard.

a similar way as the cotter and served during casting as the core (Figure 2.036).

In contrast to the belt discs or tutuli with solid spike, the small discs with hollow spike often hid the remains of core materials in the spike´s interior. Particularly well preserved are these predominant ceramic cores of the belt discs from the Svenstrup hoard (Figure 2.037-38). Analogously, rough-cast surfaces and undercuts in the hollow spike can be regarded as traces of poorly crafted ceramic cores and their irregular surface pattern, similarly documented for the tutuli from Vendsyssel on Zealand (Figure 2.039).

In summary, it can be stated that the lost-wax process seems to have been mastered to perfection in the northern European region. Even the casting of ornamented models and very thin and complicated objects seemed possible for the master craftsmen of the Nordic Bronze Age. However, was this method the 'main method' of the Bronze Age metalworker or can another technique be regarded as a potential candidate, as, for example, the repeatedly mentioned sand-casting technique?

Casting in sand (sand-casting)

Sand-casting is, similarly to lost-wax casting, a method where the form is lost after the cast. The prehistoric use of this method is highly controversial (pro: Götze 1925; Goldmann 1981; 1985; Born and Hansen 2001; Ottaway and Seibel 1997; 59; Wang and Ottaway 2004; 9; contra: Drescher 1958; Armbruster 2000) and the first definitive evidence for artefacts produced via sand-casting dates to the Middle Ages (Armbruster 2000: 88).

Using this method, a model, be it of wood, stone, metal or wax, is forced into a specially prepared moulding sand. This moulding sand is placed in a solid form, possibly a wooden box not much larger than the desired object. Studies of historical moulding sand mixtures (Fasnacht 1995b; Born and Hansen 2001) suggest a mixture of sand, clay, animal dung, brick powder and fat, which are enriched with oil or water (Brepohl 1996: 157-158). It can be assumed that charcoal, carbon black, graphite or chalk were used as release agents and were scattered on the halves of the mould, to allow a re-opening of the mould without damage. One half of the model is pressed into the moulding sand and the necessary release agent applied,[40] then the second half of the sand mould is pressed on the object. To prevent slippage of the two mould parts and to secure the exact fit of every half after removal of the model, pins or similar fixing aids are placed in the moulding box. After the model has been removed, small improvements on the form can be carried out and the sprue can be formed. The major advantage of sand-casting can be seen in the air-permeable mould material. Due to this, the otherwise necessary air pipes can be omitted, since the air can escape through the porous material (Born and Hansen 2001; Armbruster 2000; Brepohl 1996). As air pipes subsequently must be removed from the cast piece, as well as any resulting parting lines, artefacts produced via sand-casting could be recognised in the archaeological material because they show no signs of the these features. That casting seams are still recognisable even after removal, either as a slight increase or as a contrasting track, could be demonstrated by Born regarding the shaft-hole axe and socketed axes, produced in bronze moulds (Born and Hansen 2001: 219). The same can be assumed concerning the air channels and thus the absence of such air channel traces could be used as one possible argument for the presence of casting in a lost-sand mould. However, this assumption is pure speculation, and even if possible traces could be interpreted as related to this technique it is not this present author's intention to say that sand-casting was used in the way described above in Bronze Age Europe.

Nevertheless, in current research, more and more scientists open up to the possibility that sand-casting was an alternative technique to those already determined to have been Bronze Age casting methods (Born and Hansen 2001; Goldmann 1981; Goldmann 1985; Ottaway and Seibel 1997; Müller-Karpe 1990). Thus, Born underlines the possibility that sword blades up to 80 cm in length may have been produced using sand-casting. Due to the lack of moulds with which a serial production of swords, which seems quite acceptable in the Bronze Age, would be feasible, he believes that lost-wax as well as sand-casting techniques were used to make the blades. As an example he discussed the few stone moulds found for leaf-blade swords. These forms, up to 80 cm in length, face high risks, as it was 'einfach zu riskant, zu unkontrollierbar und damit undurchführbar' to use such stone moulds, in contrast the 'sehr langen Tonformen... (der Verfahren in verlorenen Formmaterialien)...einfach durch Holzverstärkungen hätten gestützt werden können' (Born and Hansen 2001: 202-204).[41] Born also assumes that tang-sickles might have been cast in sand moulds in addition to the identified castings in two-part moulds (Born and Hansen 2001: 208).[42] Additionally, Klaus Goldmann (1981) advocated for the presence of sand-casting; he even postulated that the sand-casting process should be regarded as the main method of Bronze Age metalwork. His assumptions are based on a discovery within a large bronze vessel from Seth,

[40] Here, Born mentioned that greasy sand mixtures render a release agent probably unnecessary (Born and Hansen 2001: 206).

[41] '... just too risky, too uncontrollable and therefore impracticable... very long clay moulds ... (of the lost-form cast type) ... could have been supported simply by wooden reinforcements...'

[42] Unfortunately the quoted sources 'prehistoric and early historical research' (Born and Hansen 2001: 208) cannot be traced back and therefore his statement should be seen with a critical eye.

Schleswig-Holstein, which contained the remains of moulding material consisting for the most part of sand. Thermoluminescence studies confirmed a heating of the material inside the vessel of 800 °C (Goldmann 1981: 109).

According to Born, sand-casting would be 'könnte man ihn heute bereits naturwissenschaftlich unkompliziert an den Funden nachweisen, tatsächlich als das einfachste und effizienteste Gussverfahren der Vorgeschichte zu beschreiben' (Born and Hansen 2001: 205).[43] Many recent publications, however, reject this method, pointing to the fact that sand-casting is a modern casting method and there is no prehistoric evidence for the existence of such technique (Armbruster 2000: 88; 2001; Jantzen 2008: 156).

However, the proof of sand-casting in prehistory might only be a question of definition. The analysis of the mould fragments found in Brejning and Morsum in Jutland carried out by Jantzen showed that the clay used was tempered to 90%, which. according to Jantzen. is nothing else than sand mixed with a binder supported in an additional layer by less tempered clay (Jantzen 2008: 314).

As such, sand-casting in moulding boxes, as it is known in modern casting, is undetectable in history. However, the use of moulding sand is quite likely, and confirmed by the mould fragments from Jutland (Jantzen 2008: 314) and probably also through surface structures on cast objects (Müller-Karpe 1990: 190-191).

Next to the commonly used cast via *cire perdu*e method, another technique might have been frequently used due to its great potential. Two-part moulds consisting of a very fine inner structure of up to 90% sand would have replicated the impressed model exactly. Here, the possibility of adding decorative elements in the moulding sand should be investigated. On the other hand, bronze objects could have been reproduced and a possible decoration could have been hidden by reworking the impression in sand. In this way not only bronze copies of an already existing artefact could be created, but also wax copies for further decoration via *cire perdue*. When this form is built with care, then it could have been reused to cast several identical models (reuse by producing wax models is rather likely). A two-part ceramic mould of this kind would leave nearly no traces in the archaeological record.

2.5.2 The cast-on technique ('Überfangguss')

The cast-on technique is a developed version of the lost-wax technique and used primarily to cast extravagant bronzes, and, therefore, it should be seen as a decisive factor in the quality of the pieces. This technique has some characteristic features which can, when known, be seen on the material.

Before presenting new insights gained through the examination of the artefacts in focus, the technique itself demands explanation. 'Cast-on' means the mechanical connection of two cast pieces by embracing or clasping these two parts through a third part that is subsequently cast on. This technique is mainly used to produce large, complicated artefacts and often viewed as a repair technique. In most cases, however, the cast-on technique is deliberately chosen to craft such special items more quickly and easily, where otherwise it would need an extraordinary mould construction (Drescher 1958; Armbruster 2000). This chapter discusses mainly the cast-on technique as a process in creating the artefact (crafting). However, many objects repaired through the cast-on technique can be documented, and these highlight the importance of the technique. They are, however, treated separately.

The cast-on technique may be applied as a variant of the lost-wax method or using two-part moulds. In the north, a dominance of cast-on via *cire perdue* is emerging, in contrast to south Germany (central Europe) where the use of two-part moulds is especially common in the Urnfield period for pin production (Drescher 1958: 35-44). A first occurrence of artefacts crafted using the cast-on technique, north of the German central mountains, can be seen in Early Bronze Age triangular daggers with cast-on handles. A good example might be the dagger from Wismar in Mecklenburg (Figure 2.040). Far better known, however, are the halberds (Stabdolche); their developed forms have blades fixed through the cast-on technique (Drescher 1958: 30-33). For the crafting of bronze ornaments in central Europe the cast-on technique can be documented with the Tumulus culture; here, as well as in later periods, pins especially were made via cast-on. However, in northern Germany and Scandinavia it seems that this technique was first extensively used coinciding with the advent of large belt plates in NBA II (Drescher 1958: 44-47).

Drescher´s studies concerning the cast-on technique (Drescher 1958) resulted in detailed working sequences of artefacts crafted in such a way. An example is provided with the belt plate from Grabow in Mecklenburg, which enabled Drescher to reconstruct the complete sequence due to a partially defective cast (Figure 2.041). Thus, the piece which should be combined with the already crafted bronze disc (here the spike) was modelled in wax and attached to the bronze; then the mould was constructed around the object. This should be done with great care, as explained above when referring to the lost-wax technique. However, of special importance is that the mould should cover enough of the bronze

[43] '...could this method be proved scientifically straightforward on the finds, be actually described as the easiest and most efficient casting techniques of history...'

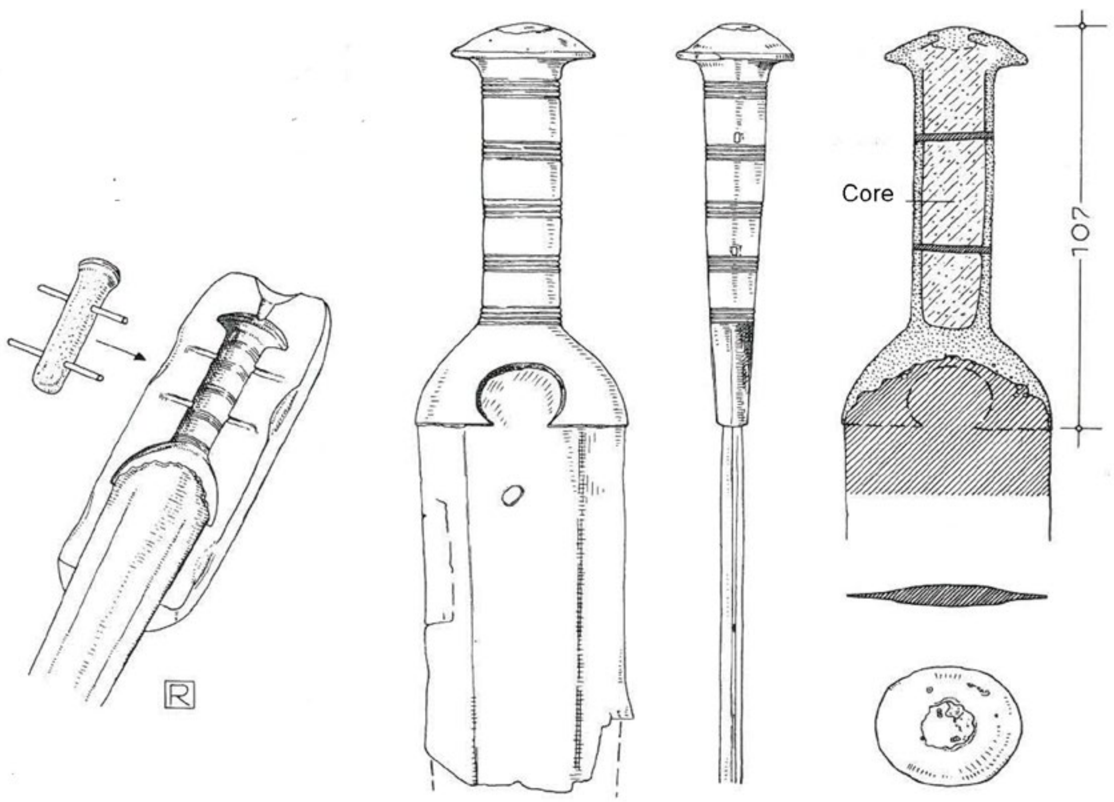


Figure 2.040: An example of an Early Bronze Age triangular dagger from Wismar with cast-on handle (after Drescher 1958: T.3).

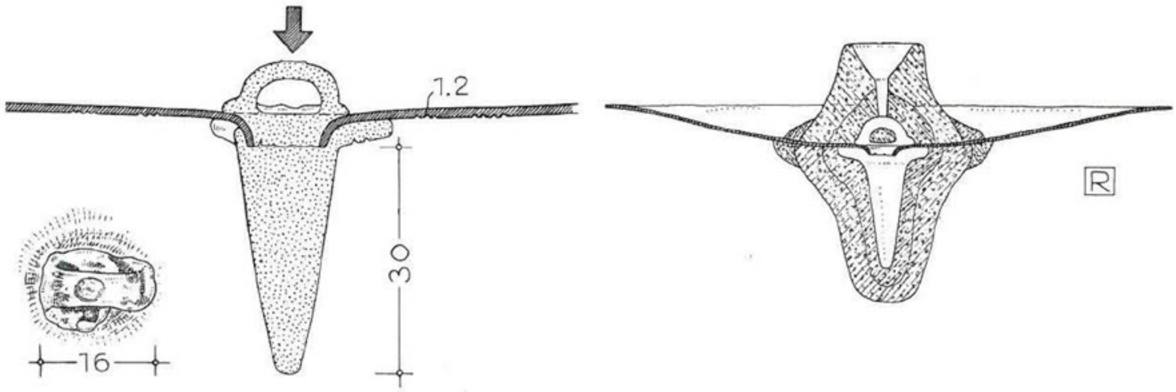


Figure 2.041: Belt plate from Grabow in Mecklenburg was made using the cast-on technique (after Drescher 1958).

plate, but not cover it completely (Drescher 1958: 6). When the mould is heated and the wax removed, then the metal disc is surrounded by the hollow model of the spike. While casting, the disc is embraced by the liquid metal. The resulting connection of the parts is not metallic, that is, the two parts are only connected due to undercuts, indentations or perforations (Armbruster 2000: 85) – they are not soldered or melted. Thus, especially while crafting the big plates, a pre-cast bulging (as seen in Figure 2.041 in the spike) is important to ensure that the compound is stable. In the case of the Grabow belt plate (Figure 2.042), a 12 mm hole was punched in the plate, resulting in an outwards bulging of the edges and emergence of partial cracks (Drescher 1958: 45).

A total number of ten almost completely preserved belt plates could be examined within this study, where the spike was attached via cast-on. The actual number of large plates where the casting method described

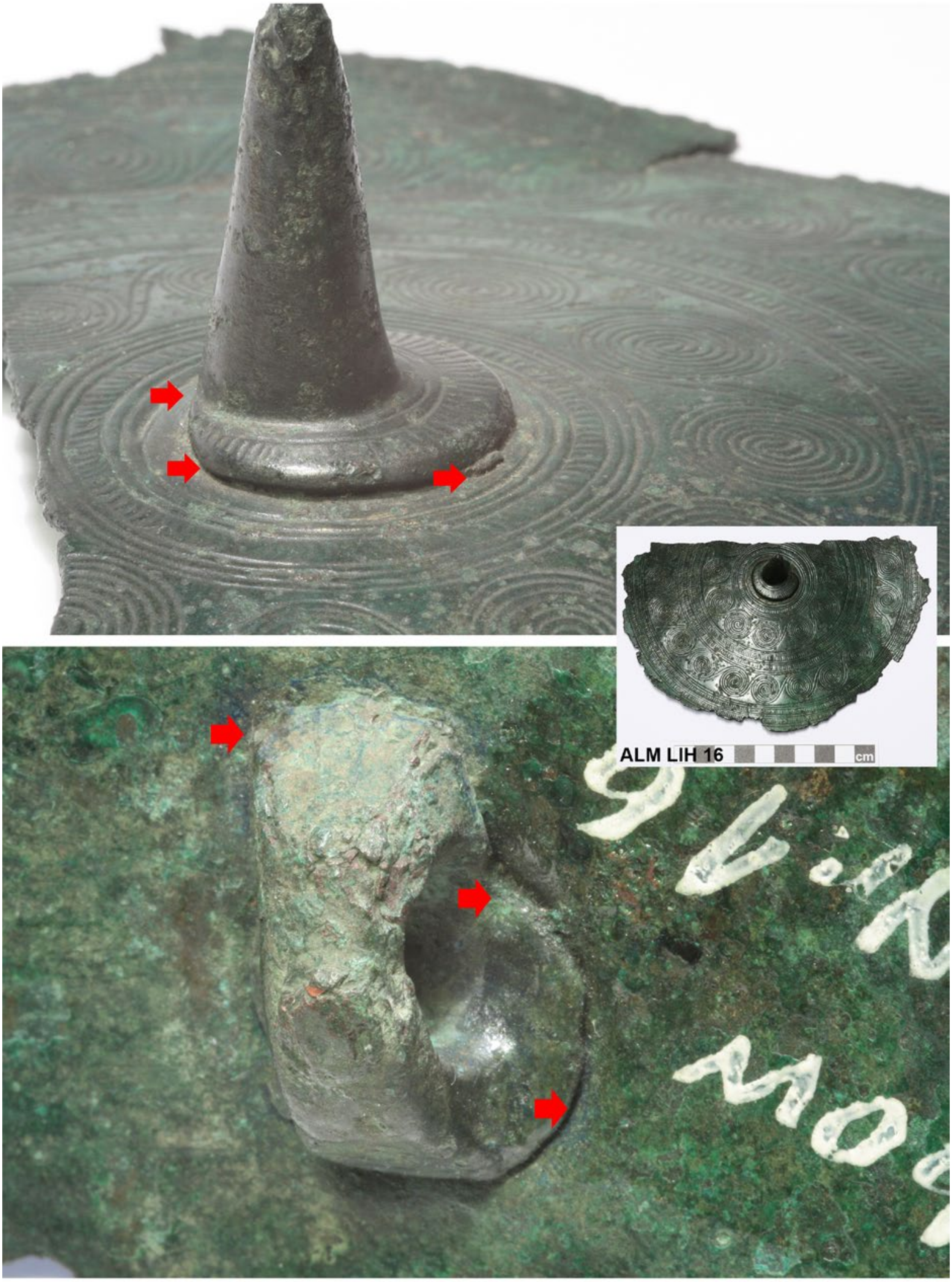


Figure 2.042: Cast-on technique shown on the belt plate from Grabow in Mecklenburg (ALM LIH 16).

Map 09: Distribution of artefacts made via cast-on technique during NBAII and III.

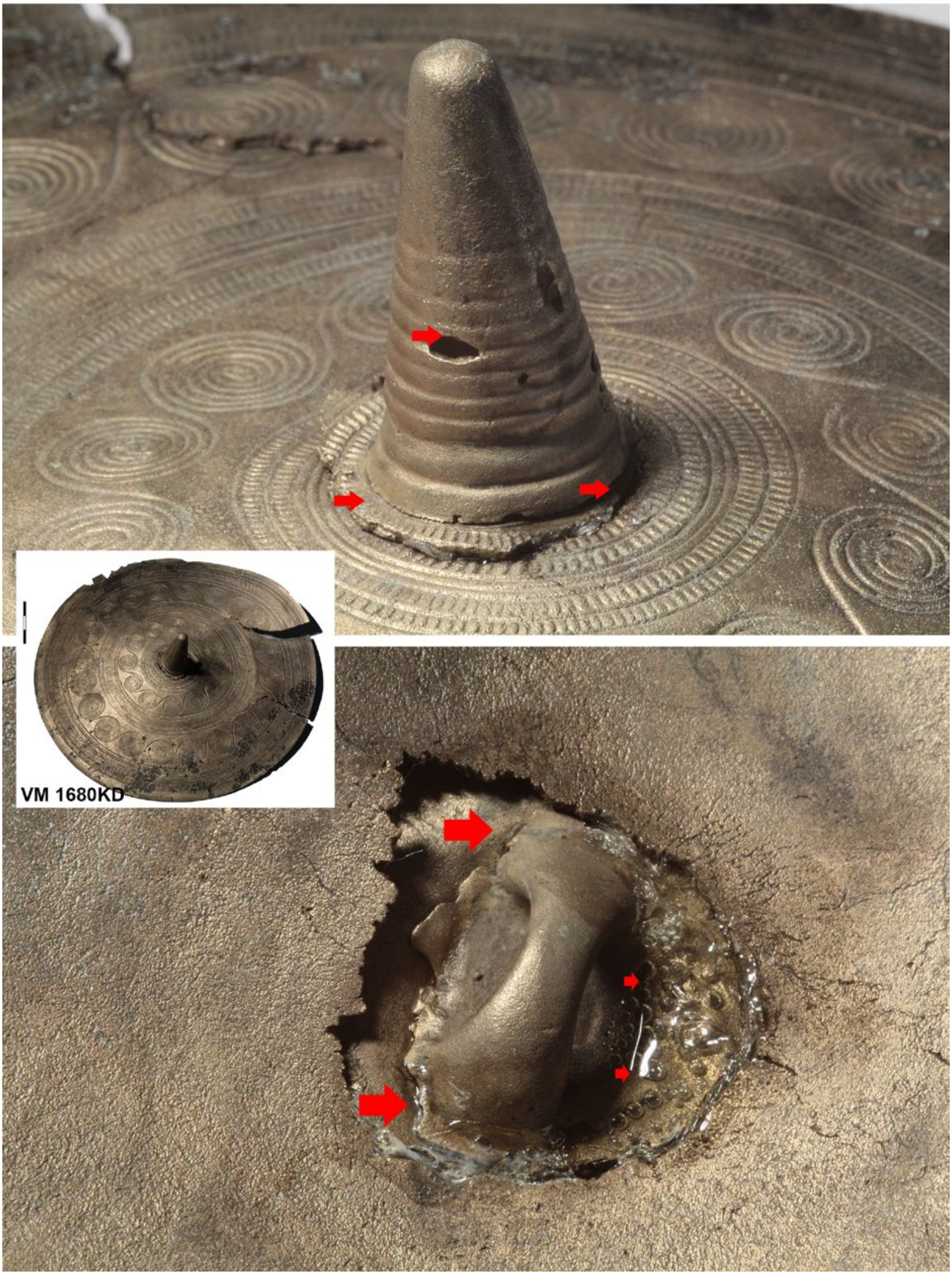


Figure 2.043: Cast-on technique shown on the belt plate (VM 1680KD) from the Vognserup hoard.

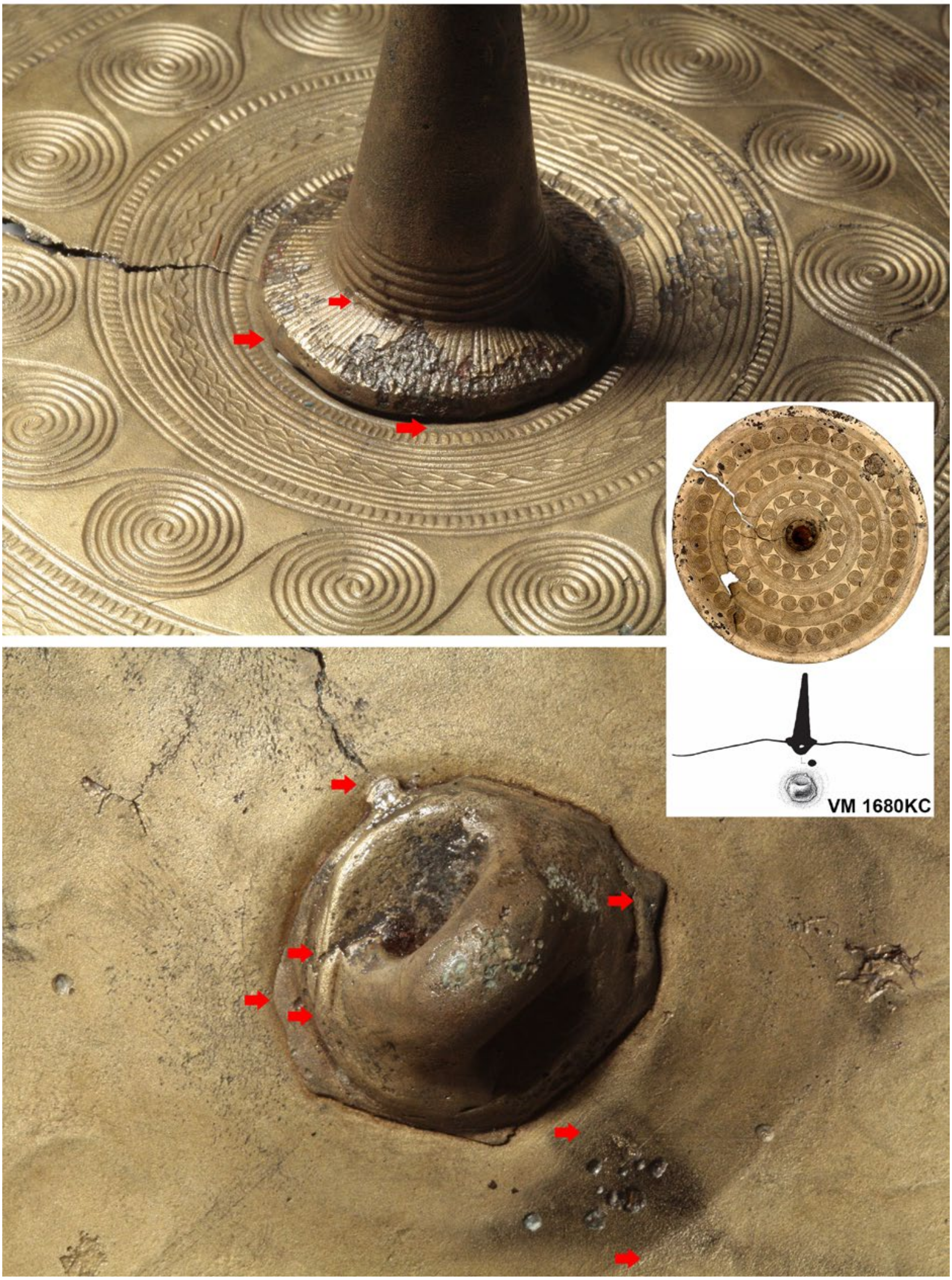


Figure 2.044: Cast-on technique shown on the largest belt plate (VM 1680KC) from the Vognserup hoard.

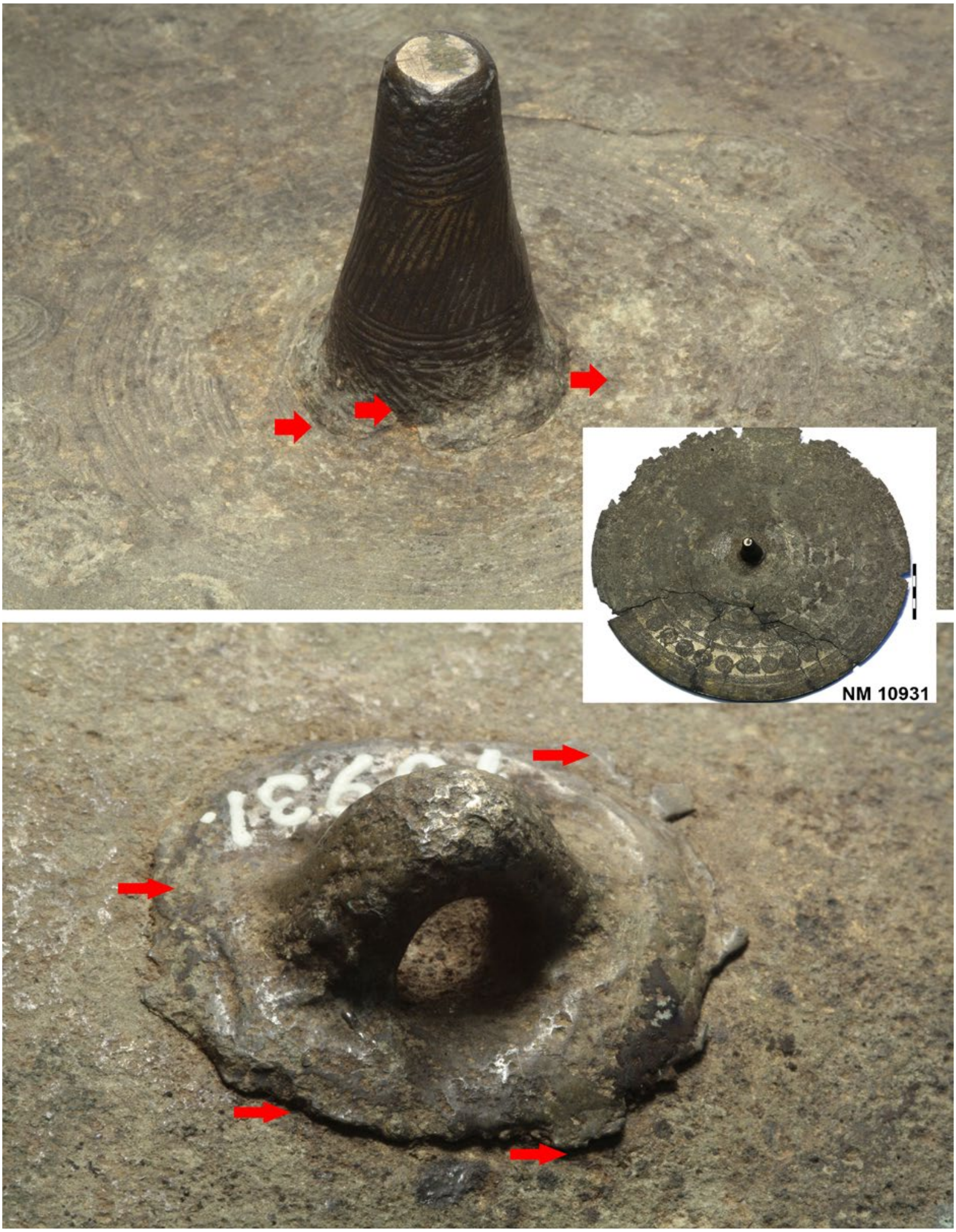


Figure 2.045: Cast-on technique shown on the largest belt plate (NM 10931) from the Svenstrup hoard.

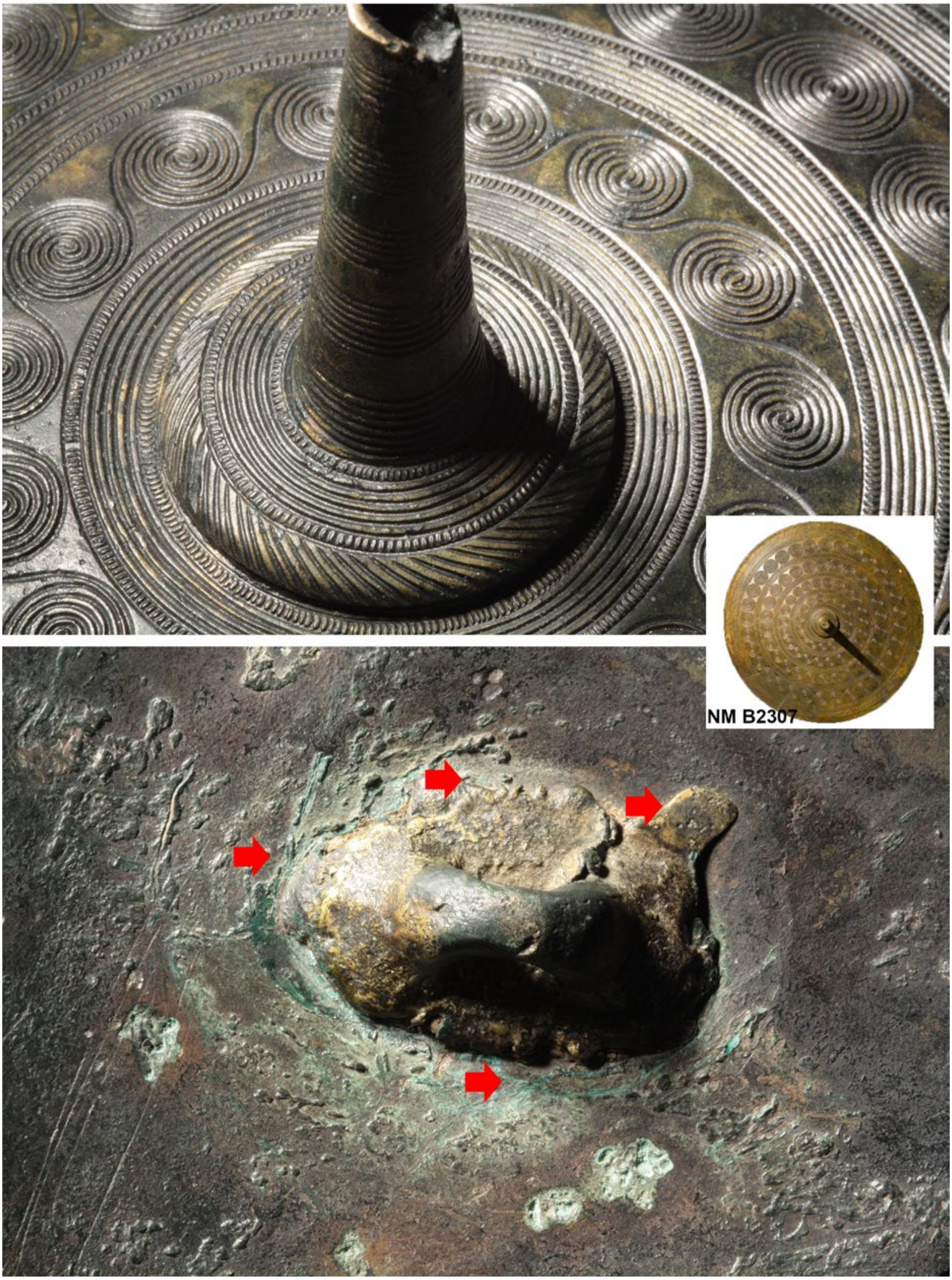


Figure 2.046: Cast-on technique shown on the belt plate from Langstrup (NM B2307).

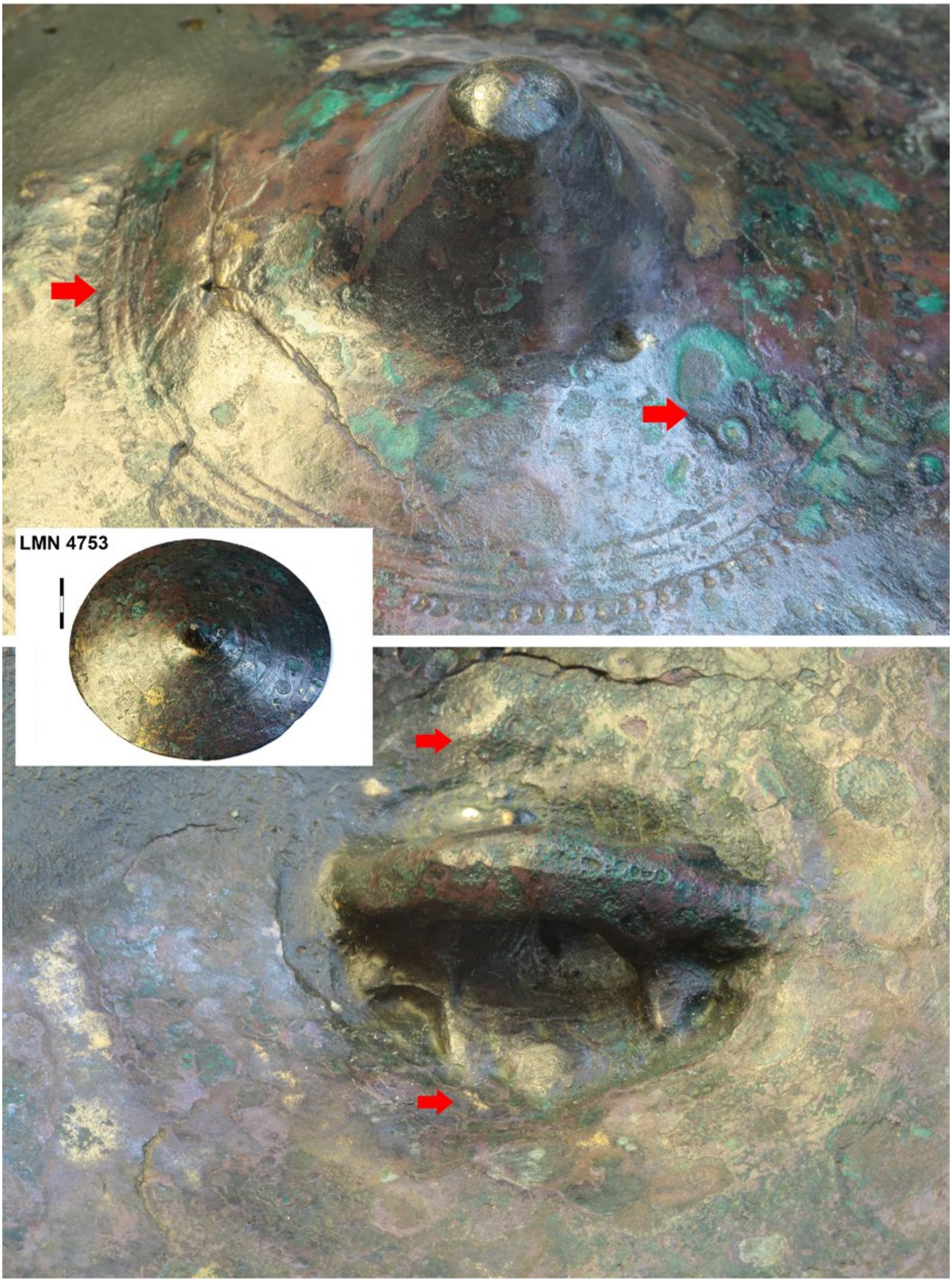


Figure 2.047: Cast-on technique shown on the belt plate from Gollern (LMN 4753).

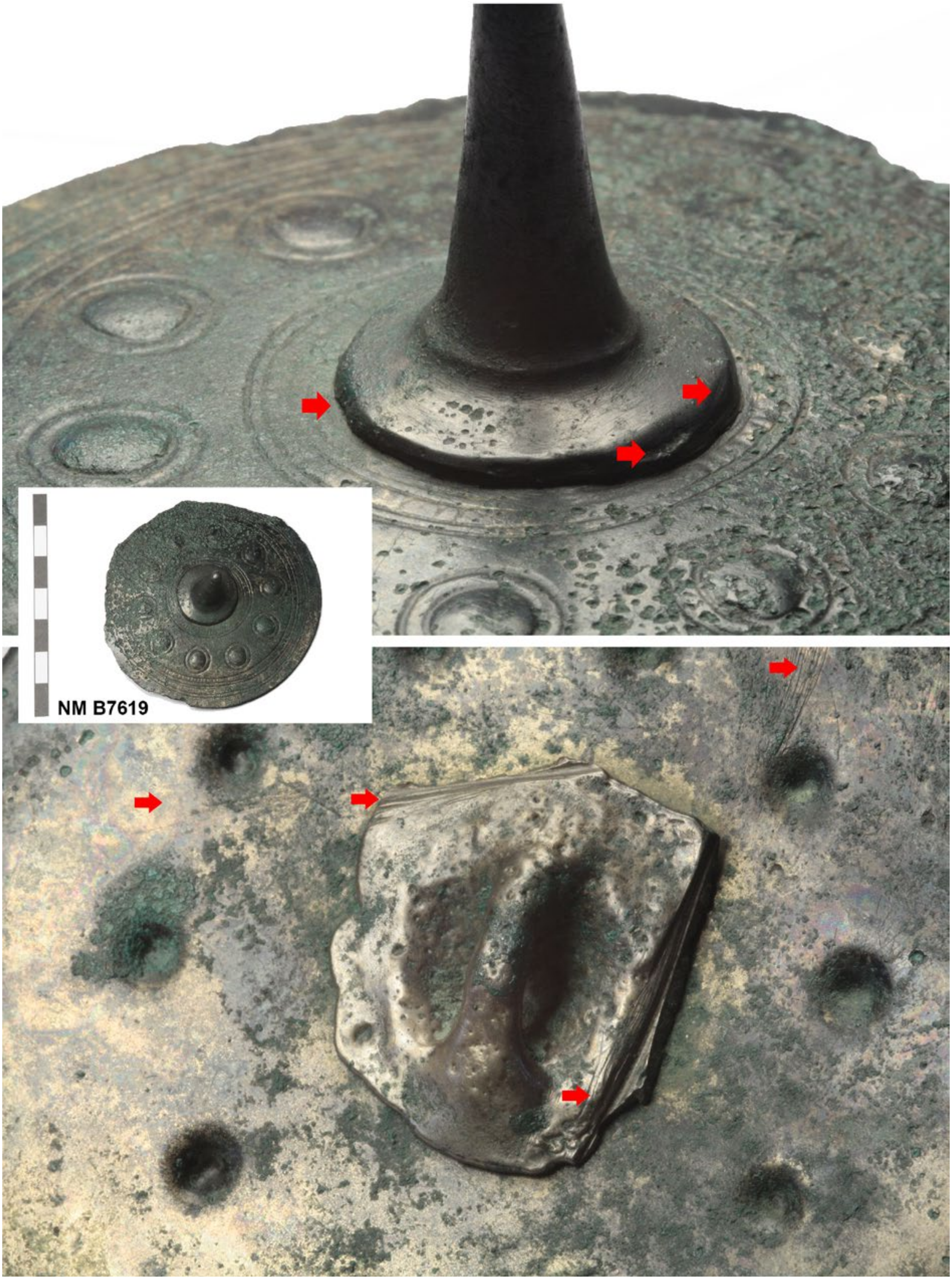


Figure 2.048: Cast-on technique shown on the belt plate from Rye (NM B7619).

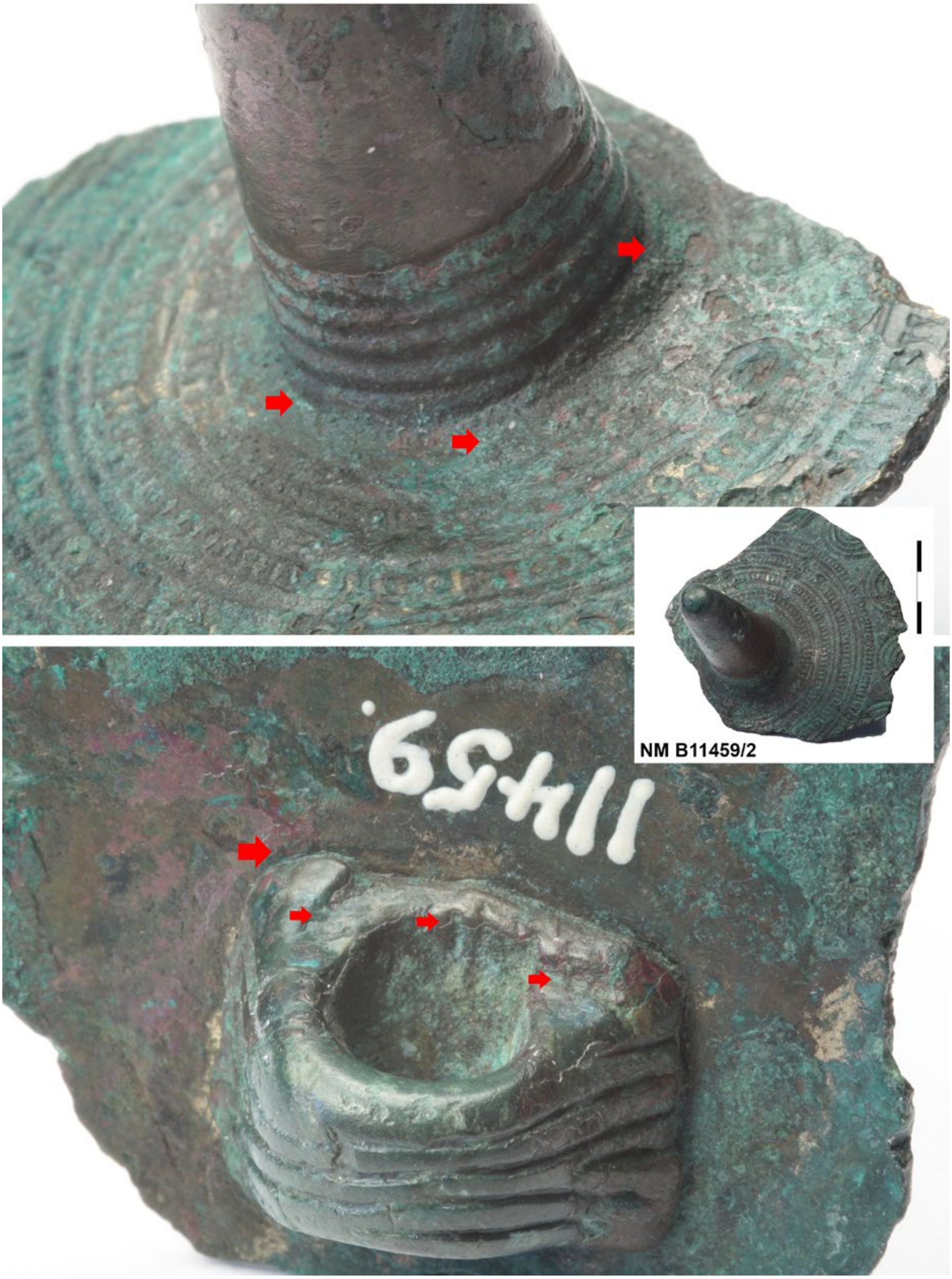


Figure 2.049: Cast-on technique shown on the belt plate from Gerdrup (NM B11459-2).

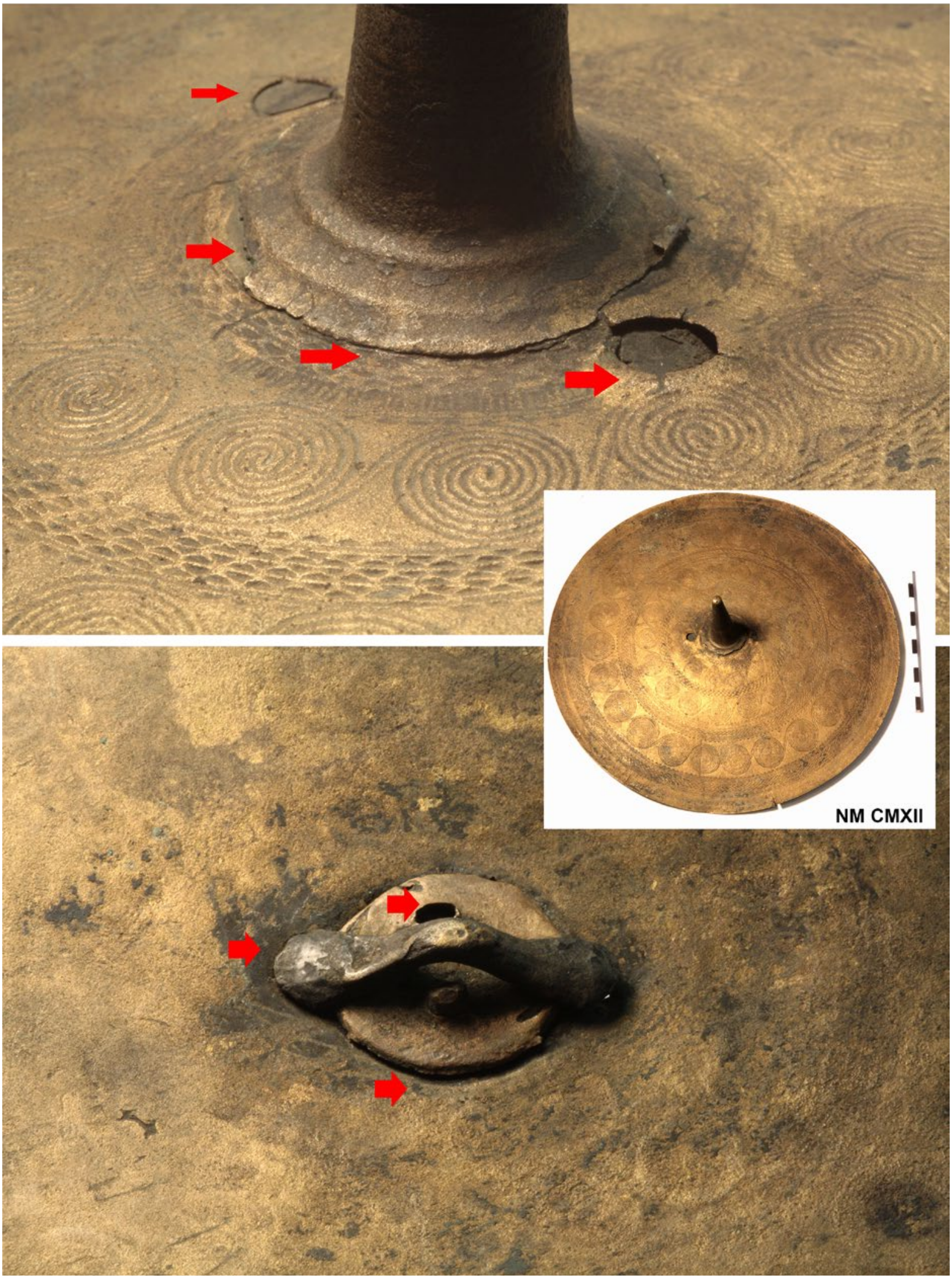


Figure 2.050: Cast-on technique shown on the smaller belt plate from the Frankerup hoard (NM CMXII).

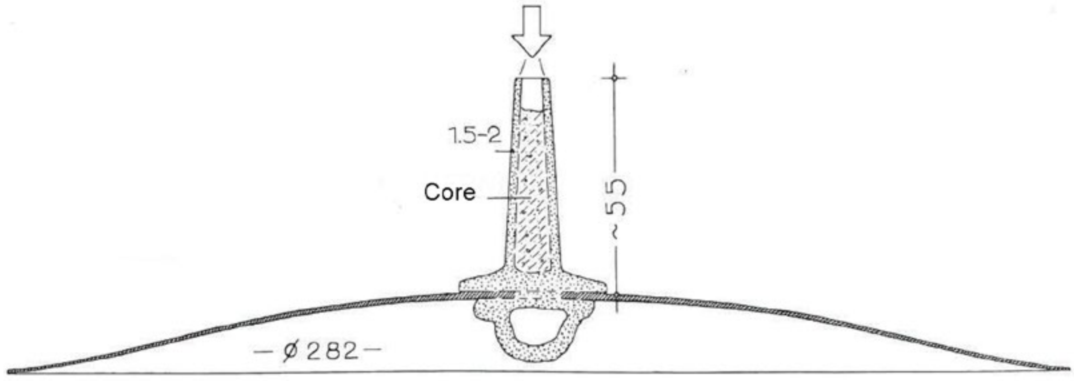


Figure 2.051: Section through the Langstrup belt plate (after Drescher 1958).

represented the most effective way of crafting is significantly higher (MAP 09). Many of these plates, however, could only be recovered with the spike missing or the spike being found without the plate (Jantzen 2008: 222). Such plates display a characteristic hole with upturned edges in their centre. Here, it can be assumed that the connection was insufficient and that the spike could easily break.

The perforation of the belt plate from the back seemed to be the preferred mode of operation. The resulting slight 'throat' on the reverse side served to engage the eyelet in the disc and was occasionally used as a limitation for the modelling of the eyelet. On the belt plates of Vognserup Enge (Figure 2.043-44), Svenstrup (Figure 2.045) Langstrup (Figure 2.046) on Zealand and Gollern (Figure 2.047) in Lower Saxony the traces of connection between the eyelet base and the already cast disc are easily recognisable. Even the impression of the tool, probably a wooden spatula, is partly visible. A feature recognisable on all examined bronzes is the leakage of surplus material due to a slightly larger cavity. On the Vognserup Enge (1680 KC; Figure 2.044) and Rye (Figure 2.048) disc, the malleable surplus material from making the spike was cut off. The rounded edges are still visible even after casting. Additionally, the liquid metal ran into this cavity, which in regard to the Rye belt plate led to a further reworking; this time the surplus material was removed with significantly sharper tools and hence resulted in damage to the disc surface (Figure 2.048).

Furthermore, a few pieces were documented in which it is not quite clear how the perforation of the disc was performed. On the belt plates from Gerdrup (Figure 2.049) and Frankerup (Figure 2.050) the eyelet was very well prepared before it was attached to the cast plate. The cast was exemplary in both cases. It can be assumed that a very large hole (in the centre) had to be filled, especially regarding the belt plate from Frankerup (NM CMXII), as the cracks on the edges are still clearly visible. Additionally, it can be assumed that the attached spike and eyelet could not meet the weight of the disc and consequently that the first attempt had to be repaired (Figure 2.050).

Furthermore, conclusions can be drawn concerning the direction in which the casting occurred. The spike of the belt plate from Grabow is cast from the eye, as Drescher states, whereas the spike of the Langstrup plate (Figure 2.051) was probably cast from the tip of the spike (Drescher 1958: 45). Upon closer examination of the specific discs it could be detected that the surplus material on the belt plate from Grabow does not come out at the reverse side but between the base of the spike and the disc (Figure 2.042). A contrary picture occurs with the Langstrup plate. Furthermore, the spike of the belt plate found in Svenstrup displays clear traces of reworking on the tip (removal of the sprue) and confirms the casting from the face side (Figure 2.045). Here, also, the surplus material comes out between eyelet and disc. Consequently, a cast were the sprue was attached to the spike can be assumed for the belt plates from Vognserup Enge (1680 KC and KD), Svenstrup, Langstrup, Rye, and possibly Frankerup (CMXIII) on Zealand. Presumably the second belt plate from Frankerup (CMXII), the second belt plate from Gerdrup (B11459-2) and from Annebjerg Skov (B997) on Zealand are cast from the reverse side (the eyelet), similar to the plate from Grabow.

The belt plate from Gollern (LMN 4753) deserves special mention; on this the spike is not placed on a base and then attached to the plate as usual, but was modelled onto the cast plate with the result that the spike and disc almost form a unit. Only the irregular edge that runs around the spike and the slightly sunken eyelet identify this piece as crafted via the cast-on technique (Figure 2.047). A similar 'strange' appearance occurs on the spike and eyelet of the discs from Lüneburg (LMN 4754), Molzen (ML 242:84 b and 84f) and Vellinge Mose (B2657). It might be assumed that these discs were also cast in two steps, however, a clear answer can only be given with x-ray examination.

In summary it can be stated that the cast-on technique in north Europe during NBA II was uniformly applied to produce the large belt plates, at least on the Danish islands and the Danish mainland. The majority of the plates crafted in two parts are of Scandinavian origin and the few northern German representatives differ in their production from the Scandinavian. A special feature is the uniform casting direction from the top (the sprue is placed on the tip of the spike) for the Scandinavian pieces, while the north German plates were apparently cast from the reverse side. Additionally, in north Germany discs occur on which the spike and eyelet were adapted to the plates, and their two-part construction is not obvious at first glance. The way in which this technique was used can be seen as a sign of a traditional behaviour within the craft. As such, regional variations within the use of the cast-on technique, for instance the different casting direction in Scandinavia and northern Germany, are of interest for the definition of craft centres, as further discussed within Part 4 of this book.

2.5.3 Casting in open moulds ('Herdguss'): the Lüneburg-type wheel-headed pin

As already mentioned while discussing the basic metalworking techniques of the Nordic Bronze Age, many casting techniques were used in parallel. An important technique, especially in the Early Bronze Age, was the use of the two-part mould for casting, with one or two negative forms. A reliable detection of the exact method can be of major importance when evaluating craft traces, especially with regard to regional differences.

Here, the wheel-headed pins, with their origin within the region of the Lüneburg Heath, with the Bronze Age culture named after the same, are good examples to demonstrate the variety of this technique. The early form of this characteristic pin was crafted using one-negative forms, with the other form part functioning as lid. This technique results in easily recognisable traces and has distinct characteristics.

Bronzes produced by casting in an open stone or clay mould should obviously only be profiled on the face side. It can be assumed that the majority of such artefacts were not produced in open moulds (Herdguss) but by means of two mould halves, wherein one mould half was not profiled, and thus served only as a cover. Armbruster called this form of casting a single chill-cast and emphasises the use of cover halves for the creation of all kinds of bronzes except simple ingots (Armbruster 2000: 70). Concerning the single chill-cast, there is a disagreement among researchers as to whether objects were actually cast without a lid (open mould casting/Herdguss) or by using chill-casting. However, there are some specific differences between these variations; when cast in an open mould the liquid metal is poured into a horizontal form and is, in most cases, subsequently taken off with a flat stone (or similar), or covered with another flat mould part (Holdermann and Trommer 2010: 794). Chill-casting on the other hand, is carried out with a mould consisting of two negative halves, or only one negative with a matching flat counterpart. This mould is placed upright, commonly dug down in sand. The advantage of a cast in a standing form is that possible shrink-holes[44] concentrate in the upper part, where the sprue is, and not in the cast object itself. Furthermore, the surface is not oxidised in chill-casting and the milk-skin that occurs while casting in an open mould does not arise. Additionally, in chill-casting the volume shrinkage under cooling is limited to the top where the sprue is located. Objects cast via open mould commonly show an inward movement of the upward facing surface (Holdermann and Trommer 2010: 795).

In addition to ingots, within the material of the Bronze Age simple devices such as flat axes can sporadically be detected, which were cast in open moulds (Born and Hansen 2001: 219; Armbruster 2000). However, in the north these items are also probably cast in two-part moulds. Within the Nordic Bronze Age, ornaments where a similar casting technique can be inferred occur sporadically. This is especially true for the Lüneburg-type wheel-headed pins with unilateral profiling (Laux 1971: 51). A characteristic of casting in an open mould is a milk-skin surface that appears through oxidation, meaning the reaction of the molten metal with oxygen. Additionally, wave-like structures can be observed on the surface, caused by a different and rapid solidification of the metal. Some of the hanging discs studied in this present work, with centre spike and peripheral ribs, display such structures on the reverse side. Since the surface of the reverse side is significantly distinct in nature from the surface of the face side, this technique can be assumed for the discs from Raven (LMN 14083, 14084 and Figure 2.052). In addition, the few studied wheel-headed pins could confirm the suspicion raised by Laux (1971: 51) that a part of these pins was cast via open mould. However, only the wheel-headed pin from Oldendorf, Luhe (ML 1009) was definitely crafted in this way – in which the metal was poured into a presumably open form – whereas the pins from Rehlingen (LMN 5032) and Westerweyhe (LMN 12018) come from a mould with cover plate (Figure 2.053).

[44] The cavities caused by volume reduction in a casting are called shrink-holes. Due to the fact that the solidification of the metal starts at the mould walls the metal atoms which have in the melt a large movement radius, are now fixed on one place, and now concentrated in a dense packing. This results in a volume reduction of the previous melt. As a result, there is a subsidence of the metal to compensate for the volume deficit. A thereby-caused trough-shaped sinking of the liquid metal in the inlet region is called 'Außenlunker', or outside shrink-hole. However, if the metal in the sprue solidifies too early the volume deficit in the centre can no longer be compensated, so cavities called shrink-holes occur in the centre (Brepohl 1996: 150f.).

Figure 2.052: Characteristic surface structures for the cast in an open mould shown on the spike-discs from Raven in Lower Saxony.

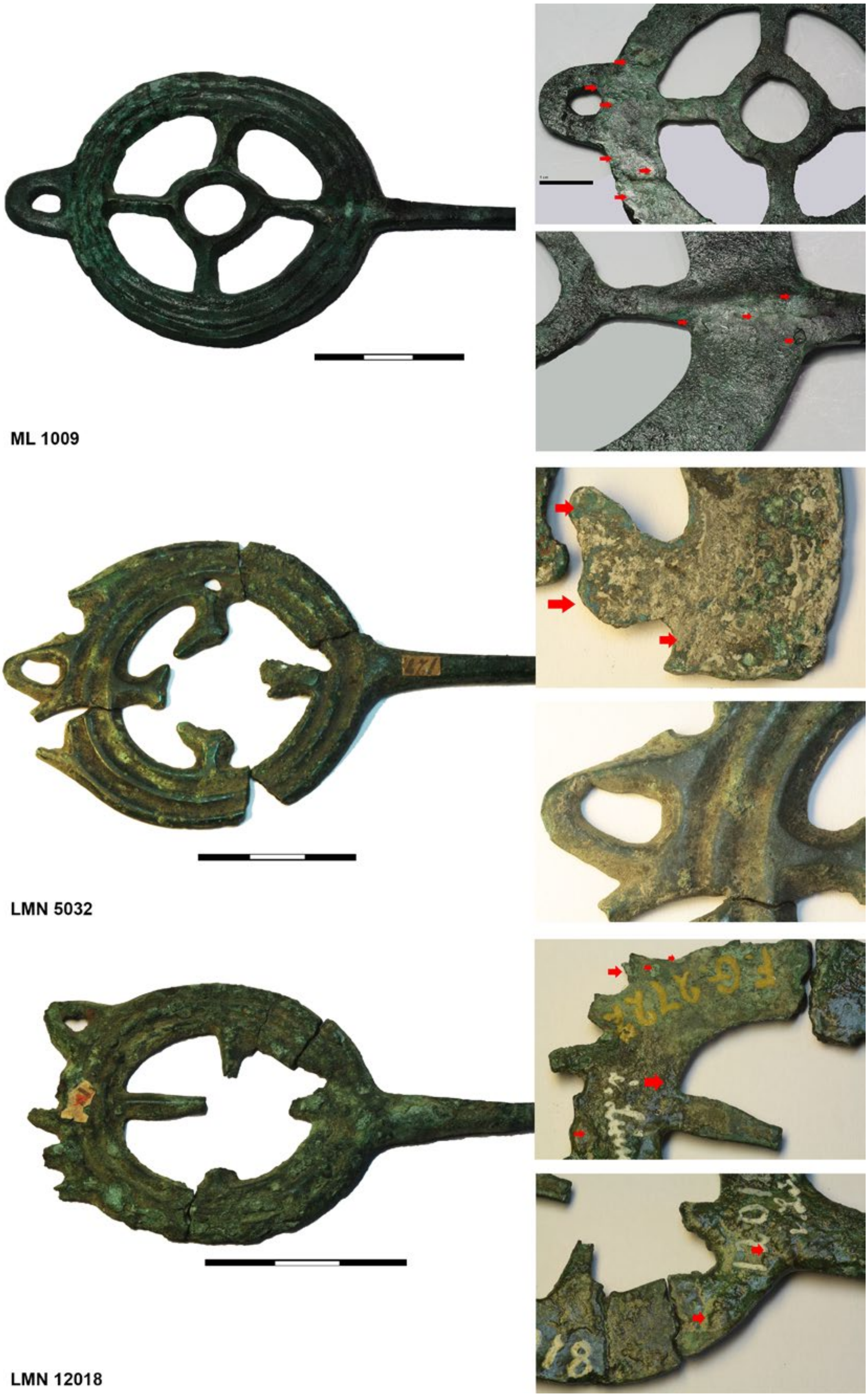


Figure 2.053: Wheel-headed pins cast in an open mould: The pin from Oldendorf, Luhe (ML 1009), Rehlingen (LMN 5032) and Westerweyhe (LMN 12018).

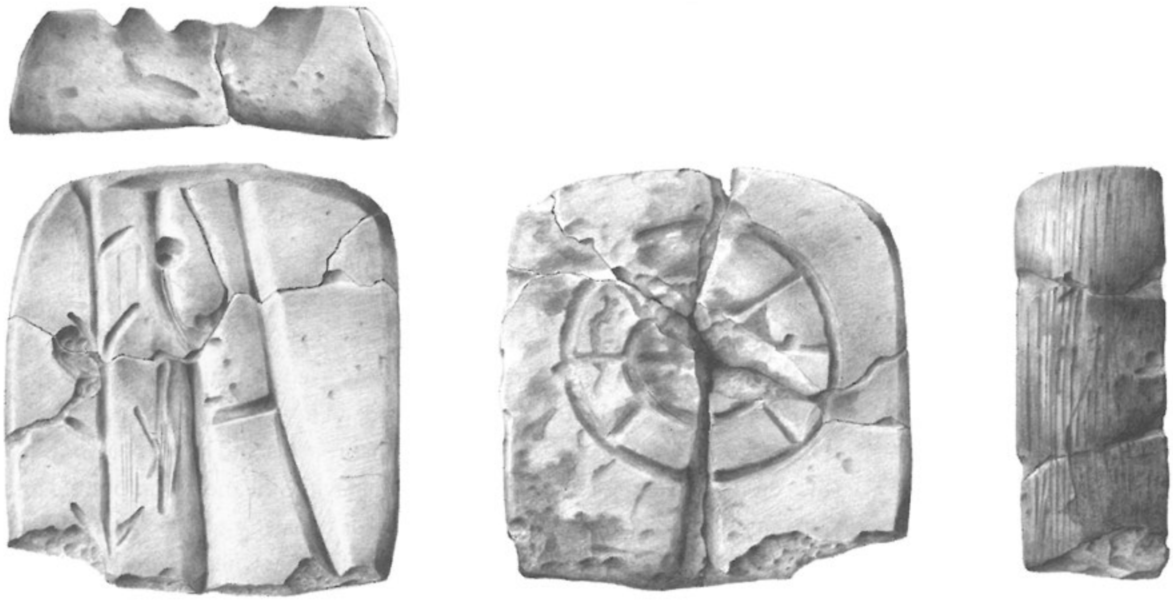


Figure 2.054: Stone mould of a wheel-headed pin found in the Bronze Age settlement Oss Horzak in the Netherlands (after Butler and Fokkens 2005: 38).

Hitherto, the assumption that in particular wheel-headed pins were crafted using reusable stone or ceramic moulds was pure speculation. To date, only a single proof of such a form can be given, found in the Bronze Age settlement Oss Horzak in the Netherlands. Here, a double-sided mould was found (Butler and Fokkens 2005: 381); one side of the mould has the negative of a palstave (no specific characteristic detectable), while the other side displays the negative of a double wheel-headed pin (Figure 2.054). This stone mould is not only unique, but also contains the indication that these pins may have been made via the cast-on technique, as is assumed for the majority of pins in southern central Europe (Drescher 1958: 35ff.). Due to the shape of the mould, the short needle shaft is funnel-shaped and could be intended solely for the insertion of the already hammered shaft, and thus this assumption can be made. In this regard, the Oldendorf pin (Figure 2.053), whose shaft approach is significantly thickened, might have been crafted in this way.

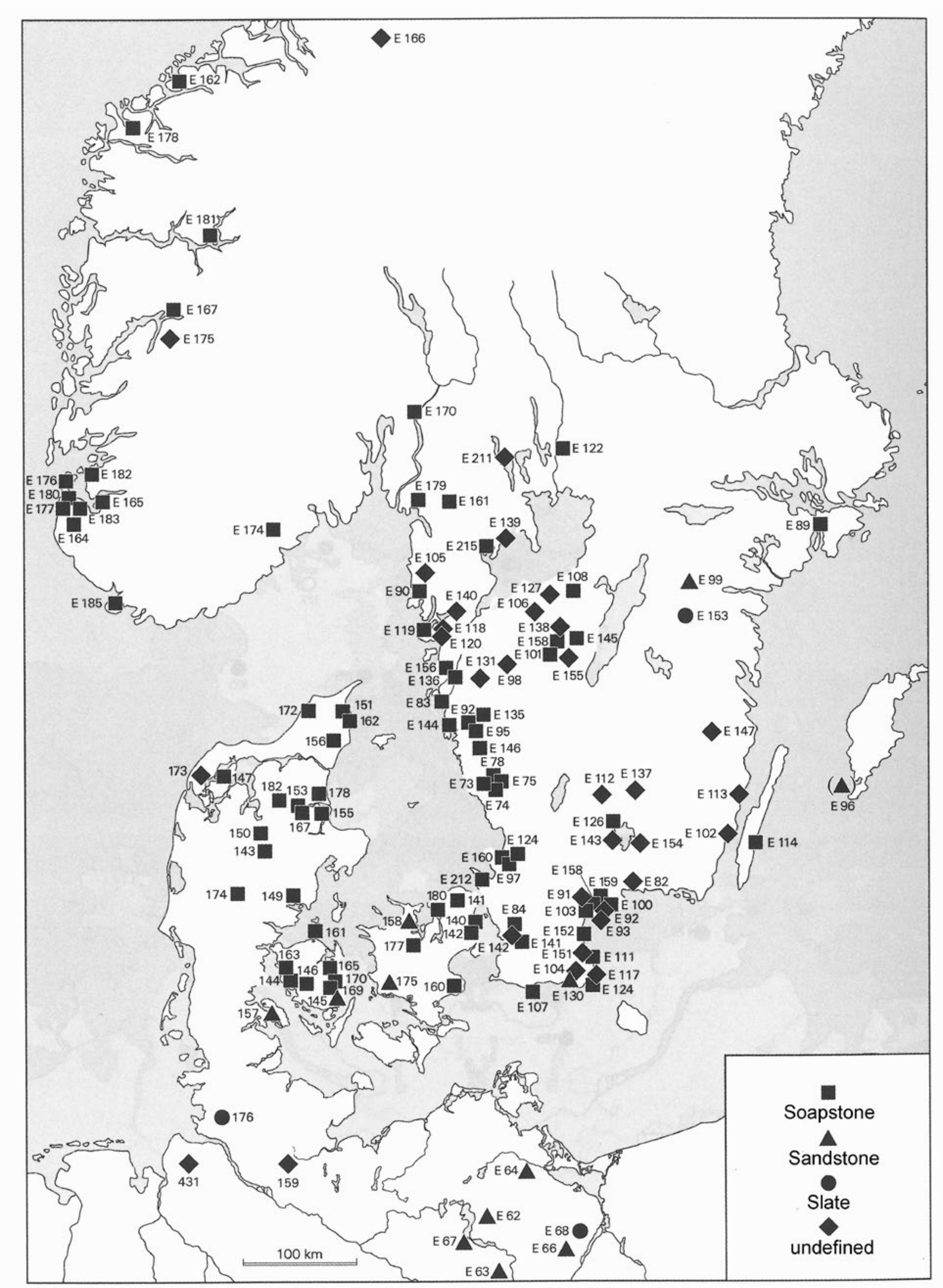
Moulds for open-form casting are rather rare in the Nordic region. Artefacts, where this technique was used are mainly distributed in central Germany, such as hanging discs and selected wheel-headed pins. More common is casting in two-part moulds, occasionally with only one half of the mould with a negative and a corresponding lid, and regularly were both parts of the mould have negative forms, as documented by the majority of the investigated wheel-headed pins.

2.5.4 Casting in two-part moulds made of ceramic, metal, stone: the wheel-headed pins

In addition to the casting techniques presented so far, several residues of moulds prove the use of two-part moulds, where both halves are profiled, throughout the Bronze Age in Europe. Items produced via casting using two-part moulds display specific characteristic traces, the knowledge of which will enable the identification of regional differences in the use of the various casting techniques.

The technique for casting using two-part moulds was mainly used for mass production of weapons and equipment, especially in the Late Bronze Age (Born and Hansen 2001), but was occasionally also used for making ornaments. A distinct feature of this technique is the burr formed at the junction of the two mould halves, also named the casting seam. Here both mould parts are provided with a negative imprint of the artefact (e.g. Armbruster 2000: 70). Such bivalve moulds can be made of stone, clay or bronze and are carefully matched during making. The stone moulds could be made from a variety of rock types, amongst which sandstone and shale were the most widely used types in central and northern Europe (MAP 10). In addition, from the NBA II soapstone moulds were in use in the northern regions of the Nordic Bronze Age (Aner and Kersten 1973: 23, 152). During NBA III soapstone become a common material for moulds.[45] Several finds, such as the sometimes roughly worked soapstone blocks and prepared split stones, testify to an intensive use of soapstone and an active transportation network between Norway and Sweden, where they probably originated, and the Danish and north German region (Jantzen 2008: 149ff.). Even if the processing of such

[45] The first forms are used to cast socketed axes and are found in Søllerød and Valby on Zealand (Jantzen 2008: 162; Aner and Kersten 1973: 23, 152).



Map 10: Stone moulds of the Bronze Age in northern Europe and Scandinavia
(after Jantzen 2008, T.106).

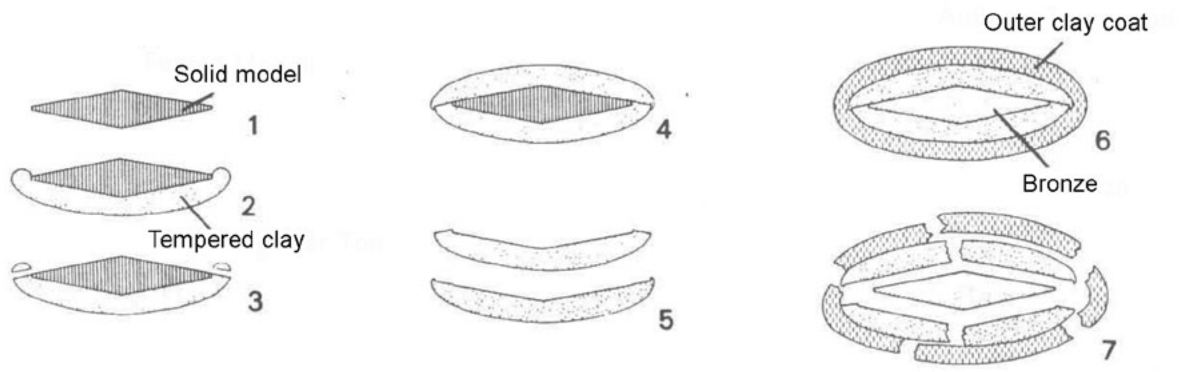


Figure 2.055: Two-part clay moulds are often destroyed post-casting (after Armbruster 2000: 71).

stone moulds is time-consuming, it guarantees, unlike clay forms, the opportunity for multiple use and also a very fine cast surface (i.e Staniaszek and Northover 1983: 265).[46] To prevent slippage of the mould halves, tenons and mortises were incorporated into the mould, or notches were placed on the outside were a string was wound to secure the fitting (Armbruster 2000: 71).

Some preserved moulds had residues of ceramic material which were placed around the mould to prevent leakage of the liquid metal from the still emerging gap (Jantzen 2008: 152ff.). Additionally, embedding in sand, as well as weighting down the mould with stones, would have prevented it from opening during casting (Armbruster 2000: 70-71; Drescher 1957a: 59). In such a mould the sprue would be mostly incorporated, however, the air pipes (commonly used in modern mould casting) are rather rare (Jantzen 2008: 154-156; Born and Hansen 2001: 204). In order that the air can escape while casting, many artefacts and cast residues confirm the assumption that the mould was held at a slight angle during pouring (Jantzen 2008: 314; Armbruster 2000; 2001a) and, additionally, similar tricks such as the above-mentioned wet fabric might have been used.

This technique is particularly of interest in regard to the Bronze Age metalworker, insofar as a mould could be used many times if made of appropriate materials, and, therefore, could be well suited for the crafting of weapons. In contrast, for the making of ornaments clay moulds were used (Jantzen 2008: 69ff.). However, such clay moulds are to be considered as 'lost-moulds', as while in use they were commonly backed together (Figure 2.055). However, this technique has another remarkable advantage, as solid models for the production of identical copies can be used repeatedly.

Among the examined bronzes, the group which was crafted in two-part moulds of stone or ceramics is restricted to wheel-headed pins. In addition to the pins 'cast in open moulds', double-sided profiled pins from the Nordic Bronze Age were also found.[47] These pins contrasted to those discussed above with a unilateral profiling, are cast in moulds with two negative halves. It was possible to examine two such wheel-headed pins in more detail (Figure 2.056), showing different stages of reworking. The simple wheel-headed pin from Oldendorf Luhe (ML 1008) has predominantly reworked neat edges and hardly cast seams, but it also has several casting defects which give the needle an unfinished appearance. The pin from Edendorf (LMN 5027) is a high-quality cast but nearly not reworked. The cast seams are clearly visible and partly very wide. Both pins are part of rich burial equipment and are related to further ornaments, and thus their qualitative differences cannot be due to their depositional context. In a rough analysis of further wheel-headed pins in the Lüneburg Heath and central and southern Germany the tendency not to remove the cast seams of the pins can be noted (Innerhofer 2000; Laux 1976; Kubach 1971; 1977). However, the fact that these pins were subject to heavy reworking after casting, namely the hammering of the shaft with repeated intermediate annealing, could be proved by metallographic investigations of the pin from Rehlingen (LMN 5032; Figure 2.057). Whether the casting seams should be seen as the result of a lack of attention, or whether they were left due to the difficulty of removing them, or if it was simply not important to remove the seams because the piece had a national recognition, remains speculation. Additionally, due to the small number under investigation there is no proof that the wheel-headed pins might have been crafted in reusable moulds. For further research, however, the object groups of wheel-headed pins would be excellent material because many of these pieces were only partially reworked after casting and thus the characteristic traces remain.

[46] A clarification of how many castings could be obtained from a form has still not been achieved. The fact that the forms can be damaged due to the heat and occasional problems while opening results in a limited use (Jantzen 2008: 156ff.; Armbruster 2000: 71; Drescher 1987: 28).

[47] Laux sees these needles having an origin in the central Rhine region, as typological counterparts to the Lüneburg-type pins (Laux 1971: 49).

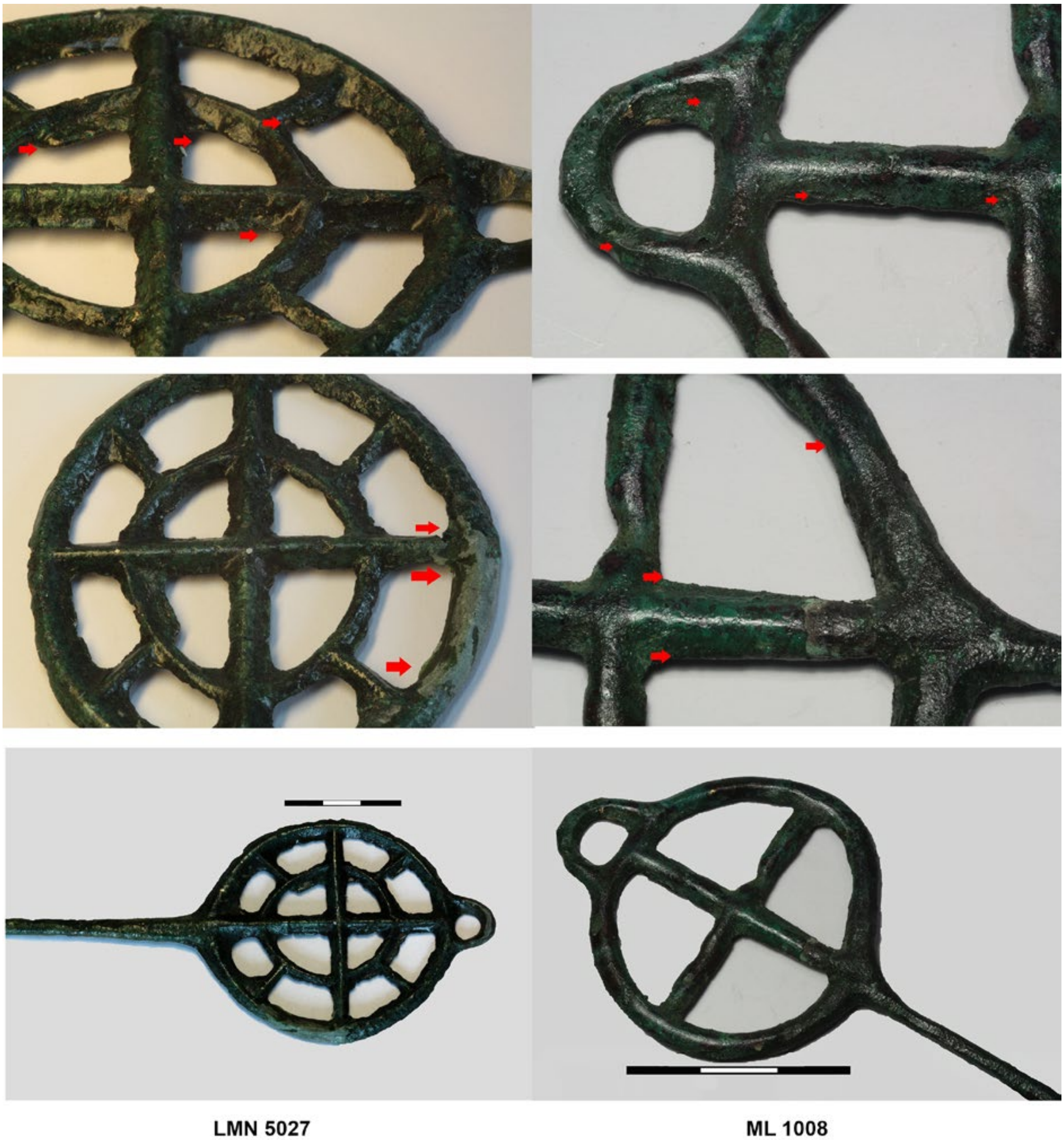


Figure 2.056: Wheel-headed pins are cast in moulds with two negative halves: the pin from Edendorf, Ülzen (LMN 5027) and Oldendorf, Luhe (ML 1008).

Concerning the casting of bronze ornaments in two-part moulds, some conclusions can be given. This technique appears unused within the Nordic Bronze Age except for the occasional appearance of wheel-headed pins. These pins, however, are of central German origin (Laux 1971: 49; also Drescher 1958: 35ff.) and should be seen as imported artefacts when found in north Germany and Scandinavia. Thus, it can be stated that casting in two-part moulds, as well as in open moulds, with lids, is not characteristic for the crafting of ornaments in north Europe. Furthermore, objects found within the Nordic Bronze Age which show the characteristic traces of these techniques should be critically examined with respect to their region of origin.

2.5.5 Concluding thoughts concerning casting techniques used in the Nordic Bronze Age

The richly decorated bronzes of the Nordic Bronze Age are almost exclusively the products of casting through lost-forms. Although a variety of metalworking techniques are well known and were also used in

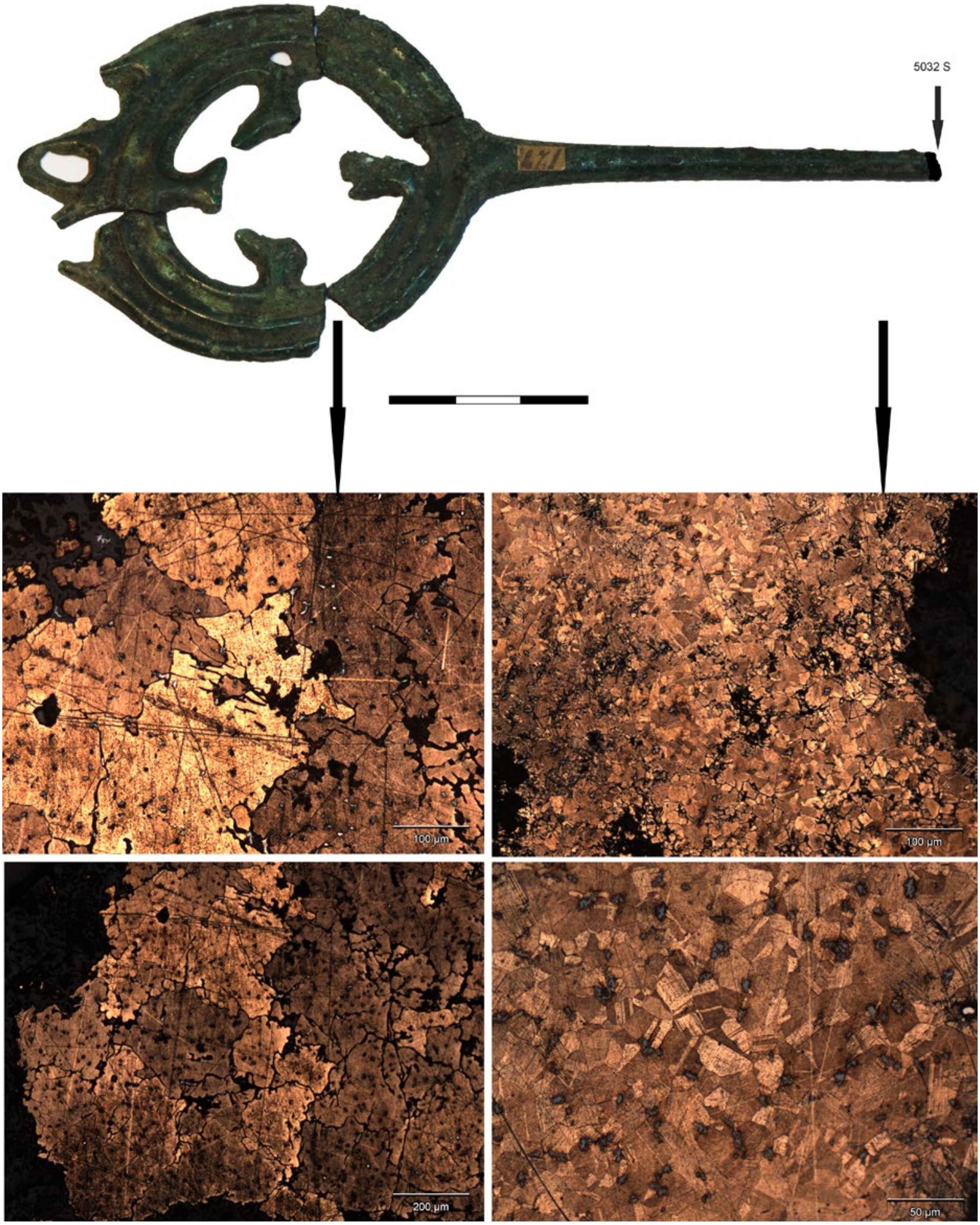


Figure 2.057: Signs of intensive reworking in the metal lattice of the wheel-headed pin from Rehlingen (LMN 5032).

	Nordic Bronze Age (source: Jantzen 2008)		Atlantic Bronze Age (source: Armbruster 2000)	
Casting techniques:	EBA	LBA	EBA	LBA
Cast in one-part open mould („offener Herdguss“)	●		●	●
Cast in two-part mould (two negatives)	○	●	●	●
Cast of ingots (“offener Herdguss”)	●	●	●	●
Cast in two-part mould with one negative half (the other half is used as a lid)	●	●	●	●
Cast in two-part mould (two negatives) with ceramic core	●	●	●	●
Cast in lost form „cire perdue“/ cast-on techniques	●	●		●
Cast in lost form „cire perdue“	●	●		●
Cast in lost form „cire perdue“ (with core and placeholder)	?	●		●
Cast within decorated mould		●		●
Cast of several artefacts in a single form		●		
Rotation-shaped wax-models				●

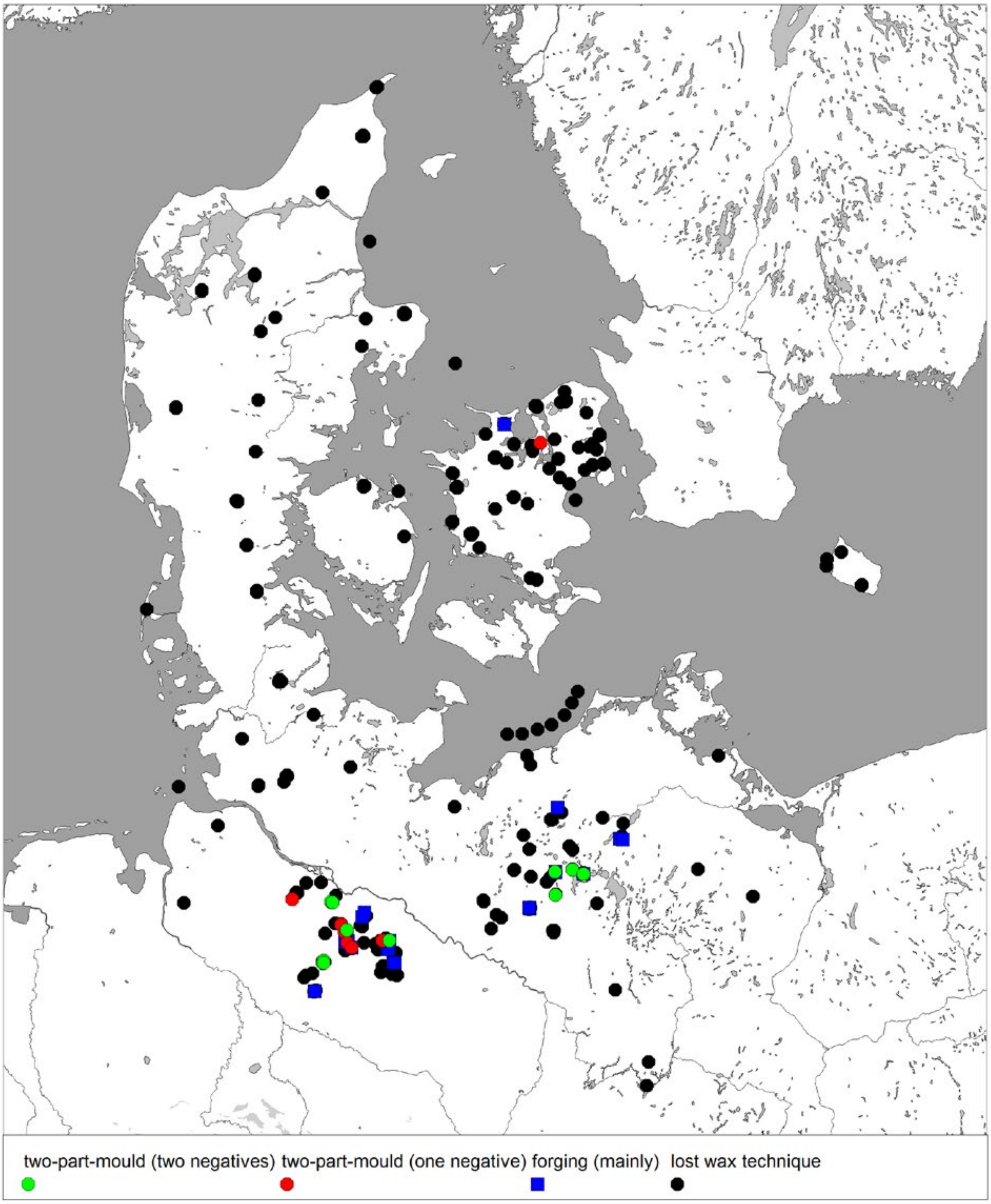
Figure 2.058: Comparison of casting techniques used in the Bronze Age in northern Europe and within the Atlantic Bronze Age
(partly based on Armbruster 1993; 1995; 2000).

crafting weapons and equipment (see MAP 10), the ornaments seem to have been consciously crafted as individual pieces.

Bronze Age material from the NBA IB period in northern Europe shows clear evidence of the lost-wax process. Thus, this technique may be confirmed by the beginning of NBA II to have been the usual approach. In addition, the casting of ornamented bronzes could be proved with the artefacts from the hoard of Vognserup Enge. Furthermore, the handling of the lost-wax process with nuclei is confirmed in the NBA II material. To what extent these rather complicated cores were cast with chaplets should be investigated in a further study. Using simple x-ray examination of the tutuli from the Svenstrup hoard the ceramic cores in the spikes could be examined in detail. Even the sometimes very long spikes of the large belt plates could be formed using clay cores, as was confirmed by the belt plate from Langstrup (see Drescher 1958: 44).

Many of the large plates were crafted using cast-on techniques. This examination has shown that across regions a unified approach was used, from the actual perforation of the disc from the back and the subsequent clasping of the disc material through the previously modelled spike. However, regionally specific behaviour was detected regarding the direction of the cast, as Danish belt plates were predominately cast from the spike. It is also likely that isolated discs had already been made with a hole or a groove in the middle to prevent the breaking of the edges. Due to documented errors on several discs not only could the casting direction be reconstructed but also multiple reworking on the spike or eyelet documented. An evaluation of these belt plates crafted via the cast-on technique leads to the assumption that, as early as the NBA II period, this technology was part of the repertoire of metalcraftsmen. However, stylistically a disparity was detected between the southern and northern regions; on the Danish islands mainly the spike and eyelet were placed on base plates, while in northern Germany an adaptation of the disc was preferred.

Furthermore, a picture is emerging within the casting process utilising lost-wax materials that emphasises



Map 11: Distribution of the known casting techniques in the Nordic Bronze Age.

individualism in the making, since the variation amongst the tools used and the partly different techniques are clearly visible. For the following studies, the inclusion of ethnographic studies is advisable, because only by comparing the range of possible techniques and tools can they ever be detected.

It can be proven that artefacts crafted in single chill-casting appear within the NBA II in northern Germany. However, evidence that this technique was used further north could not be found, and this might be also grounded in the selection of the objects. Artefacts produced in semi-permanent moulds spread, however, mainly in Lower Saxony and southern Germany, and within this investigation only wheel-headed pins were definitely produced in two-part moulds. Here, the use of moulds with two negative halves and others with only one mould and a fitting lid were documented, regardless of the pin type (Laux 1971: 49ff.; Holste 1939: 53-55). Of particular interest is the stone mould of a wheel-headed pin, which not only supports the assumption that these artefacts were crafted using two-part moulds but also points towards the possibility that some of these pins were crafted via cast-on techniques, a common method in central Europe.

As mentioned in the introduction to this chapter, the knowledge of the casting techniques used in the Bronze Age is restricted. An intensive overview is known for the Atlantic region (Armbruter 1993; 1995; 2000) and the present study could show that northern Europe shows a similar span of techniques but also features distinct differences, especially concerning the date at which varying techniques were actively used (Figure 2.058). In this regard a much earlier use of the lost-wax method could be documented in the north (MAP 11). It actually seems that Sprockhoff's statement 'der Norden sei die Hochburg der Bronzegießer' (Sprockhoff 1940: 28)[48] can be supported not only due to the preserved casting equipment (Jantzen 2008) but also because of the material itself. However, no traces of rotating equipment could be detected in the otherwise high-quality wax models occurring in the north, and it seems that this particular technique was unique for southwest Europe (see Armbruster 2000: 61f.; 1993b). The making of disc-shaped wax models was instead achieved through wax-casting, as pointed out by Rønne and Bredsdorff and confirmed in experiments manufacturing disc-shaped models (Rønne and Bredsdorff 2008). An additional result of the present study is the value that the experience gained in experiments provides, particularly for the understanding of prehistoric casting processes. Only by the intensive comparison of traditional methods, the traces they leave and the detection of these traces on the material, are we are able to understand the techniques used to craft such items.

[48] '...the north was the domain of the bronze-caster...'

Chapter 6

Crafting traces and crafting sequences

This chapter deals with the presentation of different characteristic traces within metalcraft and their informative potential, with the aim being to obtain an inferable operational sequence for the crafting of neck collars, belt plates and discs, as well as the tutuli and pins of the Nordic Bronze Age. Presented in a sequential manner and based on two crafting sequences of neck collars with different basic techniques, information about the craftsperson, the social community, or possibly the organisation of craft, shall be filtered out. In focus are documentable traces of the individual in crafting, such as basic measurement errors, visible approaches to decoration, and traces of special techniques. It will be shown that many objects reveal evidence of the planning of the piece, its actual construction, as well as errors in the making and the response of the craftsperson to those errors. Furthermore, errors in the construction of the decorative pattern occurred frequently, more often, however, on cold-worked bronzes than on model-decorated artefacts.

The knowledge gained within the first parts of this chapter will aid the understanding of the first distinctions of skill within metalcraft, mostly visible in the material by interruptions, and a new tool approach in simple lines. Interestingly, the smaller belt discs display often striking deficiencies in the merging of the line decoration, in contrast to the richly decorated belt plates. Another indication for skill differences is hidden in repairs. Here, the social environment as individual behaviour is easily visible and can be used also to identify individual craft. Highly developed techniques within crafting are in a similar manner a criteria of skill, as well as excellently trained motor skills. The material revealed, by projecting identical spirals, that the application of spirals with spiral-stamps was known. However, it can be proved, that the stamp technique cannot be described as a basic approach and that this method was apparently reserved for special, possibly very complex, bronzes.

The documented constructive peculiarities presented here, as well as the mistakes and failures, as tool traces, are detailed with the intention of matching these traces to possible analytical workshops or individual craftspeople. Tool traces, especially, can give a definite reference to the maker, as they can indicate careful reworking of tools, working directions, distinct sequences, and even the hand of the craftsman, as the traces documented might reveal. It is nonetheless of importance to highlight that morphological similarity should not automatically be equated with an item having been crafted by the hand of a single individual.

2.6.0 The ornament in focus – methods of craft-technical studies

Based on the catalogues of crafting traces established earlier, the actual differences between cast and cold-worked ornaments, and the characteristics of the various casting techniques, are known, and, therefore, the question regarding the basic techniques used to craft the artefacts under investigation can be answered relatively quickly. However, there are numerous objects for which assignment to a particular technique seems impossible. These objects are not, however, without value in terms of investigation of the craft, with a particular focus on the individual behind the piece. As will be shown below, all investigated bronzes were able to contribute something to the analysis. Even if it was not always possible to reconstruct the exact operational sequence,[49] the bronzes offered what could be a very detailed insight into the working processes and the individual steps executed. How is this identification of individual sequencing of crafting traces even possible?

Every tool and technique used leaves a trace that can be recognised in conjunction with an operation within a sequence. In contrast, not every trace can be related to an action. In most cases, it might be possible to determine the shape of the tool or to appoint by experimental tests possible tools, but due to the few tools found in the archaeological record of the Nordic Bronze Age (Fabian 2006) we have no definitive proof. As already shown, lost-form casting can be assumed for the vast majority of the investigated bronzes, and consequently wood, leather and plant materials could also have been used as tools for the creating of the models, as well as bronze tools. Ethnographic examples are especially helpful in such a case because the range of possibilities can be detected by comparisons. For example, the Swamimalei hereditary bronze manufacture in Tamil Nadu, India, uses a master palm-leaf ruler to mark the exact divisions required for the designs, and wooden spatulas are mainly used for making the model (Levy *et al.* 2008: 52-54).

However, what help do these individual marks on the artefacts provide for the understanding of prehistory? In archaeological research the study of social and economic patterns of distribution within Bronze Age society have been of great interest and several studies have attempted to determine workshop centres and workshops as central points of trade networks (i.e. Laux 1995; Laux 1997; Kubach 1977; Bóna 1975: 273-276). However, the difficulties relating to the determination of prehistoric workshops have already been discussed in the introduction. It is a prerequisite that the production traces, metal compositions and other production-related properties of the object match up before determining

[49] The Catalogue in this volume presents all the items investigated, describing them in detail, and assumptions are made concerning the techniques used for crafting.

workshops. This statement presupposes the existence of the *habitus* of the craftsperson and that every craftsman's intuition leaves its mark (see Chapter 3.2).

As such, unconsciously, a unique object is created, caused by the choice of the tool, the way in which decoration is applied and combined, the various techniques used, and the individual decisions made by the craftsperson (i.e. Creese 2012: 44-46; Hill and Gunn 1977; Hardin 1977; Muller 1977; Botwid 2013). These individual markers can enable the observer to assign the object to a craftsperson. In contrast to formal similarities, such as ornament details or the preference of certain materials, which may be due to social restrictions, traces are left by crafting activities that are characteristic to the specific craftsperson.[50]

There are several elements to such an investigation. First, the various decorative elements were noted on each piece, such as parallel lines, puncture ribbons, hourglass-shaped notched ribbons, triangle series, and more. Further, errors in the individual parts of the decoration were documented, such as overlap of individual punches, variations in the spacing or width of the elements, differences in the shape of a decorative element, and many other characteristics. Following this intensive study of the individual decorative elements and the occurring overlaps, it is then possible to reconstruct the operational sequences of nearly every item.

Subsequently, the observed errors in the decoration were then compared with possible explanations. This method allowed the creation of some very detailed operational sequences, which are presented and discussed in the next section. Many artefacts had minor errors, some of which forced the craftsperson into particular actions. It is in these features where the key to the individual behind the artefact is found, as will be shown in the following discussions. In order to allow the reader to follow the process of investigation, each section covers a specific step within the examination process, as follows:

- Crafting sequences are compared to demonstrate the crafting of formal similar artefacts with different techniques.
- Traces of crafting that bear information about the craftsperson, such as simple measurement errors.
- Traces of crafting that bear information about the social community or possibly the organisation of craft, such as visible approaches to decoration and traces of special techniques.

[50] However, as will be shown in Chapter 3, the one interpretation does not exclude the other. Technical traces are in some way the result of social behaviour due to the craftsperson's *habitus* and the way in which the same is built (see Chapter 3.2-3.4).

2.6.1 Encrypted in the decoration: operational sequences

One of the most frequently observed features when examining bronze ornaments in detail are the many overlaps and overlays of individual decorative elements within the detailed decorations. A decoration comprises individual parts, and, given that the decoration on Bronze Age artefacts was created by hand, it inevitably leads to differences in the intervals between the single elements, slightly different impressions, and overlaps within the individual decorative units.

An introduction to the way in which decoration should be read in order to gain information about the operational sequence applied is demonstrated by the decoration of the Svenstrup-type neck collar from Rye (NM B7612; see Nørgaard 2011: 39-40): In the first step, the vertical line and triangle decoration that completes the ribbed section and initiates the endplate was applied (Figure 2.059, A). Thereafter, the horizontally extending decorative ribbon would have been made. This sequence is clearly demonstrated by the distance between the vertical and horizontal decoration and singular overlap (Figure 2.059, B). To equalise the space between the vertical ribbon and the horizontal edge-accompanying ribbon, a further vertical line decoration was added, which cut the longer horizontal lines and was fitted to the remaining space. In the free field the spirals were applied, and in a further step connected with double lines. Subsequently to the spirals, the frame-accompanying triangle series were made, which can be seen by the overlap of isolated triangles in the spirals. Small irregularities within the triangle ribbons allow detailed reconstruction of the way in which they were added. The triangle line started in the middle of the short distance and was applied from the centre in both directions (Figure 2.059, D). Starting from the left side, the vertical triangle series (upper and lower row) were then applied, witnessed by overlaps in the row (Figure 2.059, E-G).

Within the material examined a detailed sequence could be constructed for almost any piece and occasionally the reconstruction of the complete sequence was possible. Consequently, for several material groups (including the collars) characteristic sequences have been elaborated. However, it is rare for complete sequences on one piece to be reconstructed because of preservation conditions. In this case similar objects of a similar distribution area (type or object groups) can be investigated together, as conducted on the 25 Mecklenburg-type collars (Nørgaard 2011: 58-62). These collars show a nearly identical operational sequence when examined independently. Accordingly, a detailed and complete working sequence could be reconstructed on the basis of the individual sequences.

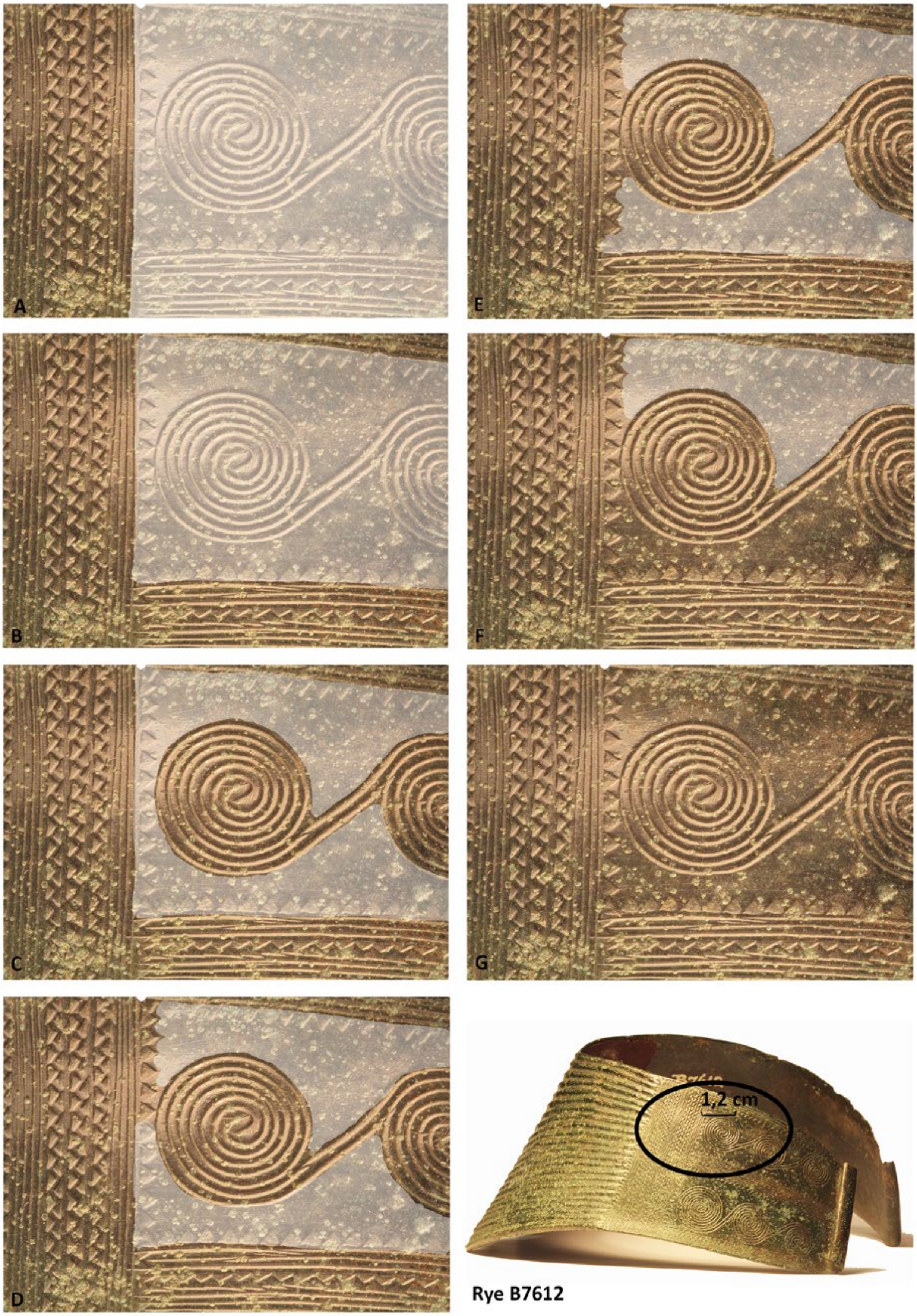


Figure 2.059: The order in which the decoration is applied, seen through the overlap in the decoration of the neck collar from Rye (NM B7612).

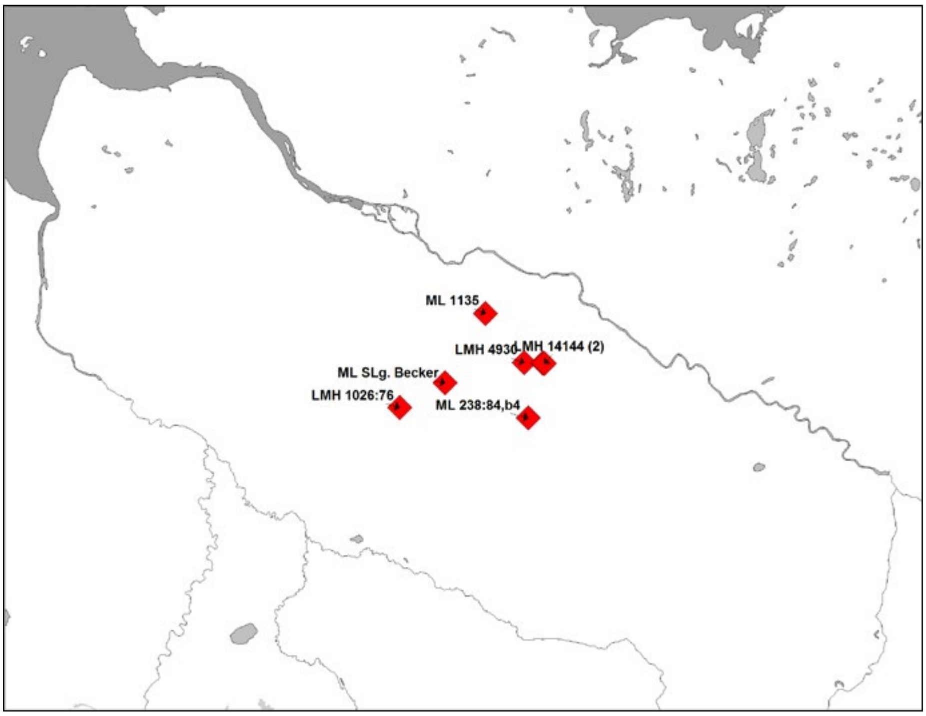


Figure 2.060: Distribution map of the Hollenstedt-type neck collars in central Lower Saxony (after Nørgaard 2011).

In order to compare the crafting of different neck collar types, a complete operational sequence of Hollenstedt-type collars – a form spread in central Lower Saxon (Nørgaard 2011: 56-58) – was established and is presented here. Both types of neck collar group have morphological similarities, such as ribs and smooth areas, which are decorated with circle and line ornaments. However, these types are chronologically and regionally different. The Hollenstedt-type collar was mainly worn in the elaborated NBA II in the area of the Lüneburg Heath (Figure 2.060). However, a Stollenarmband found in Ehlbeck and Westerweyhe allows a slightly earlier dating (Laux 1971; Nørgaard 2011: 56). In contrast, the Mecklenburg collars are only distributed in NBA III in the area between the North Sea and the rivers Elbe and Oder (a concentration in the Mecklenburg Lake district) and are deposited in graves.

The selected sequences are of particular interest, because, despite their stylistic similarity, they were crafted in distinctly different steps.

The sequence of the NBA II Hollenstedt-type collar is first explained, supported by detailed images. Following this the operational sequence of the Mecklenburg collar is presented and conclusions discussed.

Figure 2.061 shows the sequence that could be reconstructed for the seven collars of Hollenstedt-type under investigation. In addition to the technical analysis three collars were also examined metallographically. Thus, this sequence reflects the actual operations as close as modern research can get to the prehistoric activity. The working sequence is as follows (see Figure 2.061). The basic shape of the collar is formed from the wax mixture, including the ribs, additional undecorated sides, and a broad hem under the ribbed section. The ribs are reworked in the wax so that they have a fine surface structure. In Figure 2.062.1 the fine cast skin and the smooth transitions in the ribs from back to 'valley' is partly visible next to the reworked surface of the neck collar from Westerweyhe. The smooth transition from back to valley, as well as the gentle widening back towards the end, can be seen as clear indications of the modulation of the ribs in a model.

In a next step, possible air channels and the sprues (in wax) are attached to the model. The finished model is then packed in moulding loam. According to Jantzen (2008; 1991) up to three layers of different fine clay were likely to have been used. After drying, the clay mould is heated and the molten wax runs out. The piece can now be cast. That this specific neck collar was cast in its basic shape and made by hammering an ingot was confirmed by the metallographic examination. The large cloud-shaped crystals, which are a characteristic pattern for a cast pieces, are clearly visible in Figure 2.062.2 and identify the ribbed section (top rib) of the collar from Edendorf as a cast piece. Thus, the base of such collars should be assumed to have been made in wax as a model and subsequently cast via *cire perdue*.

Post-casting, the bronze ornament is removed from the mould and the mould is destroyed. Now the cast piece is prepared for the decorative work. All cast residues, the sprue and any impurities from the surface, are removed. Based on the small overlap documented in the decoration of the collar, the following sequence,

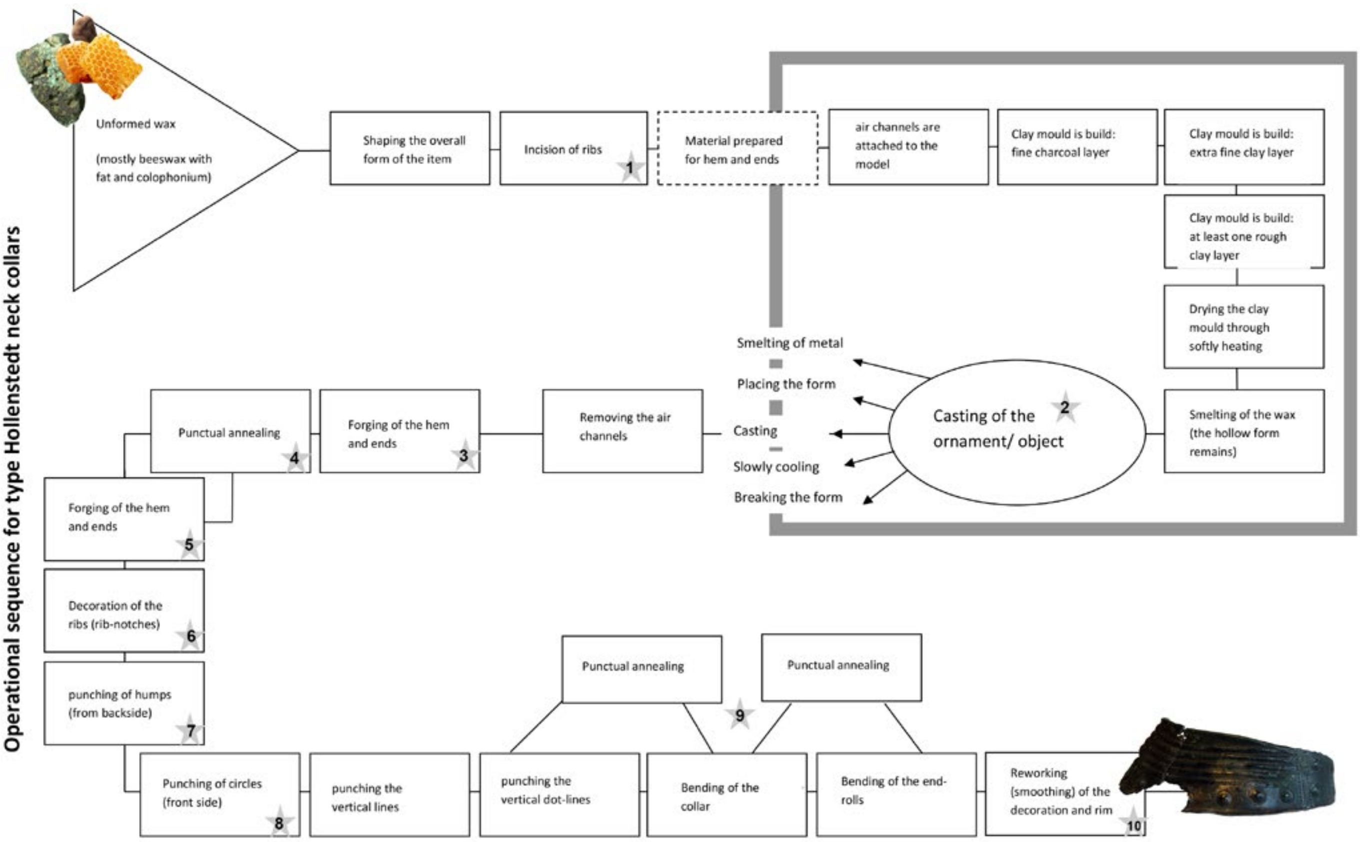


Figure 2.061: Operational sequence of Hollenstedt-type neck collars. This sequence is the result of the detailed investigation of seven collars of this type, as well as the metallographic investigation of samples of three collars.

in which single decorative elements are applied, can be reconstructed. First, the hem below the lowest rib and the sides are cold-worked (hammered) to their intended size. Here, we know from the reconstruction of the 'Nebra Disc' that 60-70 complete cold-working operations, with intermediate annealing for 20 minutes (Holdermann and Trommer 2010), were necessary to get the achieved shape. For the hammering of the seam and the ends of this neck collar, however, fewer operations should be assumed. The metallographic investigation (Figure 2.062.3), however, supports repeated intermediate annealing during cold-working. It was also shown that the annealing predominantly concentrated on certain points. The microstructure of the Edendorf neck collar (LMN 14144-2) shows, within a small section (the transition from ribbed belly to smooth end plate), the somewhat abrupt change from a cast structure (Figure 2.062.4, right) to a cold-worked (hammered) structure with pressure twins (Figure 2.062.4, left).[51] Thus, it should be inferred that not the whole collar was annealed, probably only the areas which should be hammered.

Following this, the decoration was applied directly onto the cast and hammered piece, probably mostly with bronze punches. The rib decoration was likely applied first, as confirmed by an overlap of the hem decoration on the rib-notches on the Ehlbeck collar (Figure 2.062.6). However variations occurred, as shown on the Edendorf collar (LMN 14144-2), which was probably decorated on the ribs after the completion of the hem decoration.

Subsequently the humps were emplaced from the rear side. As shown on the collar from Kolkhagen (Figure 2.062.7), predominantly one direct punch was necessary, although in some cases multiple strokes can be documented. The circular decoration around the humps was added from the front side and resulted often in the humps being limited. Here, the flat expiring base of the hump, which is caused by the thickness of the material, was cut off (Figure 2.062.8). Presumably this circle decoration was added by hand, as may be inferred by the varying line width and irregular shape. Gradually the hem and end-decoration were added.

[51] Pressure twins are a clear sign of the annealing of a piece that was worked. The annealing of a pure-cast microstructure would result in the formation of equally large crystals, which is not apparent, however, on the piece shown. On a cast structure worked without annealing the strain lines are visible, as can be partly recognised on this ornament.

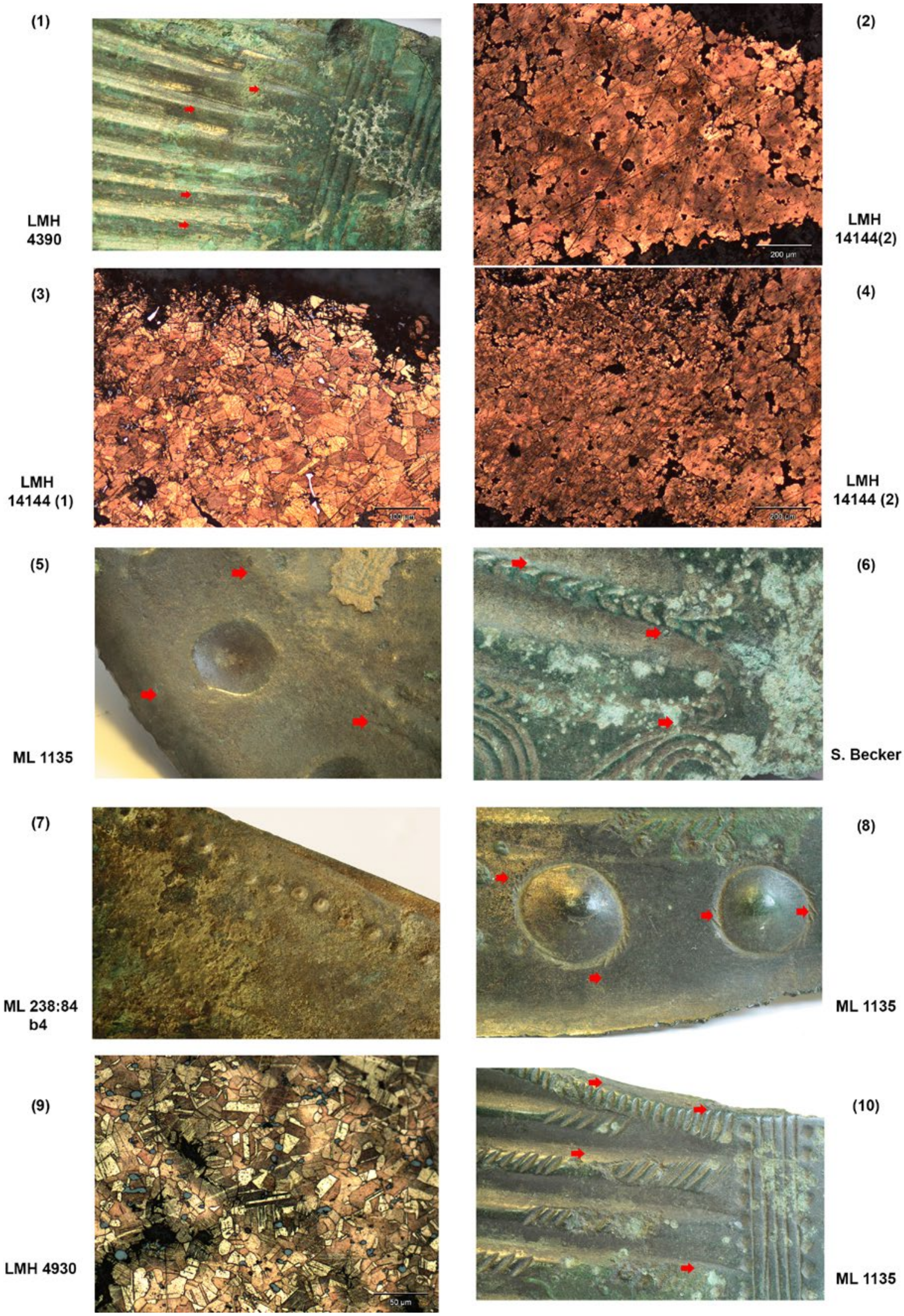


Figure 2.062: Examples from the examined material supporting the single steps within the operational sequence of the Hollenstedt-type collars 2.062.

Overlaps serve here as evidence for the exact order, which can vary from piece to piece. On the Edendorf collar it could be demonstrated, amongst other things, that the vertical decorative ribbons were created before the circle groups on the end plate, as they interrupt the decoration. Additionally, on the neck collar from Lüneburg the dotted lines accompanying the end decoration were added after the lines, as indicated by the overlap. However, the humps and circular rings appear to have been made before the vertical decoration. All these processes were accompanied by repeated intermediate annealing, and after completion of the decorative work of the collar its final form was created. Here, the flat artefact was then bent over an auxiliary body (probably wood) until it had the desired shape. The clearly visible elongated deformed crystals, with multiple strain lines at the transition from the frontal side to the end plate, support this sequence (Figure 2.062.9). These strain lines are also an indication that the collar was not annealed after completion of the decorative works, and that the tension after bending in the metal was intentional and probably served for the preservation of the form. Edge-parallel hammer marks and polished ribs point towards an intensive reworking of the nearly finished ornament, and a final polish.

Most of the operational sequence of a Mecklenburg-type neck collar, in contrast, deals with the making of the model (Figure 2.063). Here the basic form of wax is shaped similarly to the method described above. However, this collar type is almost completely formed as a model, as the majority of investigated collars support. The assumption that the decoration was applied in the model can be proved by the overlaps and material movements on the pieces. Thus, after forming the ribs they were decorated in most cases with circular grooves or square notches with the help of a wooden or bronze tool, directly pressed into the wax. A superficial casting defect on the collar from Lübz proves that the shape and decoration of the ribs was already formed in the model (Figure 2.064.1). The most common next step in the sequence was the application of the spirals in the fields framed by the ribs. As seen on the collar from Sparow, the spirals cut into the rib decoration at the top and bottom (Figure 2.064.2), and occasionally the spirals cut into the 'slope' of the ribs. The order of the following steps varies between the pieces, most commonly, after the placing of the spirals, the connecting lines between them were added (Figure 2.064.3). Here, the most variations occur; for example the spiral row of the Lübz collar seems to be applied in one fluid motion (spiral - connecting line - spiral - connecting line) and on other pieces spirals and dotted lines are separate steps, resulting in an overlap of both elements.

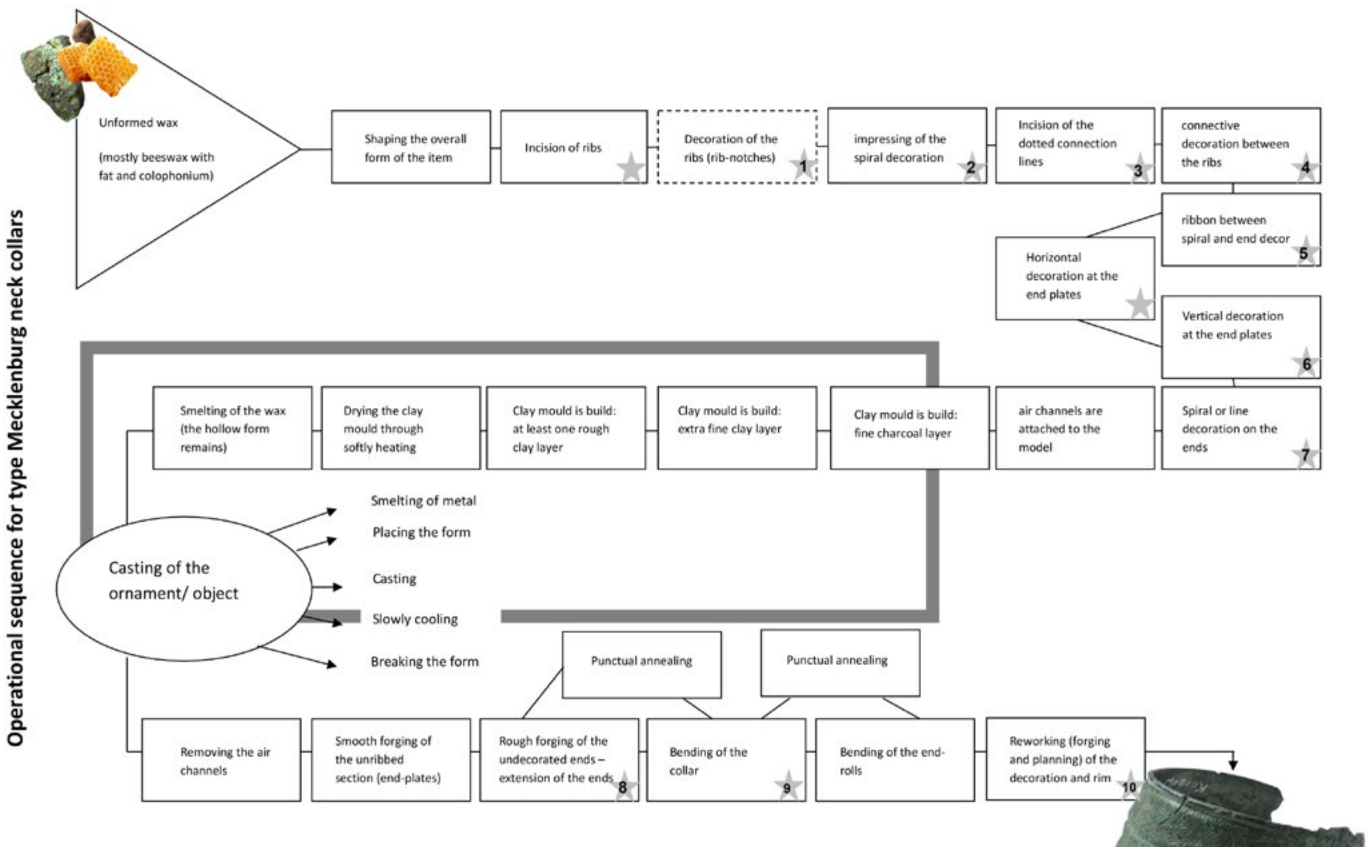


Figure 2.063: Operational sequence of Mecklenburg-type neck collars. This sequence is the result of the detailed investigation of over twenty collars of this type.

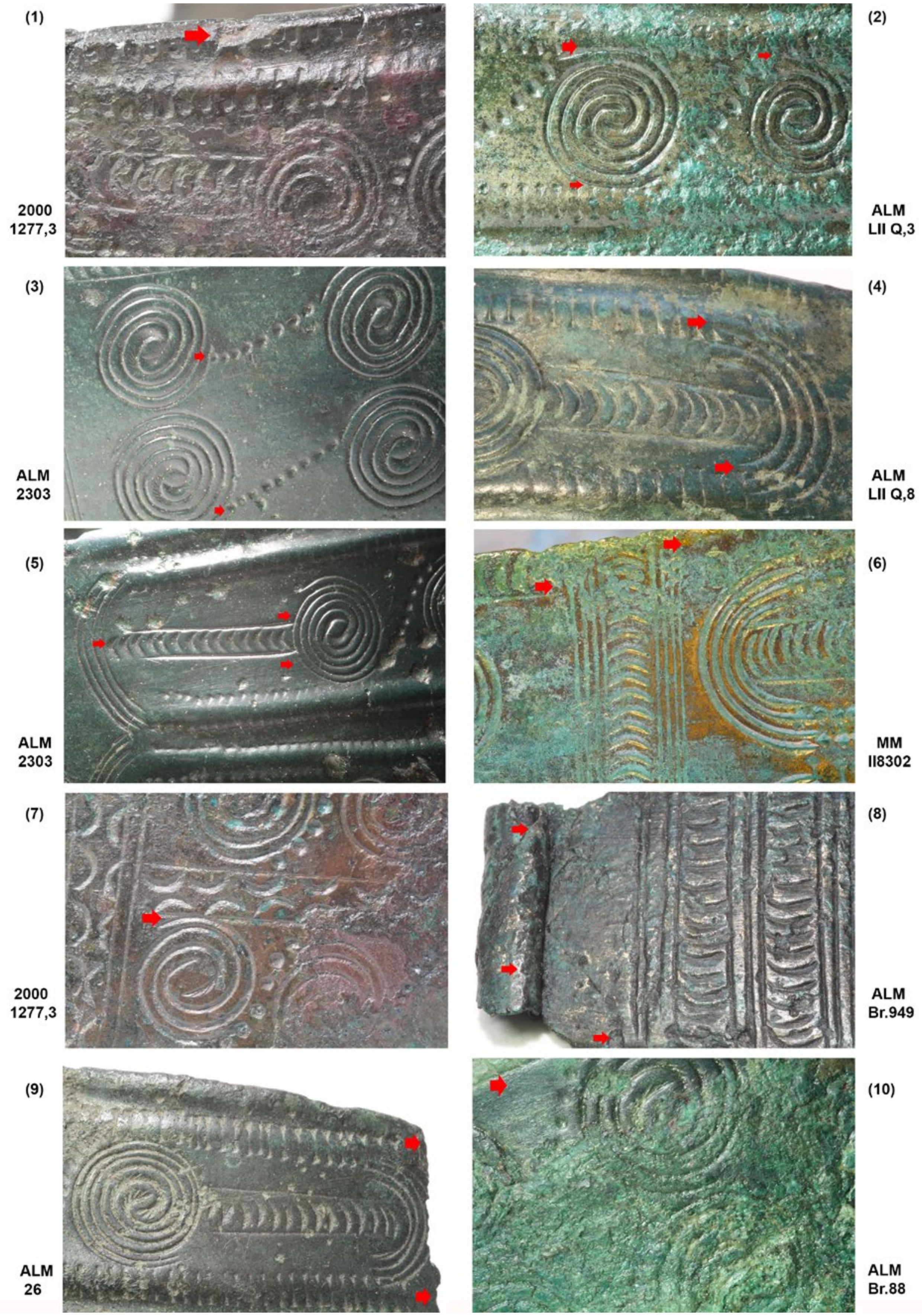


Figure 2.064: Examples from the examined material supporting the single steps within the operational sequence of the Mecklenburg-type collars 2.064.

The following steps in the sequence are again more uniform between the artefacts. After the decoration was added in the central fields, the rib-connecting arches were applied (Figure 2.064.4) and then the vertical arrow or bow ribbon towards the spiral series (Figure 2.064.5). It can be assumed that the decoration of the end plates was added after completion of the front decoration, although, however, still in the wax model. It seems that here the vertical line decoration that separates the front from the sides was applied first, followed by the horizontal and then vertical decoration on the ends (Figure 2.064.6). The overlap between spiral and horizontal decoration on the collar from Lübz (Figure 2.064.7) displays the most common sequence, where the spirals of the end plates were applied after the decorative ribbon. It seems that the individual variations in the decorative design of Mecklenburg neck collars were due to local customs (see Chapter 3.2).

These collars were cast subsequently to the application of most of the decoration. Next, the sprue and possible air pipes were attached, and after creating the mould the object was cast (see Figure 2.063). When the mould form was destroyed after cooling, a nearly complete Mecklenburg-type neck collar appeared.

However, several pieces show traces of intensive post-casting reworking of the decoration. Especially, on a fragment of a neck collar (unknown locality) from Mecklenburg, some Bronze Age as well as modern traces of reworking of the spirals and line decoration are recognisable. Within a conventional sequence, the ends were then hammered (so that they could be bent to form end rolls) and finally the collar was bent. Intermediate annealing, and the use of soft movements and the right tools, makes this step nearly invisible. However, the end-piece of the collar from Poltnitz shows hammer marks near the end rolls, and also dents in the surface of the nearby decoration (Figure 2.064.8).

Clear signs of the post-casting cold-working (hammering) of the collar without a final annealing are the frequent break points showing at the transition from the front to the end (Figure 2.064.9). Due to the intensive deformation at this point, the material becomes brittle and predetermined breaking points occur. If the ornament, while worn, was bent several times (presumably due to shape and size), the most deformed parts of the microstructure tended to break first.

Similarly to the sequence presented above, the piece was finally reworked, as the irregular grinding grooves on the Karbow collar demonstrate; here a rather sloppy reworking was carried out (Figure 2.064.10).

Both sequences (Figures 2.061 and 2.063) represent the reconstructed operational sequence of a morphologically similar bronze ornament, namely a ribbed collar with smooth decorated fields. However, the single steps within the sequence, as well as the techniques used were fundamentally different, a fact that is not visible at first glance. The NBA II Hollenstedt-type collars were mainly based on hammering. Here, most work was done post-casting. In contrast, while crafting Mecklenburg-type collars the most work was put into the making of the model. These different approaches consequently resulted in the use of different techniques and thus different traces were left.

Even if Nordic Bronze Age neck collars are one of the most investigated ornament categories (i.e. Nørgaard 2011), these sequences revealed many technical traces and added new information enabling the detection of regionally specific crafting behaviour.

2.6.2 Legacies of the Bronze Age smith: mistakes in manufacture as indicators for the 'craftsperson'

In addition to frequently occurring overlaps in decoration that provide evidence for successive steps, bronze ornaments can provide more information. Although these traces were often visible with the naked eye, however, only detailed macroscopic and microscopic documentation made it possible to analyse and present these traces of crafting. Many objects revealed evidence of the planning of the piece and its actual construction, as well as errors in manufacture and the response of the craftsperson to those errors.

Measurement systems and measurement error

Such lavishly decorated bronzes required some kind of measurement system to secure an error-free application of the decoration. Based on markers and recurring decorative units, Drescher verified the use of measurement aids and possible compass-like tools, even in the Early Bronze Age (Drescher 1954: 44ff.). In addition, the material under investigation displays auxiliary lines and other kinds of markings that can confirm construction of the decorative pattern. Above all, indications of compass-like tools, based on the centre point of the disc, are common (see also Rønne and Bredsdorff 2008; Drescher 1954: 46). That such auxiliary tools, however, were not only used in constructing the large plates but also in others can be shown on the disc-headed pins from Lüneburg (LMH 12041) and Heitbrack (LMH 137:81), and on the Kolbedal tutulus (AM 5106). The latter, especially, has a deep auxiliary line on which the edge-accompanying dotted line is oriented, drawn concentrically around the central hump (Figure 2.065, 5106). Not as clear, but still recognisable, is the auxiliary line visible on the two disc-headed pins from Lower Saxony (Figure 2.065, 12041 and Figure 2.066, 137:81). Similar to the tools used while crafting the tutulus, here also a compass-like tool must be assumed, anchored in the centre of the disc.

In addition to these still visible lines, notches or incisions might also have served as guides and can be documented on the bronzes. Such measuring units can be carefully incorporated into the decoration of the ornament, as indicated by the Vejlbymark tutulus (Figure 2.066, 0877). Such measuring points differ from

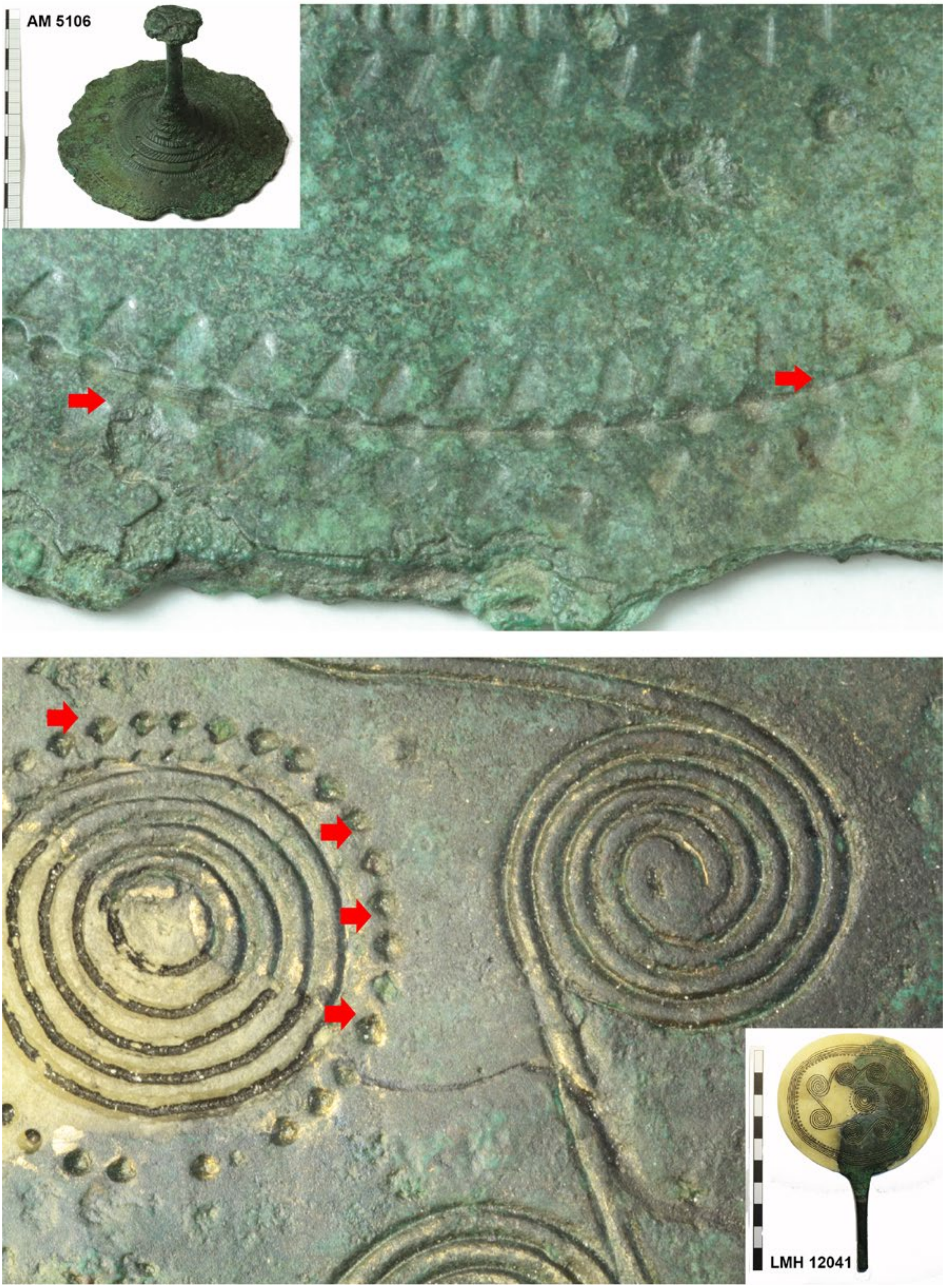


Figure 2.065: Auxiliary lines and other kinds of markings on the tutuli from Kolbedal, Vejle (AM 5106) and the pin from Lüneburg, Lower Saxony (LMN 12041).

the rest of the decoration, either being greater than the remaining impressions (Figure 2.067, 25787 and B3574), varying in distance and length (Figure 2.068, 62375), or in their orientation (Figure 2.068, 11969). However, such clear traces, as seen on the Estrup neck collar (Figure

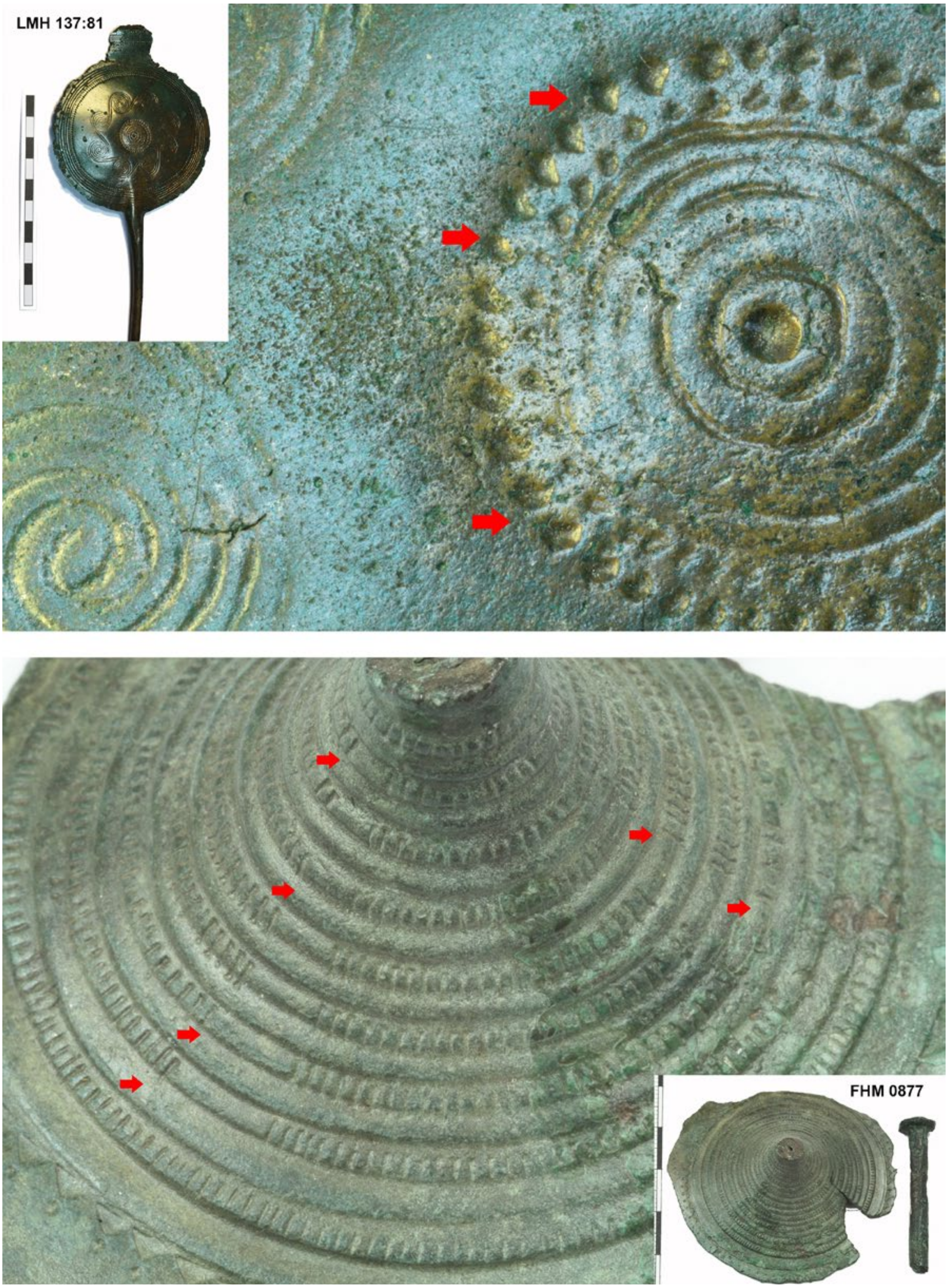


Figure 2.066: Auxiliary lines and other kinds of markings on the pin from Heitbrack, Lower Saxony (LMN137:81) and the tutuli from Vejlebymark, Vejle (FHM 0877).

2.068), are rarely recorded. The majority of bronzes allow no insight into the design of the ornament.

Despite such aids, errors in the construction of the decorative pattern occurred frequently, more often,

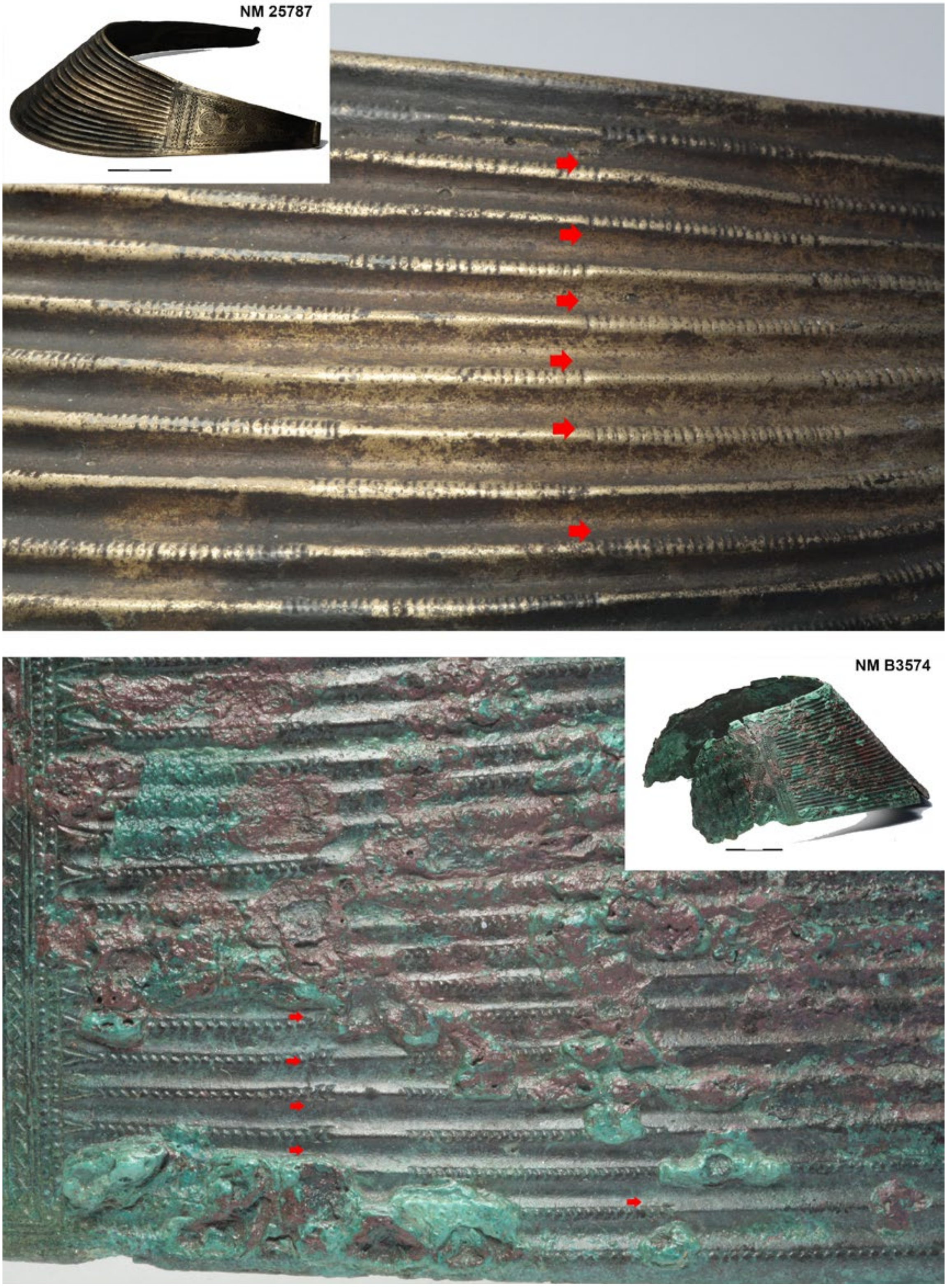


Figure 2.067: Auxiliary lines and other kinds of markings on the neck collars from Vellinge, Fyn (NM 25787) and Sibberup, Sorø (NM B3574).

however, on cold-worked (hammered) bronzes than on model-decorated artefacts. Of interest in this concern are the belt discs from Molzen (ML 242-84c) and Apel (LMN 4769), whose decoration had to be adapted due to measurement mistakes. On the Molzen disc the triangle that deviates in its dimensions is clearly visible. It can

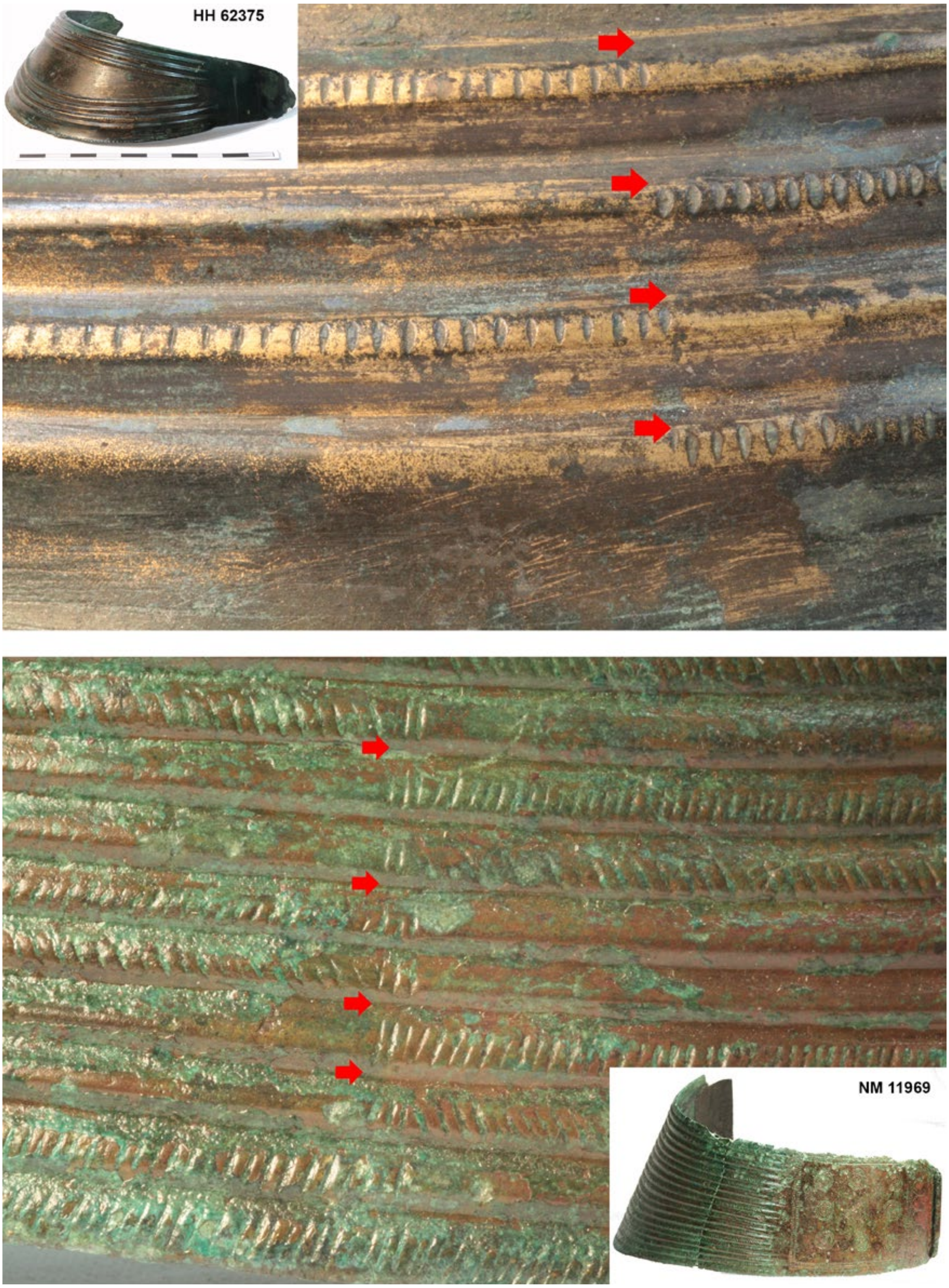


Figure 2.068: Auxiliary lines and other kinds of markings on the neck collars from Toppenstedt, Lower Saxony (HH62375) and Estrup, Sorø (NM 11969).

be assumed that this specific triangle was inserted as the last decorative element of the series, and thus had to be adapted to the supposedly free space (Figure 2.069), whereas the second disc displays a significant overlap of, in this case, the large triangle (Figure 2.069). The construction of such a triangle-decorated disc is illustrated on Figure 2.070. In order to construct such a pattern successfully, the edge- and spike-accompanying

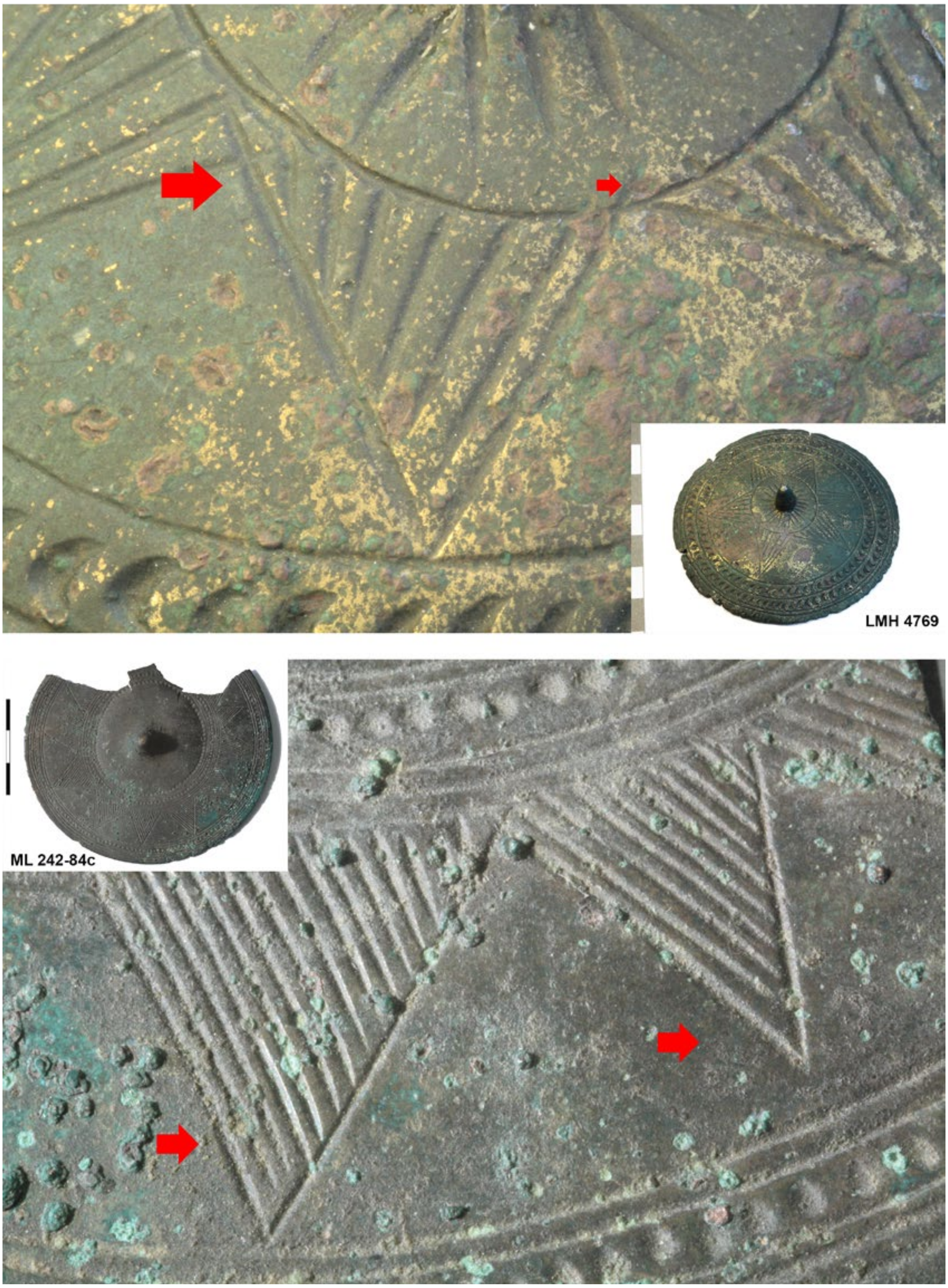


Figure 2.069: Measurement errors in the construction of the decorative pattern on the small belt discs from Apel (LMN 4769) and Molzen (ML 242-84c) in Lower Saxony.

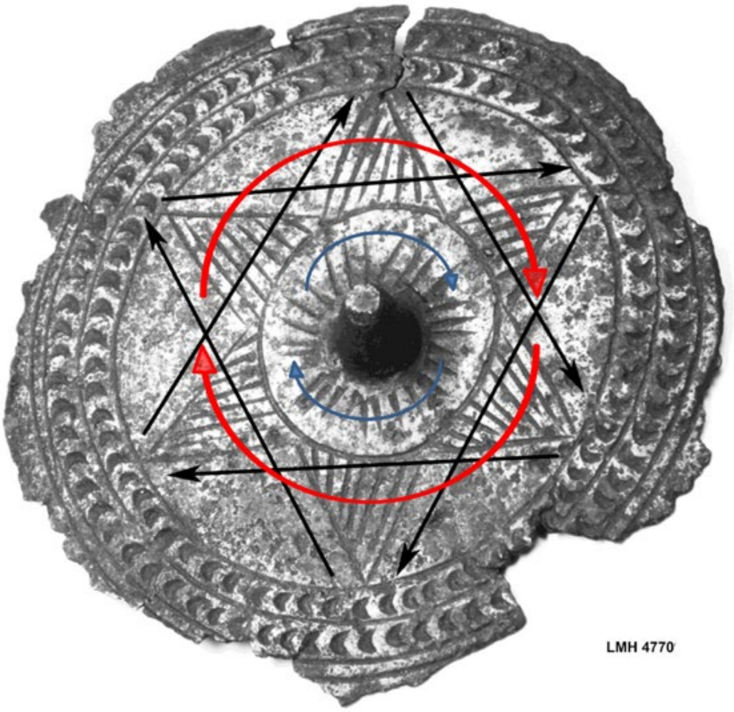


Figure 2.070: Construction of a triangle-decorated disc explained on the small disc from Appel, Lower Saxony (LMN 4770).

circular lines were probably drawn as an orientation. Subsequently the triangle star-shape pattern was constructed using solid aid-lines to adjust the single triangles. The line-filling of the triangles was applied clockwise, in the same way as the line decoration around the spike. Here, the different skill levels can be seen in the quality and technique used; good quality discs were constructed in the presented manner.

However, errors within the decoration due to carelessness and mistakes during measuring show up in many areas. As on the disc (B2655) from the Vellinge bog find, and on the disc (NM 10935b) from the Svenstrup hoard, missing or incorrectly arranged elements in the notch-and-diamond ribbon can be detected (Figure 2.071). Clearly, a measurement error is visible within the arch ribbon of the small disc from Vognserup (VM1680KK), whereas on another disc from the same hoard (VM1680KM) some signs of carelessness can be deduced, for example one of the double-line triangles is constructed by the use of three lines (Figure 2.072).

Such errors as those presented above attest to the difficulty of applying this elaborate decoration. As already mentioned, such errors occurred on metal-decorated artefacts, as well as on model-decorated ornaments, i.e. the Vognserup discs.

Although such measurement errors are understandable in metal-decorated bronzes, similar errors in model-decorated artefacts entail questions as to why such errors were not corrected in the process of making. Here it is necessary to be aware that the making of a wax model is as time consuming and labour intensive as the creation of decoration post-casting. If the correction of mistakes was to some extent possible on the model, it would mean, however, that errors were consciously recognised as such. This might only have occurred after completion of the piece. Furthermore, and most importantly, the correction of the specific error appears to have been necessary.[52]

Moreover, some documented deviations show not only the direction in which the decoration was worked, but also the point at which it began. Some of the above-introduced overlapping of decorative elements also indicates the beginning and end of each decorative ribbon (see Figure 2.072).

Decorative ribbons, application and making

Transitions or connections within the single decorative ribbon provide information on the craftsman´s skills, since here familiarity with the tool (either punches or wooden spatula) is shown. Interruptions and a new tool approach in simple lines are the most common features. Here, the range of ability is most obvious because lines can be connected in a way in which no recognisable interface is created, up to a significant offset (Figure 2.073) or running side-by-side passages (Figure 2.074). When looking at the material examined in terms of possible detectable interruptions in the

[52] As an example, one thinks of the cake that is already in the oven but whose ingredients may have been added in the wrong order: you could make a new cake, however, is it worth the effort?

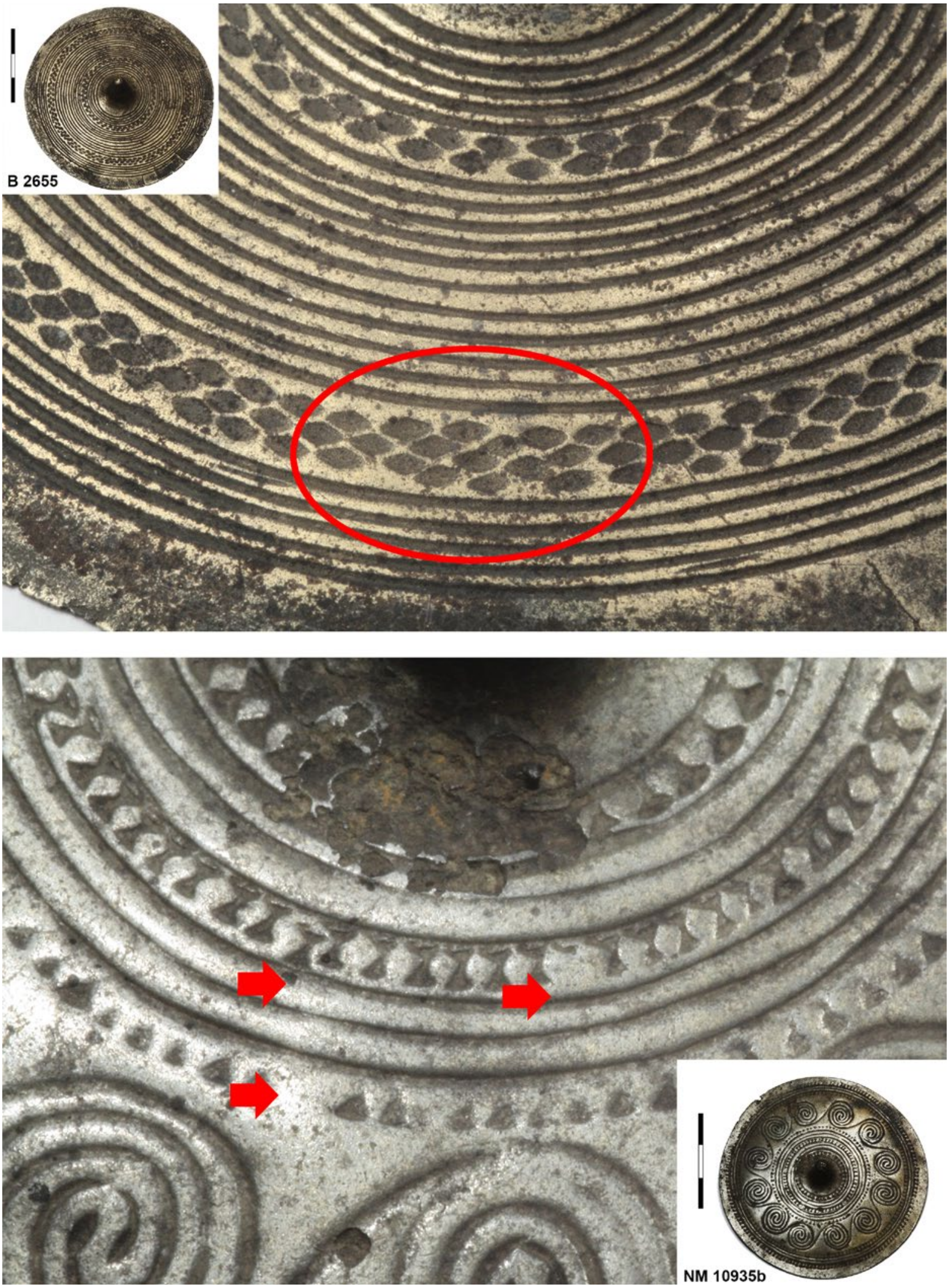


Figure 2.071: Measurement errors in the construction of the decorative pattern on the belt discs from Vellinge, Fyn (NM B2655) and Svenstrup, Zealand (NM 10935b).

Figure 2.072: Measurement errors in the construction of the decorative pattern on the belt discs (VM 1680 KK and KM) from the Vognserup hoard on Zealand.

line decoration, a clear imbalance between artefact groups occurs (Figure 2.077). On up to 75% of the belt plates and belt discs such tool approaches can be documented, whereas this is only possible on 21% of the neck collars. In addition, the smaller belt discs display often striking deficiencies in the merging of lines, in contrast to the richly decorated belt plates. Furthermore, similar interruptions, interpreted as initial points, can be detected on the elaborated decorative ribbon (Figure 2.075). These traces reveal information concerning the direction in which the tool was operated, or even the tool type. As on some

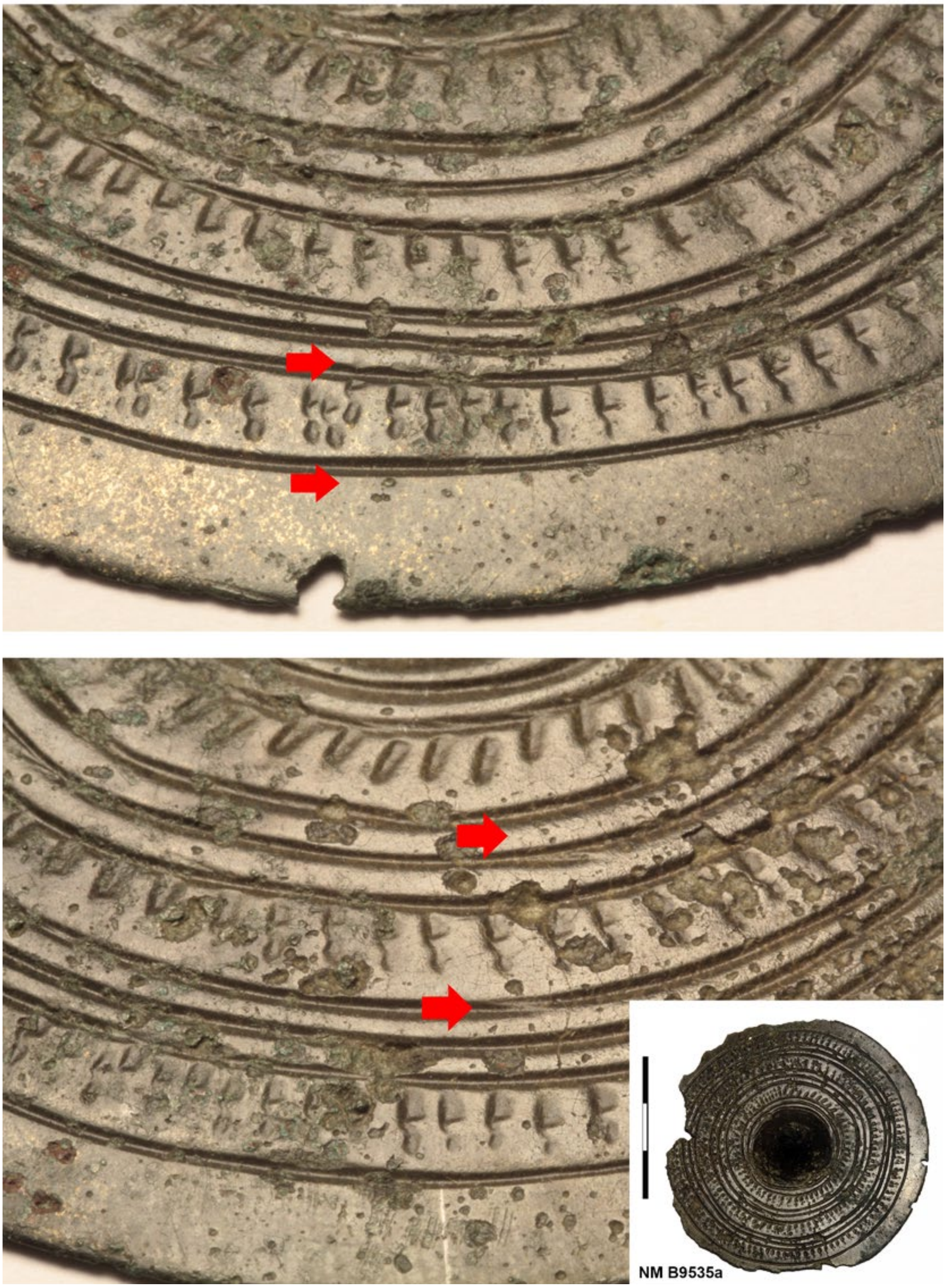


Figure 2.073: Decoration on the belt disc from Glæsborg, Jutland
(NM B9535a) demonstrates the different transitions or connections within the single decorative ribbons.

ornaments, the decorative ribbons are composed of lines and separately applied notches or impressions. The belt plate from Frankerup (CMXIII) presents the described situation particularly well; here, the parallel lines converge at the initial point of the ribbon while the internal grooves overlap (Figure 2.075). A similar method of construction can be inferred for the small disc from Glæsborg (B9535a), on which shoe-shaped notches are placed in a disordered manner within the framing lines (Figure 2.073). On other ribbons, however, the framing lines and the internal notches form a unit, as seen on the Grabow disc (Figure 2.075, L1H16).

Figure 2.074: Belt discs from Vellinge, Fyn (NM B2657) and Rehlingen, Lower Saxony (LMN 4755) demonstrate the different transitions or connections within the single decorative ribbons.

In a similar manner, many triangle series seem to be introduced as a unit with the help of rotation or multiple tools pressed onto the model in a similar way.[53] A uniform offset, as it would occur when using such a tool, is presented particularly well in the triangle ribbon (Figure 2.076) on the belt plates from Gjedsted (B13260) and Svenstrup (NM 10932). The modern goldsmith is

[53] Due to the fact that these tool imprints made while turning a wheel-like tool can only be used for the decoration of malleable materials such as wax.

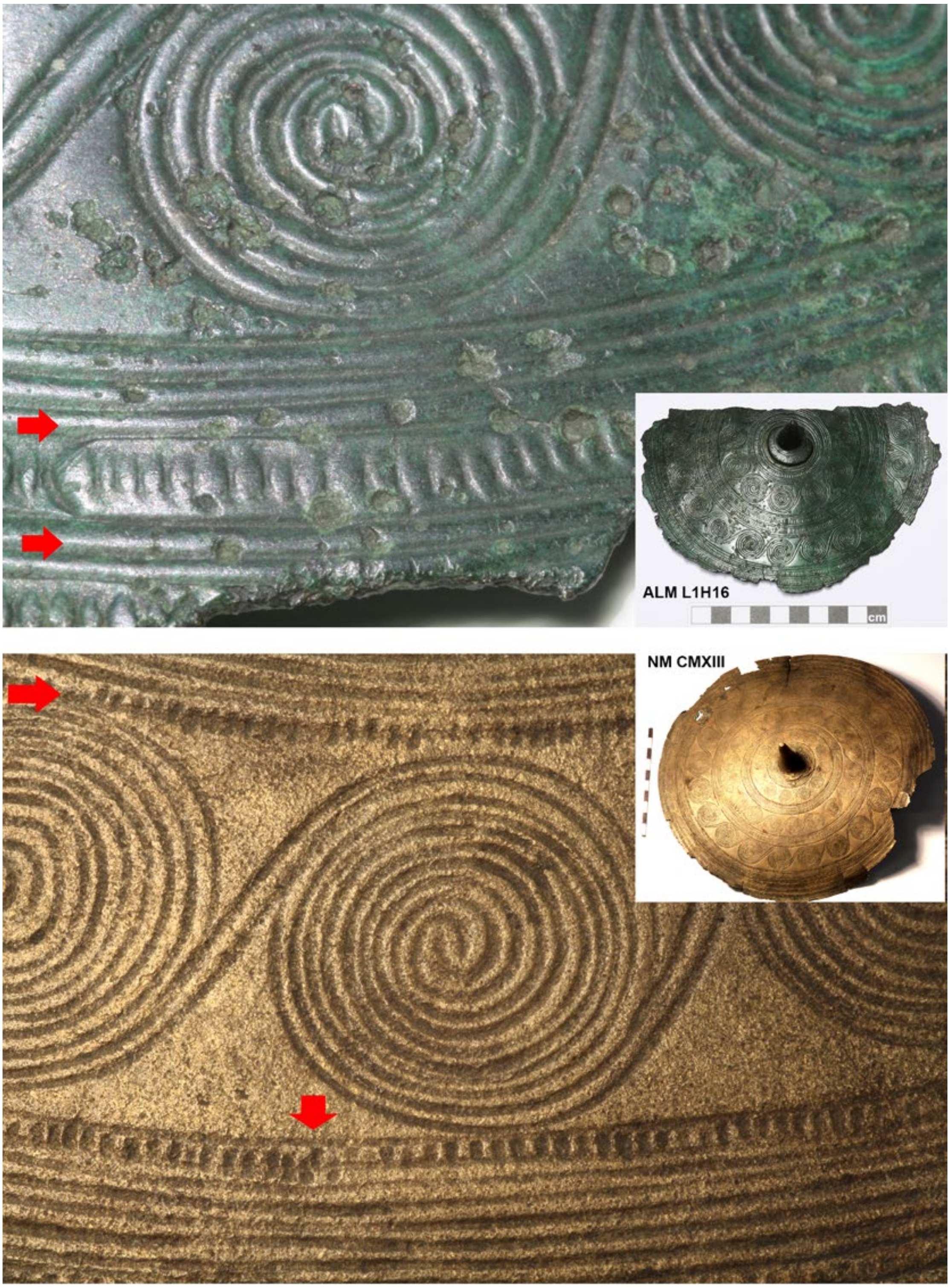


Figure 2.075: Belt discs from Grabow, Mecklenburg (ALM LIH16) and Frankerup, Zealand (NM CMXIII) demonstrate the different transitions or connections within the single decorative ribbons.

familiar with several ways to create effectively recurring patterns. Among others, punches can be used that have a long stroke path on which the adjacent elevations form a patterned row, named 'Faulenzerpunzen'. Such tools are known from the depositions in Génelard, Cote-d'Or and Larnaud, Jura in France (Armbruster 2012: 390), and another Late Bronze Age hoard in Upper Bavaria (see Figure 1.048), and seldom show use-wear traces that indicate a possible use during model making (Nessel 2009: 42). The latter hoard provides another potential tool, described as a wheel (Nessel 2009: 39). Nessel excludes the benefits of this piece as a tool due to its

Figure 2.076: Belt plates from Gjedsted (NM B13260) and Svenstrup (NM 10932) on Zealand demonstrate the different transitions or connections within the single decorative ribbons.

irregular axis rotation and a groove in the notched zone. She interprets these objects as parts of spindle-headed pins, which seems understandable (Nessel 2009: 46). However, notched ribbons in multiple shapes with some inexplicable limitations (Figure 2.078), wavy notched ribbons (Figure 2.079), as well as wavy notch groups as rib decoration (Figure 2.080), are quite frequent. Wheel-like objects on the other hand are frequently predominantly decorative elements on several pins. These wheel-like thickenings can be decorated with notches similar to the ones used as rib decoration in form and size (Figure 2.081). Thus, the decorated wheel is known during NBA

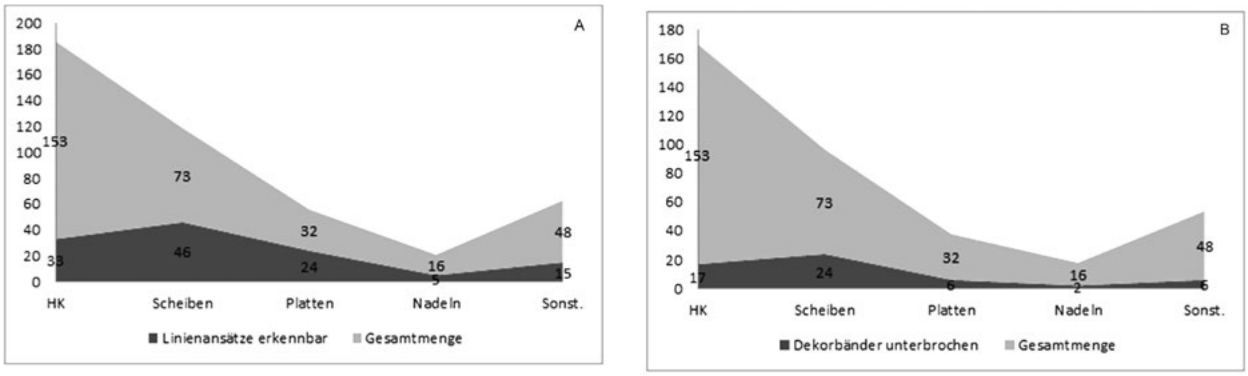


Figure 2.077: Diagrams show the relation between the artefact, the occurrence of measurement errors and line interruptions in the decoration: A) line approach visible and B) interruptions in ribbon visible.

Figure 2.078: Decorative ribbon of the neck collar from Estrup, Sorø (NM B11969).

III at least, and, regarding the construction of these pins as models (see Chapter 2.8.4), it can be inferred that lens-shaped wheel-like devices (wood or bronze) might have also been used as tools for model decoration, if not the pins themselves.

The investigated material revealed that design stamps, or Faulenzerpunzen, as well as the use of wheel-like tools, were possibly used in the production of wax models for NBA ornaments. It can be assumed that some Faulenzerpunzen were used for the decoration of bronze surfaces. The use of wheel-like tools,[54] however, should be seen only as possible for the decoration of malleable materials. Additionally, the way in which decorative ribbons are applied, connected and arranged, should be noted as decisive evidence of a craftsperson's skill.[55]

2.6.3 Specialised techniques to create decorative units

In addition to simple technical 'tricks', with which decoration was applied to artefacts, highly sophisticated techniques were also used to decorate bronze ornaments.

Many different methods to create spirals have been suggested (Strzygowski 1925; Ringbom 1933; Lowery *et al.* 1976; Thrane 1977; Lenerz de Wilde 1977; Savage *et al.* 1982; Rønne 1989), however, their use has never definitively reflected itself in the material culture. Nevertheless, the material provides features that can be very likely correlated with some of the methods mentioned (see Chapter 2.2.3).

Thus, the application of spirals with spiral-stamps can be detected in the material using successive identical, projecting spirals. For example, the use of well-finished stamps can be demonstrated on the belt plates from Frankerup (Figure 2.082) and Langstrup (Figure 2.083). Spirals created through stamps should be alike in their turns, the distance from turn to turn, possible mistakes, and the spiral centre. To better illustrate

[54] A more detailed examination of the surrounding decoration of the small wheel-like discs of Spindelersfeld- and Weitgendorf-type pins, and a comparison with the well-known notch ribbons of the bronzes produced with the aid of models, would probably provide new insights into the decorative techniques of wax models.
[55] The definition of skill and its detection within the material culture of the Nordic Bronze Age is discussed in length in Part 3, Chapter 4 and Part 4, Chapter 2 (see also Nørgaard 2018).

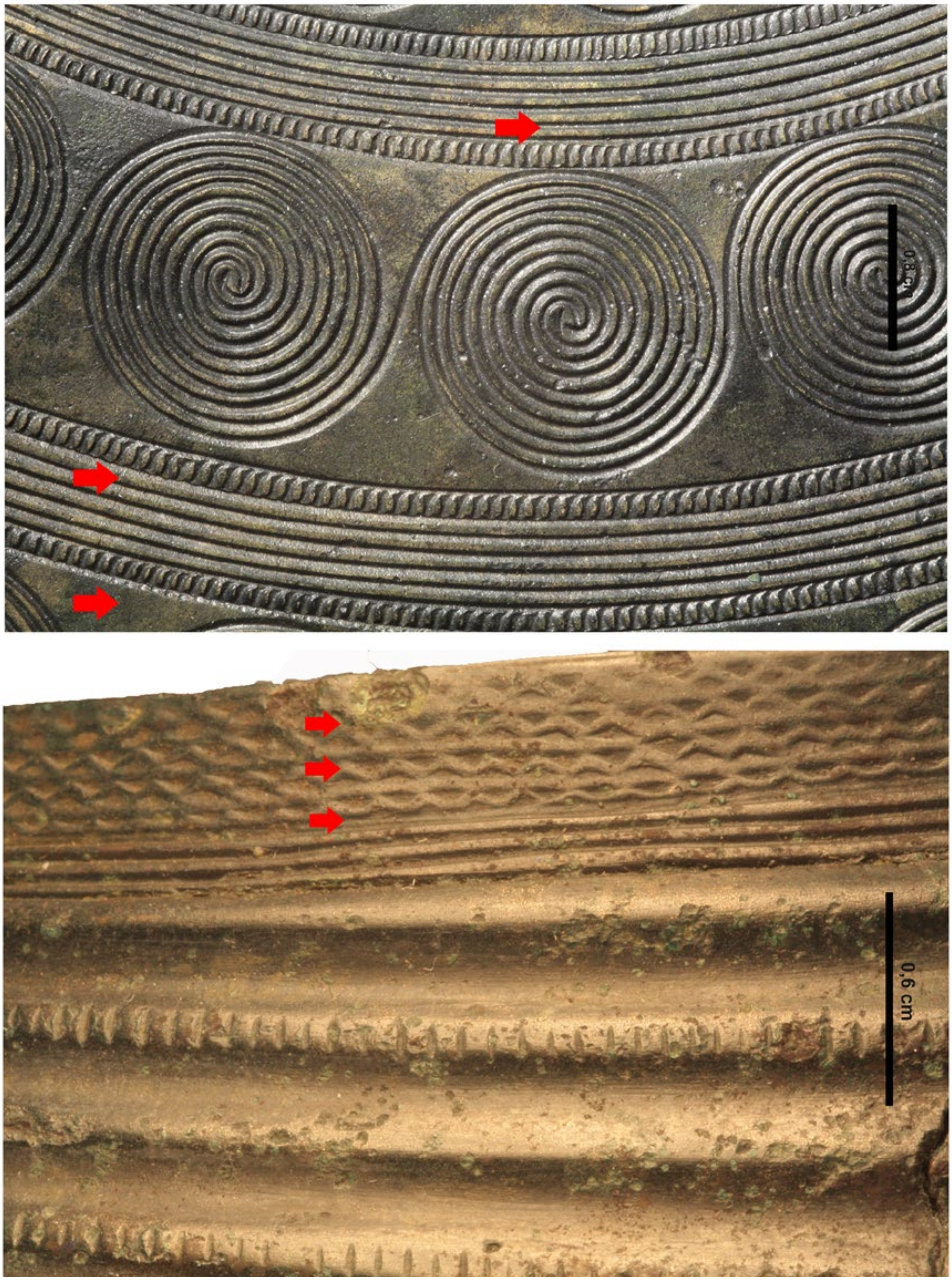


Figure 2.079: Waves in the decorative ribbons of the belt plate from Langstrup (top, NM B2307) and the neck collar from Rye (bottom, B7613).

these characteristics, one half of a spiral and one half of a distant spiral of the same artefact are joined in order to check the construction of the centre, the trend in the turns and their formal characteristics. Regarding the above-mentioned belt plates, the respective parts of each spiral fit without error. Using this simple method within the area of research on 48 artefacts (on ten pieces the use of a stamp is likely), the use of spiral-stamps could be proved (Figure 2.084-86). In contrast, hand-drawn spirals, as on the Glæsborg belt disc (Figure

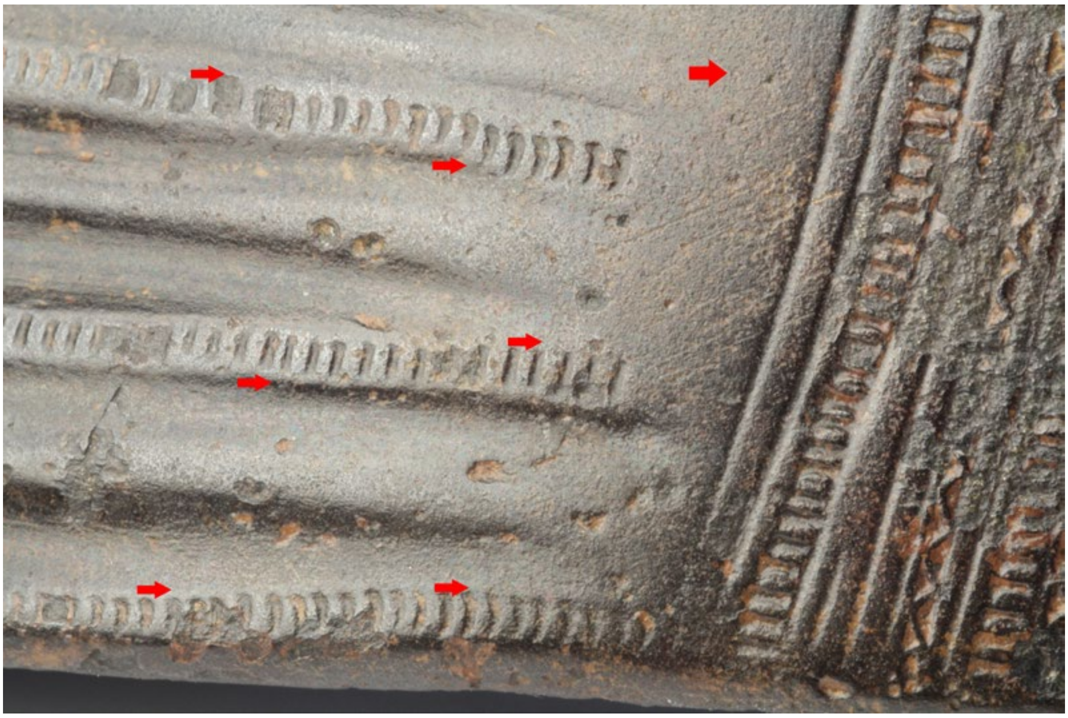


Figure 2.080: Rib-notches of the collar B2659 found on Zealand (Sjælland) are applied in wavy lines making a wheel-like tool possible.

Figure 2.081: Weitgendorf-type pin from Weisin, Mecklenburg (ALM 2696a) has wheel-like thickenings decorated in a notch ornament known from many ribbed collars.

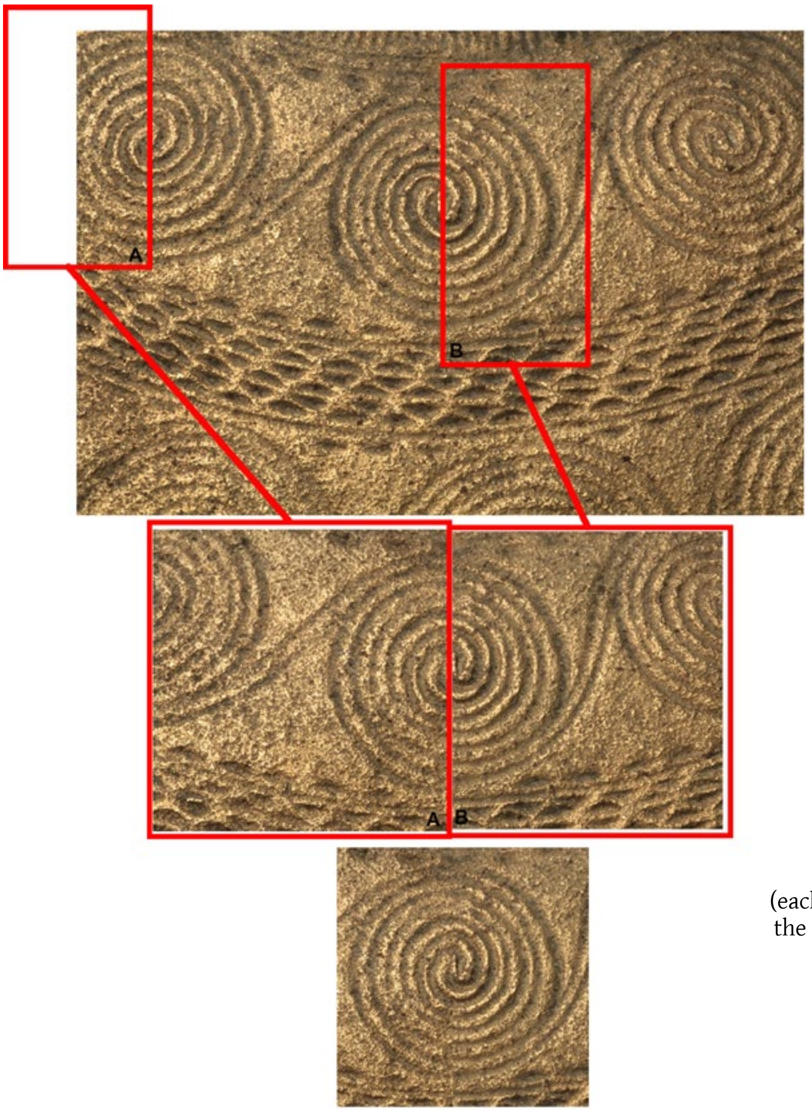


Figure 2.082: By joining two half spirals (each half of a different spiral) the application of the spirals with a spiral stamp can be proved on the belt plate from Frankerup (NM CMXII).

Figure 2.083: Identical spirals of the belt plate from Langstrup (NM B2307).

2.087), show distinct differences within the individual windings in the depth and width of every turn.

However, the pieces crafted with the help of such a stamp-tool form only a small proportion of the examined artefacts. While 51% of large belt plates were

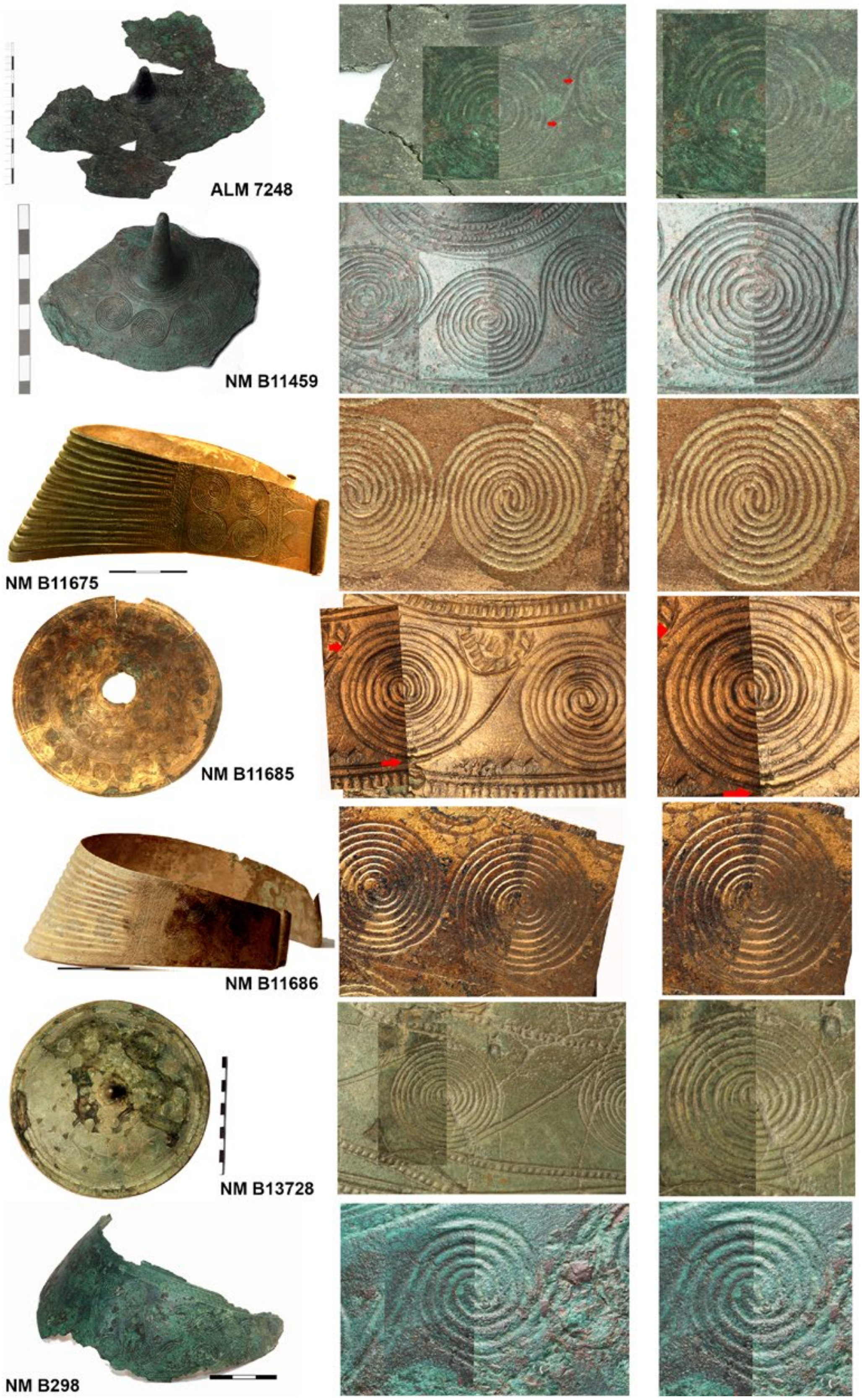


Figure 2.084: Artefacts 1-7, where the use of spiral-stamps could be proved using successive identical, projectable spirals.

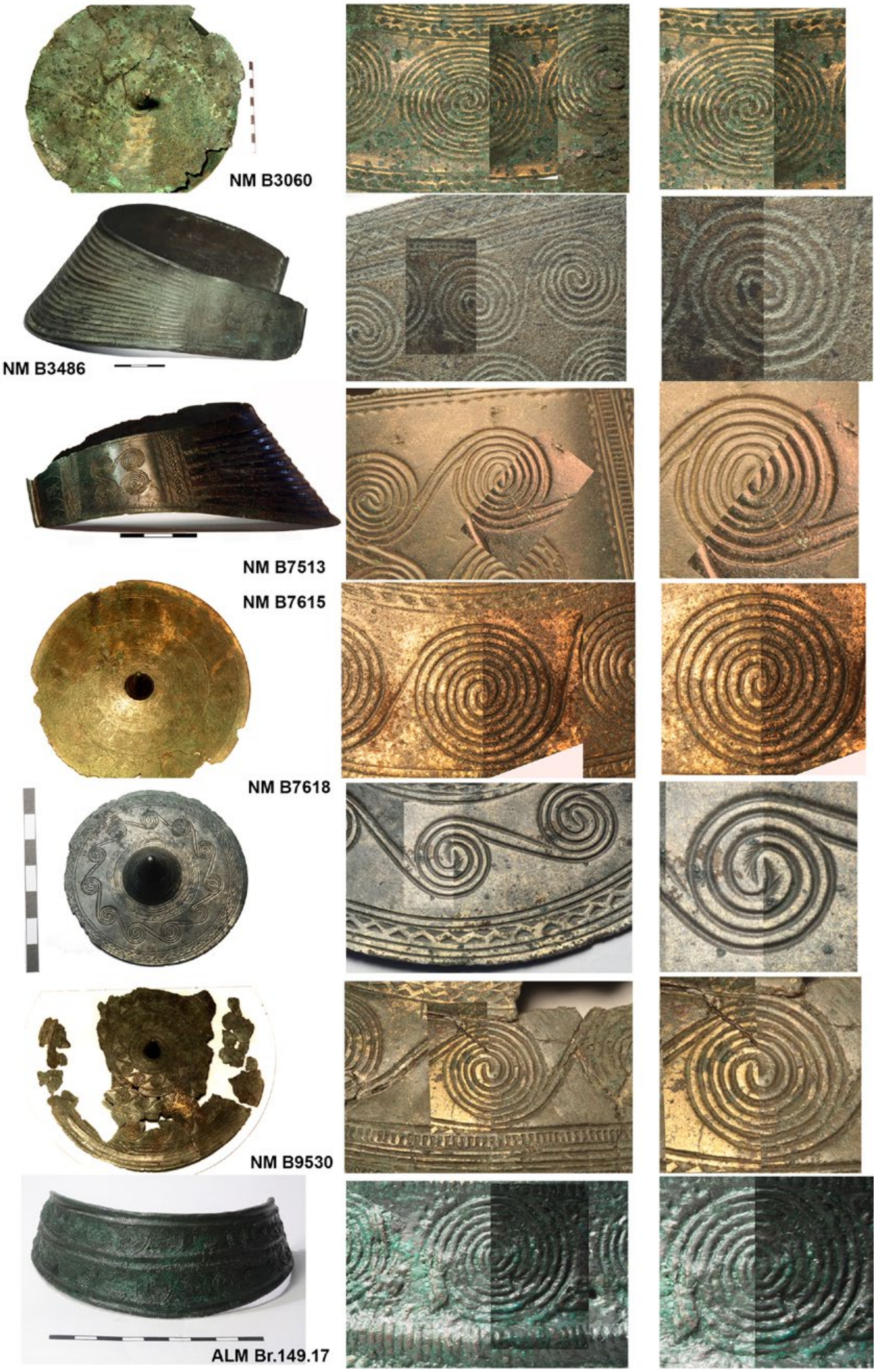


Figure 2.085: Artefacts 8-14, where the use of spiral-stamps could be proved using successive identical, projectable spirals.

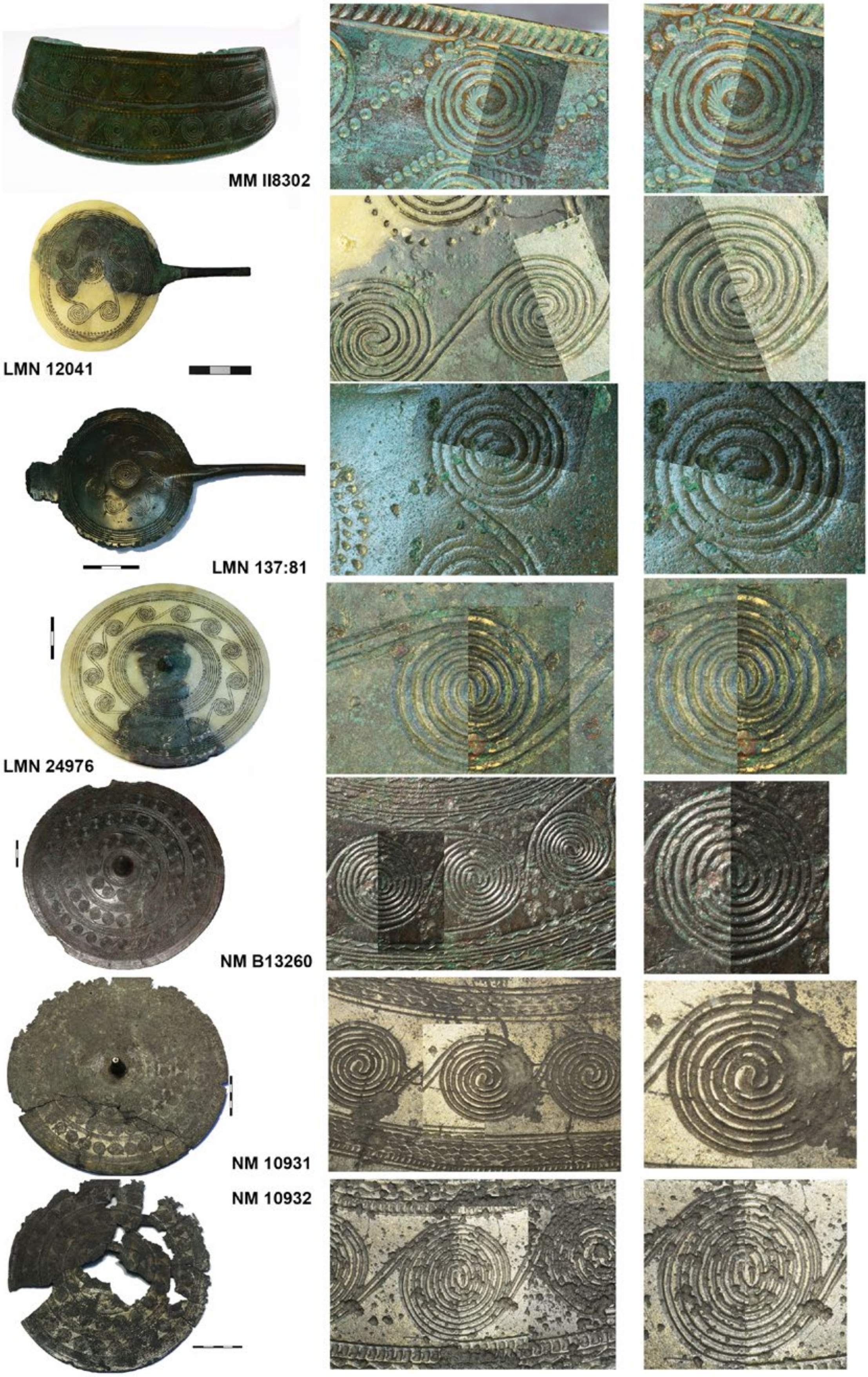


Figure 2.086: Artefacts 15-21, where the use of spiral-stamps could be proved using successive identical, projectable spirals.

Figure 2.087: Hand-drawn spirals on the Glæsborg belt disc (B9534).

stamped in the model, only 19% of the neck collars, and less than 5% of the needles and belt pulleys, were crafted using spiral-stamps (Figure 2.088). This clearly demonstrates that the stamp technique cannot be described as a basic approach and that this method was apparently reserved for special, possibly very complex, bronzes.

The disc-headed pins of Heinrichswalde (ALM 7236b) and Sparow (ALM LIIZ1g1), originating in eastern Mecklenburg, allow insight into another special technique used in the application of hump rows. These two pins differ in their design (probably due to chronological reasons), however, they do not differ in the way they were crafted. Within the hump series, each of the discs is decorated with several rows of differently sized humps; multiple points of light reveal the technique used to make this design. On the large humps of the disc from Heinrichswalde (Figure 2.090), the light reflections are a clear sign that here up to three strikes were necessary to give the hump the desired depth (Figure 2.089). Similar traces and interpretations can be drawn from the disc from Sparow (ALM LIIZ1g1), and the belt discs from Toppenstedt (HH62376b), Molzen (242: 84h) and Vendsyssel (B4753). Some artefacts may not have been annealed, or annealed only carelessly, as in some instances the material could not withstand these blows and tension cracks appeared (Figure 2.091). These cracks at the highest point of the hump are, in particular, an indication that the humps

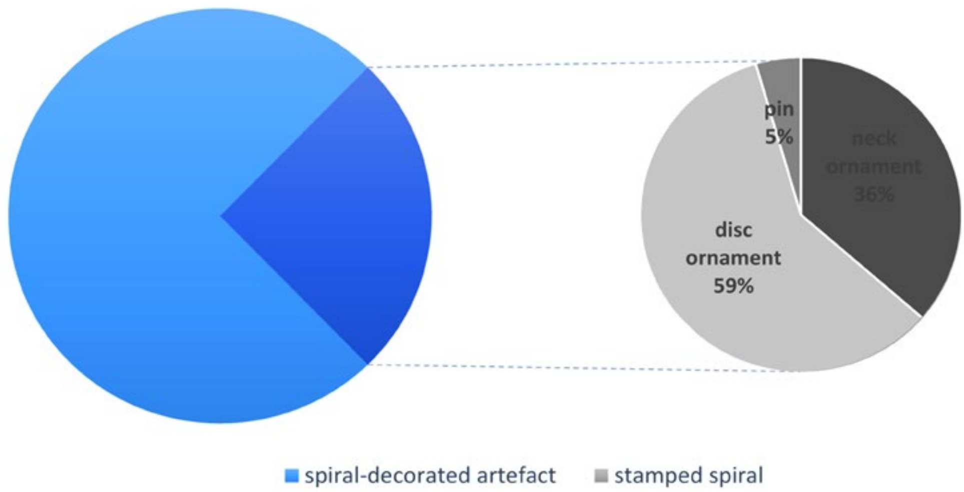


Figure 2.088: The chart displays the amount of stamped spirals within the material culture of the Nordic Bronze Age.

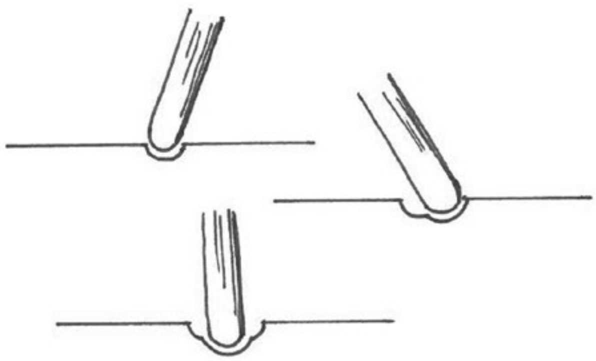


Figure 2.089: The reconstruction of the crafting technique used to apply the humps with multiple light bulges.

were hammered in the metal in the cold-worked disc, as the microstructure is already brittle. For this one probably needed wooden or bronze tools depending on the material thickness.

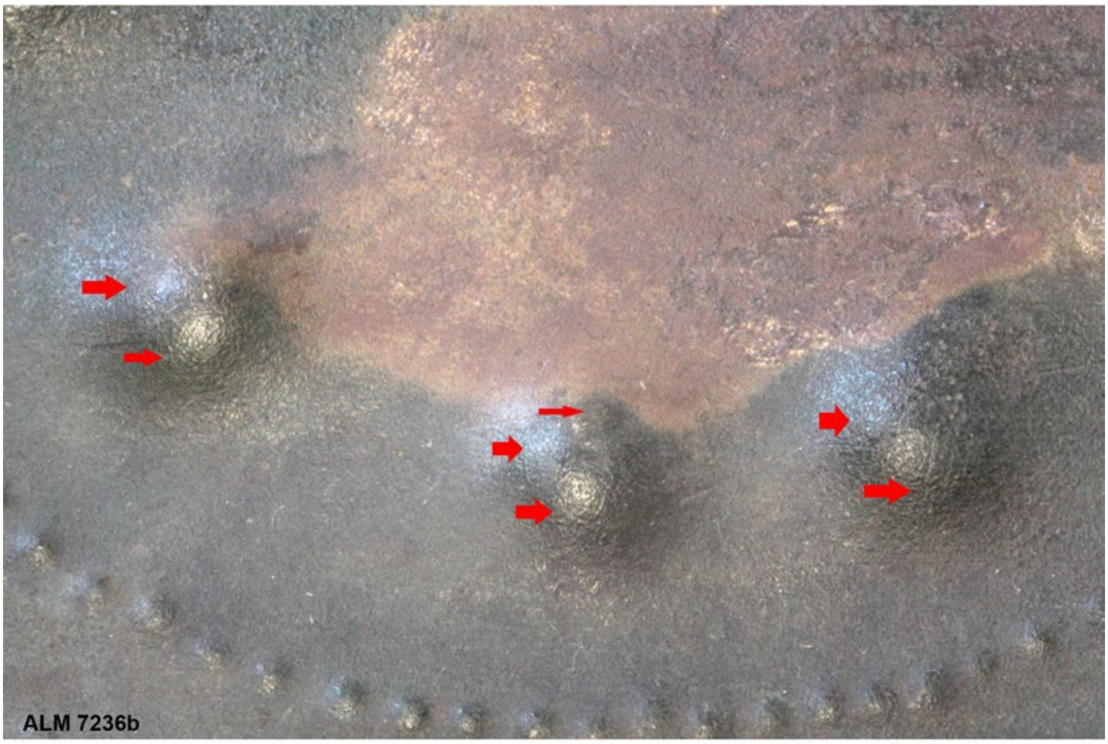
The sharply defined transitions from hump to disc surface of the outer hump series of the Heinrichswalde disc suggest the use of the latter tool (Figure 2.090).

The Vendsyssel belt disc (NM B4753-1) clearly shows that parts of the hump decorations can be applied in the model (Figure 2.091). A similar technique can be inferred with the disc-headed pin from Lüneburg (ML 1133) and the small belt disc (VM 1680 KL) from the Vognserup hoard (Figure 2.092-93). Here, the impression of the humps are visible, very probably made in the soft malleable material of the model with a rather large spherical tool from the rear side. The characteristic result would be a flat expiring hump on the face side, as displayed by the disc in question. Post-casting, the existing impression is processed using bronze tools. In Figure 2.091, B4753-1 the difference in the surface structure of the large hump impression (a fine casting skin) and the compacted surface in the smaller, subsequently introduced, impact is highlighted. The same can be seen on the disc-headed pin from Lüneburg. Here, however, several juxtaposed divots were created to give the hump the desired shape. The flat tops of nearly every hump are additionally a sign that this piece was placed on a shock pad (wood) while the humps were applied, and thus every hard blow resulted in a flattening of the domes (Figure 2.093).

The traces presented here underline the manifold opportunities to produce the same decoration. It was shown that spirals were applied using various techniques; they were punched in metal, drawn in wax, or imprinted with special tools. Only in a small proportion of particularly complex bronzes could the use of spiral-stamps be proven. However, almost all the pieces, and also the model-decorated artefacts and those with stamped spirals, show signs of more or less intensive reworking and corrections of the decoration after casting. Thus, even identical spirals can differ due to hand-applied corrections post-casting. Furthermore, individual and unique techniques are documentable in addition to information about techniques used to create individual decorative elements.

2.6.4 Traces of individual and unique techniques

Many crafting traces provide information about the technical repertoire selected for the making of the ornament. Other traces cannot be explained on first sight and perhaps are first explainable when referring to other crafts.



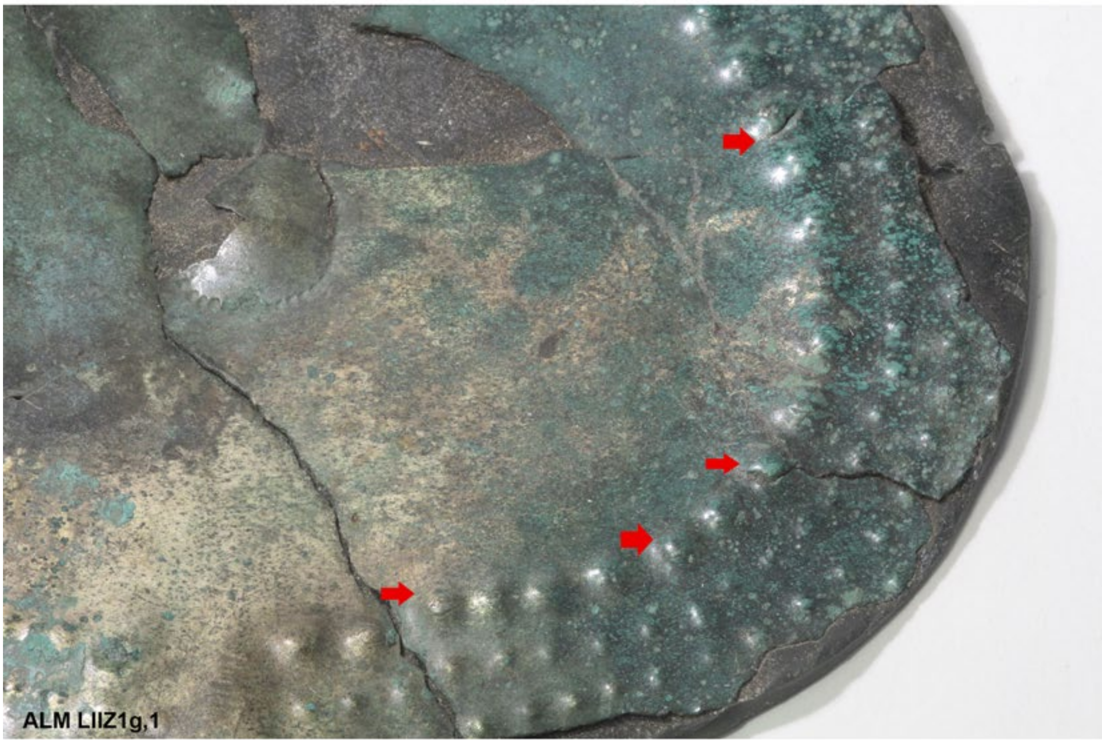


Figure 2.090: Light reflections on the humps of the disc-head pin from Sparow (ALM LII Z1g,1) and Heinrichswalde (ALM7236b) in Mecklenburg support the assumption that they were inserted with several punch blows.

As already mentioned, a large proportion of southern and central European pins were made by cast-on technique. In the north, however, this technique is not very common within pin production. Only in the case of the disc-headed pin from Ehlbeck could this method have been used (Figure 2.094).

However, another technique was apparently applied in this region. Based on traces detected on the Weitgendorf-

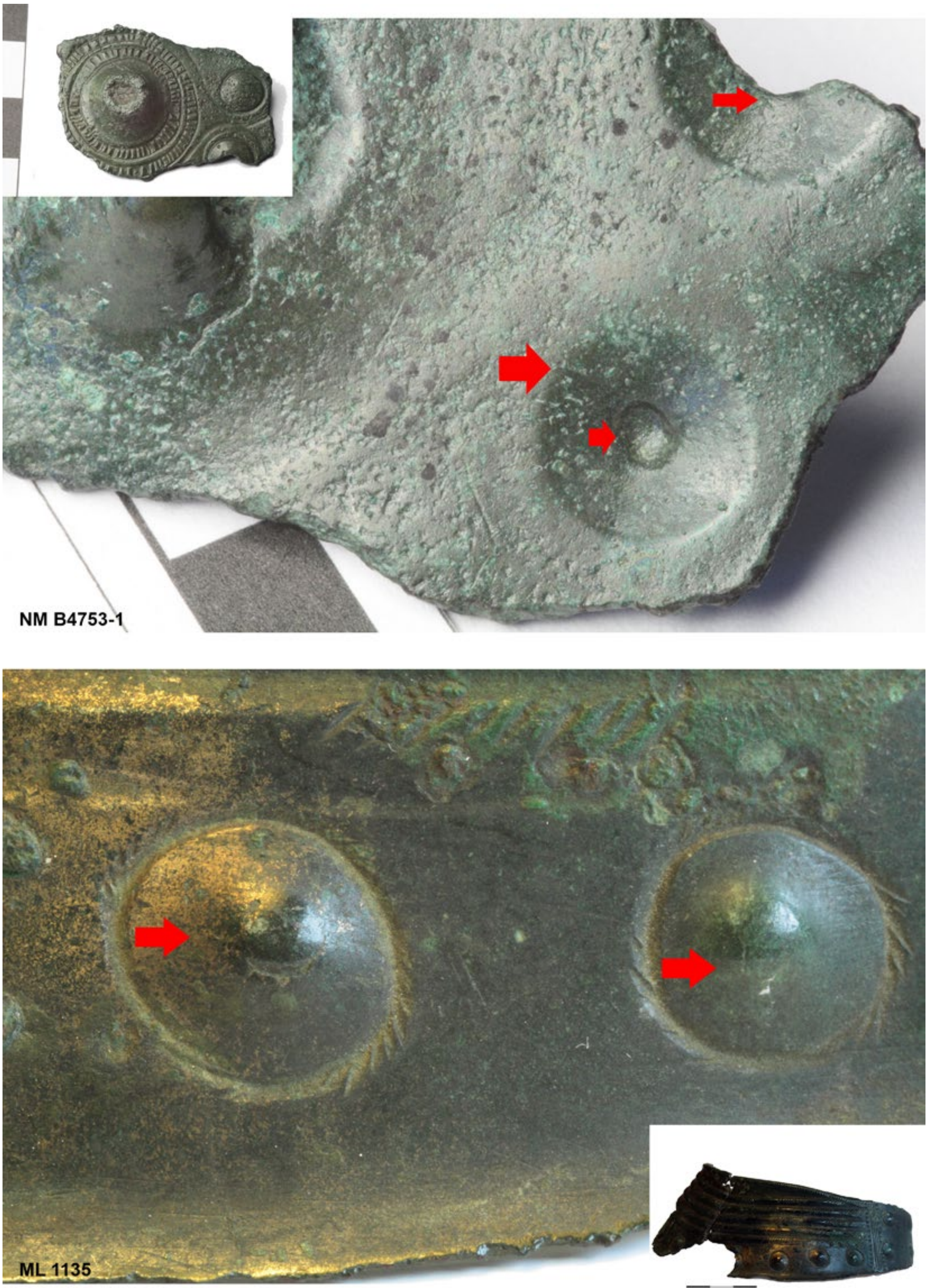


Figure 2.091: The belt disc from Vendsyssel, Zealand (NM B4753-1) and the neck collar from Lüneburg, Lower Saxony (ML 1135) show distinct characteristics for humps inserted with several punch blows.

type pin from Weisin (Figure 2.095) and Karbow (ALM Br 92), near Parchim in Mecklenburg, a previously unknown method used to connect pin head and shaft was reconstructed. The technique with which both parts were connected is known from ceramics, and can be described as 'spreading'. Here, the material of the pin shaft was spread with the aid of a rod-like tool into the material at the back of the top plate and thus connected. As for this process, a mouldable material is necessary, or at any rate a compound mass; it may be assumed that

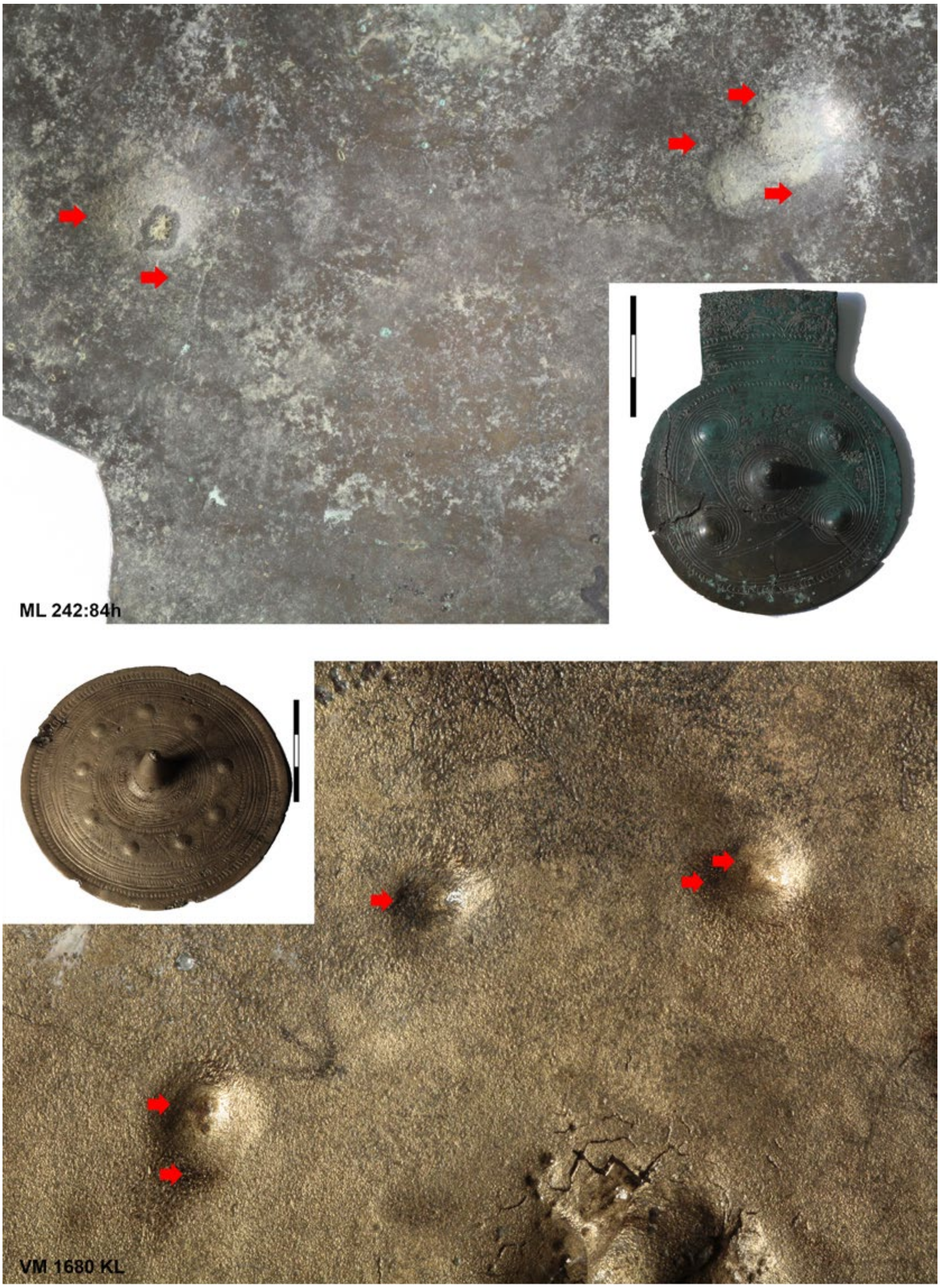


Figure 2.092: The humps of the hanging disc from Molzen, Lower Saxony (ML 242:84h) and the small disc from Vognserup, Zealand (VM 1680KL) were made in two steps: a weak impression placed in the wax model, and post-casting the impression is processed using bronze tools.

Weitgendorf-type pins were made as a model in order to be cast in lost-form. Additionally, sand-casting would be possible (see Müller-Karpe 1990; Ottaway and Seibel 1997; Goldmann 1981) and would allow, with respect to the model, the use of very different materials. A closer inspection of the shaft and the added regular lenticular attachments on the pin from Weisin (Figure 2.095) reveal grooves between the shaft and the individual lenses.

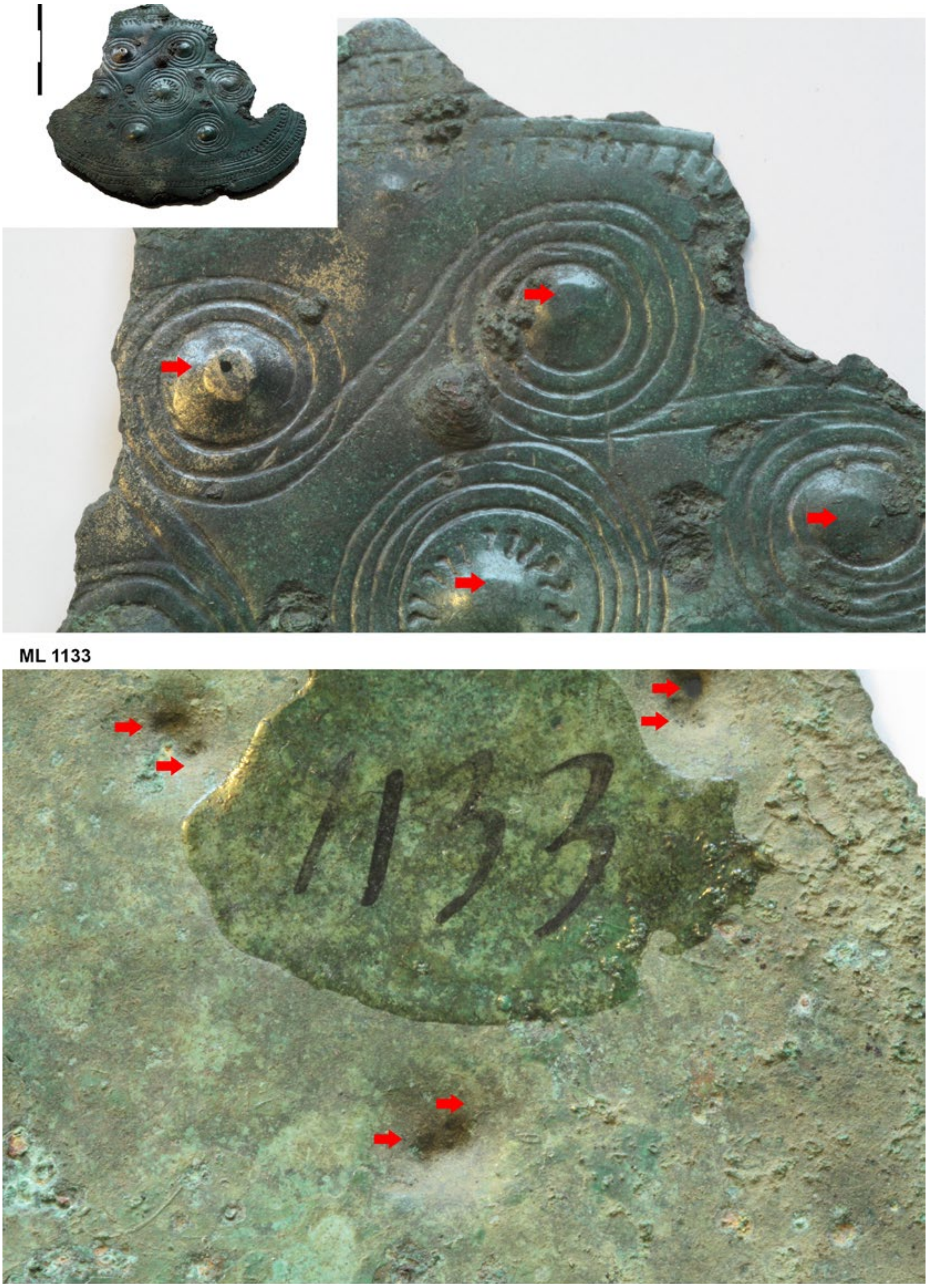


Figure 2.093: The humps of the disc-head pin from Lüneburg (ML 1133) were made in two steps: a weak impression was placed in the wax model followed by post-casting the impression using bronze tools.

Thus, as an alternative to the making of this specific pin via *cire perdue* technique, two wooden models may have been connected with each other with the help of wax. Subsequently, lenticular beads made of clay or wood could have been placed on the shaft. The final pin model formed in sand (or a two-part sand-clay mould) would yield a similar cast piece to the ornament from Weisin. When the two-part moulds were used to cast the artefact casting seams should show up. The investigated bronzes, however, are too corroded to determine this.

Furthermore, while attaching the spike to the disc found at Dabel near Sternberg in Mecklenburg, an identical connection method by 'spreading' was used (Figure 2.096). The design of the disc indicates that it has been cast as a whole piece and a few parts of the decoration were added post-casting. To connect the probably two parts of the model (spike and eyelet with the disc), material was spread from the spike´s base onto the disc. During this procedure, small elongated notches were created as a result of the chosen technique, which were partially obtained post-casting.

Another special feature is represented by the eyelet of one belt plate from Vognserup (Figure 2.097). In contrast to predominantly round hammered bars that were used as eyelets in tutuli, this bar is made of a sheet metal clearly showing the continuous fold line. On three other artefacts similar folding lines can be detected, although not as clearly (Figure 2.098). Here, a folded wire was probably inserted into the wax model of the hump.

When making wires, the most obvious method is that rod-shaped ingots were hammered until the desired reduction of the cross-section was achieved. This resulted in a significant extension of the actual ingot. The post-hammering 'square wires' were created in forming blocks (Armbruster 2000: 102; Pietzsch 1964: 54). Wires made through twisting or rolling were, according to Armbruster, first known from the Early Iron Age as fine gold wires. However, the artefacts under discussion show eyelets which were crafted from a rectangular flat sheet, which may have been folded to shape in a forming block (hence the continuous groove).

The use of techniques that have their roots in other disciplines is not unfamiliar even to today's researchers. In particular, in Bronze Age society, where it can be assumed that certain craft directions such as pottery and metalwork were closely related, overarching techniques and practices are to be expected (see Wallaert-Petre 2001). The spreading-lines at the junction of pin-head and shaft of the investigated Weitgendorf-type pins can be connected directly to a known pottery technique. Thus, due to the impossibility of applying this technique in bronze, a direct indication towards the used material is given, i.e. modelling wax. To conclude, therefore, it seems that special techniques again point towards a technological diversity in craft that should be considered when determining workshops, as the fold lines on several eyelets reveal a previously unknown technique

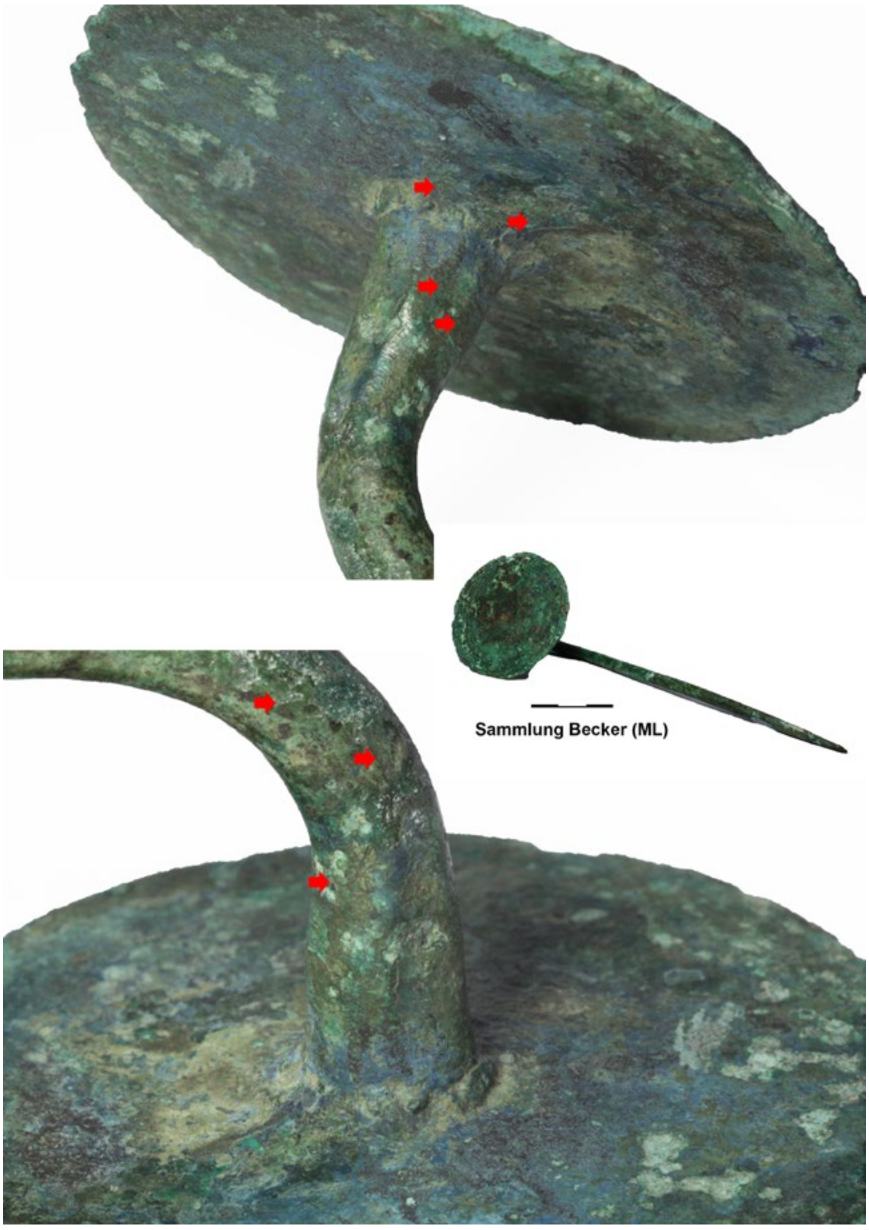


Figure 2.094: The disc-head pin from Ehlbeck (collection Becker) was probably made via the cast-on technique.

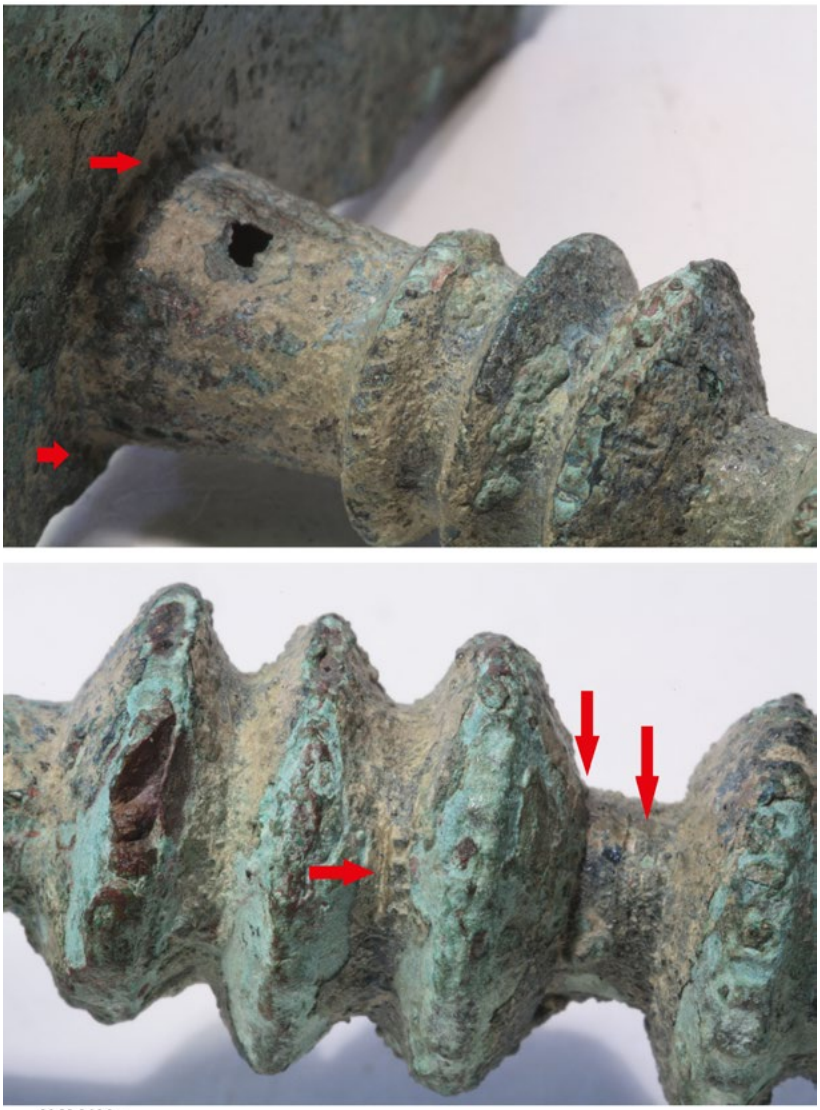
to make wires during NBA II and III.

2.6.5 Repair as reaction to mistakes in crafting and their potential for tracing individual behaviour

Within a workflow, interruptions or mistakes can occur due to inattentiveness of the craftsperson, leading to an unscheduled execution of the decoration or design of the artefact. Occasionally, such interruptions in the operational sequence are detectable even today.

The resulting errors are an important source of information as they can inform us about the craftsperson, his/her skills and habits.[56]

In addition to the measurement errors discussed above, deviations in the decoration are repeatedly documented, and these can be inferred to be the result of interruptions in the workflow, of distractions, of inexperienced craftsmen, or the result of the work of several people. Most frequent amongst these are interruptions in the decorative rows that can be interpreted as the starting point of a decorative ribbon, as discussed above, or which are clear indications of measurement error or carelessness. Of special interest are those types of mistakes when traces of repair can be detected.



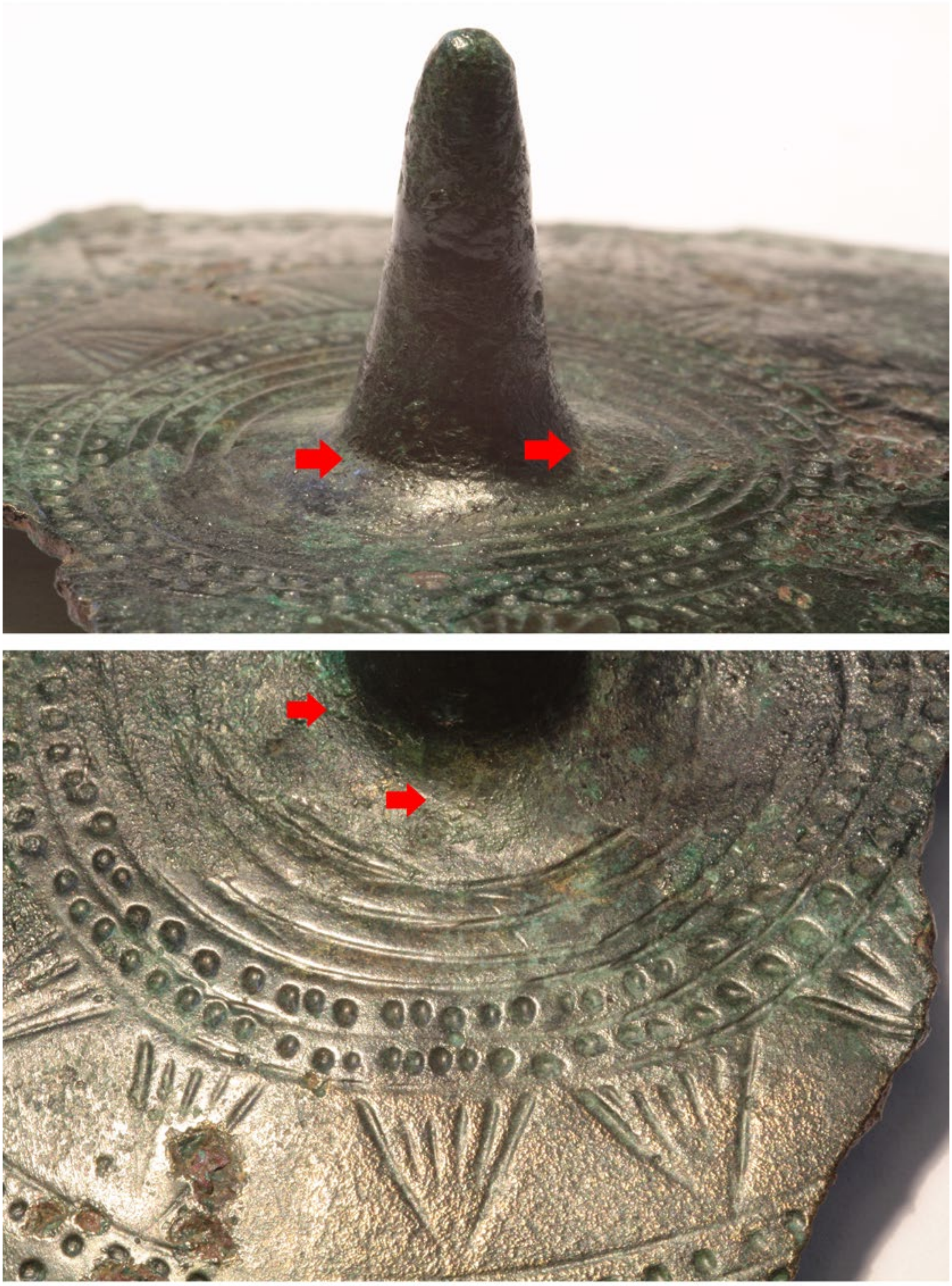
ALM 2196a

Figure 2.095: The ‘spreading’-technique demonstrated on the Weitgendorf-type pin from Weisin (ALM 2196a).

Occasionally, mistakes within the workflow were repaired in ways that were preserved on the artefact, as on the belt disc (NM 25789) found in the Vellinge hoard (Figure 2.099). Here, close to the base of the spike, a notched decorative ribbon can be detected, which was probably set incorrectly. It was then reworked by hammering and finally corrected. Since the disc was probably decorated post-casting, the error could not be fully repaired and is still visible today. The belt disc (KS 20284a) from Schleswig (Figure 2.099) displays a similar mistake, where a misplaced diagonal hatching (at the left side of the image) between the parallel lines was clearly not intended and was stopped shortly after. Subsequent processing was not done due to the decoration of the disc post-casting and the potential difficulties which would have existed. Rather, it seems as if the decoration was applied after this interruption. It is probable that scarcely any traces would be left by either of the above-mentioned errors if they were made while decorating a wax model.

However, even on model-decorated artefacts it is possible to trace mistakes during crafting and the subsequent repair. The two Mecklenburg-type collars from the burials near Weitgendorf were probably completely decorated in wax. Additionally, it could be proven that, regarding neck collar II8302, spiral-stamps were used (see Figure 2.086). Due to a partly careless handling of the stamp clear offsets and breaks are recognisable in the outer turns (Figure 2.100). For the decoration of the

[56] Possible causes of errors in crafting are discussed further in the theoretical part of this study (Part 3). Additionally, a deeper insight into the various reasons behind mistakes in crafting is discussed in terms of lack of concentration, different types of apprenticeship, and learning behaviour.



ALM Br. 239

Figure 2.096: Characteristic features of the ‘spreading’-technique documented on the disc from Dabel (ALM Br.239).

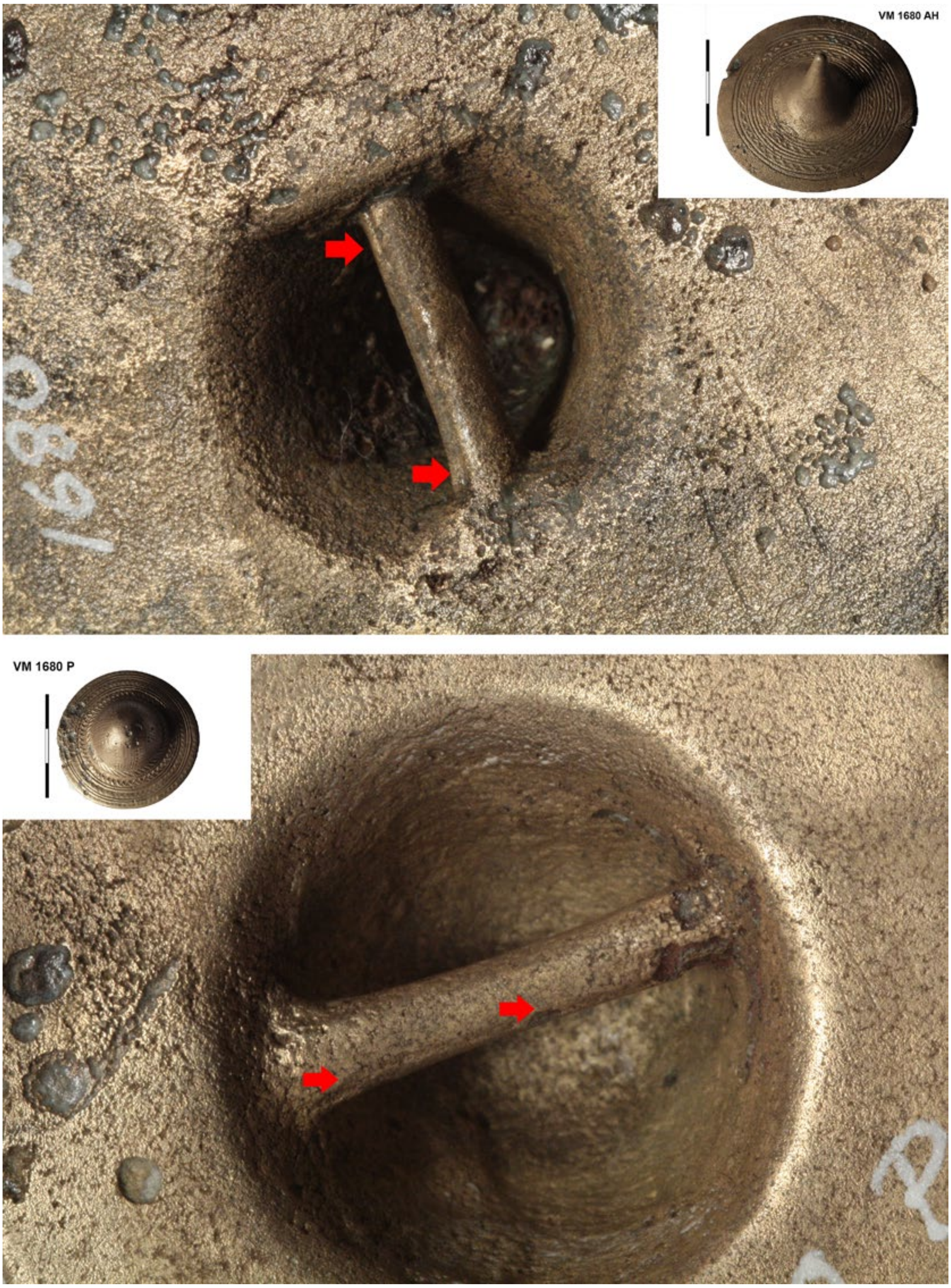


Figure 2.097: Metal bar used as eyelets on the tutuli from Vognserup (VM 1680 AH and P) is made of a folded sheet metal.

Figure 2.098: Metal bar used as eyelets on the tutuli from Præstergård (B15848) and Annebjerg Skov (B 1000) on Zealand is made of a folded sheet metal.

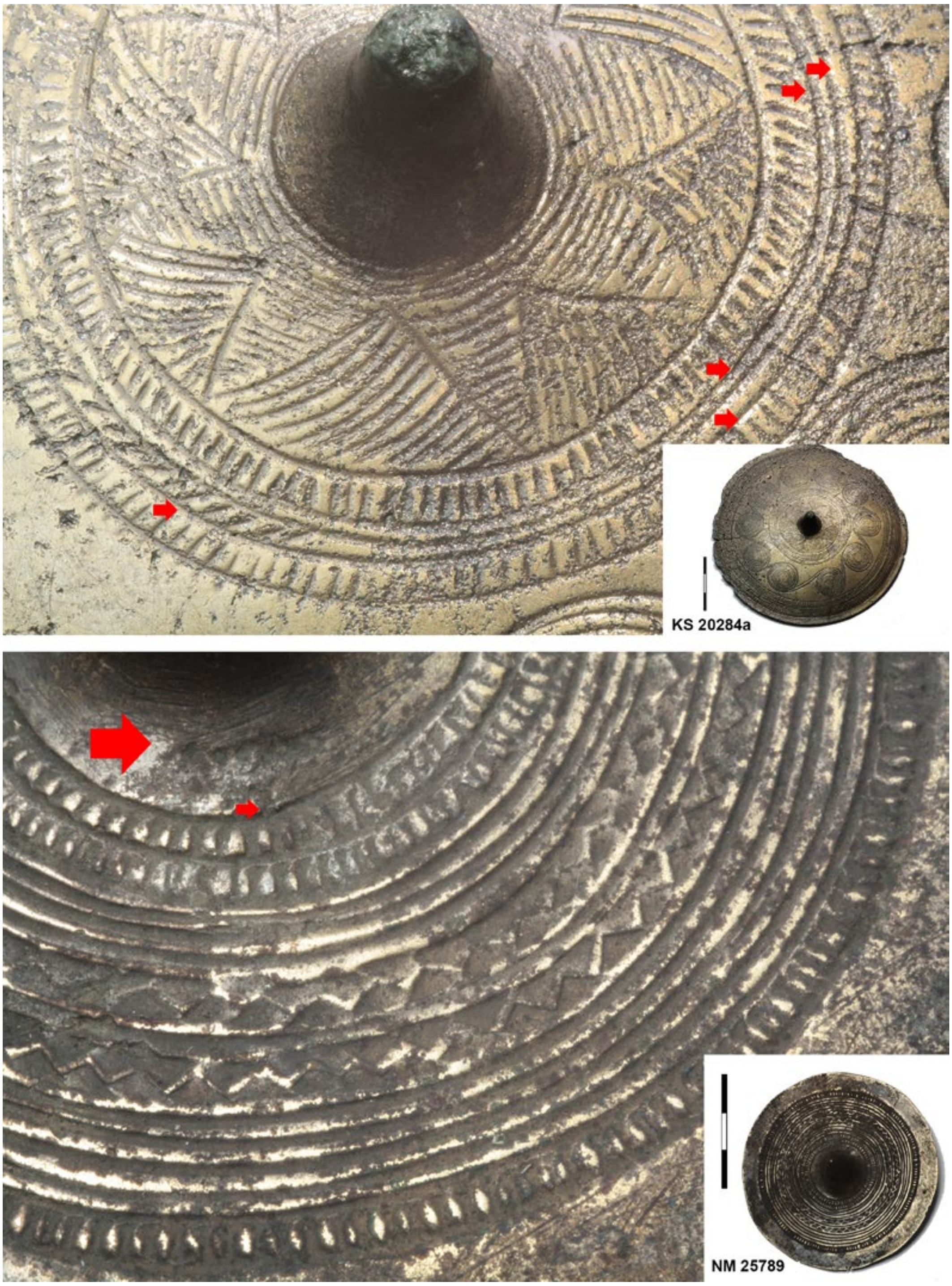


Figure 2.099: Mistakes in the decoration of the belt disc from Schleswig, Schleswig-Holstein (KS20284a) and Vellinge, Fyn (NM 25789) were partly reworked.

second collar from Weitgendorf (II8269) it seems that spiral-stamps were only occasionally used, as irregular distances between the spiral turns and arbitrarily extended ends indicate. It can be assumed that the outer spiral turns were added free-hand in the model (Figure 2.100). From today's perspective both pieces were crafted in a careless manner. An extension of the outer turns can be made without visible traces, as was done on the same pieces. These probably indicate defects to a repair, which took place after the completion of the model. In such a case the wax cannot be heated and repaired without significant damage to the adjacent decoration.[57] Consequently, correction

[57] The heating of the wax would lead to a levelling of the surface and thus the already applied decoration would melt away. However, this

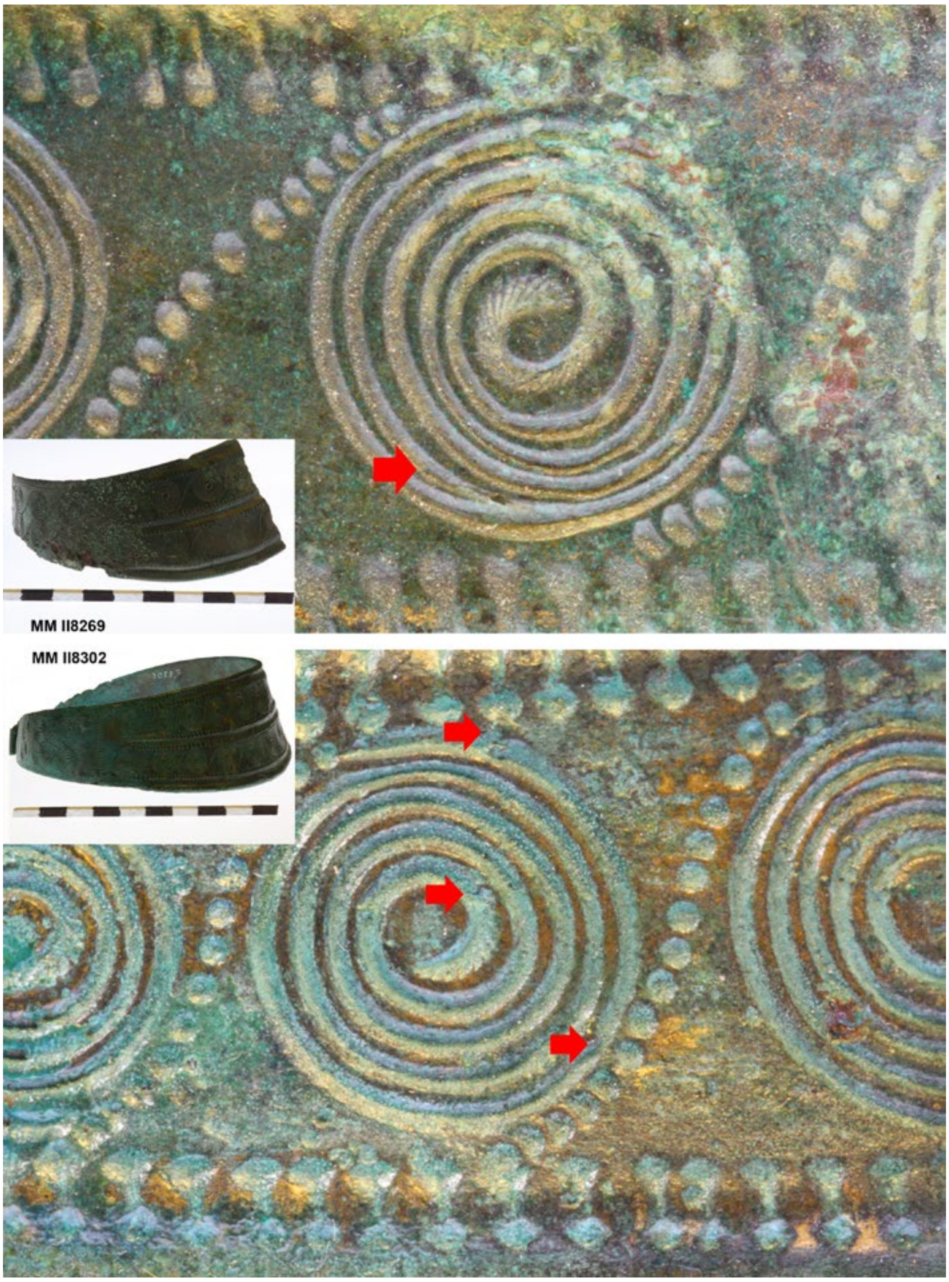


Figure 2.100: Offsets and breaks recognisable in the outer turns of the spirals of the collar from Weitgendorf (MM II8269 and 8302) are the result of a careless reparation.

within the decoration or repairs will be visible on the cast ornament.

Repairs that are executed within and as part of the operational sequence, however, are rarely recognisable on the finished piece. On items made via *cire perdue*, however, such repairs can occasionally be detected, mostly as deviations in the decoration.

These clearly visible waves in the rib decoration of the Pisede-type neck collar (ALM 94/3, 1), from Lubmin in Pomerania, are the result of a mistake concerning the material and the tool used that took place during the crafting process. While cutting the decoration in the ribs (a working step done in the wax model), too much material was moved, requiring subsequent smoothing (Figure 2.101). This smoothing, probably with the help of a leather, cloth or spatula-shaped tool,[58] resulted

process is not limited to a small area and would greatly damage the adjacent decorative parts as well as the thickness of the collar.

[58] The tools above are just suggestions with which a similar result could be achieved. Here, further experiments are necessary to identify a suitable tool. Three different examples also clearly demonstrate

in the spreading of the surplus material. Instead of obtaining the smooth rib images, the surplus material accumulated in the strike direction and formed a wave-like pattern on the notches (see Nørgaard 2014b; 2015a; 2015c). Comparable structures occurred on four more collars in Mecklenburg (Figure 2.102), one in Thürkow (ALM 2003, 1201), in Sarmstorf (ALM Br.93), in Weisin (ALM 2199), and on one from an unknown locality in Mecklenburg (ALM LIIQ, 2).

In addition to the artefacts in eastern Mecklenburg, further objects with similar changes to the rib notches can be documented. Here, the collar from the Vognserup hoard (VM 1680 KE) seems most comparable to the Mecklenburg pieces. Also here, parts of the notched decoration on the ribs are deformed and display a wave-like pattern (Figure 2.103). To what extent this ornament can be allocated to the above-mentioned group must be considered, as a decisive chronological deviation exists. However, it is becoming apparent that it is not only the decorative style of this collar that indicates connections to Mecklenburg.

The wide, rounded ribs of the neck collar (NM B15847) from Præstergårdsmark (Figure 2.103) appear to have been reworked after insertion of the notches mentioned above. As a result, the elongated grooves are partially only preserved at the sides and have a slight wave form here. These rib waves seem to have a similar technical origin to those previously introduced. Nevertheless, they are not comparable in length, shape and type to the waves on the Mecklenburg collars. Thus, one can assume that similar difficulties occurred during making, but, however, that they were resolved with different methods and thus resulted in slightly different pattern. On two other collars from the Rye deposit (NM B7612) and from a grave near Bagsvaerd (NM B11391) very similar elongated notches are detectable, which are partly waisted (Figure 2.104). This material accumulation seems to be caused by a smoothing of the back of the rib. Furthermore, the slightly hourglass-shaped notches, with which the neck collar (B4750-2) and belt plate (B4753-890) from Vendsyssel are decorated, have partly flattened interspaces (Figure 2.105). In addition, the intense reworking of the decoration might have caused the flattening and subsequently the wave-like appearance of the notches. Probably, protruding material was pressed down intentionally or accidentally beaten flat while reworking the reverse side.

Cast-related errors are most often the cause of style-changing repairs. Many of these weakened zones on artefacts, caused by shrink-holes or inclusions, occurred due to a subsequent processing when the thinnest layer of metal that covered the shrink-hole was removed. They caused interruptions in the workflow, which led to a spontaneous change of the fixed operational sequence. In the same manner, the end role, with wing-like extensions, of a neck collar found in Mecklenburg (unknown locality, ALM S6) was created. Despite a probable shrink-hole in the material, the collar was hammered as planned and the end roll bent. Since within the entire piece shrink-holes can be detected, it should be expected that these were responsible for the damage to the end roll. However, during the intensive cold-working of the ends the shrink-hole became visible. The clear dents which cover the ends can be interpreted as hammer traces and support this inference. Due to the near-surface shrink-hole, only the sides could be hammered as the middle section did not contain enough metal and consequently resulted in a wing-like end roll.

On two bronzes from Molzen in Lower Saxony such changes due to material-related problems were documented. Cracks and holes caused a similar material defect during hammering on two other artefacts (Figure 2.106). The presented features give information about the reactions of the craftsperson during the operation, they are also a source of information for the position of the object while casting. In general, an increased formation of shrink-holes is to be expected near the sprue. Accordingly, it can be considered that the described pieces have been cast from the ends.

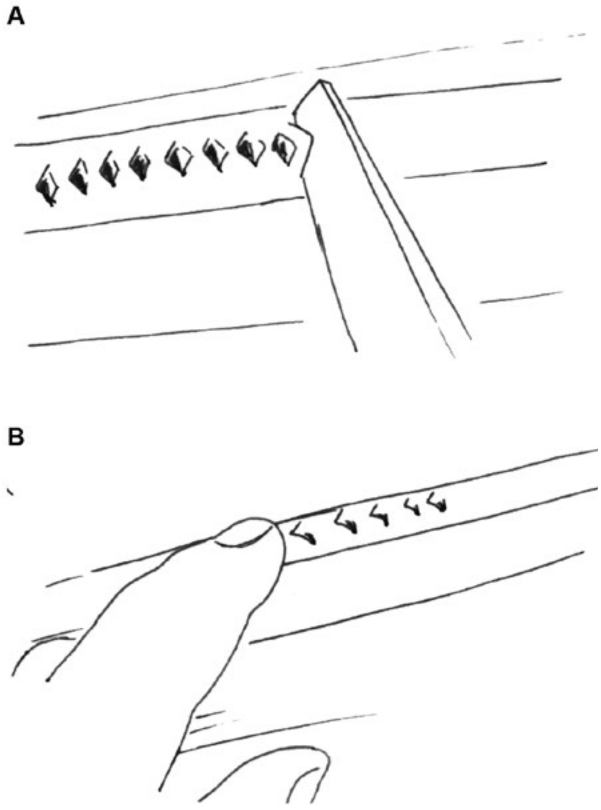


Figure 2.101: The reconstruction of the crafting technique used to make rib-waves.

that different tools were probably used.

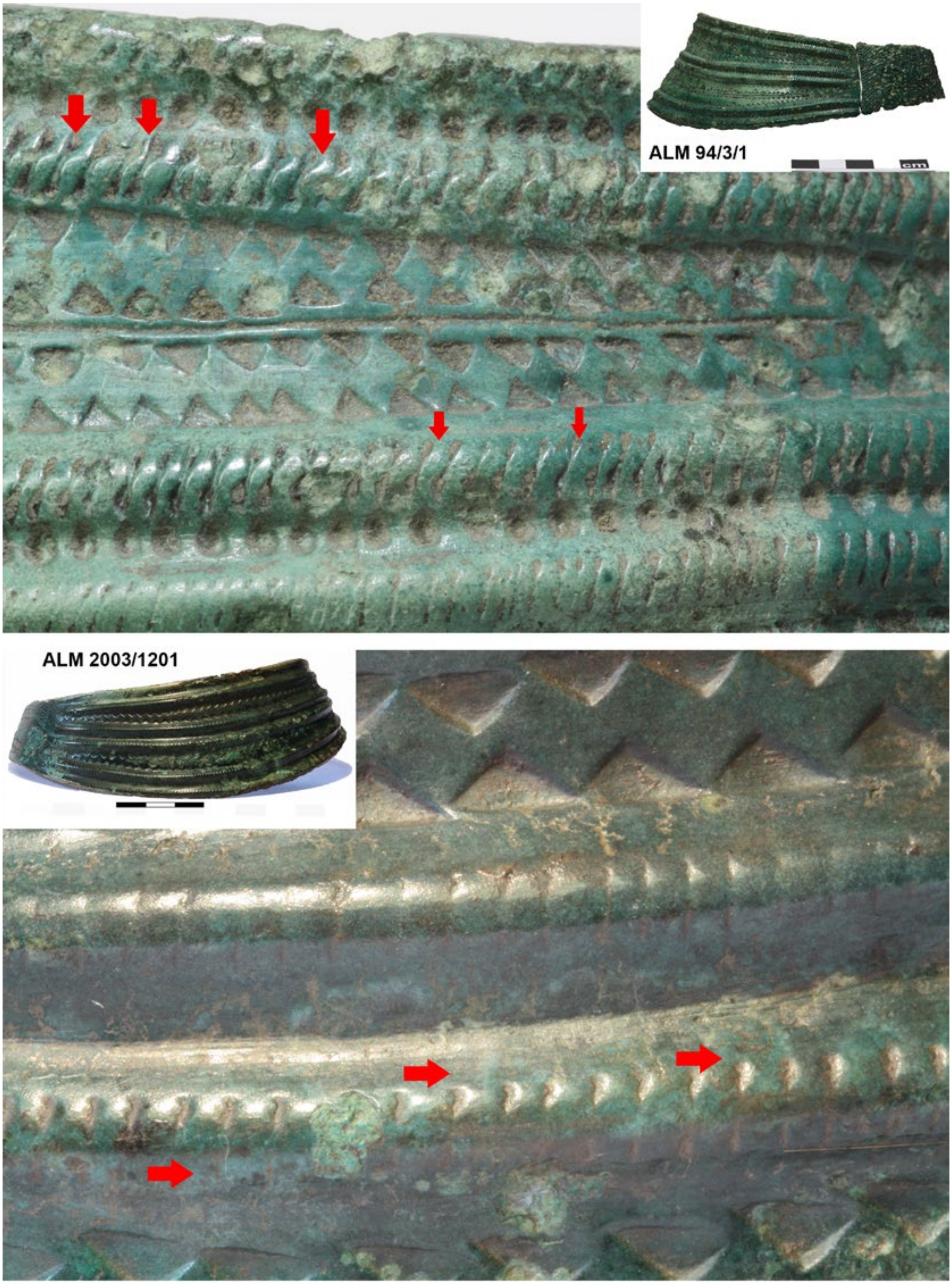


Figure 2.102: Rib-waves documented on the collars from Lubmin (ALM 94/3/1) and Thürkow (ALM 2003/1201).

The previous section discussed different types of error that may have arisen during the processing of ornaments. Basically, interruptions in decoration or changed lines caused by carelessness are to be distinguished from errors that caused by a particular technique. Cast-specific errors, such as shrink-holes, lead to a spontaneous reaction of the craftsperson and are within the material mostly unclassifiable. They are a mirror of the skill of the craftsman and his knowledge of the material. In contrast, errors due to carelessness

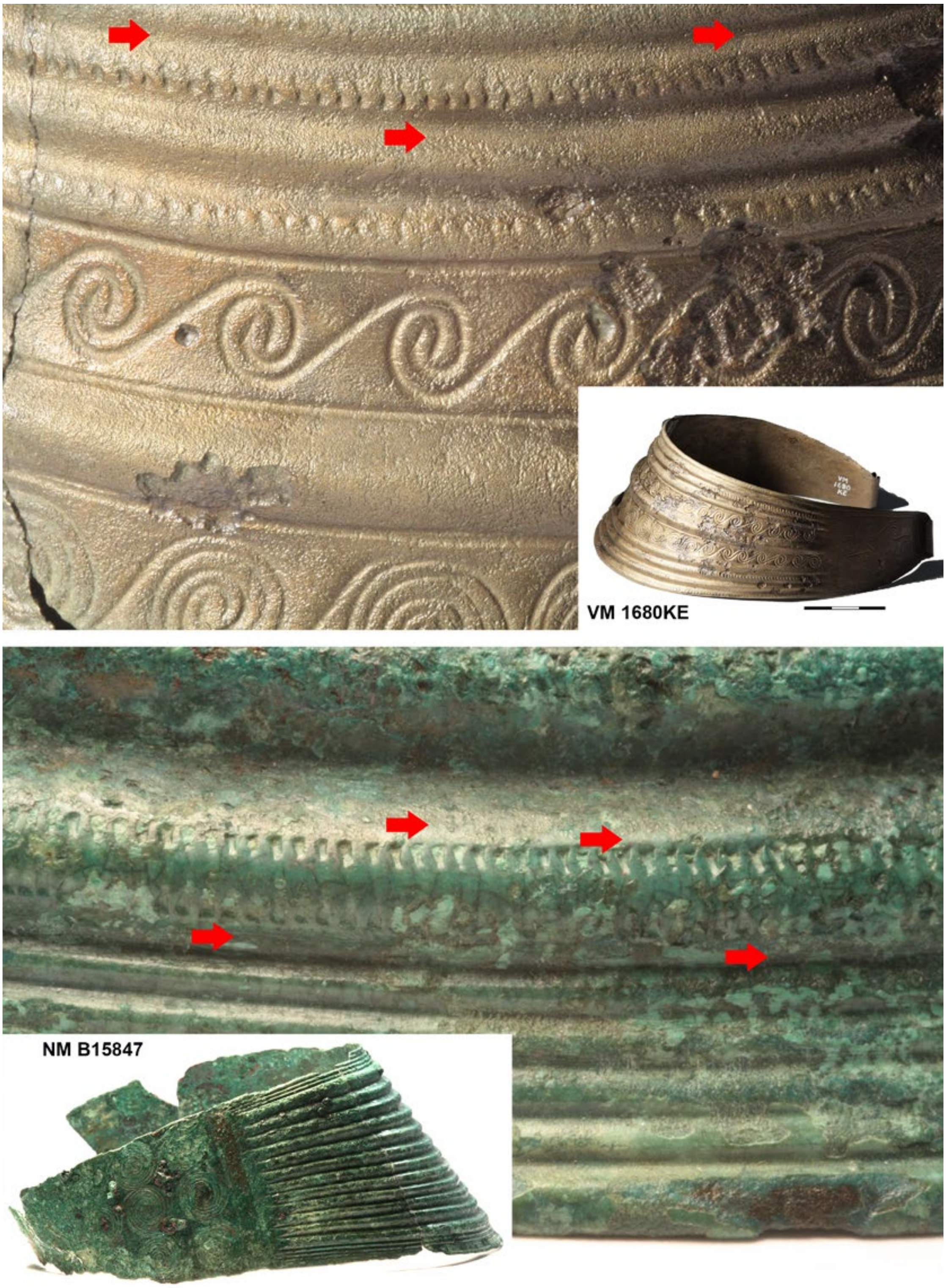


Figure 2.103: Rib-waves documented on the collars from Vognserup (VM 1680KE) and Præstergårdsmark (NM B15847) on Zealand.

are far more informative. They can be the results of an increased production as well as an indication of different skills. Furthermore, defects due to carelessness should be distinguished from measurement errors or the traces left by approaching tools, as these represent individual qualifications and might be interpreted due to the craftsman´s *habitus* (see Chapter 3.4.0).

As shown in this chapter, such conceptual errors were partly due to carelessness, preserved both in model-decorated artefacts as well as in post-casting decorated objects. Some errors, especially those that occurred during crafting can lead to new stylistic features. Such statements, however, should be critically viewed, as spontaneous reactions can also be controlled by the

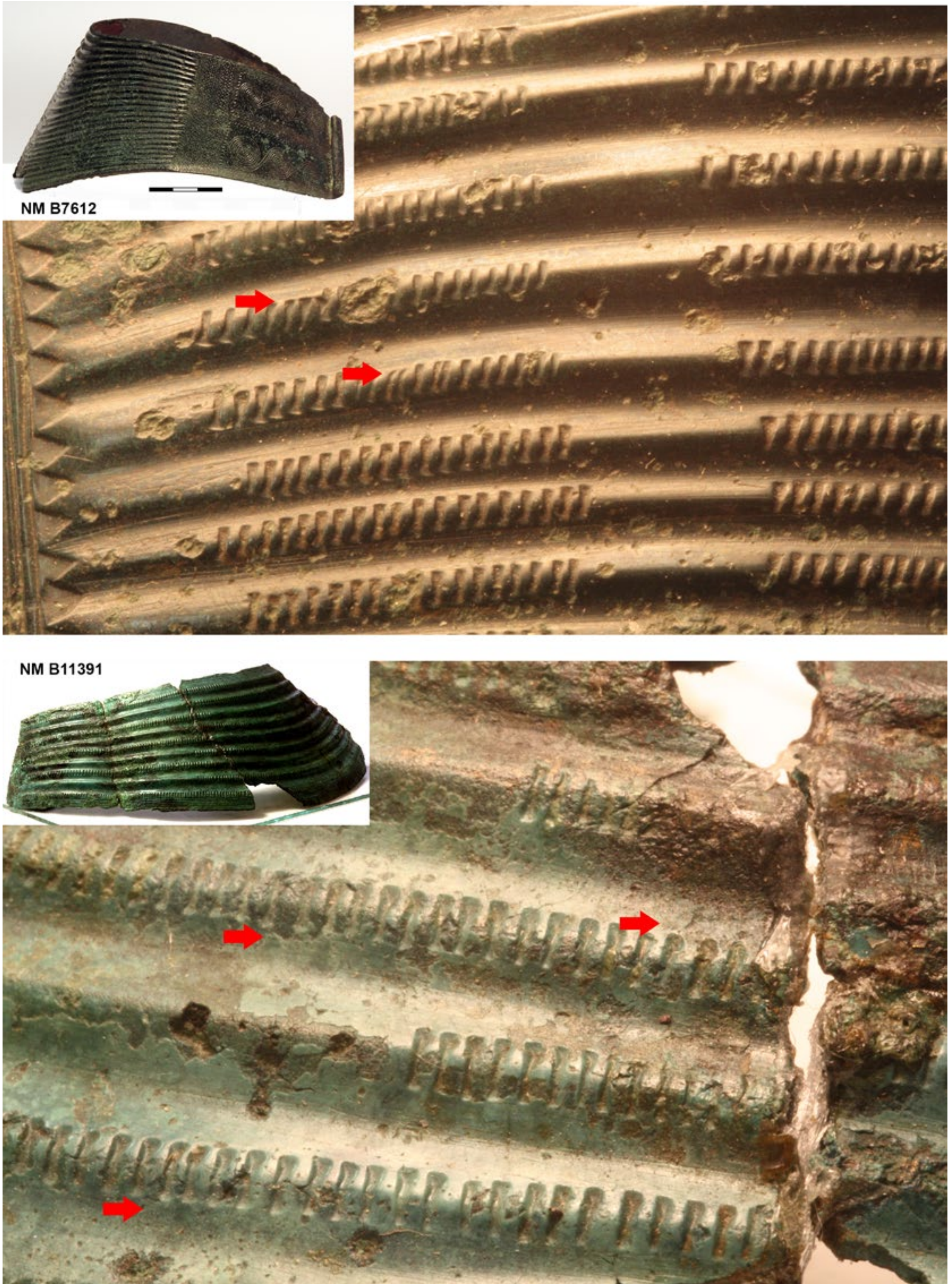


Figure 2.104: Rib-waves documented on the collars from Rye (NM B7612) and Bagsværd (NM B11391) on Zealand.

properties of the material. Concerning the nine bronzes with rib-waves, it could be demonstrated that they were probably caused by the same working process, but with a different result. On the slightly different waves in the rib decoration of the Danish pieces from Rye, Præstergårdsmark and Bagasværd (see Figure 2.104), it becomes clear that such a style-changing repair is characteristic of the craftspeople involved in the making and can be seen as a fingerprint of their skills. As this is, however, not the impression of a tool, it is particularly difficult to pursue such traces in order to eventually define relationships and distribution centres or workshops. Here similarities should be analysed intensively, as in case of rib-waves, where two parallel actions took place with the same result. In contrast, tool marks are clear indications of the same craftsman.

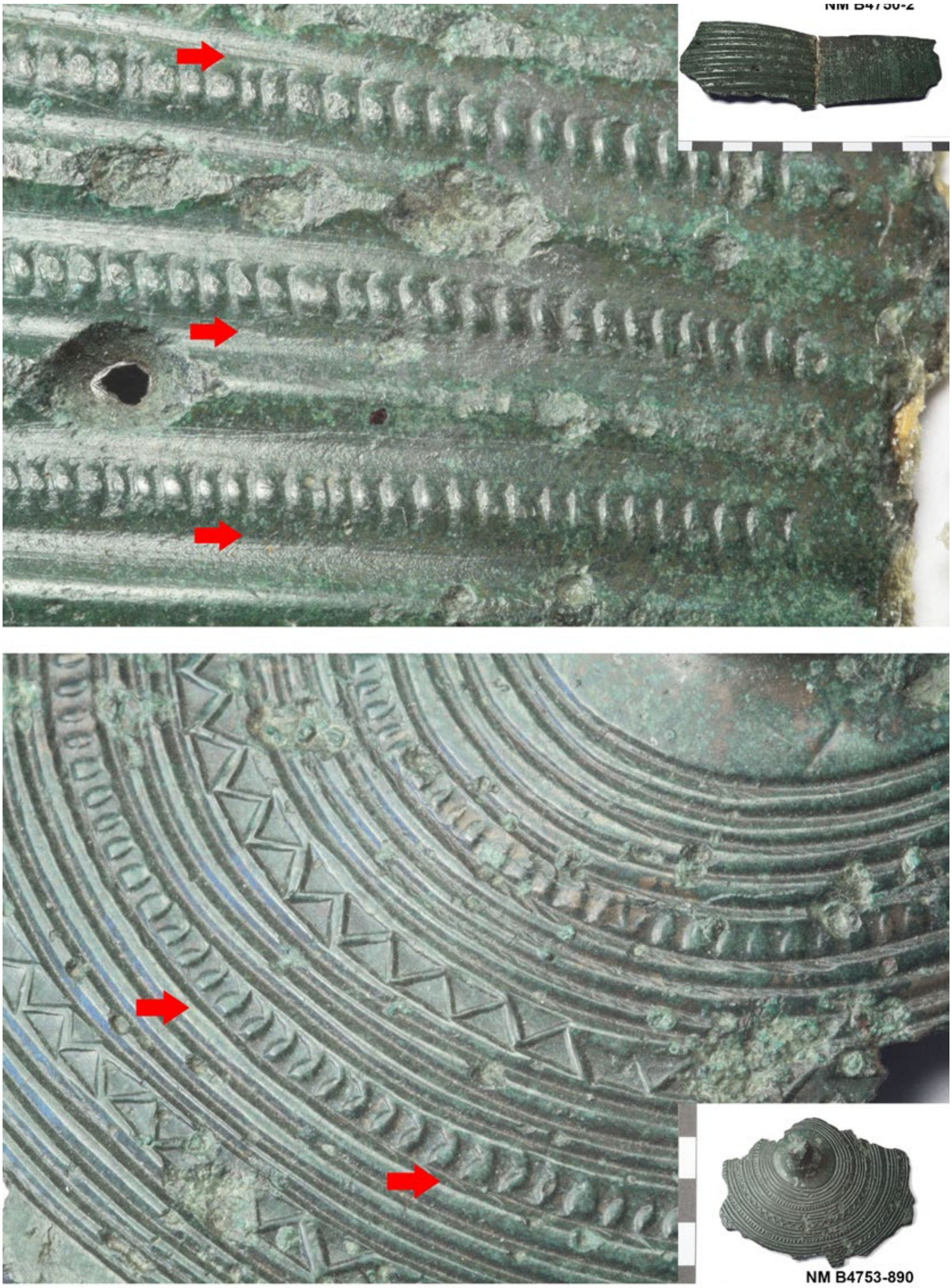


Figure 2.105: Rib-waves documented on the collar (B4750-2) and belt plate (B4753-890) from Vendsyssel on Zealand.

2.6.6 Tool traces and the use of identical tools

The previous chapter discussed individual technical variations in the decoration of artefacts by artisans. Together with preserved tool marks, they are to be considered characteristic of the person behind the artefact. By collecting and comparing tool traces and the technical peculiarities described, it might be possible to define craft interaction groups ('analytical workshops') or even individual craftspeople.

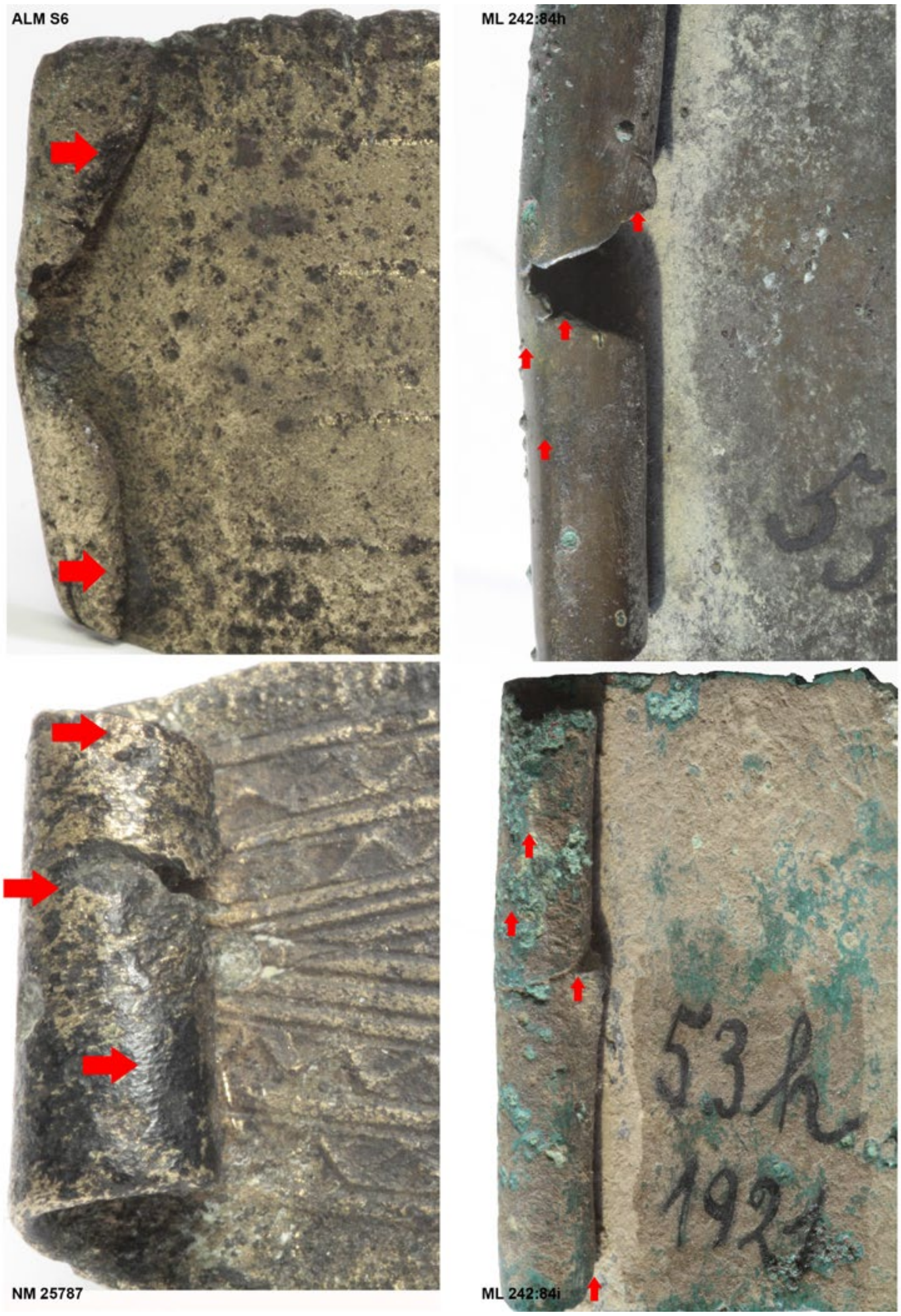


Figure 2.106: A casting defect caused deformation of the end rolls post cold-working (hammering).

The identification of tools is possible, because these leave some characteristic traces that remain on the objects. An identified tool allows conclusions about the owner, because the tool seems to be part of a personal relationship with the craftsman (Saraswati 1978: 83; Høgseth 2012: 62). However, the identification of individual tools is comparable to finding a needle in a haystack. The use-wear of bronze tools and their repeated regrinding change the imprints these tools leave. Wooden tools, in contrast, may not be re-sharpened for use on wax models, however, there are other reasons why they can be used only for a short period: they can break, or the wax can stick to them and change the shape of the imprint. Nevertheless, it

Figure 2.107: The spiral of the belt plate VM1680 KD projected on the spiral from belt plate VM1680KC shows a high correlation.

was possible to note individual tool traces from specific tools in the material examined.

Of particular interest here are the spiral-stamps that could certainly be made of oiled vegetable fibres, horse hair or other fibre-like organic material. It has already been shown that about half of the large belt plates were decorated with the help of such stamps and that the majority of the elaborately decorated collars were stamped. In addition, it was possible to prove the repeated use of the same stamp *inter alia* on the two belt plates from the Vognserup hoard (Figure 2.107). The stamp used was probably adapted to the respective number of turns, as the spirals of plate VM1680 KD are much smaller than those of plate VM 1680 KC. Accordingly, it can be assumed that the large belt plates were made close together in time by the same person. This may not be surprising, particularly regarding the find context, as all items here were freshly cast and were probably made in the same manner.

The second tracked pair showing a match in the stamps used consists of two objects that share neither the same nature nor the same locality. In central Lower Saxony, the spirals of the small belt disc from a burial in Hohenbünstorf near Uelzen are made using the same tool (spiral-stamp) as the spirals on the disc-headed pin found 25 km away in the burial ground near Lüneburg (Figure 2.108).[59] These two spirals fit together perfectly and only differ in the winding, as one of them is looser. It can be assumed that both artefacts were made by the same person, or at least within a group of closely related craftspeople from the same workshop.

Moreover, it was possible to determine a special, very peculiarly shaped tool that was used on several belt discs and belt plates from the Svenstrup hoard (Figure 2.109, A-F). This design punch was probably made of bronze, since the small discs were decorated mainly post-casting and its impression shows antler-like extensions at one end. It is possible, however, that the punch used was slightly damaged and this resulted in the specifically shaped imprint. This assumption is based on the fact that some discs, which display the antler imprint are also decorated with perfect hourglass-shaped notches (in the same decorative ribbon). These notches are partly interrupted by an oval cavity at one end, probably the error in the punch before reworking.

[59] However, there is the possibility that the bronzes were labelled incorrectly by the collector and may come from a different locality. In the specific area, especially, the items collected in the 18th and 19th centuries are less well documented. Nevertheless, with the bronzes under investigation, the probability that they originate from the location named is possible, as a description of a burial as well as the name of the place is registered.

Figure 2.108: The spiral of the disc-head pin from Lüneburg (LMN 12041) projected on the spiral from the belt disc from Hohenbünstorf (LMN 24976) shows a high correlation.

In this case, first the multiple regrinding of the tool (bronze punches wear out quickly when working on a similar hard material) leads to error (possibly a shrink-hole) and leaves the antler-like impression on a total of five bronzes from Svenstrup and on a neck collar from the Vendsyssel hoard, 100 km away (Figure 2.109,G).

Furthermore, hourglass notches similar to those mentioned above were detected on three other pieces. However, they seem to form their own group. The strongly waisted and slightly staggered notches of the Langstruper belt plate (B2307) and those of the Sibberup neck collar (B3574), are very similar to each other and give the impression of antler-like extensions due to the slight stratification of the notches (Figure 2.109, D,H). Compared with the more elongated impressions on the Svenstrup artefacts, however, the use of the same tool is not very likely, despite a similar shape. Consequently, the decoration of the Langstrup plate was made with a different tool than the items from Svenstrup, and the collar from Sibberup was probably decorated with its own specific tool as these imprints are antler-shaped due to their position on the ribs.

The Svenstrup hoard contains another exceptional feature that should be mentioned. It could be proved that the spirals of the great belt plates were demonstrably made using spiral-stamps. On the smaller belt disc, however, a specific U-shaped tool was apparently used to create the centre (Figure 2.110, A-B). Among the 323 bronze ornaments which were included in this study, such tool marks were found on seven artefacts. Occasionally, the dimensions of the tool and the ends can be clearly distinguished from the rest of the spirals (Figure 2.110, G-H), in other cases only the small offsets within the innermost turn provide the reference (Figure 2.110, D-E). Interestingly, in the dissemination of these pieces the already familiar connection between east and west Zealand is visible, as well as the horizontal axis towards Jutland (MAP 12).

Furthermore, on the small belt discs from Glæsborg another specific tool can be identified that was used on both pieces. Thus, the crafting of these two discs happened also to be carried out as a pair (Figure 2.111). The shoe-shaped impression seen on these discs is unique within the material.

Of particular interest are the decorative ribbons on the bronzes of Lübz (ALM 200/1277, 3), Poltnitz (ALM Br 949) and Sparow (ALM LIIZ1g1) in eastern Mecklenburg, as the specific element used there might inform us in

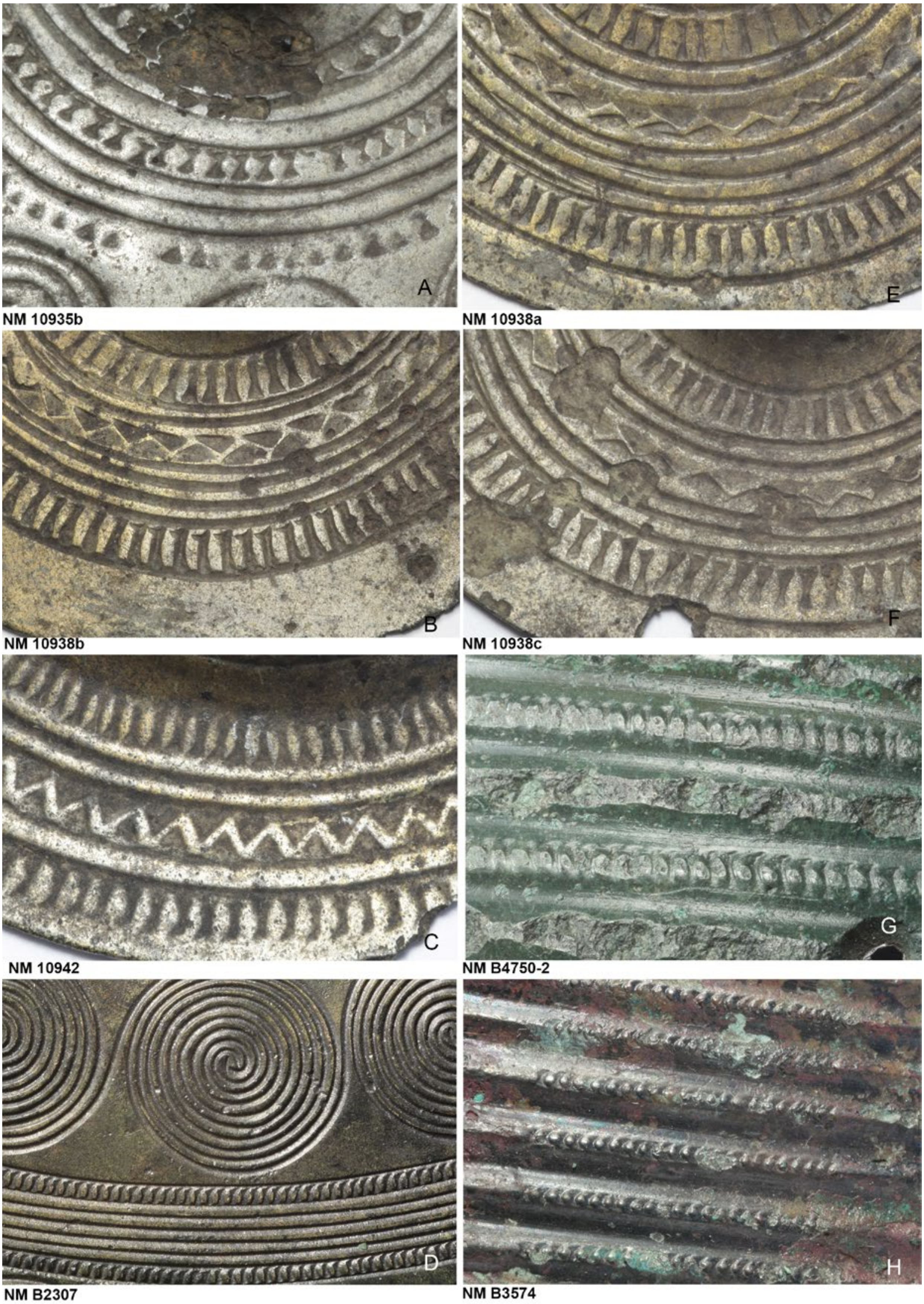


Figure 2.109: Antler-like notches documented on the artefacts from the Svenstrup hoard and on the neck collar from the Vendsyssel hoard on Zealand.

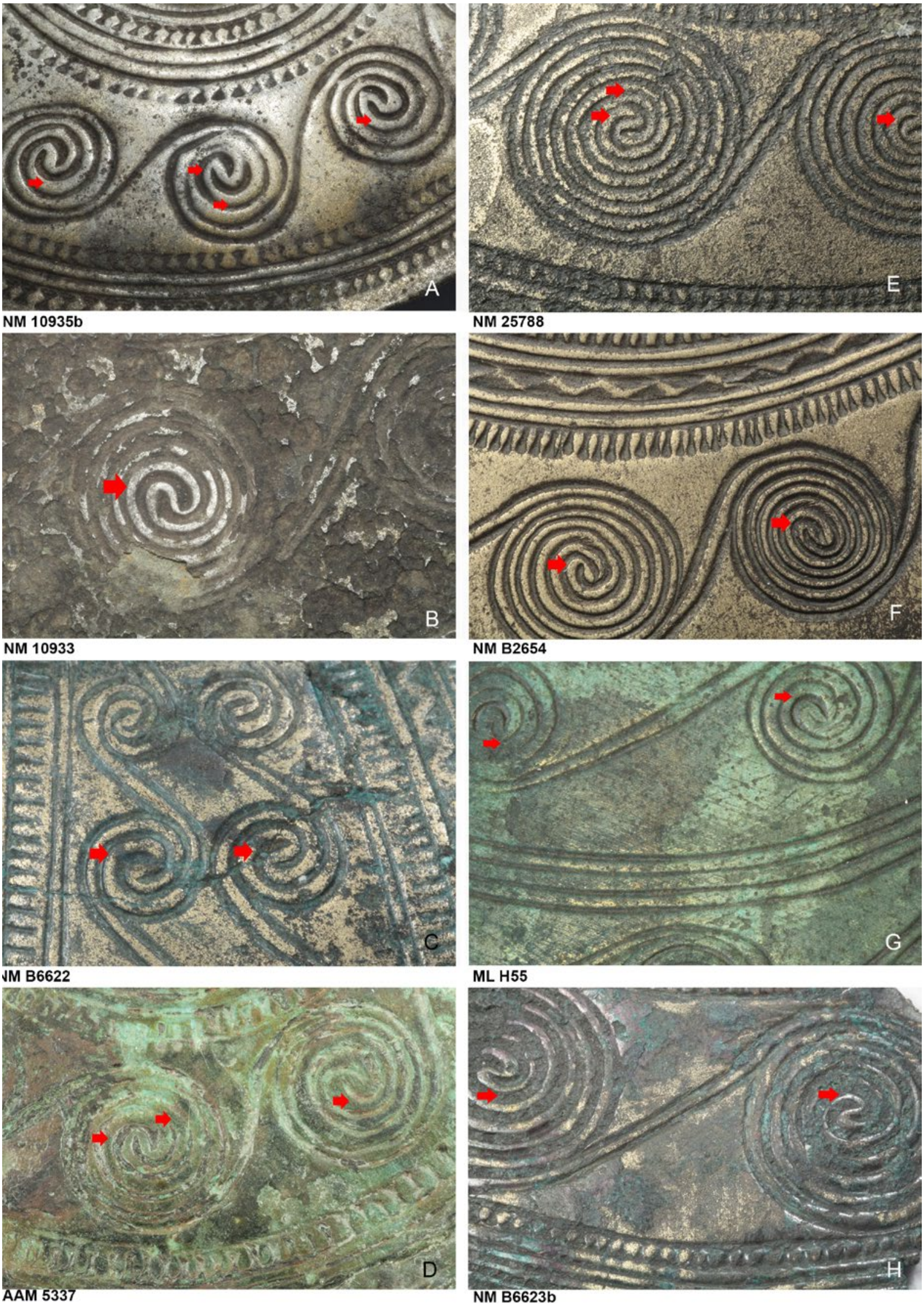
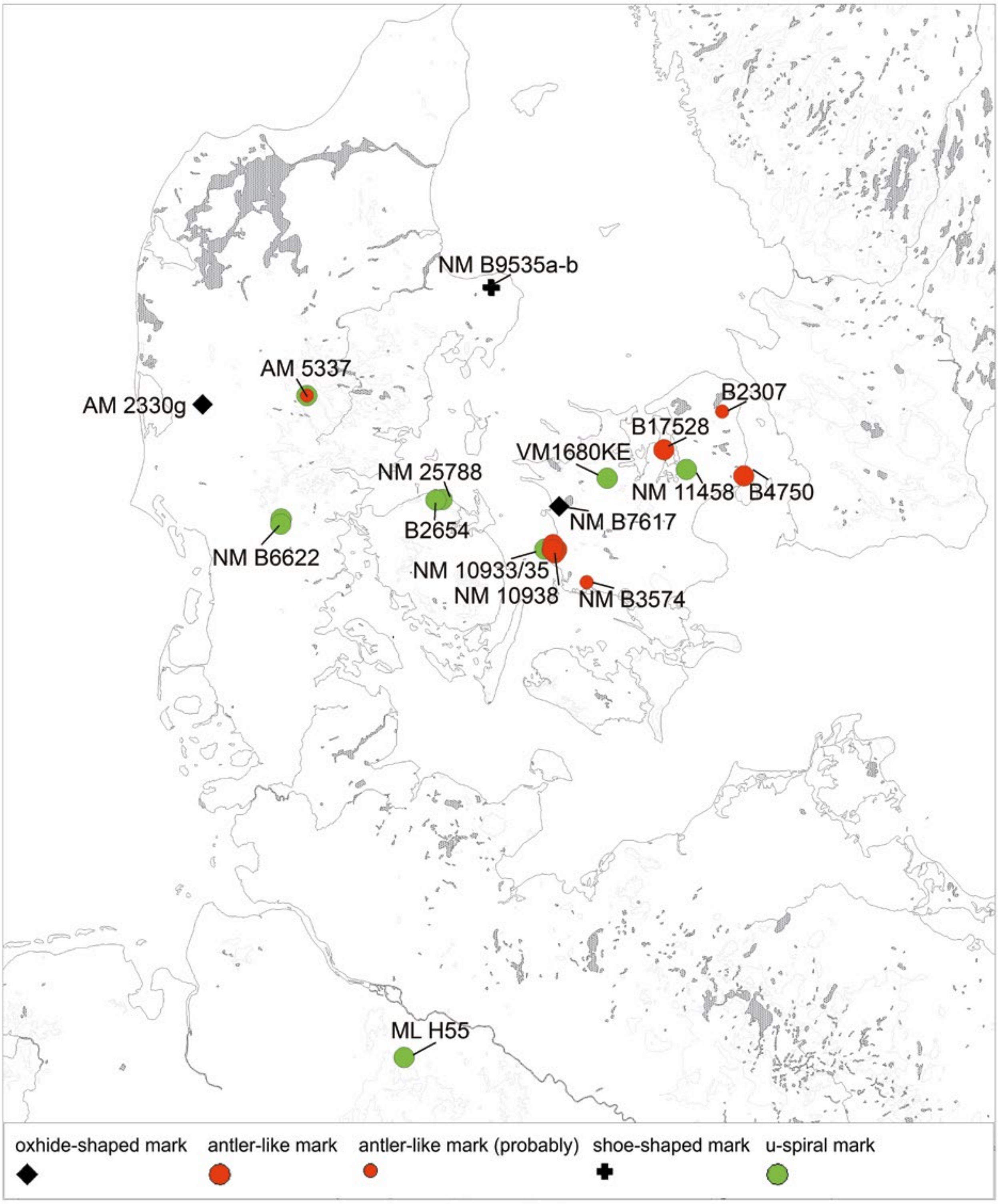


Figure 2.110: Example of spiral-decorated artefacts, where a specific U-shaped tool was used to create the spiral centre.

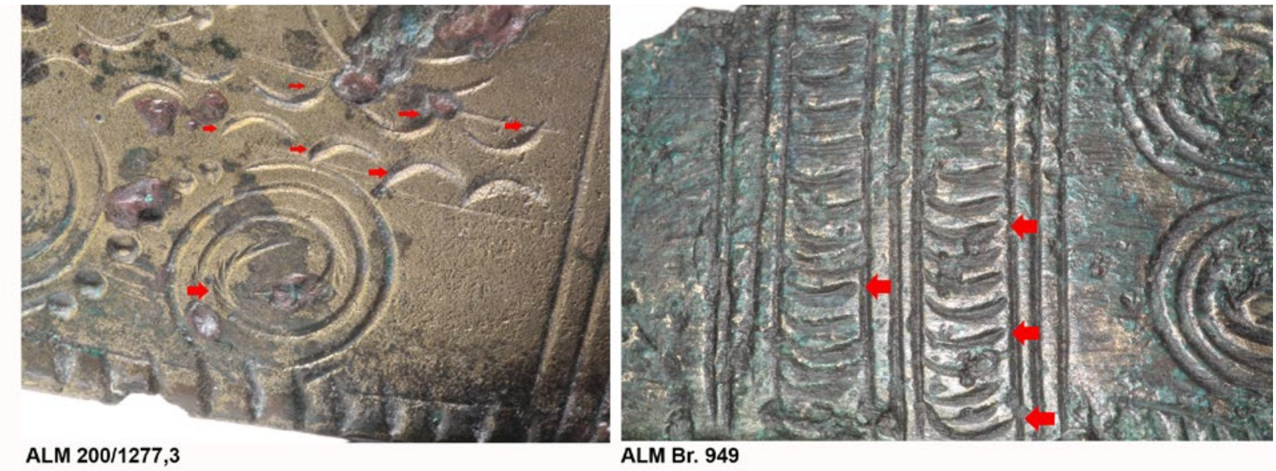


Map 12: Distribution of the artefacts with individual tool-traces.

Figure 2.111: The shoe-shaped impression seen on these discs from Glæsborg was made by a unique tool.

most detail about the prehistoric craftsman (Figure 2.112).

Within the arch-ribbon every individual arch shows a deeper impression on one side. Such an impression can arise when the tool is held slightly tilted. The deepest impression of the decorative element is thus the point where the tool was used with the greatest pressure, and the inclined position of the tool is due to the direction of pressure – the working direction. Such an above-



2.112: Fingernail imprints as decorative element detected on collars from Lübz (ALM 2000/1277, 3) and Poltnitz (ALM Br.949) in Mecklenburg.

Figure 2.113: Dotted lines as an indicator for the working direction seen on the disc from Dabel (ALM Br.239) and the neck collar from Sparow (ALM LIIQ, 3) in Mecklenburg.

described pattern arises independently of the material and allows conclusions as to the working direction, and, broadly, to the hand used. However, the difference in the depth of the impression is more distinctive when the tool is pressed into soft material, as seen on these specific items. Furthermore, in this particular case, the oblique, mostly flat, expiring edges inside the arc are notable, as well as the uniform small errors at the bow (Figure 2.112). These traces result in the assumption that the tool used was the fingernail of the maker. In doing so the decoration was applied from left to right, which resulted, due to an oblique hand position, in a deeper and wider impression on the left side. Occasionally, within the arch, the inside of the thumb left traces as well. To add the whole decorative ribbon whilst maintaining the same direction of work, the piece needed to be rotated (clearly identifiable by the different depths in the decoration).

In a similar way, information regarding the working direction is also provided by the dotted lines of the neck collar from Sparow (ALM LIIQ, 3), as well as the dots on the belt disc from Dabel (ALM Br.239) (Figure 2.113). Such traces have significant explanatory relevance as they directly refer to the craftsperson; they are sort of a fingerprint of the Bronze Age smith. To a certain extent it is even possible, on the basis of the impact direction of the tool, to determine the hand with which the tool was held. As already mentioned, here knowledge of the material is of special importance, since such a decorative element was probably pressed into a soft material, but then punched (beaten) into a tough material such as bronze. The arch decoration of the neck collars from Lübz, Parchim and Sparow are believed to have been applied using the hands. With respect to the arch shape, its deeper left side and the inclination of the 'tool' suggest that the right hand was used. The decoration on the belt disc from Dabel was added from left to right, and it can also be inferred that the tool was held in the right hand. When using a round punch and a percussion instrument to add this decorative element, the hammer would have been in the right hand and the tool held with the left.

Reconstructions concerning the position of the hand are possible using the documented traces, however, these are done from a modern perspective. Since it is not known how many people were left- or right-handed in Bronze Age society, or if it was at all possible to work with both hands due to religious beliefs (see Wallaert-Pètre 2001: 485ff.), the statement above should be taken only as a suggestion.[60] In contrast, that hands and fingers were used as a direct tool is a very important aspect, particularly regarding rarely found tools.

In the last section, it was shown that many tools used were custom-made and very likely also of organic material as wood, which is not recorded in the material culture. Furthermore, it seems that a reconstruction of the tools, as well as their adaptation to new conditions, was quite common, as was shown on the large belt plates from the Vognserup hoard. Nevertheless, it must be assumed that isolated tools were used several times, although only those having a characteristic shape are today recognisable. Tool marks can additionally be seen as an indicator of the repertoire of the Bronze Age metal craftsman, and also occasionally provide data that lead to the individual behind the artefact.

2.6.7 Ornaments in pairs: an indicator for similarity

Until now, traces of tools, techniques and of the craftspeople themselves were in the main focus of study. When, however, can one speak of a similar or even identical tool trace or a similar technique, or even a similar way of doing? How similar can objects crafted by hand be when made by the same person?

A good resource in order to become aware as to what extent handmade objects can be alike (or the opposite) is given by objects occurring in pairs. As an example, two spiral leg rings ('Fussbergen') made as a couple and crafted by the same person are compared. The characteristics detected are presented below. In a second example, two belt discs, very similar in their appearance, are compared in order to clearly demonstrate differences between ostensibly the same decoration and the same craftsperson.

Especially in costume equipment from northern Germany are bronze artefacts occurring in pairs represented in a regular way (Bohm 1935; Schubart 1972; Laux 1996b; Laux 1971). Predominantly arm and leg rings are established as pairs, as well as large (sometimes up to 20 cm) spiral leg rings. Especially in Lower Saxony, due to the frequent use of trimmings and pendants as costume ornaments (Wels-Weyrauch 1978), slightly more paired crafted artefacts occur than in the rest of the Nordic Bronze Age. Where these pairs of ornaments are in good condition they offer the archaeologist an excellent opportunity to study the work of one craftsperson. It might be assumed that pairs were most likely made by one person. However, regarding the large ensembles (belt discs or hanging discs) the possibility must be considered that the pieces were collected.[61]

A particularly well-preserved pair, and thus, for the analysis presented in this chapter, of particular value, are the spiral leg rings from burial mound I on the 'Schwerbusch', near Poltnitz (Parchim) in Mecklenburg. In grave 1, situated on the northern edge of the burial mound (some 24 m in diameter), an east-west oriented inhumation was placed under a stone packing. The grave goods were found in situ. In addition to a neck collar of Mecklenburg-type, spiral rolls, fibula and several bracelets, two spiral leg rings were also found (Figure 2.114) with notch decoration on the spiral turns (Schubart 1972: 139). What is striking is the almost identical weight of the rings (492.5 g and 492.6 g), as well as the mirrored decoration and shape. In terms of the number of turns no differences could be observed and the size of the individual spirals varies only slightly from spiral to spiral. Common to both leg rings is that the respective lower spiral is slightly larger, but differs in the size of the round rod (6.5 mm in item Br.954a, and 7.4mm for item Br.954b). This difference, although in the millimetre range, has a significant visual impact. Comparing the two spiral leg rings, one item (Figure 2.114b) seems to be much larger than the other. This impression is supported by further measurement data, as the clamp of the right ring (Br. 954a)[62] measures in cross section 4.4 mm, with a maximum width of 1.31 cm, while the clamp of the left ring (Br. 954B)[63] measures 6.3 mm, with a maximum width of 1.23 cm. However, since both leg rings have the same weight, the craftsperson cannot be accused of inaccuracy; on the contrary, exceptional craft knowledge was needed for this similarity. With a small change to the overall dimensions of the artefacts, the craftsperson was able to compensate for the existing size difference in the

[60] Furthermore, the hand position is not necessarily important for an understanding of Bronze Age metalcraft. It is, however, interesting how much information working traces can provide when interpreted from people involved in craft.

[61] One thinks here of the charm bracelets that were so popular at the end of the last century, and which began as mere bracelets supplemented over the years by numerous pendants of different nature. Many of these pendants (available separately) represented travel memories and therefore were made by various manufacturers. Although this example is of a modern context, the principle may also be applied to prehistory, especially if one takes into account the position of metal as a status symbol.

[62] Hereafter referred to as 'right ring'.

[63] Hereafter referred to as 'left ring'.

Figure 2.114: Spiral leg-rings from Poltnitz in Mecklenburg are a good example of the work of a single craftsperson.

respective rings of half a centimetre (probably due to fitting) so that both rings at the end needed the same amount of bronze. The difference in the material thickness also affects the centre of the spirals.

The identical spiral centres are made through furling a rounded wire that is just placed on the wire of the next turn (Figure 2.115a). The round in cross-section wire is undecorated for the first three turns and then an incised notch decoration was applied. Due to the differences in the material thickness, the length of the cuts with the increasing coil diameter is much more significant in the right ring than in the left ring (Figure 2.115a). The nature of the cuts, however, is identical and so too are the occasionally documented faults, such as cuts introduced at a slight angle or only half executed notches (Figure 2.115b). Differences between these artefacts were detected in regard to the arrangement of the notches. On first impression, the decoration seems to be projected and mirrored onto the other piece. At a second glance, deviations in the interstices can be documented between triple-notches and also within the continuous notch series. However, the deviation does not exceed one or two notch widths, and thus underlines their having been crafted by hand, probably without complex measurement aids.

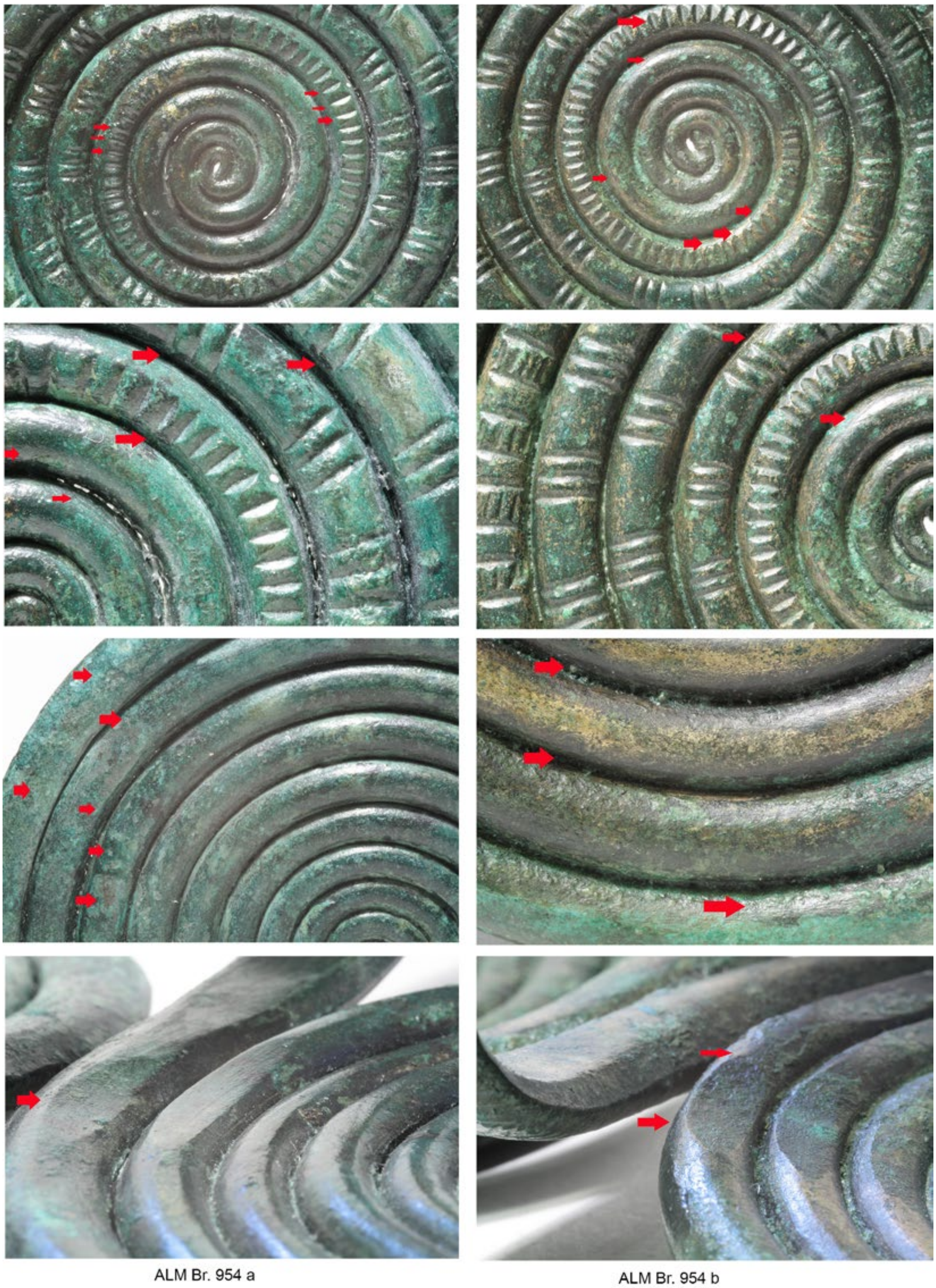


Figure 2.115: Comparison of characteristic features on both spiral leg-rings.

Furthermore, on the rear side of the spirals of each ring similar crafting traces are detectable, for instance the nearly identical horizontal grooves in the spaces and the light hammer marks on the wires (Figure 2.115c). Of interest is the flattened area on the reverse spiral side near the clamp, which clearly derives from the hammering of the ring into its final shape. It can be assumed that each ring consisted in its basic features of two spirals connected by a straight centre-bar (clamp), and was probably hammered over a wooden model (with a soft hammer). During this process, the area at the base of the clamp where the spiral initiates was particularly

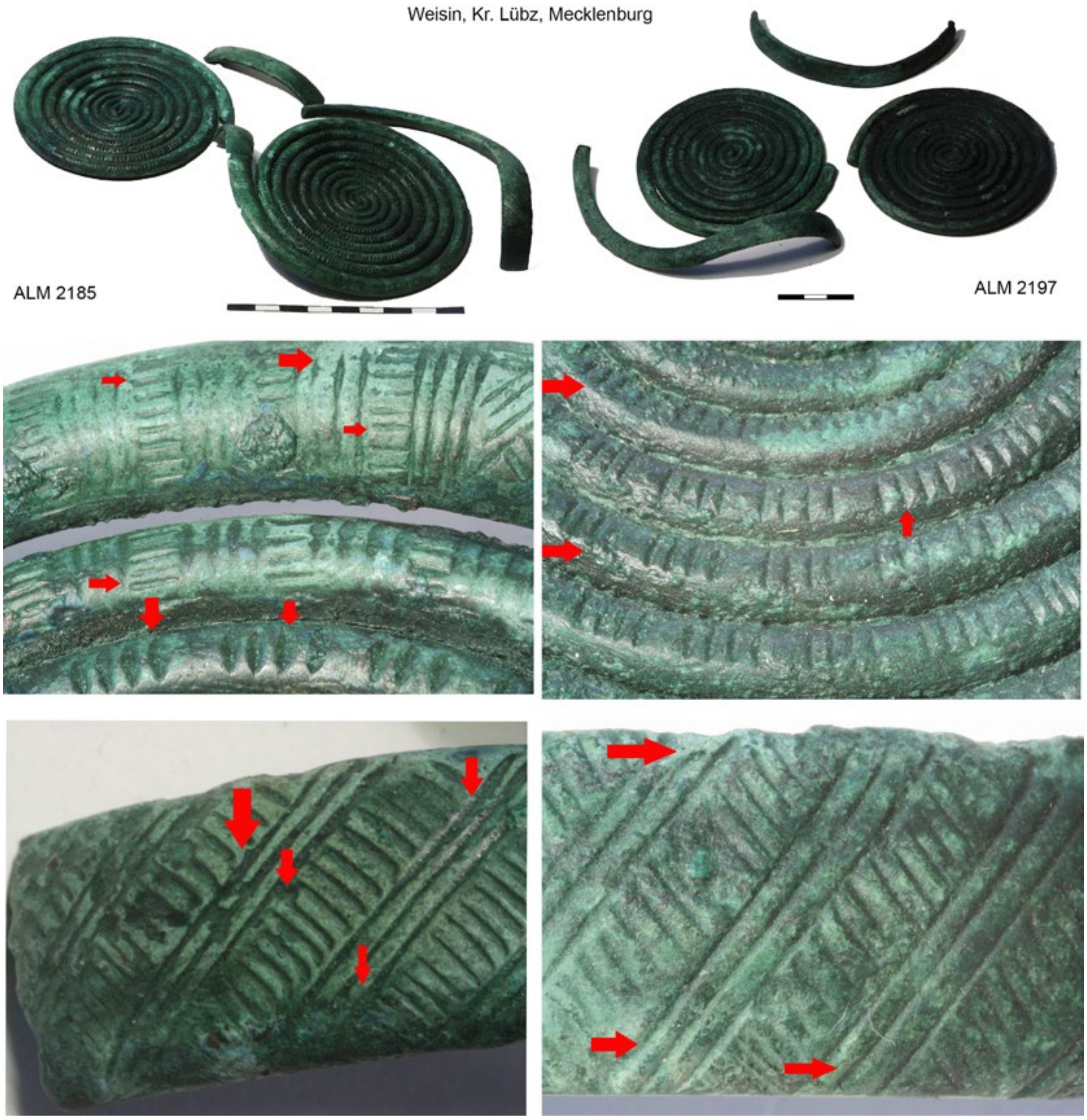


Figure 2.116: Spiral leg-rings from Weisin in Mecklenburg are also very similar in their dimensions.

exposed to great pressure, which caused a flattening of the area. Both leg rings display the same traces, only the left ring shows a wider throat due to the thicker wire.

The presented spiral leg rings were crafted by one individual. The detected similarities, especially with regard to their weight and dimensions, are remarkable, more so when one is fully aware that these artefacts were hammered from an ingot. The craftsperson behind these pieces has proven in several instances an exceptional understanding of the material, and the documented traces highlight the uniformity of the work.

A further pair of spiral leg rings investigated within this work was found in Weisin (Parchim) in Mecklenburg. These leg rings come from burial mound III on the Tannenkamp (Schubart 1972: 171), and are also very similar in their dimensions. However, these rings have yet another interesting feature in common which suggests production by a single hand. The chisel-made decorative lines of both pieces are widened in similar places, such as at the edges of the clamp (Figure 2.116). This specific trace can be explained by a similar working position, or posture, and hence points towards the same craftsperson.

Nevertheless, morphological similarity should not automatically be equated with having been crafted by the hand of a single individual. Particularly good examples to illustrate this fact are the small belt discs from the Glæsborg hoard near Randers in Jutland (Kersten 1936: 121). The hoard contains several belt discs, a large spiral-decorated belt plate and two neck collars. Some of the discs within this hoard have already been mentioned, in relation to the shoe-shaped notch decoration that clearly shows the use of the same tool on two of the small belt discs. Despite this similarity, these two discs provide an alternative interpretation. A similar decoration consisting of lines and notches, the use of the same tool and similar proportions, leave the impression that both discs were made by the same craftsperson as a pair. Additionally, the basic techniques are the same. Both discs are cast in lost-wax, with the decoration probably already applied in the model. Additionally, significant traces of post-casting reworking are visible on both discs. However, on closer inspection the crucial features are very different, to the extent that crafting by a single person becomes unlikely (see Figure 2.111). The discs differ in size from one another by 5%, additionally the larger disc is about 15% heavier. Furthermore, the proportions of the individual elements are not alike. The spike of the larger disc is noticeably narrower and longer, the spike of the smaller disc noticeably wider.

The main reason for the assumption that at least two different hands were at work, however, is the construction of the decoration and the rear eyelet. As could be clearly shown in the first example, similar work processes, when executed by the same person, result in similar results (such as the back throat on the spiral leg ring). In this regard, the previously presented possibilities to construct the rear eyelet must be called again to mind (Chapter 2.5.1). As already shown within the Nordic Bronze Age, cotter from organic material, ceramic cores, perforated eyelets, as well as metal bars attached through the cast-on technique, are all known. It is likely that a technique once adopted would not be replaced indiscriminately. As illustrated in many studies, activities learned (in craft) through repetitions are integrated into the workflow until they are unconsciously carried out (see Chapter 3.2; i.e Pelegrin 1990; Sennett 2008). Insofar as this is true, the eyelets of the two small belt discs should have been made using the same technique, if they were by the same person. Yet the eyelet of one disc (B9535a) is separated from the disc by means of a ceramic core in the spike; disc, spike and eyelet are constructed around the ceramic core as a unit. The eyelet of the other disc (B9535b), however, is protruding, and the spike is not hollow. To avoid collapsing, the eyelet was fixed with an organic cotter before packed into moulding loam. This major difference in the preparation of the eyelet alone would be enough to reject the assumption that both discs were made by the same craftsperson.

Moreover, differences in the decoration also indicate the participation of several individuals in crafting. Interestingly, none of the discs can be described particularly as work of high quality; they both represent a similar level of quality. The lines of the smaller disc (B9535a) are regular and of uniform depth, so the 'shoe-design' varies significantly in distance and position. The slightly larger disc (B9535b), however, shows very irregular line widths and depths, and very close lying impressions from the design punches (see Figure 2.111).

The question becomes what is the relationship between these two belt discs, when they were presumably not made by one specific craftsperson? A simultaneous or temporally close crafting of both pieces is very likely, especially concerning the use of the same tool. Whether these pieces show direct interaction between a skilled craftsman and a novice, or whether one disc copied the other, including the production of a special tool, is nearly unprovable. However, the two belt discs from the Glæsborg hoard demonstrate, on the other hand, that in the allocation of objects to a craftsperson morphological similarities are not exclusively decisive.

As such, the allocation of specific artefacts to the same craftsperson can be difficult to confirm. Objects made by one person, and, accordingly, are similar in the techniques used, tool marks and personal characteristics (although the morphology might be slightly different), should be separated from artefacts which display a similar design but which are in their technology different, as they might have been crafted by more than one craftsman. Thus, for the identification of twins in crafting, in other words artefacts made by the same person, the use of the same techniques and a similar way of using them is key. Furthermore, some features are characteristic of objects crafted by one hand, such as recurrent markers in the decorative elements, inclinations of impressions, a similar tool approach and position, and uniformity in depth and width of the patterns.

Chapter 7

Archaeometallurgical investigations

As part of the craft-technical investigation it was possible to carry out exemplary archaeometallurgical investigations on bronzes originating within the Lüneburg group in central Lower Saxony, and more precisely on neck collars, belt discs, bracelets and pins dating to NBA II. As the aim was to define the underlying crafting techniques, the changes within the artefact (within its structure) were of major interest as providing precise knowledge of the techniques that led to these changes. Thus, metallographic studies were undertaken. Metallography refers to the study of the microstructure of a metal or alloy on a sample prepared for this by means of a microscope and allows a more precise informing of the operational sequence used to craft metal artefacts.

Within the following chapter, an overview of the development in metallographic studies within archaeology is given. One of the first proponents was Hans Drescher, who already in the 1950s described the cast-on technique with the help of metallographic samples. An analysis of the microstructures of metal objects is largely based on the knowledge of the structure of the metals and the changing effects of external influences, which are in the same manner introduced as the several steps of the examinational chain.

Already the first microscopic documentation of the specimen samples, which takes place after the grinding and polishing, revealed, due to to different degrees of advanced corrosion, micro structures ranging from as-cast to heavily cold-worked structures. After the application of acids to reveal the grain boundaries, the microstructures revealed a technological variety from pure cast artefacts, with partly visible dendrites, to partly hammered artefacts, with low deformation rates and less signs of annealing, towards purely cold-worked items, showing repeated recrystallization and deformation in the microstructure.

For the purposes of this ambitious goal, it can be stated that the samples provide clear evidence for a reworking of rib decoration, for example in terms of a repair to the cast decoration. Furthermore, through metallographic analysis it was possible to confirm a combination of casting and forging technology for the production of bronze ornaments during NBA II in central Lower Saxony.

2.7.0 A natural scientific method with immense potential for the investigation of prehistoric crafts

In the introduction to the second part of this research the importance of using different methods of investigation was highlighted. In addition to the traditional archaeological methods there are several scientific methods to document crafting technical features. Within this wide spectrum of scientific methods to investigate specific metalwork, metallographic examination provides an excellent complement to traditional archaeological methods and can, correctly evaluated, answer questions concerning the technology used and the origin of artefacts.

Metallography refers to the study of the microstructure of a metal or alloy on a sample prepared for this by means of a microscope. Such an analysis allows a more precise informing of the operational sequence used to craft metal artefacts. The microstructure of an artefact informs about the basic technique used, such as casting, cold-working (hammering) and annealing, and furthermore can give information concerning the temperature used to anneal the artefact (Northover 1996: 321). The cross-section through the object, which is achieved through sampling, also reveals any kind of additive surface treatment, such as silver plating or inlays. Moreover, the determination of the alloy composition is possible on the sanded surface of the sample, through X-ray fluorescence analysis with a scanning electron microscope, and the hardness can be measured as well as the composition of the matrix with its individual phases and inclusions.

For modern archaeology, this scientific method is particularly advantageous because a small sample size of 1 mm x 3 mm allows all the above-mentioned investigations without destroying the sample. In principle, a superficial metallographic examination of the objects would be possible. However, with regard to the viewing angle and the corrosion of the bronze, microstructural changes would only be visible to a limited extent (see Kienlin 2008b: 25). However, the superficial metallographic structures can be accidentally made visible while using acid cleaning products, as documented on the Vognserup hoard items (see Chapter 2.5.1).

In order to achieve the best possible results, the sampling should take place at a right angle to the surface, and at the size described above, or a polished section should be created directly on the artefact (Schumann 1991: 78). Furthermore, the preparation of the sample is of great importance and should, therefore, be carried out with special care, especially when unique artefacts such as the NBA II ornaments from the Lüneburg Heath are sampled.

Despite their significance for the investigation of metalcraft in prehistory, metallographic studies in archaeology are rarely applied, albeit with a few exceptions (Kienlin 2008a; Hosek 2000; McCall and

Buchheit 1971; Northover 1996; Levy 1991). A major reason is the destructive nature of this scientific method. However, the sample size can be reduced to the size of drilling chips (Löffler 2010: 77ff.).[64]

Nevertheless, some craft-related studies used metallographic investigation and one of the first proponents was Hans Drescher, who already in the 1950s described the cast-on technique with the help of metallographic samples (Drescher 1958: 116ff.). J. McCall examined pendants of a copper-silver alloy from a settlement in Ecuador by means of metallographic studies. The crafting of these ornaments, dating between 700-1519 AD, could be thoroughly investigated by this method (McCall and Buchheit 1971). Peter Northover looked at the Danish axes of the late Neolithic and the Early Bronze Age in terms of their technical features (Northover 1996: 321ff.). His investigation was based on the classification of the microstructures of the cold-worked copper alloys he experimentally created, to see the changes in microstructure in relation to the alloy and deformation applied (Northover 1989: 112ff.). Furthermore, Buchwald and Leisner (1990) were able by means of a comparison of experimental castings to reconstruct the making of a Bronze Age lure, and had within their collection of artefacts also bronze belt plates. More recent studies that have applied metallographic investigations are those by J. Hosek, who examined medieval metalwork (2000), and by T. Kienlin (2008a; 2010). Kienlin identified significant differences in crafting within the Early Bronze Age axe types in southern Germany and the Alpine region by studying their microstructure. He was also able to demonstrate that already in the the Late Neolithic flat axes were crafted in a multi-stage process at a high technical level (Kienlin 2008a: 99-104). Another notable work is that by Ingolf Löffler (2010), who explored on the basis of Eneolithic copper artefacts the question as to what extent native copper was directly processed, or if in Neolithic times various casting techniques were already used. Löffler used drilling chips for the metallographic investigations and showed that the majority of the pieces were hammered from a cast ingot (Löffler 2010: 77-101).

In addition to the studies that used the microstructure of prehistoric artefacts to answer questions concerning crafting, there has been an increase in recent years of those studies seeking clarity about changes in metallic microstructure during different deformations on the basis of experiments (i.e. Buchwald and Leisner 1990; Wang and Ottaway 2004).

The study presented here will show the results of the metallographic investigation of in all 26 artefacts[65] originating in the Lüneburg Heath and dating to NBA II. Within the sampled artefacts are neck collars (19 different pieces were ready for sampling), two wheel-headed pins, three stud-bracelets, a simple bracelet and a sickle fragment.

2.7.1 Method and documentation

An important step before sampling is the adequate documentation of the artefact. In this case, the pieces were photographed, drawn and sketched, indicating the detailed measurements. Then, the location was indicated where the sample would be taken from on the item. Subsequent to the removal of the sample the object was photographed again.

The position from which the sample was to be taken was selected based on various criteria. The aim was to answer several specific questions concerning the crafting process, such as:

- Can the operational sequence used to craft the artefact be exactly defined?
- Was the cast of the completely decorated wax models executed in the Bronze Age?
- Can possible pre-casting steps be defined, such as the model-making, and additionally what steps were carried out post-casting, such as plastic deformation?
- Were the decoration of the ribs, the decoration of the end plates and any cold-working operations executed post-casting?
- Is it possible to identify whether for the belt discs the decoration was introduced pre- or post-casting?
- For the bracelets and neck collars, to what extent were the artefacts hammered in shape after casting? (Here it was expected that any deformations would be the result of intensive cold-working.)

Accordingly, the sampling took place at a position that included the different decorative units of the specific piece and the best parts of the applied decoration, such as the back of the ribs and the valley on the neck collars. Where it was possible to sample several places, then the sampling took place on parts of the artefact which looked to have been worked differently, for instance the shaft and head of a wheel-headed pin or the frontal region and end plate of a neck collar.

[64] To what extent the effect of heat of the drilling process can affect the microstructure in the drilling chip should be decided individually. Since in many cases the question behind the investigation relates to the crafting process and the operational sequence, a modern physical change of the microstructure should be avoided.

[65] To keep damage to the objects as minimal as possible, only fragmentarily preserved artefacts were sampled, or those that will not be reconstructed due to their state of preservation.

Another criterion was the least possible destruction of the object. Since in this investigation the 'special' bronzes were examined – bronzes that should be considered unique legacies of the Bronze Age population – the examined pieces were subject to special care. To this end, sampling was carried out only on the broken edges and not in the centre of the piece. The size, width and length of the sample was based on the condition of each artefact. It was not possible in many cases to sample particularly elaborate ornaments, even if the first choice would have been to take a sample at such a position. Nevertheless, on several objects a sampling of parts of the decoration, as well as areas of different processing, was appropriate. As far as possible, the sampling took place at similar locations in order to compare the results obtained (see Kienlin 2008b: 25; Schumann 1991: 77ff.).

The third criterion was predominantly due to practical reasons and depended on the technical possibilities. The sampling itself took place on the premises of National Museum of Lower Saxony in Hannover, and all the necessary tools needed to be transported here and a workshop established accordingly. Using a goldsmith-saw the samples were cut out while the artefacts were held by hand (to avoid damage through mechanical fixing) on a bench clamp attached to the table (a piece of wood about 10 cm wide was used as a base, attached with clamps), which optimised the handling of the saw. Due to the sometimes fragile nature of the artefacts, it was necessary to choose a position for the object on the bench clamp that would not damage the object by the applied pressure. However, this only affected the sampling of one object, the Bülkau neck collar (HLM 5552).

After collection, the samples were individually wrapped and carefully labelled. All drilling or sawing chips were collected and stored for possible analysis in a separate container and labelled with the same find number and location information as the sample. While collecting the residues the patina was removed from the chips.

In general, the samples had a thickness of 1 mm with a length of 2 mm to 8 mm. Their respective positions on the artefacts can be seen on the descriptions in the metallographic catalogue. In eight cases, it was possible to get two samples from one piece. Thus from the collars from Becklingen (HLM 13135a and 13135b), and the collars from Amelinghausen (HLM 13177), Edendorf (HLM 14144), Luttmissen (HLM 14161), Raven (HLM 4932) and Bleckmar (HLM K 851: 76) samples of the front section and end plate were collected. For the wheel-headed pin from Rehlingen (HLM 5032) a sample was obtained from the head and shaft.

The preparation of the samples took place in the Bergbaumuseum in Bochum.[66] This was undertaken in several steps, which are described in detail with the varying possibilities by Kienlin (2008b: 28-33). Since the basic methods of sample preparation do not deviate, only the specifically performed operations with regard to this research in the preparation of the bronzes are described in this work, and links to other possibilities will be omitted.

For better handling the samples were fixed on a glass plate (four similarly sized samples together) and then set into a Bakelite ring to be filled with epoxy resin. For subsequent assignment of the samples to the artefacts they were labelled at the back, in this case by means of a cast-in paper label. After drying the resin, the glass plate can be removed and the samples can be further processed. Very thin samples were fixed individually due to the risk that they could be ground off during the polishing. The grinding as well as the polishing process was performed in several stages, in each stage finer grits were used, to the final stage of using a polishing cloth.

After the samples are polished (occasionally they are very small and thin), the first examination under a polarizing microscope (Axiophot, Zeiss) should be done relatively quickly before the polished surfaces oxidise. The partial, strongly advanced corrosion on some samples made the investigation difficult, as it was already partly visible in the centre of the sample and left less material to detect the microstructure. In particular, some samples taken from old fractures were severely damaged by corrosion. In the course of the further investigation the corrosion became a significant problem, not only because the measurement results of the scanning electron microscope were changed (see Nørgaard 2017b), but also because etching the sections became difficult.

The first step of the visual documentation process of the specimen sample happens when the sample is polished. However, the now highly reflective surface only reveals microstructures if they differ in their reflection and absorption properties of the environment (Kienlin 2008b: 34; Schumann and Oettel 2005: 224; Beckert and Klemm 1976: 23). Among the particularly prominent structural elements are cracks, pores or shrink-holes, which are usually visible as black, round or oval inclusions and can be of considerable size (Figure 2.117, A and H), as well as sulphides or oxides. Non-metallic inclusions, which show different colours

[66] Here, thanks must go to the archaeometallurgy department in Bochum for providing the opportunity to learn the process from scratch and execute every step of the investigation personally, greatly assisted by: Michael Prange, Michael Bode, Dirk Kirchner, Andreas Hauptmann, Ünsal Yalcin, Andreas Ludwig, Moritz Jansen, and Ingolf Löffler.

when examined under the light microscope, could be detected in the examined material.

Often the light- to medium-grey marbled tin-rich phases (δ-phase) could be detected clearly under the light microscope (Figure 2.117, D). The size and quantity of the δ-phase varied considerably between the individual samples. To determine the respective inclusions minutely, point analysis was performed using the scanning electron microscope (SEM) Supra 40 VP from Zeiss, within the material science laboratory of the German Mining Museum (Deutsches Bergbaumuseum Bochum). The relatively high homogeneity of the polished samples made it possible to determine the existing inclusions, as little variation between the different samples occurred.

The various copper-compounds were recognisable in large quantities (see Buchwald and Leisner 1990: 94). Especially on the polished samples, the sometimes large quantities of bluish-grey copper sulphide (Cu_2S) could be well determined by its characteristic speckled form (Figure 2.117,C). Cuprite (Cu_2O), a copper oxide, occurred mainly on those samples already heavily attacked by corrosion and was often recorded near the grain boundaries (Figure 2.117,B). Due to the only slight colour difference of both the copper sulphides and oxides, to distinguish between them under the light microscope was only possible with the help of the scanning electron microscope. Predominantly, cuprite could be considered as a by-product of corrosion, however, in some cases it seems likely that the mineral cuprite was part of the melt and was crystallized (Figure 2.117, A).

Amongst the smallest documented elements detected in the polished sections were lead droplets (Figure 2.117, E), which did not measure over 1 micron. Partially, lead was detected in an alloy with silver. Additionally, bismuth crystals not greater than 2 microns were detected through their characteristic geometric shape (Figure 2.117, G).

To make the microstructure of an alloy visible, further treatments with etchants are required. This classic method in metallographic studies of optical microstructural contrasting (Kienlin 2008b: 34; Schumann 1991: 105ff.; Petzow 1994: 42ff.; Beckert and Klemm 1976: 13ff.) is based on the principle of the removal of material, especially from the boundaries that separate the grains of the specimen surface. Here, through the dilute acids of the etchant an electron discharge of the metal from the sample is caused and thus the electron goes into solution. On the specimen surface an oxidation takes place and in the etchant parallels a reduction, a so-called redox reaction (Kienlin 2008b: 34). To what extent a metal will go into solution depends on its electrochemical voltage, the specific term for this is the metals solution effort (Schumann and Oettel 2005: 227).

Different phases, due to their different composition, can have a different solution endeavour ('Lösungsbestreben') depending on the percentage of the noble metal. Such differences in the chemical composition of a phase are referred to as 'chemical inhomogeneity'. Such chemical inhomogeneities do also occur in segregations,[67] at dislocations and small-angle grain boundaries with an increased impurity. They cause, in a similar way to 'physical inhomogeneities' – such as deformation inhomogenities – orientation differences between adjacent grains, and differences in lattice field concentration, the so-called 'potential differences' (Schumann and Oettel 2005: 228).

Due to these potential differences, the etchant is more effective in areas with increasing base metal (tin) in relation to areas with more noble metal (copper). Very heavily deformed atomic structures (grid structures) through physical inhomogeneities, for example with a higher energy level, which are caused amongst other things by cold deformation, behave in this respect like base metals and are thus exposed to a higher etching attack as undisturbed areas (Kienlin 2008b: 34). As a result, a relief of the specimen surface is created (Figure 2.118). Here, the supernatant areas represent the least degraded phases (Beckert and Klemm 1976: 24).

Among the etchants, there are those which restrict themselves to the reduction of the grain boundaries without a major attack on the grain surfaces, and those which seek for the roughening of the grain surfaces (*Kornflächenätzung*). The latter results in a different reflection behaviour of the individual grains (Beckert and Klemm 1976: 46ff.). There is usually a combination of both results, which is also often desirable for a better understanding of the microstructure (Schumann and Oettel 2005: 228). In the same way as the choice of etchant affects the visualisation of grain boundaries and grain surfaces, metal alloys require different etchants (Petzow 1994: 103ff.; Beckert and Klemm 1976: 73ff).

Within the polished specimen sections there were only copper-tin alloys, sometimes with strongly varying tin content. While etching, copper alloys can be treated similarly to pure copper and thus the etchants developed for copper are applicable; only the time is shortened with increasing levels of alloying (Beckert and Klemm 1976: 272).

[67] Segregation is a phenomenon that arises in impure metals or alloys when the different components have a different melting point. Here, one element solidifies before the other in a dendritic formation. However, there are other forms of segregation as well (see Scott 1991: 2ff.).

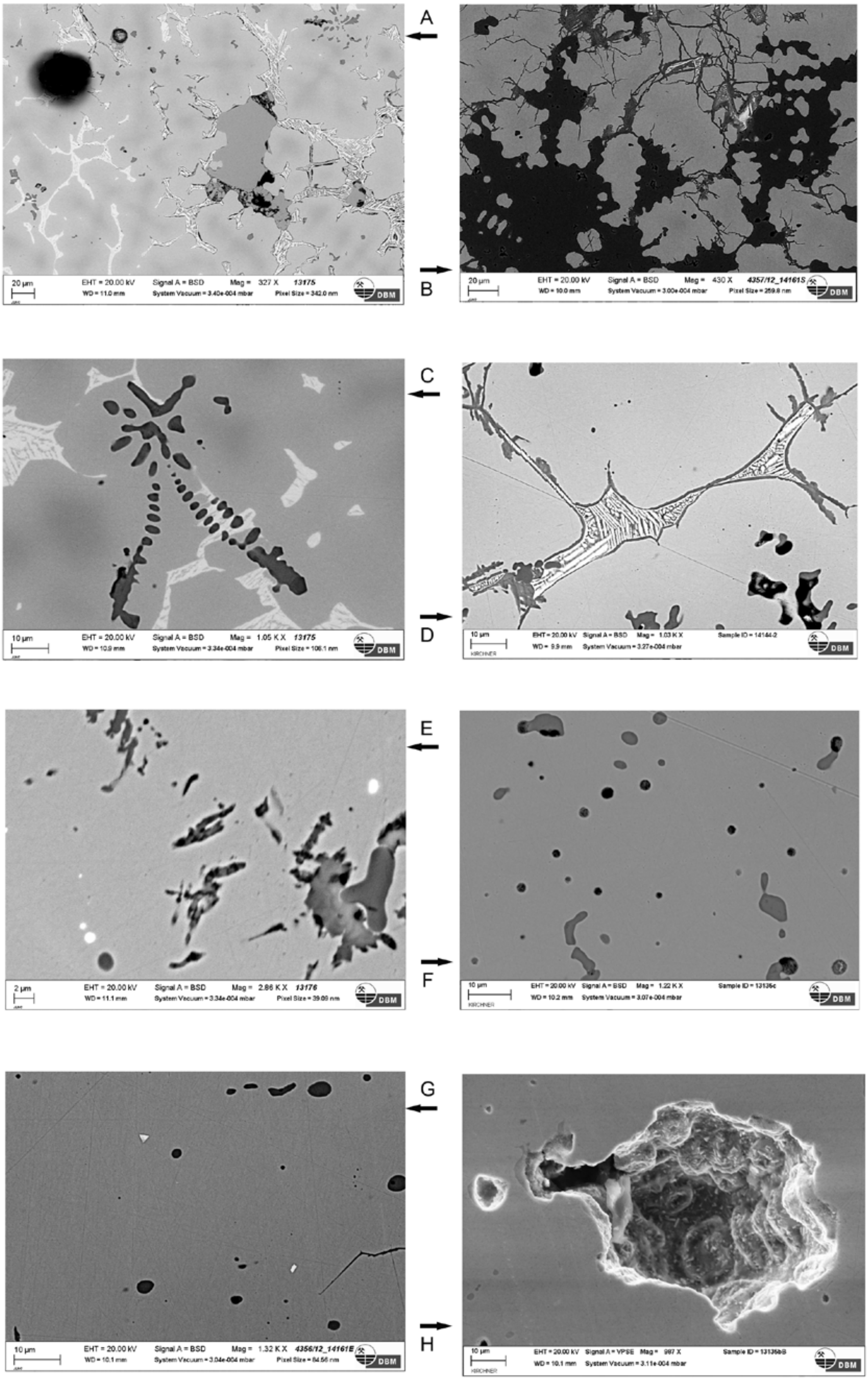


Figure 2.117: Different kinds of inclusions documented in the SEM
(kindly provided by Bergbaumuseum Bochum).

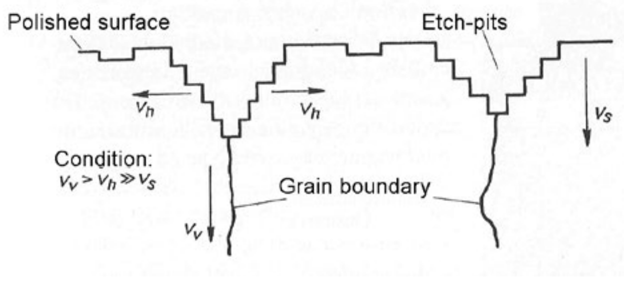


Figure 2.118: By etch pits-induced microrelief (after Schumann and Oettel 2001: 215.)

The basis for the choice of the etching solution was the test series carried out by Kienlin (2008b: 34), since within this study copper alloys with a tin content up to 8% tin were included. The use of alcoholic hydrochloric acid FeCl3 etchant was already evident after the first sample to be particularly advantageous. The etchant was mixed in a mixing ratio of 100ml ethanol (96%), 20ml of hydrochloric acid (32%) and 5g of iron (III) chloride (see Kienlin 2008b: 35; Petzow 1994: 107; Schumann 1991: 744). The application of the etchant was carried out using a pipette, as each individual specimen sample should be treated separately due to the sometimes highly advanced corrosion. The etching time varied from two to more than ten seconds. Generally good results were achieved, only on heavily corroded samples the microstructure was difficult to display by etching as mainly the corrosion was attacked by the etchant.

After successful etching, all polished specimen samples were examined a second time under a polarizing microscope and documented.

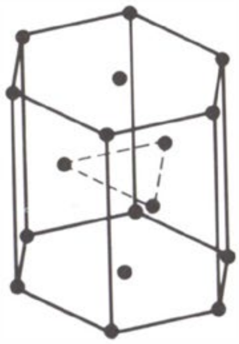
2.7.2 Microstructures in metals: the basics

An analysis of the microstructures of metal objects is largely based on the knowledge of the structure of the metals and the changing effects of external influences. Basic properties of metals are their characteristic metallic lustre, opacity, high electrical and thermal conductivity (which depends on the particular metal), and in general its good plasticity (Schumann and Oettel 2005: 1). These special properties of metals can be explained by a special kind of atomic binding. Simply said, within the mutual approach of metal atoms ionic cores are formed, between which the emitted electrons form themselves into an electron gas. The negatively charged electron gas provides the bonding between the positive ionic cores. The presented characteristic properties of metals are the result of such metallic bonding between the atomic blocks (Schumann and Oettel 2005: 2; Schröter 1990: 172ff.).

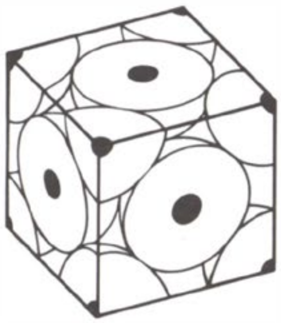
In the metallic state, the ionic cores have a regular, three-dimensional periodic arrangement which extends over the entire volume and can, therefore, be referred to as crystals (Schumann 1991: 251; Löffler 2010: 77). Metallic materials are usually made of a variety of differently oriented single crystals, called grains, which form a microstructure. Boundaries between structurally similar grains are called grain boundaries and boundaries between disparate areas (called phases) are called phase boundaries (Schumann and Oettel 2005: 4-5). A model which describes the lattice structure of the majority of the metals is that of the spheres stacked in closely packed layers. Two basic variants are the closely packed hexagonal system and the face-centred cubic system (Figure 2.119; Schumann and Oettel 2005: 17; Scott 1991: 1). Important metals with a face-centred cubic system are aluminum (Al), silver (Ag), gold (Au), nickel (Ni), copper (Cu), lead (Pb) and platinum (Pt). Metals, with a closely packed hexagonal system are, among others, zinc (Zn), titanium (Ti), zirconium (Zr), magnesium (Mg), beryllium (Be) and cadmium (Cd), whereas iron (Fe), vanadium (V), chromium (Cr) and tungsten (W) have a body-centred cubic system (Figure 2.119).

In terms of metal technique, of particular importance is the fact that metals can mingle with each other or with non-metals to form alloys. The information contained in an alloy concerning the different crystal structures or amorphous regions are grouped according to their structure in phases, in which the zone of a phase must have a similar structure. The mixture of different components in an alloy can lead to very different phase formations. Thus, the individual components of a Cu-Pb (copper-lead) alloy have virtually no mixing ratio and exist as separate phases (Schumann and Oettel 2005: 20-21). In tin bronzes (CuSn) a so-called mixed-crystal segregation may occur. In this case, a copper-rich phase drops out at higher temperature and a tin-rich phase at a lower temperature, due to the different *solidus* and *liquidus* temperatures of the components. The resulting uneven distribution of elements is of special interest when analysed in the micro range (Voss *et al.* 1998: 179).

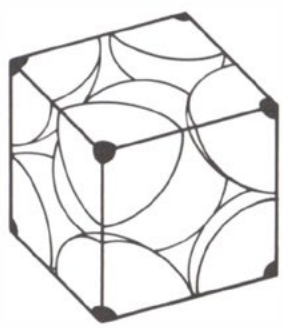
Within a crystal lattice deformations may occur, caused by natural disturbances or irregular arrangement of the atoms, and they represent a mechanically deformed weakness zone (Schumann 1991: 220; Löffler 2010: 79). Such lattice deformations may be the result of impurities or alloys, for example when different sizes of atoms are incorporated, or an atom is removed from its lattice site. The resulting vacancies in the atomic lattice are filled by a slight displacement of the neighbouring atoms, partly so that the disorder is not limited only to the area of the missing atom (Schumann and Oettel 2005: 34). Additionally, locations of mixed crystals with a lower atomic radius can occur within in an interstitial 'hole' in a metal lattice, meaning in the spaces between



A: (CPH) Close-packed hexagonal unit cell structure. Atomic packing factor of 0.74.



B: (FCC) Face-centered unit. An FCC structure has four atoms per unit cell and an atomic packing factor of 0.74 in most elemental crystals.



C: (BCC) Body-centered cubic unit cell. A BCC metal has two atoms per unit cell and an atomic packing factor of 0.68 in elemental crystals.

Figure 2.119: Three common types of lattice structure that metals belong to (after Scott 1991: 1).

the assumed spherical atoms. Mostly, these interstitial compounds are with carbon, hydrogen or nitrogen (Schumann and Oettel 2005: 25). When an impurity sits in a similar manner in the interstitial hole of the lattice then it is called a substitutional compound (Schumann and Oettel 2005: 35). Due to the different atomic radius a shift within the lattice is a result that is, however, no longer noticeable after a few atomic distances.

Dislocations can also be caused by external mechanical influences. In all cases, a certain pressure is to be exerted in order to achieve a deformation, which then mainly takes place at the grain boundaries. Such dislocations (also called edge or screw dislocation) can be understood as an offset. Initially, these are pursued at lower applied stress in the lattice until a tangle of dislocations is built up, similar to a carpet fold, that prevents any further working (Schumann and Oettel 2005: 36-39; (Löffler 2010: 81; Scott 1991: 3). Due to this process, the dislocations, especially in the course of cold-working of metals, are a key factor in the consolidation (Kienlin 2008a: 356-358). The plastic properties and the diffusion behaviour of crystals, to name but a few, can only be understood if one assumes the existence of such grid error (Schumann and Oettel 2005: 33).

2.7.3 Microstructures in metals: revealing the potential for reconstructing operational sequences

Having described above the theoretical foundations of the understanding of the metallic structure, in the following the formation of the metallic microstructure (especially copper-tin alloys) and its phenomena are presented in relation to casting and plastic deformations.

The starting point of each working process is a cast structure (Figure 2.120). Under optimal conditions, this is represented by a dendritic cast structure with large irregularly shaped grains showing segregation (Scott 1991: 5). The emergence of the different phases is in copper-tin alloys mainly due to the high temperature differences at which the individual alloy components solidify (Voss *et al.* 1998: 324). Since copper has a melting point of 1083 °C and tin, however, melts at 232 °C, the point of solidification is strongly dependent on the temperature (Figure 2.121). Generally, it can be assumed in a binary alloy that the melt is enriched with the element of the lower melting point, whereas in the crystals, the element with the higher melting point accumulates (Schumann and Oettel 2005: 375). When cooling a melt with 85% copper and 15% tin to a maximum of 520 °C firstly α-phase grains are produced that are initially homogeneous.

Scott (1991) states that theoretically up to 17% of tin is soluble in copper, although practically he sees the total amount of tin likely at 14%. Thus, it seems unlikely from the melt that only a homogeneous phase crystallizes without tin-rich phases (Scott 1991: 25). These α-phase grains are rich in copper (Scott 1991: 15), while the still existing melt is enriched in tin. Below the stated temperature, the solubility of tin in copper decreases greatly. Occasionally, at a temperature of 798 °C β-phase grains can be produced which are transformed at 586 °C to γ-phase grains. At the temperature of 520 °C this

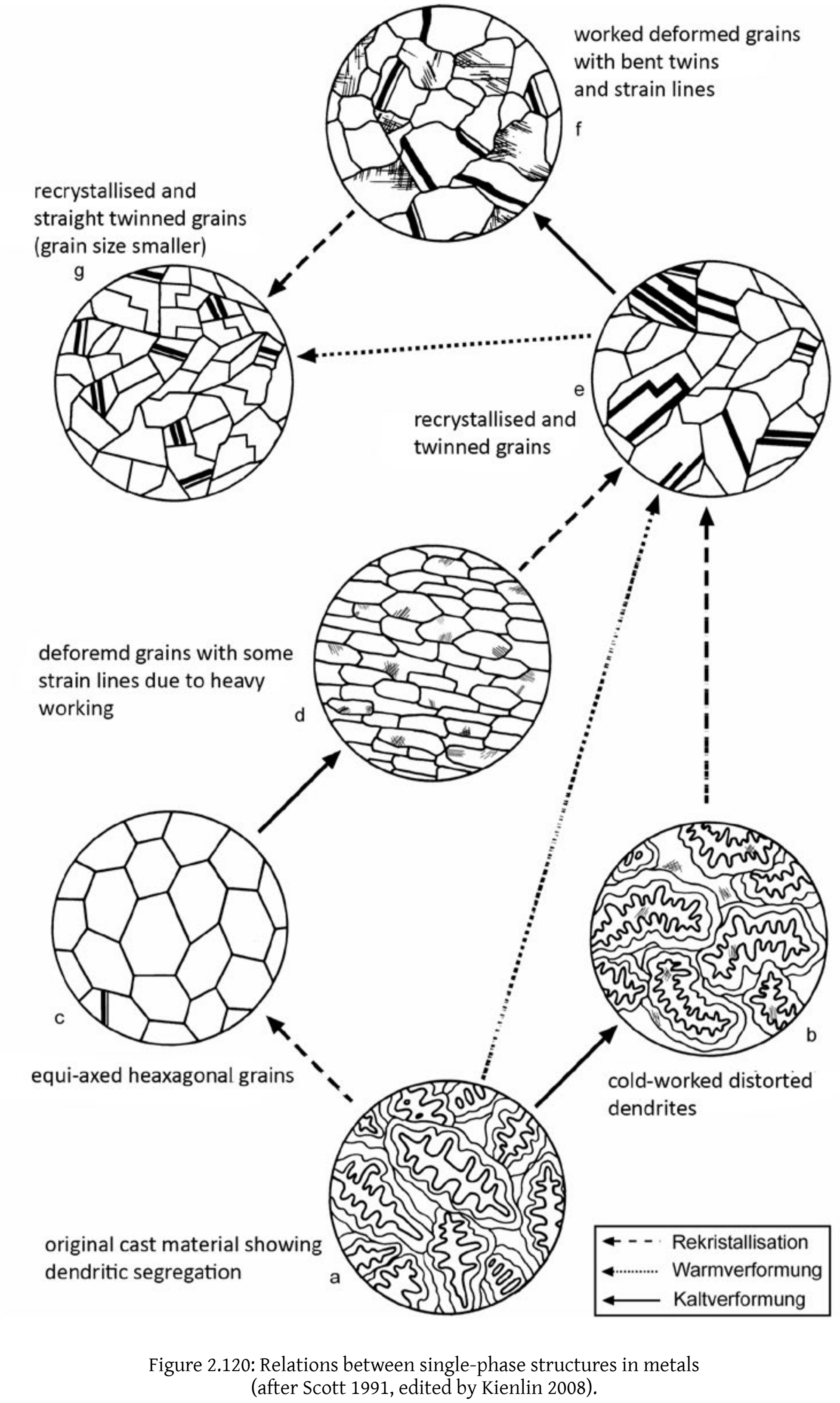


Figure 2.120: Relations between single-phase structures in metals
(after Scott 1991, edited by Kienlin 2008).

γ-phase transforms into the final mixture of α and δ eutectoids (Scott 1991: 16). This δ-phase, consists of an intermetallic compound with a solid composition ($Cu31Sn8$). Under the polarising microscope the δ-phase is seen as a light blue (or grey-blue) phase (see Figure 2.117, D) often oriented on the grain boundaries. They have a jagged shape and often contain islands of α-phase similar to a marbling. With a large amount of δ-phase an adaptation of the bronze becomes difficult (Scott 1991: 15).

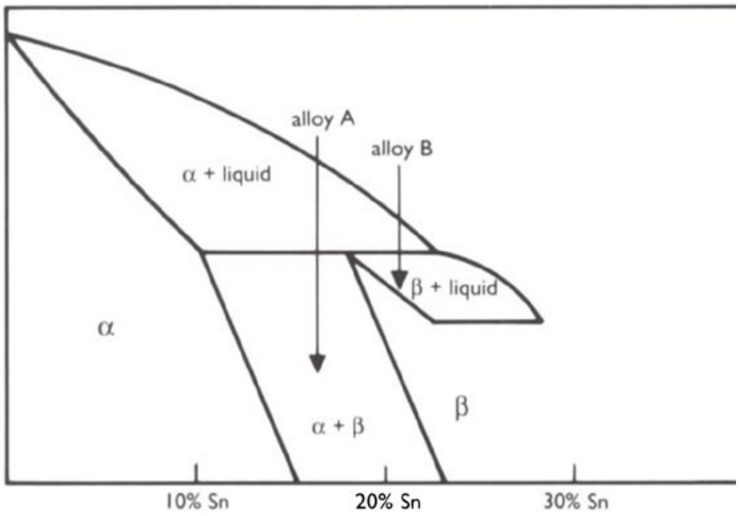


Figure 2.121: Copper-tin phase diagram is the simplified form after Scott (1991: 18). Since in reality impurities and other additives influence the alloy and seemingly impossible states occur (according to the copper-tin phase diagram), and were repeatedly detected in prehistoric metal objects (see Scott 1991: 25; Kienlin 2008b: 14), this study choses to present the simplified diagram as the crucial information is included (from Schumann and Oettel 2005: 771)

Based on the size of the grains, an approximate statement concerning the solidification rate can be made. With slowly decreasing temperature, large grains can form (or dendrites). Rapid cooling, which takes place mostly at the edges of the cast objects, results in smaller grains. It is precisely the above-presented features, such as grain size, extent of material inhomogeneities contained in the bronze (including the δ-phase), and the casting pores and shrink-holes, that are the criteria for the mechanical properties of the alloy (Kienlin 2008a: 43; Scott 1991: 5ff.). The formation of dendrites is the characteristic microstructure of binary alloys being cast, as in such alloys one of the metals has a lower melting point. In copper-tin alloys, therefore, the formation of different material distributions within the dendrite arms is common, the base is copper-rich, and the ends are tin-rich (Scott 1991: 5), as was also confirmed by the investigation in this study.

To ensure a cast artefact becomes workable, a homogenising of the microstructure is necessary (i.e. Kienlin 2008a: 43; Scott 1991: 6), so that the dendritic structure can be converted into a crystalline structure (an equi-axed hexagonal grain structure). During this process a partial dissolution of the δ-phase may be possible (Kienlin 2008a: 45) and thus an improvement of the mechanical properties of the artefact.

The plastic deformation visible in the microstructure can be classified in several stages; in Bronze Age contexts such plastic deformation is commonly due to cold-working (hammering). The first signs of plastic deformation appear in the microstructure, characterised by strain lines, followed by a deformation of the grains as well as the inclusions (see Figure 2.120). According to the experimentally determined results concerning the changes in the microstructure of copper alloys in plastic deformation by Northover (1989),[68] the first individual systems of strain lines occur at a stress rate of less than 20%. At a deformation of up to 30%, different systems of strain lines occur simultaneously (Northover 1989: 112ff.). Also in the material investigated, the amount of artefacts displaying strain lines suggesting deformations of up to 30% were common (see Chapter 2.7.3).

Permanent cold-working (hammering) leads to hardening of the material and, ultimately, the deformability of the artefacts decreases. At the point when the material becomes too brittle to be further processed, or 'the grains are said to be fully work hardened' (Scott 1991: 6), the material must be annealed to become workable again. The process of annealing (also thermal softening (Kienlin 2008a) or intermediate annealing) usually takes place at temperatures between 500-800 °C, with time related to the size and thickness of the artefact (Scott 1991: 7; also Holdermann and Trommer 2010). Through the ongoing heating, a recrystallisation of the microstructure is achieved and thus the possibility for further processing. With an adequate annealing temperature and a sufficiently long annealing time, not only the entire microstructure can recrystallise but also the δ-phase within the alloy, provided the tin content is not more than 14%, can fully go into solution (i.e. Scott 1991: 15). As a result this homogenisation process increases the workability considerably. During recrystallisation of cold-worked microstructures, pressure twins are formed within the grain boundaries and the previously achieved hardness decreases significantly (i.e. Kienlin 2008a: 43; Scott 1991: 7 ff.).

In the respective publications (Scott 1991: 7; Northover 1989: 112; Budd and Ottaway 1995: 100; Kienlin 2008a: 44) it is repeatedly stated that such a twinning is in the same way typical for a dynamically recrystallised structure while hot-forging (see Figure2.120).

[68] These experimentally developed values could partly be confirmed by the investigations conducted by Kienlin. He warns, however, against the negation of strain lines below the deformation rate specified by Northover, since these also occur at lower stress rates (Kienlin 2008a: 50).

However, copper-tin alloys with a tin content of about 8% become significantly brittle at higher temperatures. Therefore, plastic deformation would be not possible while heated (Northover 1989: 112). Furthermore, the handling of such a workpiece, as well as a further filigree processing, is very difficult when heated, as Kienlin has pointed out with respect to axes (Kienlin 2006: 102). Accordingly, twinning as the result of hot-forging could be excluded for the investigated bronzes in this study.

The recrystallisation process leads at each intermediate annealing to the formation of new crystals. However, it should be noted that most of the inclusions and phases within an alloy do not recrystallise and rather break or flatten under plastic deformation (Scott 1991: 7). The size of the newly formed grains is dependent upon the cooling time and the degree of deformation of the microstructure. Usually, slow cooling results in the formation of larger grains compared to rapid cooling. Such differences in the grain size can be recognised within an artefact, as the edge commonly shows smaller grains than the centre. Kienlin (2008a: 44) also illustrated that the deformation intensity influences the crystal formation during recrystallisation, as strongly cold-worked microstructures recrystallise smaller than those with a low deformation rate.

Thus, the consciously chosen form of cooling should be seen as an independent step within a sequence that uses the grain size to achieve the best possible mechanical properties of the piece.

However, prehistoric bronzes often display not fully implemented or only partially effective recrystallisations. A good identifying feature for insufficient annealing is the existence of δ-phase in combination with pressure twins in bronzes with a tin content of less than 14% tin. As already mentioned, this phase, which can be inconvenient when processing, will result in a homogeneous solid solution during a well-conducted annealing. Prehistoric bronzes support the notion that annealing took place commonly only partly, due to the appearance of cast microstructures and recrystallized microstructures within an artefact (see Kienlin 2008a: 55ff.). Particularly on objects where the traces of processing were limited to the edges, this phenomenon was observed.

To summarise, among the most important facts for the interpretation of microstructures it can be stated that the majority of the above-presented microstructures are only visible in the etched specimen sample, as, firstly due to the removal of material from the grain boundaries, the single grains become visible. However, some characteristic features can be detected already in the polished state as post-cast applied stress. Moreover, the microstructure of prehistoric bronzes allows exact reconstruction of the operational steps within the crafting process, mostly also the exact order of steps.

Additionally, while metals are corroding insoluble products are formed which are deposited on the original surface or extend into the object. The corrosion of a prehistoric object can reveal, in addition to the information on soil conditions at the place of deposition, important information concerning the production process.

2.7.4 Corrosion

The vast majority of Bronze Age metal objects are coated with a heavy corrosion layer and in some cases also with several millimeters of varnish or paint.

Within the metallographic structure, corrosion can be detected usually along the grain boundaries and at points of weakness of a grain, due to existing gaps. With advanced corrosion, it is possible especially in copper alloys, to detect the grain boundaries as well as the various systems of strain lines already in the polished specimen sample. The significance of the corrosion while displaying microstructures (Figure 2.122) was shown in Scott (1991: 81). Thus corrosion patterns can inform about the reason for corrosion, about plastic deformation and about recrystallisation, as well as contributing to clarification of the existing microstructures by replacing the original metals and thus displaying their places (Scott 1991: 43).

Constantinides and colleagues, furthermore, observed an aggressive corrosion process in tin-bronzes at places ‘where the original surface is destroyed’ (Constantinides *et al.* 2002: 93). Such developments are advantageous in craft technical studies, as punch marks, intensive hammering of the surface, or inserted decoration would as such be visible within the corrosion layer, as the analysis of the bronzes described here showed.

On the samples from Amelinghausen (HLM 13175 and 13178), on the neck collars from Lüneburg (14147) and Edendorf (14145), as well as on the stud-bracelet from Luttmissen (14161 S), the copper oxide (cuprite) – a corrosion product – highlights the dendritic structure of the original alloy (Figure 2.123). Here, due to the corrosion only the dendritic cast structure can be determined.

In the course of the metallographic studies at the German Mining Museum in Bochum, further investigation concerning the corrosion (or patination) of the investigated bronzes was possible. The main motivator for this additional investigation was the definition of the corrosion layers of the bronzes, and, especially, the change of the alloy composition.

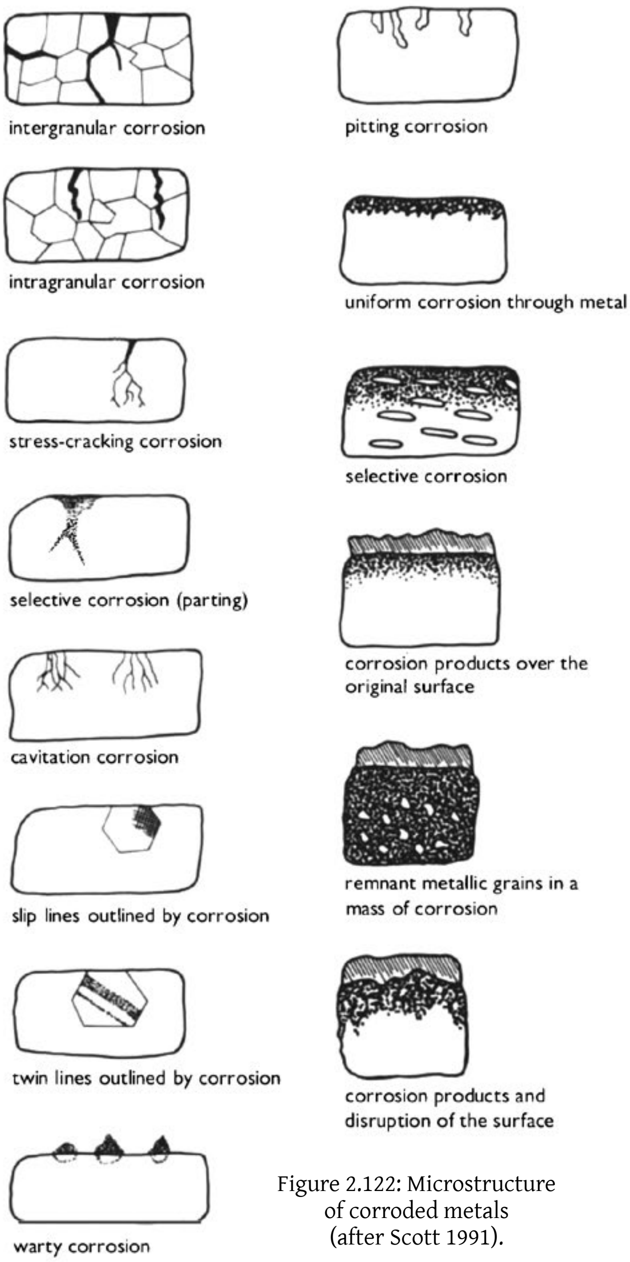


Figure 2.122: Microstructure of corroded metals (after Scott 1991).

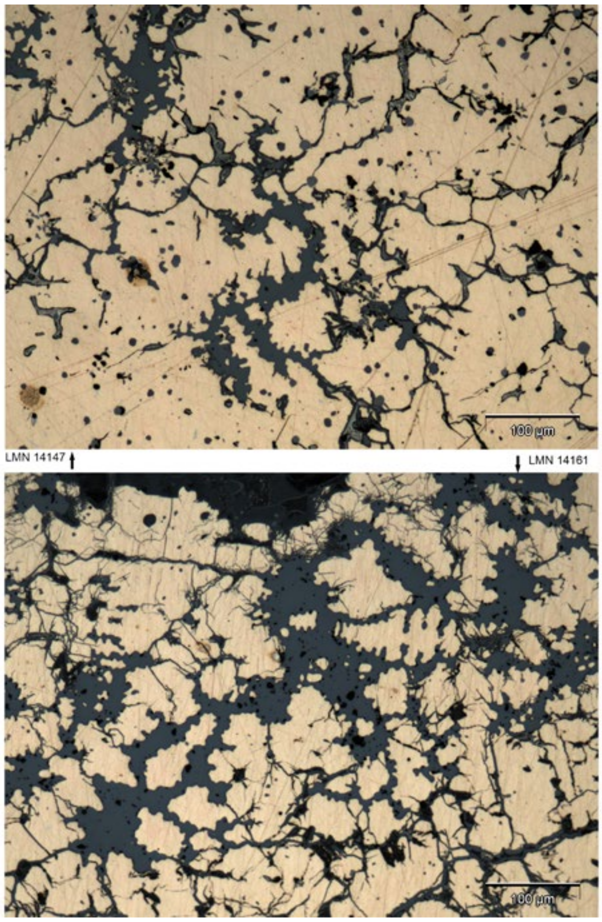


Figure 2.123: Cuprite highlights the dendritic structure of the neck collar from Lüneburg (LMN 14147) and the stud-bracelet from Luttmissen (LMN 14161).

The metal composition of a corrosion layer differs considerably from that of the pure metal. Under pre-industrial conditions copper in moist air formed a patina that contains large amounts of basic copper (CuCO3). The result is a colourful layer covering the artefact, consisting of various corrosion products,[69] such as monoclinic emerald-green to blackish-carbonate, glaze-blue azurite, which develops into the familiar greenish malachite (Wolters 1991: 206). Additionally, earlier investigations showed that within the corrosion layer there is an accumulation of tin and a concentration of secondary metals, including iron (Pernicka 1995: 44).

It has also been noted by several researchers, that trace-element values measured superficially on corroded artefacts give little insight about the actual alloy (e.g. Härke 1978; Lutz and Pernicka 1996; Otto 1973; Pernicka 2010).

All the samples investigated in this context (10 of the 19 bronze ornaments from the metallographic investigation), had a tin content around 12%, isolated traces of arsenic, and a distinctive patina. The appearance of the patina can be transferred to many of the bronze ornaments of NBA II and III in the Nordic Bronze Age. The majority of the bronzes were found on agricultural areas or in bogs, and, due to a similar climate and agriculture in northern Germany and Scandinavia, the majority of the finds were exposed to similar conditions.

During the metallographic examination and the definition of non-metallic phases and metallic inclusions under the SEM, a line-scan on distinct samples was executed to measure the change within the element distribution.

[69] For a more detailed explanation of the various corrosion products, see Nørgaard 2017b.

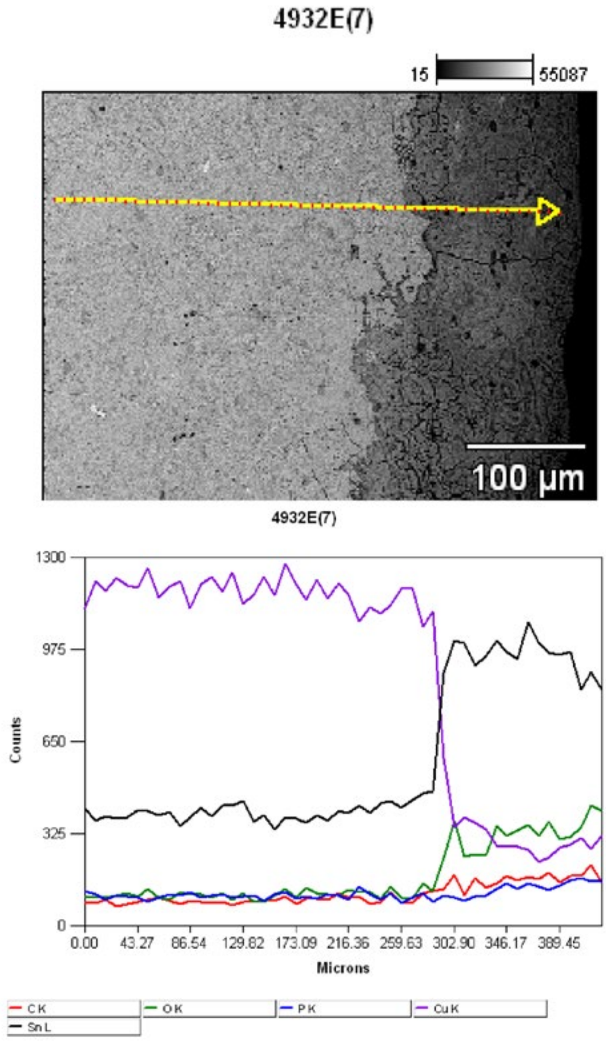


Figure 2.124: The change in the alloy composition towards the corrosion layer can be demonstrated on a specimen sample of the neck collar from Raven, Harburg (LMN 4932), dating to NBA II, . With the onset of corrosion the copper content decreases significantly and in parallel increases the tin content. This phenomenon can be explained mainly by the rising oxide value and its reaction with copper to cuprite (a copper oxide). (Scan/ Image: Dirk Kirchner, German Mining Museum, Bochum).

This element distribution curve, measured from the sample centre to the edge of the corrosion layer, revealed a rapid drop of the copper values with a simultaneous disproportionate increase in the tin content with the start of corrosion (Figure 2.124). Along with the decrease in the copper values the oxygen content rises sharply. This effect results from the reaction of copper and oxide to the copper-oxide cuprite. Similar phenomena have already been documented in other studies of ancient bronzes, mostly within conservation studies, while comparable results have been achieved in studies of artificially created patinas (Fernandes *et al.* 2013: 5; Oudbashi *et al.* 2013: 3; Šatović *et al.* 2013; Constantinides *et al.* 2002: 93ff.). The process is commonly known as 'decuprification' and starts with selective dissolution from the copper solid solution α-phase (see Robbiola *et al.* 1998: 2108). During this stage, the dissolved copper reacts with soil anions such as chloride (Cl) and carbon (C), and as these copper salts are soluble in soil waters, they can be carried away from the metal surface (see Chase 1994; Oudbashi *et al.* 2013; Weisser 1975).

Since tin reacts to a much lesser extent with oxygen, the percentage of tin content in the alloy is not changed; in fact, the additional enrichment of tin in the corrosion layer (Pernicka 1995: 44) results in a distinct increase in its proportion relative to other components.

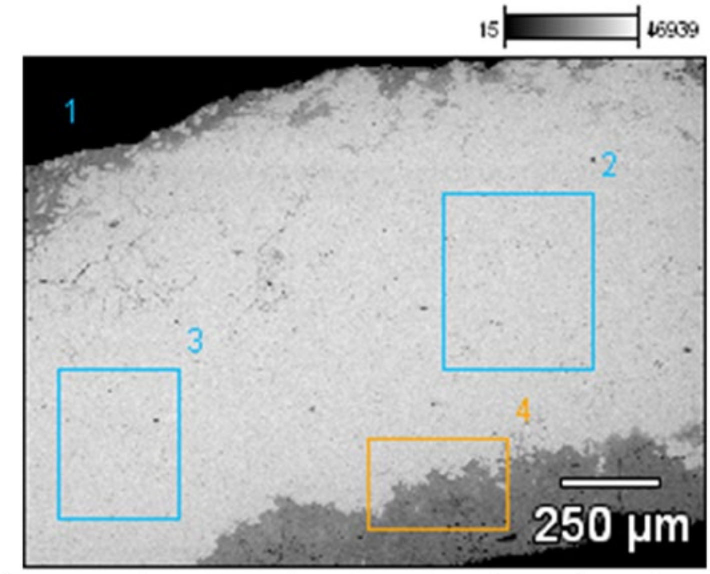
In several studies of bronze corrosion, a high tin concentration has been detected in corrosion layers. Selective de-alloying, or destannification, from the bulk metal (and the tin-rich δ-phase) towards the corrosion provides one possible explanation for this phenomenon, while selective removal of tin offers an alternative (see for example Chase 1994; Weisser 1975). In this case, the fast oxidation of tin can be seen as the main motivation for its dissolution from the bulk (tin-oxide films); however, this phenomenon requires further investigation (see also Nørgaard 2017b: figures 2 and 3).

In addition, the minor trace elements contained within the alloy also exhibit changes that are caused by the corrosion process. In the vast majority of the metallographically examined bronzes from the Lüneburg Heath were sulphur inclusions. The detectable percentage of the sulphur content of most samples was constant. However, within the corrosion layer a slight increase in the sulphur values could be detected.

Moreover, arsenic could be only sporadically documented in the samples. Striking, however, was that arsenic containing inclusions predominantly occurred at the transition to the corrosion layer, but, however, were never measured at the outer edge of the sample (Figure 2.125).

Of particular importance for the understanding of the corrosion layer is the influence of minor elements contained in the soil. The metals contained in the immediate area around the deposited bronzes can accumulate in the corrosion layer, in particular manganese and cobalt, but also phosphorus and silicon occur commonly in modern soil due to modern field work. Consequently, the above-mentioned processes lead to a metal composition of the surface that does not coincide with the composition the prehistoric artisans had chosen.

Thus, by comparing surface measurements of trace elements (by portable XRF) from patinated artefacts with measurement of the metal core of the same



	C-K	O-K	Si-K	P-K	S-K	Cu-K	As-K	Sn-L
14161E_pt1	53.37	31.95				11.89		2.80
14161E_pt2					0.38	86.07		13.55
14161E_pt3					0.24	85.17		14.59
14161E_pt4	5.81	17.10	0.65	0.32		51.84	0.46	23.82

Figure 2.125: SEM analysis of the specimen sample from the end plate of the neck collar from Luttmissen, Uelzen (LMN 14161). The table lists the measured values of the individual measurements 1-4. (Scan/ Image: Dirk Kirchner, German Mining Museum, Bochum).

artefacts, the results clearly show a non-rule based and modified values of copper and tin in the corrosion layer of the artefacts (Nørgaard 2017b). Here, the investigator needs to be cautious with matters related to individual craft behaviour.

Moreover, due to the different patina compositions of visually similar objects, which are seldom definable through by surface examination of the artefact, measured trace element values vary strongly. Even with the exact knowledge of the deposition conditions the data can only inform about a rough ratio of copper and tin.

Therefore, one should always, when investigating patinated bronze artefacts, be aware of the corrosion layer. In metallographic studies, corrosion might help to identify areas of high stress – the post-cast, cold-worked parts of the artefact – in order to identify the methods in which, for example, the decoration was applied.

It should be noted, however, that when using surface analytical methods, such as the portable XRF device, on prehistoric metals, the question behind the analysis is crucial for its successful application. With the help of this non-destructive method it is possible to gain an overview of the material. It can clearly be informative if the object of interest is of gold, silver, tin bronze, brass or copper. A question about the percentage of the alloying components or the existence of minor metals is, however, only answered by this method to a limited extent, since the composition of a possibly measured corrosion layer is not comparable with the metal composition originally selected by the craftsman.

2.7.5 Cast and hammered: the microstructures of NBA II and III ornaments

The microstructures documented on the artefacts from the Lüneburg Heath range from pure-cast structures with partly visible dendrites, cast microstructures with cloudy crystal formation, structures with lower deformation rates and less signs of annealing, up to structures showing repeated recrystallisation and deformation.

All these structures display individual steps within the operational sequence. The following interpretation of these microstructures aims to reconstruct the order of individual crafting steps to provide a scientific base for the determination of the absolute operational sequence.

Pure homogenically cast structures with clearly visible dendritic structures, as known from the experimental castings of Buchwald and Leisner (1990: 69-70), were only detected in a few cases in the sampled material.

The *pure dendritic cast structure* could be documented (Figure 2.126) on the investigated stud-bracelets, on a neck collar from Becklingen (13135b) and on the wheel-head of the pin from Rehlingen (5032). The microstructures of these bronzes did not show any traces of processing and, accordingly, may be referred to as pure-cast structures. Furthermore, the dendritic structures were highlighted by the formation of the corrosion-related cuprite (see Figure 2.123) on the specimen sample from Luttmissen (14161S), as well as on the slightly worked piece from Lüneburg (14147).

In regard to the crafting technique used to craft the mentioned ornaments, the detected microstructure should not be transferred to the whole piece, as several artefacts will show. It can, however, be noted that the relief-shaped bronzes (especially the stud-bracelets) received the ribbed structure before the cast, either in the model or in the mould. Furthermore, it can be stated that for the stud-bracelets extensive finishing can be excluded. With respect to the further samples, such as the ribbed section of the neck collar (13135b) and the wheel-headed pin from Rehlingen, a reworking of the specific region has not happened.

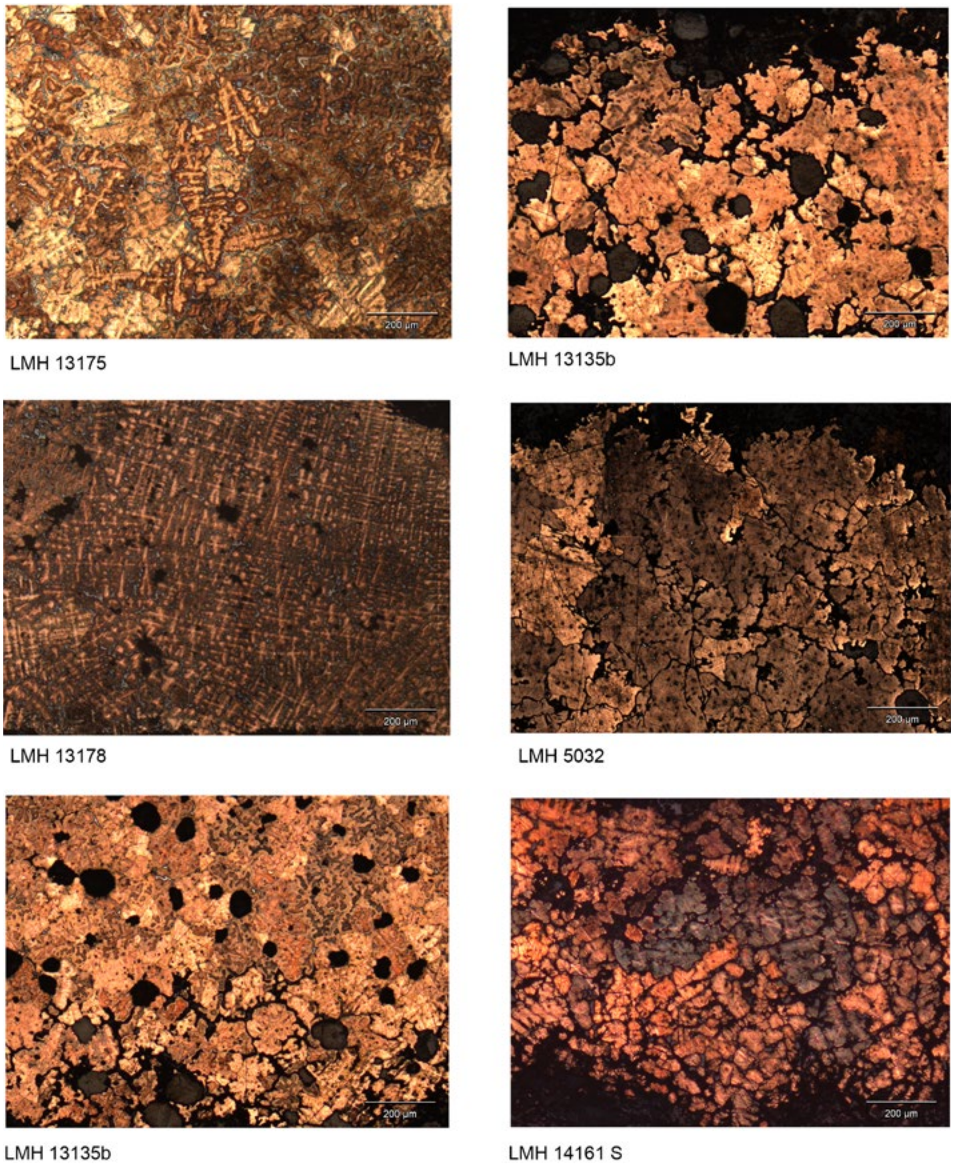


Figure 2.126: Artefacts with a pure dendritic cast structure (the straight, object-crossing lines within some of the pictures are the result of an insufficient polishing process of the specimen sample and not part of the micro-structure).

By contrast, *cast structures* displaying slight changes of microstructure due to a presumably superficial processing are documented more often. The specimen samples of the collars found near Lüneburg (14147; 195-78), in Amelinghausen (13177), Raven (4932) and Bleckmar (K851: 76), displayed clearly the dendritic basic structure within cloudy grains (Figure 2.124). All samples are taken from the frontal (ribbed) part of the collar. In all samples strain lines were visible, pointing towards a deformation rate less than 20%, concentrated on the surface of the artefact. The possibility that the former, pure dendritic structure was prepared for working by an homogenising of the microstructure (through annealing) is likely, as isolated recrystallised grains are visible (Figure 2.127, 4932). However, a complete recrystallisation did not take place. Furthermore, the significant presence of the δ-phase, especially at the grain boundaries (Figure2.127, 13177), supports the assumption of an almost pure-cast structure.[70]

In addition to a deliberately executed annealing of the whole artefact, in this case, the possibility can be considered that the piece was only partially annealed (as for example at the ends of the collar), and the residual heat of this operation affected the microstructure at this point.

As a result, a recrystallisation would only be partially successful (single hexagonal shaped grains) and probably in the regions of the most applied stress (see Kienlin 2008a: 44).

Since the observed strain lines and the occasional recrystallisations were predominantly found in certain

[70] As already stated, in a tin content of up to 14%, the δ-phase would go completely into solution when properly annealed.

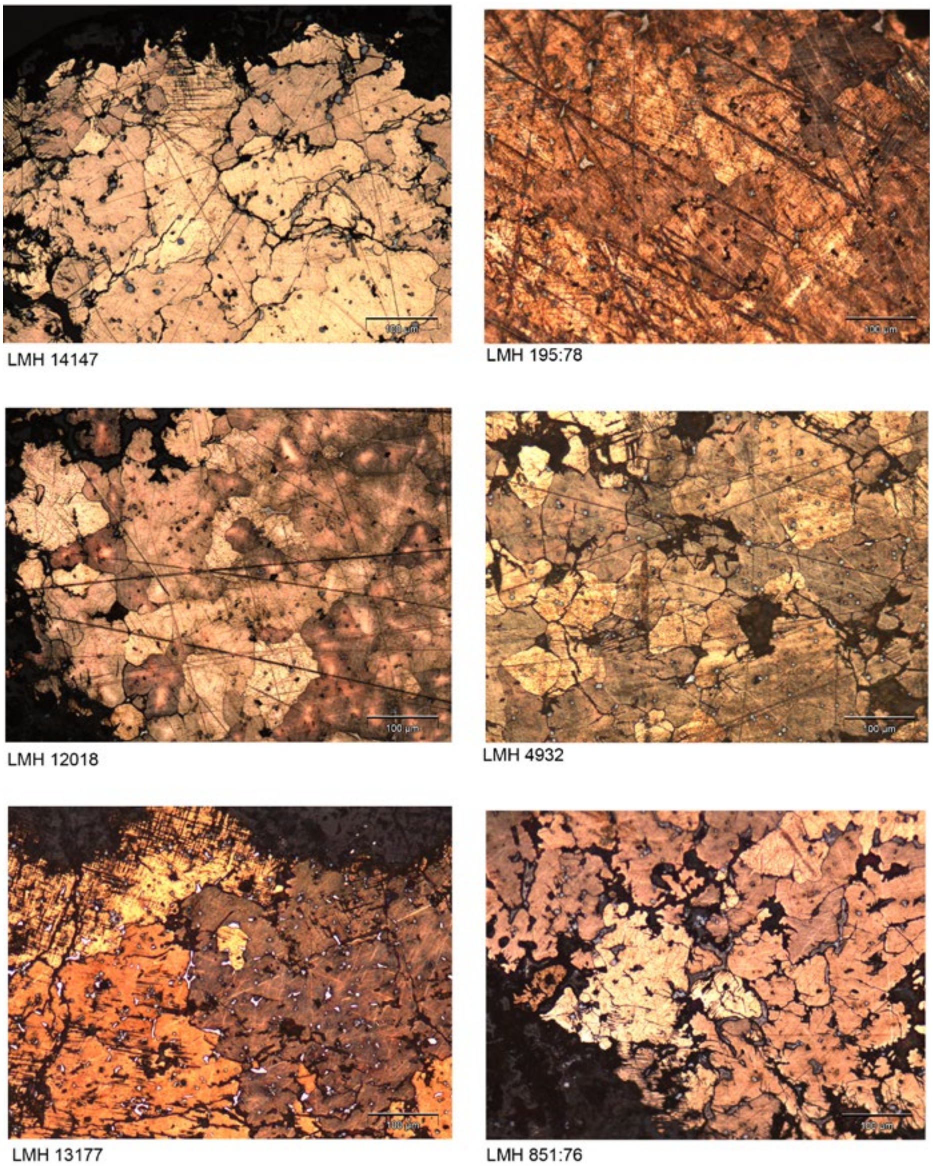


Figure 2.127: Artefacts showing a cast structure with slight changes in the microstructure caused through deformation (the straight, object-crossing lines within some of the pictures are the result of an insufficient polishing process of the specimen sample and not part of the micro-structure).

areas of the specimen samples, it is possible here to express assumptions about the kind of deformation. Frequently, the peripheral areas of the neck collars and stud-bracelets are worked, as well as the rib-back and slopes. Particularly impressive are the traces of reworking concentrated on the rib-back (Figure 2.128) of the collar from Lüneburg (14147). The sample of the stud-bracelet from Lüneburg (14148) shows strain lines, which are restricted to the rib-slopes and point towards a processing of the rib-valleys post-casting. Such traces can be obtained by a subsequent treatment of the surface, possibly by lightly hammering, but also by smoothing the surface with the help of a bronze punch. The applied force is very low in most cases and, therefore, should not be seen as cold-working (hammering) but rather as a superficial cleaning of the cast piece.

In addition, occasionally signs of repair were detected, mostly on the reverse side where material was spread to cover superficial shrink-holes, as documented on the stud-bracelet (14148) found near Lüneburg (Figure 2.129).

Increased working, comparable to the straightening of edges and corners by gently hammering, was visible on the samples from Amelinghausen (13179). Additionally, on the rib-back on the collars from Moorkate (99:33), Lüneburg (14146) and Raven (4932), limited traces of intensive hammering were detected, which can be only explained by the adding or reworking of rib decoration (Figure 2.130). Whether these samples provide the proof that the rib decoration was applied post-casting (Drescher 1953b: 70) should be tested in further research with comparative experimental specimen samples, showing the changes in microstructure when

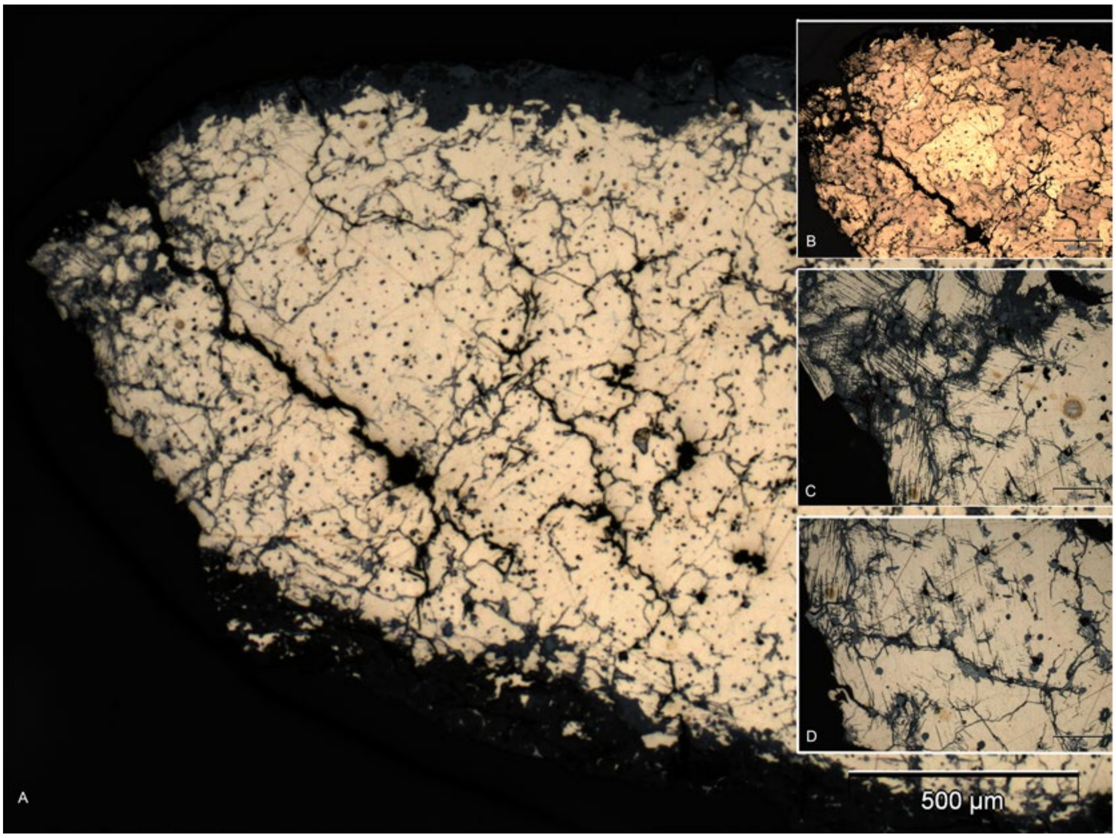


Figure 2.128: Traces of plastic deformation in the cast structures concentrated on the rim of the artefact from Lüneburg (LMN 14147).

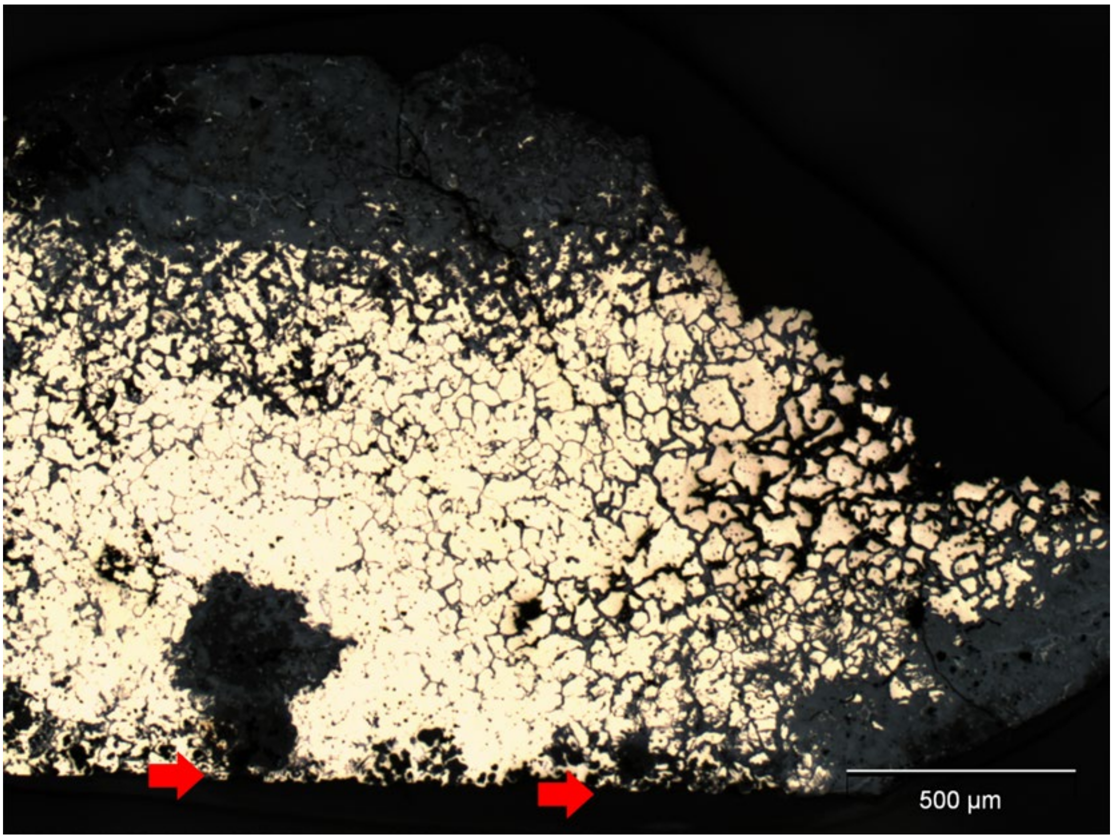


Figure 2.129: A superficial shrink-hole is covered with material on the stud-bracelet (LMN 14148) found near Lüneburg.

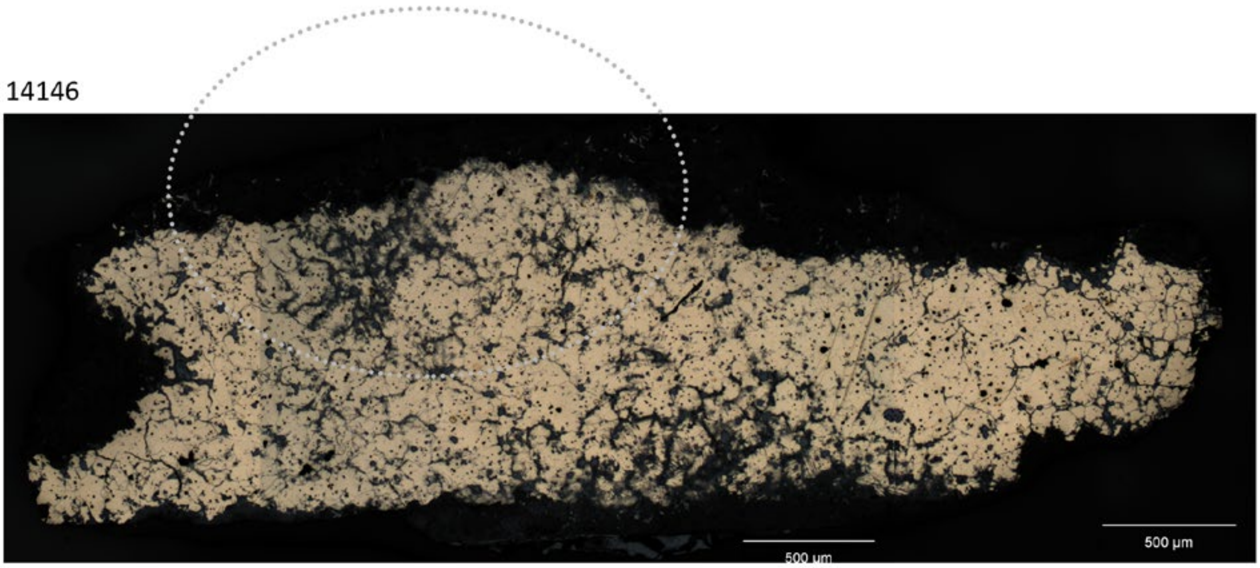


Figure 2.130: Spatially limited traces of intensive cold-working
(hammering) on the rib of the collar from Lüneburg (LMN 14146) caused by the adding or reworking of rib decoration.

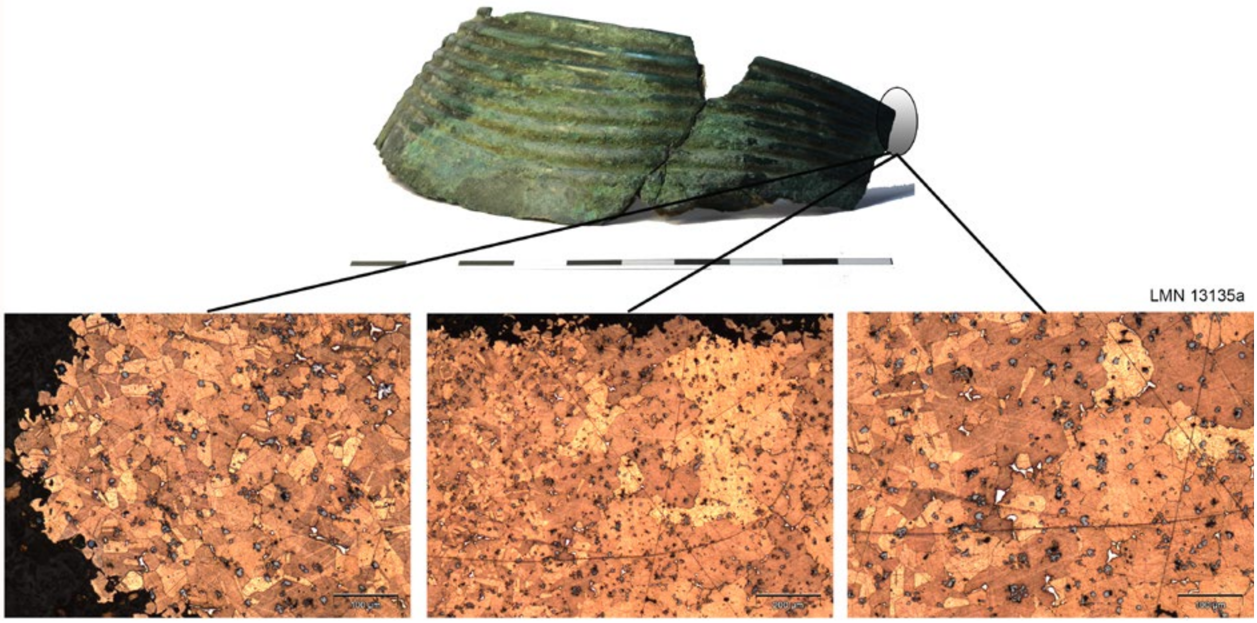


Figure 2.131: Changes in the microstructure within the small sample from the Becklingen collar (LMN 13135a) suggest a selective annealing and hammering.

the decoration is punched and the changes occurring when reworked.

Until then, it can be stated that the samples provide clear evidence for a reworking of the rib decoration, in terms of repair to the cast decoration.

Changes in the microstructure from *pure cast structures to heavily cold-worked structures* quite often occur within one sample. Such radical changes within these relatively small samples were particularly documented at edge regions, at the transition from the face side to the end plate of several collars, and on samples taken near the hem of the specific collars spread across the Lüneburg Heath (Figure 2.131).

The bronzes from Becklingen (13135c), Edendorf (14144) and Luttmissen (14161) have a microstructure with a smooth transition from cloudy grains, similar to those referring to a cast structure, to strongly deformed structures with indications of several recrystallisations (Figure 2.132). Here, the cast structure is commonly towards the centre of the piece, the cold-worked (hammered) structure towards the hem or edge of the collar.

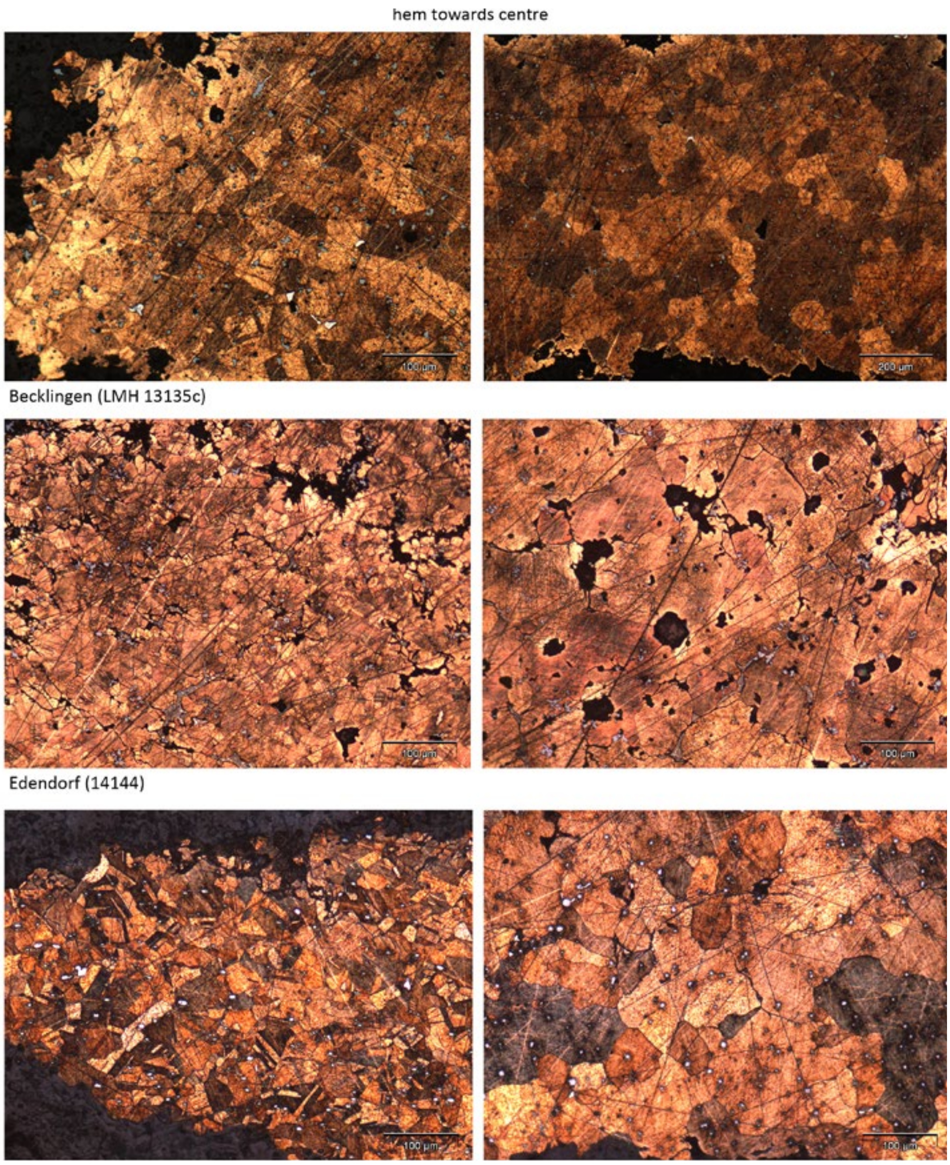


Figure 2.132: Changes in the microstructure on the examined artefacts: the cast structure is visible in the centre and the deformed structure in the hem (the straight, object-crossing lines within some of the pictures are the result of an insufficient polishing process of the specimen sample and not part of the micro-structure).

The specimen samples of the neck collar from Rehlinger (4931), Tangendorf (14154) Becklingen (13135a) and Edendorf (14145) show a similar structure change from large, non-ordered grains in the rib-facing area of the collar, to highly deformed and repeatedly recrystallised grains in area towards the end plate (Figure 2.133). As especially neck collars display this structure, the samples support the theory of a hammering of the end plates post-casting to create their final shape (Drescher 1953b: 70). Additionally, an intensive processing could be proven for the collar hem, an element typical for the central Lower Saxony region. In all documented cases the area under highest stress was selectively annealed in order to achieve a recrystallisation for further reworking. If the complete artefact was annealed, the recrystallisation process would have affected the whole artefact, and the structures shown above (cloudy crystals with partly dendritic structures) would not be visible. The fact that within only one centimetre of specimen sample the structure can change from non-recrystallized to highly deformed and repeatedly recrystallised is only explicable by selectively annealing. This could have been achieved using a blow pipe or through placing red-hot charcoal pieces (Holdermann and Trommer 2010: 800) on the area of interest. Partly newly formed crystals within the cast structures indicate a slight warming, but not sufficient for a complete recrystallisation.

The microstructure of the hammered areas on the samples display predominantly deformation rates between 30-40%, a few show also deformation rates of up to 50% (after Kienlin 2008a: 49; Northover 1989: 112). In general, the stress rate is greatest in the area of the hem and in the end plate.

The increasing degree of deformation towards the end plates of the neck collars could be shown by the multiple sampling of the pieces from Becklingen (13135a), Edendorf (14144) and Luttmissen (14161). The specimen samples taken from the end plate near

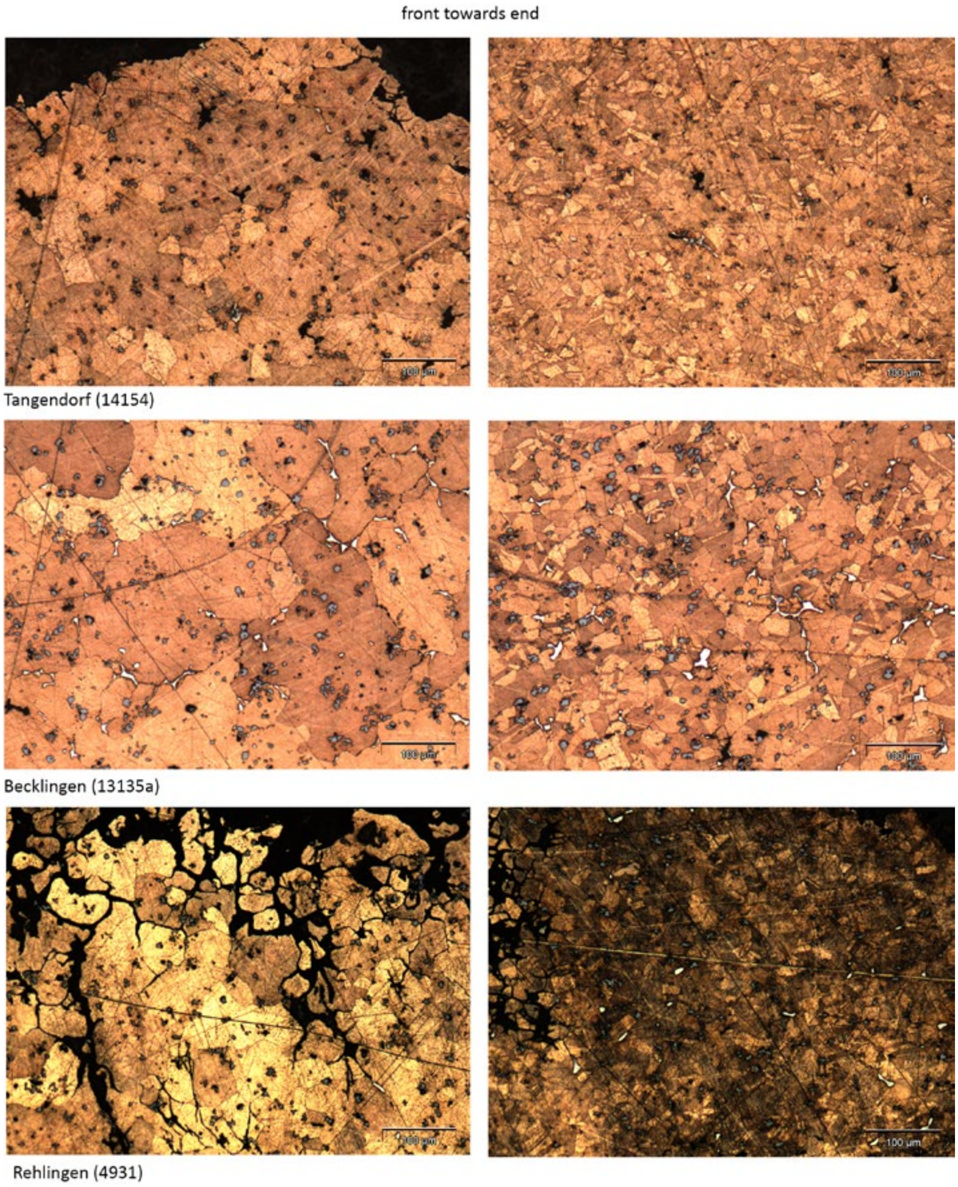


Figure 2.133: Changes in the microstructure on the examined artefacts: the cast structure is commonly in the ribbed section and the deformed structure at the ends (the straight, object-crossing lines within some of the pictures are the result of an insufficient polishing process of the specimen sample and not part of the micro-structure).

the end-rolls show a *clear cold-working structure*, as also shown in the sample of the collar from Westerwehye (4930). Additionally, samples taken from the hem of the collars from Bülkau (5552), Amelinghausen (13177), the Lüneburg (14147) and Raven (4932) display heavily deformed structures (Figure 2.134). These samples illustrate the partial processing of the collar, which was already assumed by examining the samples with varying microstructures. In the heavily deformed areas a stress rate from 30-45% can be documented.

In contrast to the only partly appearing, hardly deformed, microstructures in neck collars, the samples taken from pin-shafts and bracelets, especially, display a fine-grained microstructure with a deformation rate of up to 50%. Additionally, here a repeated annealing and recrystallisation can be determined. Of interest is here the wheel-headed pin from Rehlingen (5032), as several samples were taken. In contrast to the sample taken on the head (clear dendritic cast structure) a significant deformation was documented via the sample taken from the shaft (Figure 2.057). A similar fine-grained structure was detected on the sample from the bracelet found near Amelinghausen (13176). Both specimen samples show a nearly homogeneous change of the microstructure through plastic deformation. Presumably, a different cooling rate between shaft centre and shaft edge can be cited as the reason for the different grain size, since in the centre occasionally significantly larger grains occur.

Consequently, it can be stated that the pin shafts, as well as the massive bracelets, were cold-worked (hammered). Regarding the simple, massive open bracelets, the hammering from a rod-like cast ingot must be assumed. Similarly, the pin shaft is created significantly reduced in the model and cast before it is subsequently brought to the desired length.

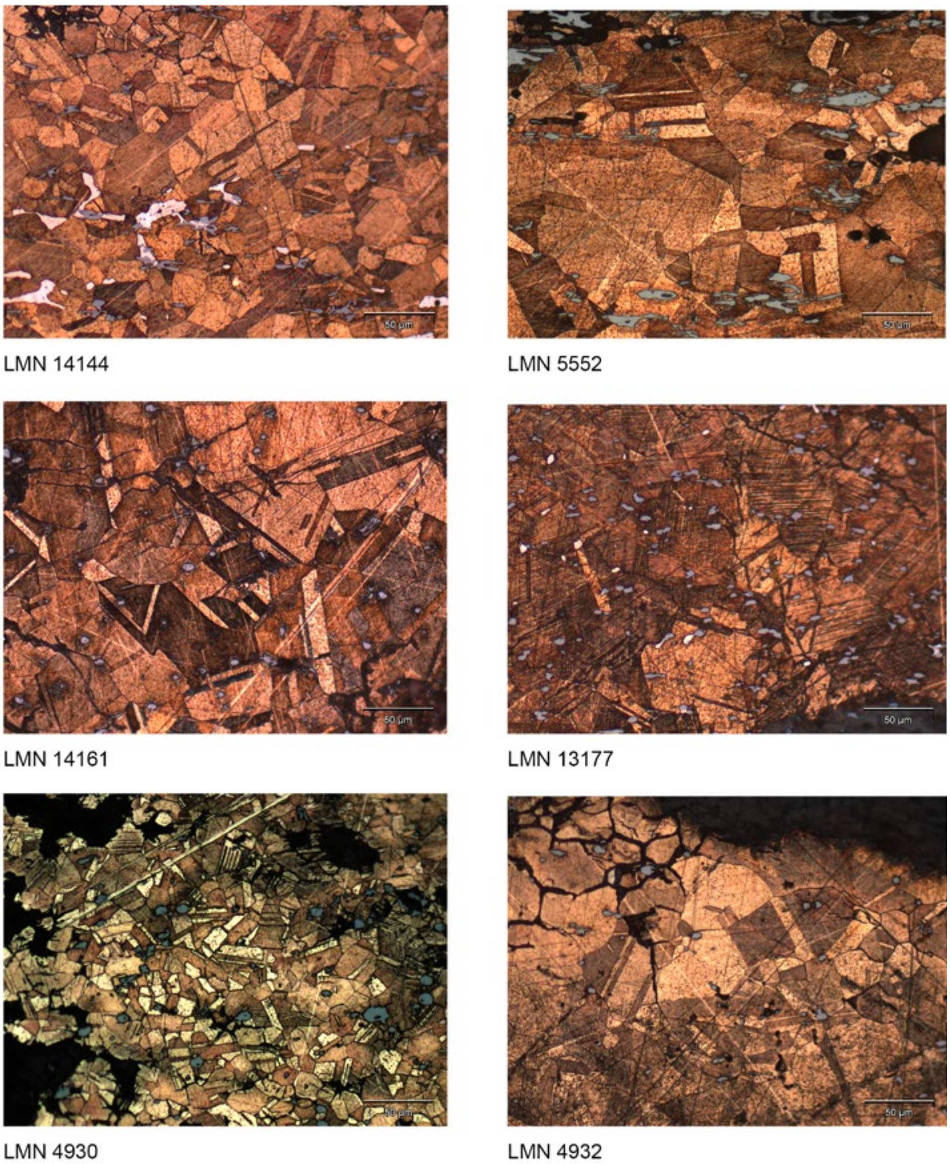


Figure 2.134: Artefacts showing a clear cold-working structure with several annealing phases (the straight, object-crossing lines within some of the pictures are the result of an insufficient polishing process of the specimen sample and not part of the micro-structure).

In addition to the information on the degree of deformation and the approximate amount of annealing, the above-described, highly deformed microstructure hides further information. Using the size of the individual grains as well as the homogeneity of the structure, a statement on the annealing temperature is possible. It is shown that the annealing process had happened at the hem of several collars at lower temperatures, and the recrystallisation did not, therefore, take place at all points with the same intensity. In contrast, the documented recrystallisation on the collar end plates is far more homogeneous and thus a higher annealing temperature is to be expected. The above-described microstructure corresponds to the actions of a skilled metal craftsman, who would intuitively adjust the annealing temperature and duration to the thickness of the material to avoid damage to the piece.

The very badly corroded specimen samples of the bronzes from Rehlingen (5032) and Amelinghausen (13176) showed, during the documentation of the polished samples, the fine-grained structure resulting from a high plastic deformation (Figure 2.135). The samples display multiple systems of strain lines that are visible through the progressive corrosion. Thus, a deformation of at least 30% can be suspected, because firstly in such a deformation rate the corrosion can attack the grain boundaries (Northover 1989: 112ff.). The examination of the etched sample allowed the addition of further information, such as the multiple recrystallisation of the artefact and thus probably a much higher stress rate. The existence of strain lines is, however, crucial for the assumption that a final cold deformation, and thus a hardening of the shaft, took place without further annealing. Subsequently, it is always necessary to collect the information of both documentary possibilities of metallography in order to obtain a meaningful result.

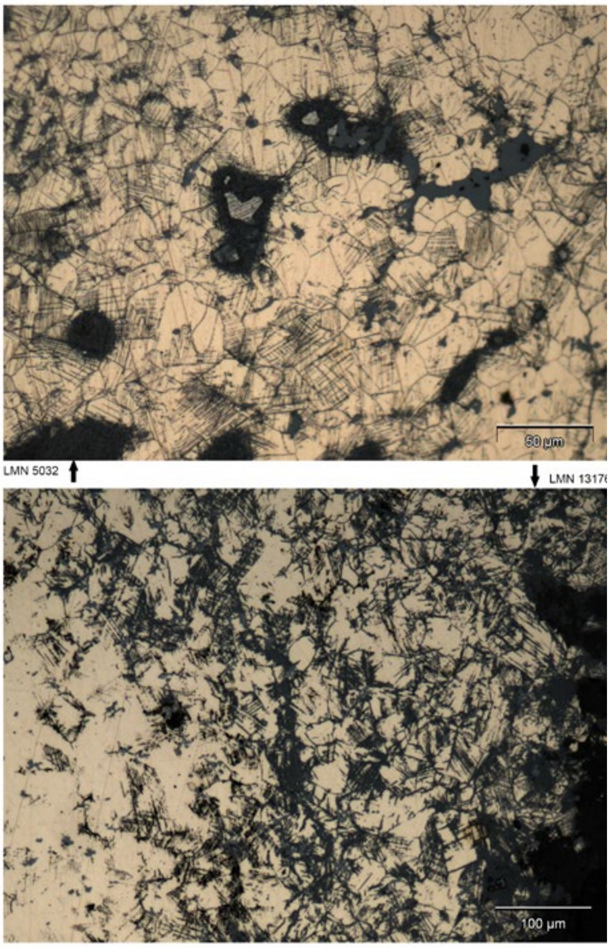


Figure 2.135: Corrosion makes the fine-grained structure visible from the pin of Rehlingen (LMN 5032) and the bracelet of Amelinghausen (LMN 13176).

In summary, through the metallographic analysis of the selected bronzes it was possible to confirm a combination of casting and cold-working technology for the production of bronze ornaments during NBA II in central Lower Saxony. Pin-shafts, especially, were heavily cold-worked, and in regard to neck collars so too were the hem sections as well as the end plates. Many samples provided evidence for selectively annealing (relaxation of the metal concentrated on one point) carried out several times on the artefacts during crafting. Particularly informative were the pure-cast structures, as such a structure appeared predominantly in the ribbed area of the neck collars and suggested the casting of a pre-made model. As the only source of information, however, a metallographic examination is not sufficient to fully answer the questions concerning the production of Bronze Age ornaments. The results obtained are based on small samples and can only be used effectively if the sampled area is compared with a superficial examination of the piece. An interaction, however, between the classical archaeological documentary method, the knowledge of metallurgical processes and material properties, and the results of the metallographic examination, can make it possible to reconstruct basic prehistoric craft techniques.

Chapter 8

It starts with the model – results of the craft-technical investigation

This chapter shall be understood as more than just a simple repetition of the documented work traces. It has the aim, to demonstrate the operational sequences, for each ornament group, using the essence of the technical and scientific investigation. It shall be shown, that in the area of the Nordic Bronze Age not only did formal deviations occur in the otherwise similarly used ornaments, but also the techniques used for crafting varied by region. The use of spiral-stamps is mainly restricted to the Danish islands, while the cast direction during the application of eyelets on the large plates using cast-on techniques seems to be indicative for a distinct analytical workshop. Dendritic microstructures visible on the surface prove the casting of decorated models, however, the majority of the examined ornaments display evidence of only a partial application of the decoration already in the model and intensive post-cast reworking. A different treatment between the small belt discs and large plates is particularly evident in the decorative style (spirals), the use of stamps and the use of elaborated techniques, such as the cast-on eyelets. The crafting of the wheel-headed pins, on the other hand, demonstrates different model-making skills – the shaping of a mould. The contrast between the microstructures documented on the pin heads and shaft, however, show that the negative of the wheel-headed pin in the moulds likely only included the approach of the shaft. The predominant part of the shaft is hammered into shape as suggested for all pin types.

New facts, such as the accumulation of casting defects on neck collars, allow deeper insight into the crafting processes than hitherto known. Thus, such defects can be related to the position of the sprue and indicate that the collar was locally restricted and cast in a bent state. Additionally, the new insights regarding how the various decorative elements were applied to the wax model revealed that a variety of tools made of organic materials was probably made specifically for this purpose. So was it possible to show the use of fingernails for decorative design and suggest the application of a specific kind of rib decoration on neck collars with comb-like devices that were drawn through the wax. The crafting of the disc-headed pin of Weitgendorf-type could be explained via models placed in lost-forms. In this case, however, several features suggest that it is not necessarily a wax model, but rather a kind of model 'kit', where different organic materials are combined and probably impressed in two-part lost-moulds.

2.8.0 Chronological and spatial distribution pattern

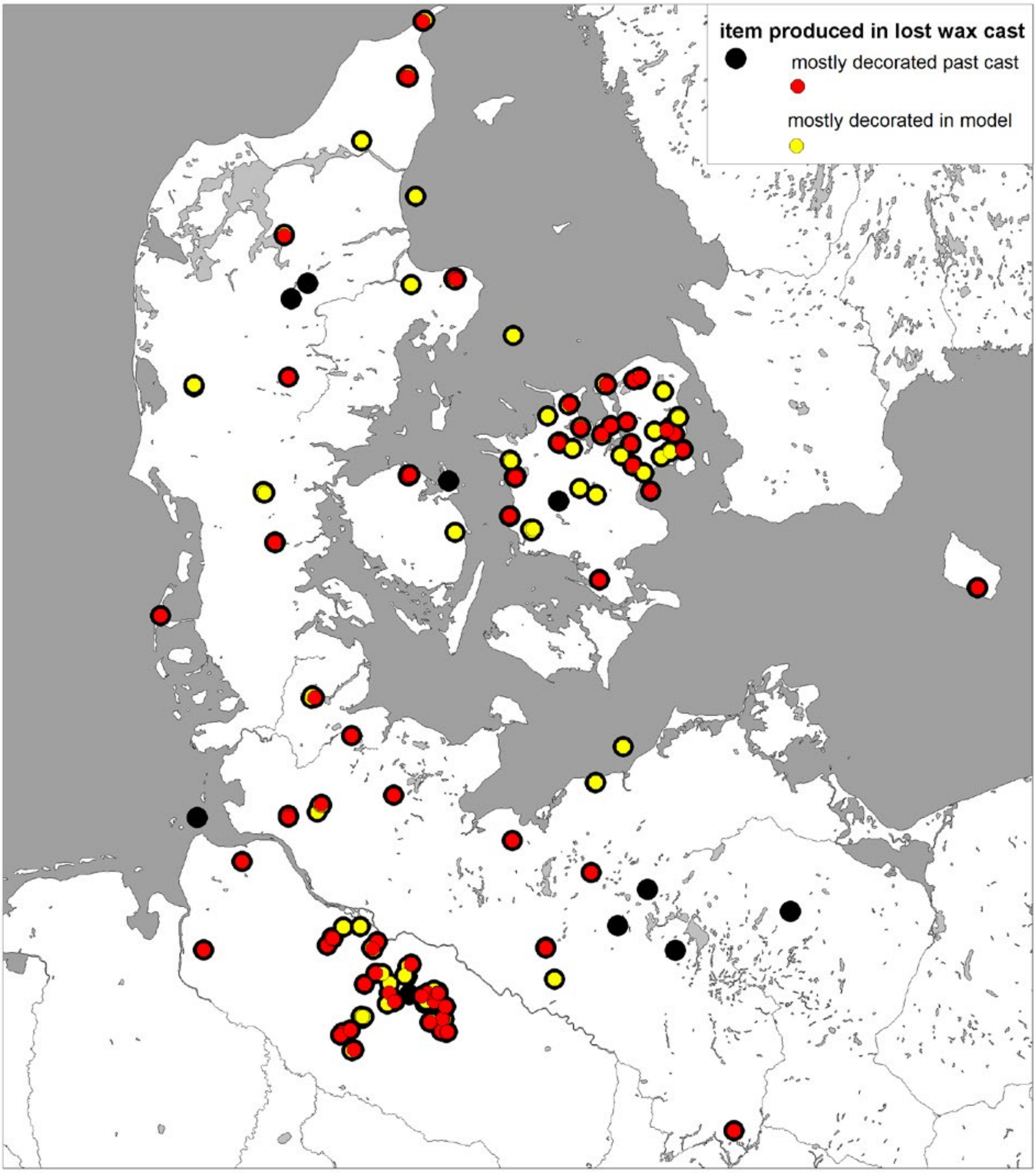
So far, detailed information concerning the crafting of many of the examined object groups was obtained, but as a first step, regardless of chronological or spatial distribution. Later, in a second step, the chronological and spatial distribution was examined and regional connections from a technological point of view were determined. As such, an east-west axis between the Danish islands and the Danish mainland, as well as a south-north axis from north Germany to Jutland, was defined, exhibiting technical similarities such as tool marks and specific techniques. Additionally, the geographically limited use of casting techniques was significant, and could be visualised by mapping (MAP 11). Occasionally, chronological priorities were documented in the use of certain techniques, for instance as seen in making eyelets through perforation.

The importance of the model was repeatedly noted within the crafting of Nordic bronze ornaments. Almost all the objects were created with the help of models, be it special wax models, complex moulds, or casting cores.

Furthermore, it was found that visible deviations could be assigned as mainly conscious acts in order to achieve another, potentially higher, goal, as for example the same weight in pairs of crafted artefacts. It became obvious that such conscious decisions caused further deviations (such as rib-waves). The metallographic investigations were indispensable as evidence for the interpretation of the visible traces and supported the initially constructed theories. Thus, the microstructure of the Hollenstedt-type neck collar confirmed what was postulated earlier through analysis of visible work traces (such as the gentle transitions from rib-slopes to -valleys) – the initial creation of a wax model with the basic morphology, such as ribs, and which was cast and hammered into shape post-casting.

Despite repeated attempts in previous research to apply a generally applicable procedure to Bronze Age metal technology (Schwab *et al.* 2007; Rønne 1989), this study emphasises the diversity in metal crafts. The decoration of shaped castings with bronze tools is represented in a similar number to models which were cast almost fully decorated. In contrast to the clear dominance of the cast via *cire perdue* technique in Zone 1 of the Nordic Bronze Age (Kersten 1936), no such clear picture arises when mapping technical preferences in applying the decoration (MAPS 13 and 14). Rather, individual preferences for one way of working appear in different regions, such as in Zealand in Lower Saxony and in Mecklenburg. Furthermore, the reworking of the decoration post-casting was also detected in the model-decorated artefacts. Only occasionally do artefacts occur which were completed in the model without subsequent processing being necessary, and these are scattered all over the area.

Moreover, some artefacts point towards long-distance connections, for instance, such as the use of the same spiral stamp on the belt disc from a burial at



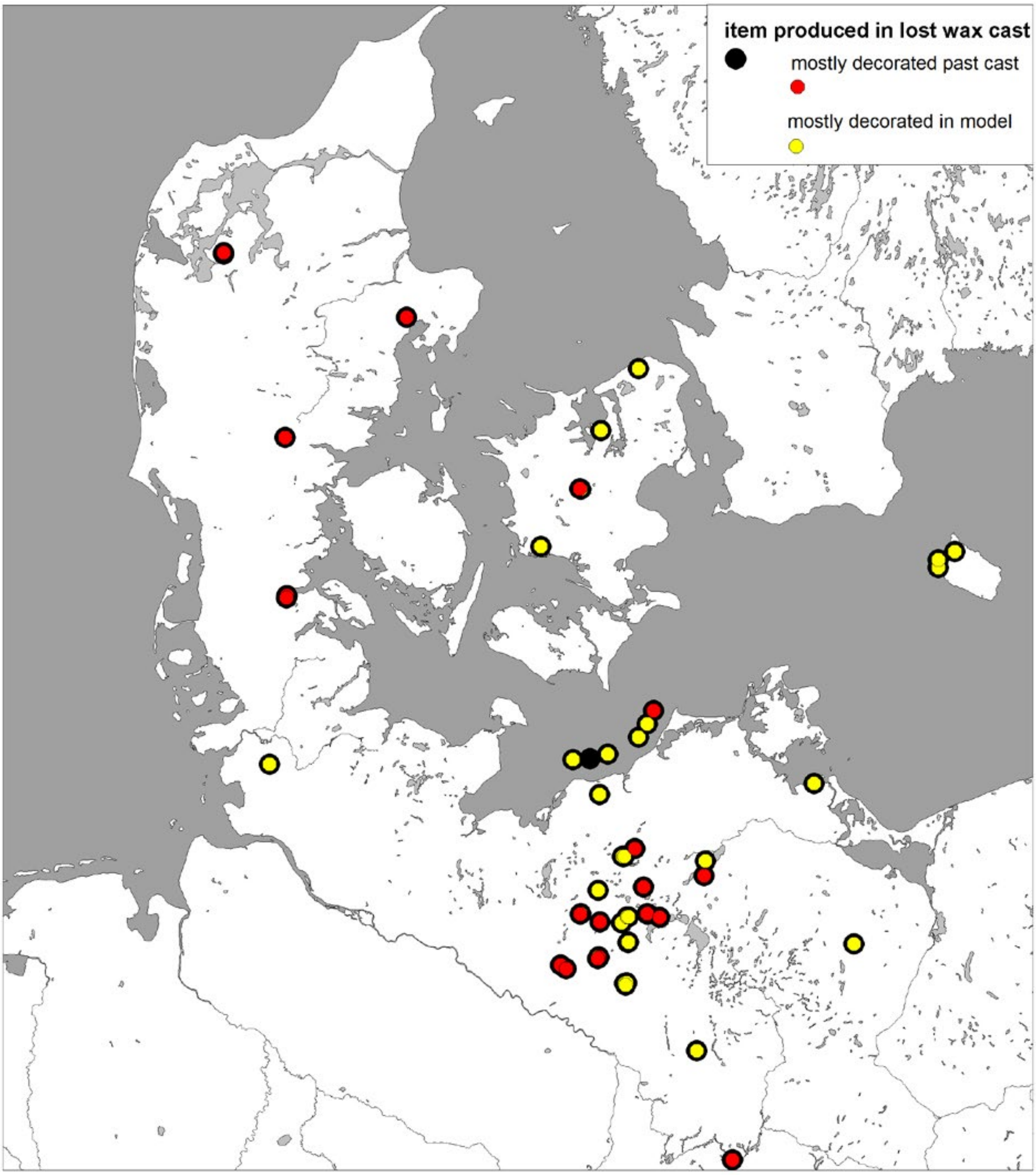
Map 13: Technical preferences in applying the decoration in NBA II.

Hohenbünstorf (Uelzen) and on the disc-headed pin from the grave site near Lüneburg has shown. These locations are 25 km away from each other and could provide the first indication of the influence of a regional workshop.

Having summarised the main information from the technical analysis, the following chapter will present the crafting sequences for the neck collar, belt plates and belt discs, hanging discs, tutuli and pins, using the traces left from crafting. The described steps are to be regarded as a guide. The material examined has shown that individual variations occur regularly, as seen later in this study.

2.8.1. Crafting neck collars

To the already detailed knowledge regarding the making of neck collars can be added information as to the extent that the collars were probably not only cast



Map 14: Technical preferences in applying the decoration in NBA III.

vertically as a straight piece (Drescher 1953b), but were even cast when bent.

Based on an analysis of the cast-related errors on neck collars, increasingly superficial defects caused by shrink-holes and pores were detected not only at the ends but also in the central area. This kind of fault emerged due to the influence of gravity during the cooling process, when the liquid metal was poured into the mould at the highest point of the form and, therefore, close to the sprue (Figure 2.136). The same situation occurs in relation to the gases that can cause porosity in the areas of the cast which solidified last (Hasse 2003: 180ff.). As a result, accumulations of casting defects, such as pores, flattened decorative elements or reworked shrink-holes, could contain references to the casting direction and positioning of the sprue (Figure 2.137).

A study of 153 neck collars showed that 62% of them had abnormalities, such as clusters of pores, superficial changes which might suggest previous shrink-holes,

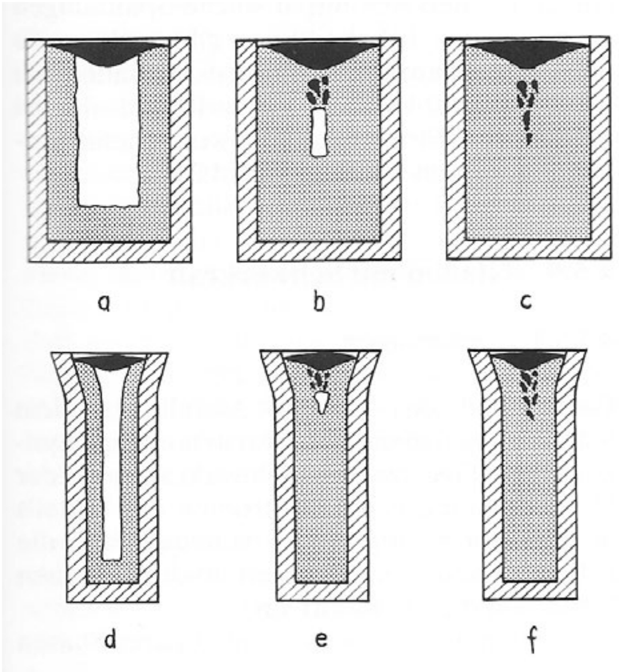


Figure 2.136: The scheme illustrates how shrink-holes emerge during the cooling process of the liquid melt (after Brepohl 1996: 150).

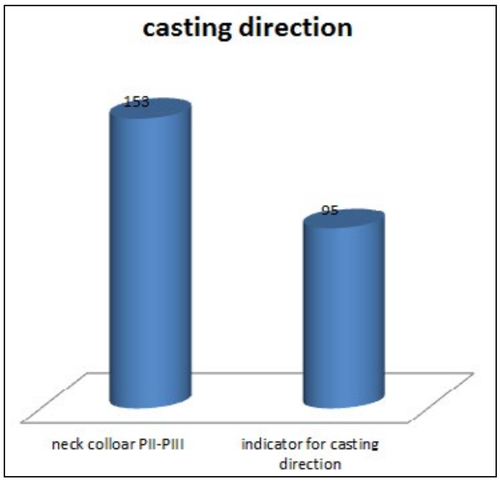


Figure 2.137: Percentages of neck collars in NBA II and III, where an indication for the casting direction could be obtained.

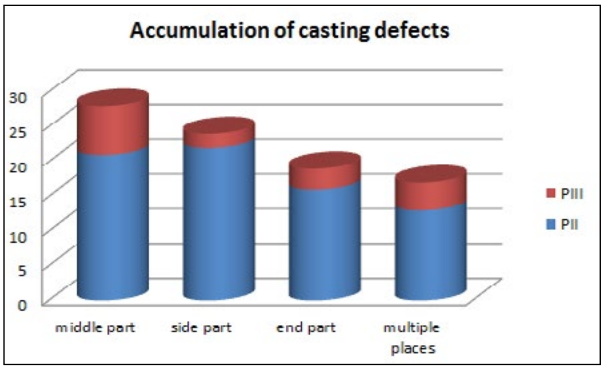


Figure 2.138: Accumulation of casting defects on neck collars, which are indicative of the casting direction.

and particularly heavily corroded areas on otherwise well-preserved collars (Figure 2.138). Amongst these, many pieces had the most striking changes in the ribbed section on the central area (front and back). The accumulation of these casting defects can be related to the position of the sprue and thus it might be possible that this position indicates that the collar was cast in a bent state. The casting of curved or ring-shaped objects is quite common, and especially used for bracelets (Drescher 1955: 138; Drescher 1972). Using multiple sprues while casting the bent collar, filling out the entire form would be accomplished in a similar manner as with the vertical casting.[71]

Pieces showing multiple porous zones, spread over the collar, support this argument, as they might indicate the presence of various sprues. On a few pieces the connection points of the sprue and the objects were found to be poorly reworked. The neck collar found in Bringe (B3486) is a very large and has an elaborately decorated collar. On its reverse side elevated structures are visible at the bottom hem, in the centre of the ribbed section and slightly towards the side (Figure 2.139). In particular, the superficial features at the side may have come from a sprue which was not completely reworked. Similarly, on the collar from Rye (B7612), with several roundish spots on the face side where the decoration was damaged through selective reworking.

While mapping the described features it becomes obvious that neck collars with an accumulation of casting defects at the ends often occur in northern Germany (MAP 15, top right). On the Danish islands, however, the most elaborate pieces are widespread, and many collars have been found with multiple accumulations of casting defects on the ribbed section (MAP 15).

Thus, particularly concerning the large collars, casting in the bent state is probable. In contrast, the smaller collars south of the Elbe, which were partly strongly hammered at the hem and the ends, seem to have been cast in a straight and upright position. The collars of the Mecklenburg area, during the third period, seem to have been made with both techniques. The decision as to what position the collar was to be cast in appears to have been caused by the shape. The majority of the collars of the Pisede-type (Nørgaard 2011: 64ff.) – those without spiral-decoration – display casting defects on the central area, and thus might have been cast in the bent state. The spiral-decorated collars, in contrast, show signs of having been cast from the end, occasionally having accumulations of casting defects on the sides and possibly having been cast in the bent

[71] When casting the collar in a vertical position the sprue is attached at the topmost end and the liquid metal can run easily into the form.

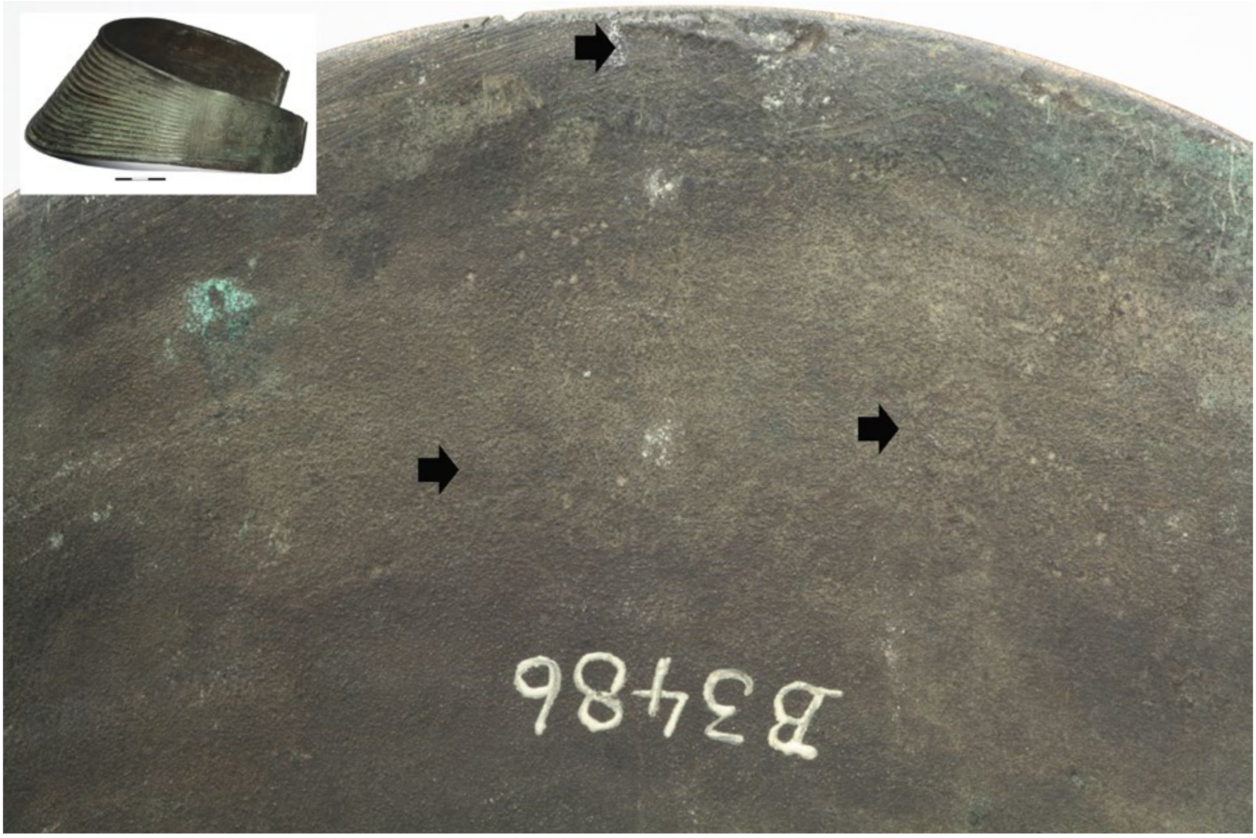


Figure 2.139: The neck collar from Bringe (B3486) shows several changes in the surface structure on the reverse side, which indicate the location of several sprues.

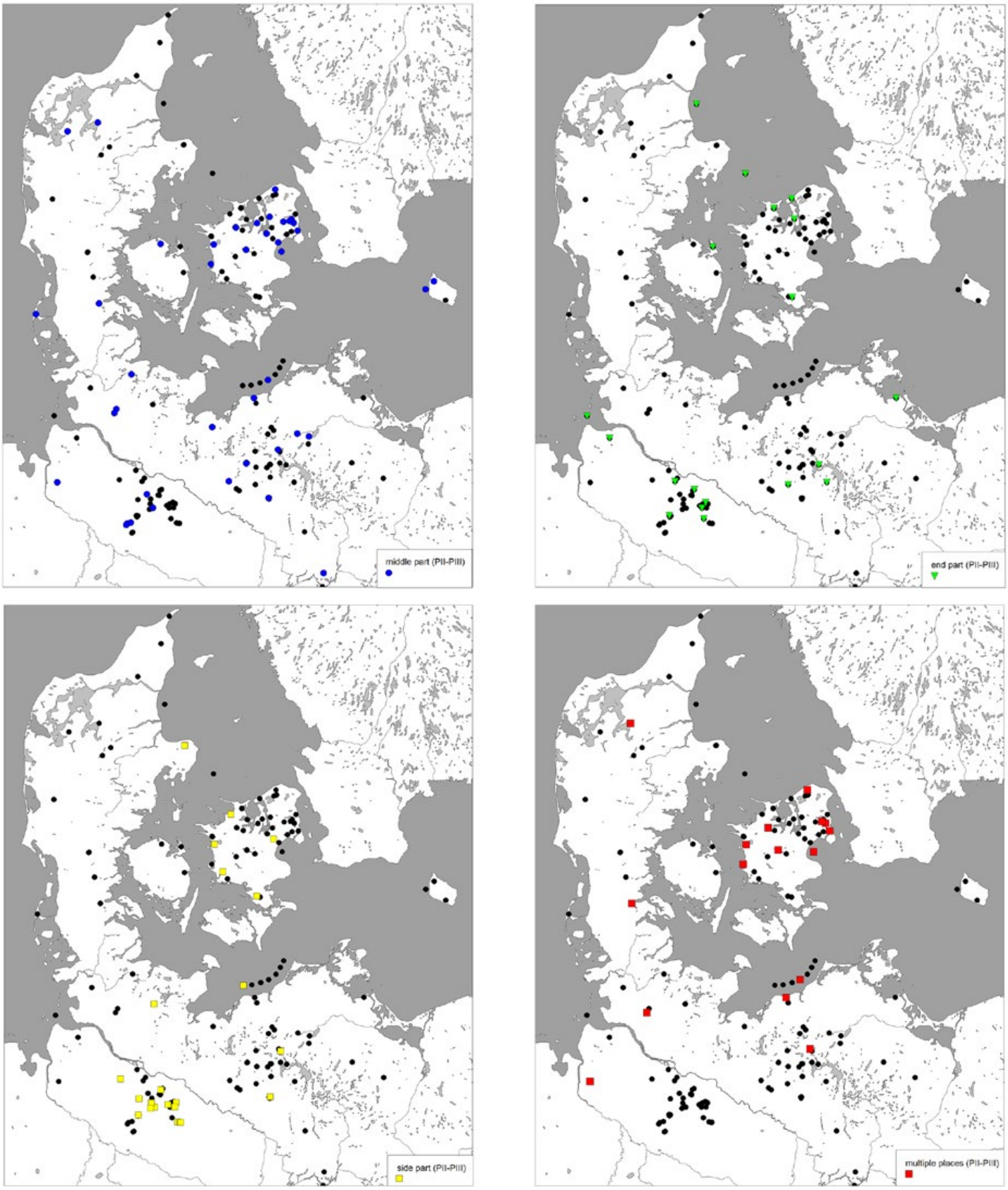
state as well. However, the casting defects shown allow an inference as to the cast direction. A more reliable determination of the casting direction of neck collars could be made in the future by the inclusion of X-rays in craft technical investigations.

It was shown in the first section of this chapter that the collars were made in various ways. The documented traces support the idea that rudimentary collars made and cast in the model were hammered and decorated elaborately after casting (like the Hollenstedt-type collars), in the same way as the production of decorated models (artefacts from the Vognserup hoard). Additionally, the metallographic investigation confirmed this by the appearance of cast structures adjacent to heavily deformed structures (see Chapter 2.7). Irregularities in the microstructures of these pieces gave rise to the conclusion that, especially in crafting the neck collars, the examples were only partially annealed in order only to relax the points to be processed. Thus the microstructure of the ribbed region of the collar commonly showed some pure-cast structure. Towards the areas of high plastic deformation (such as the hem and the end), abrupt transitions in the grain size sometimes occur; this might have occurred due to the placement of glowing coals on the piece (Holdermann and Trommer 2010: 800).

The examination of the neck collar allowed new insights regarding how the various decorative elements were applied to the wax model. In addition to a variety of tools made of organic materials probably made specifically for this purpose, the use of hands for decorative design could be inferred. The arch ribbons on the collars of the Lübz (ALM 2000/1277 3) Poltnitz (ALM Br 949) and Sparow (ALM LIIZ1g1) examples are believed to have been pressed using fingernails.

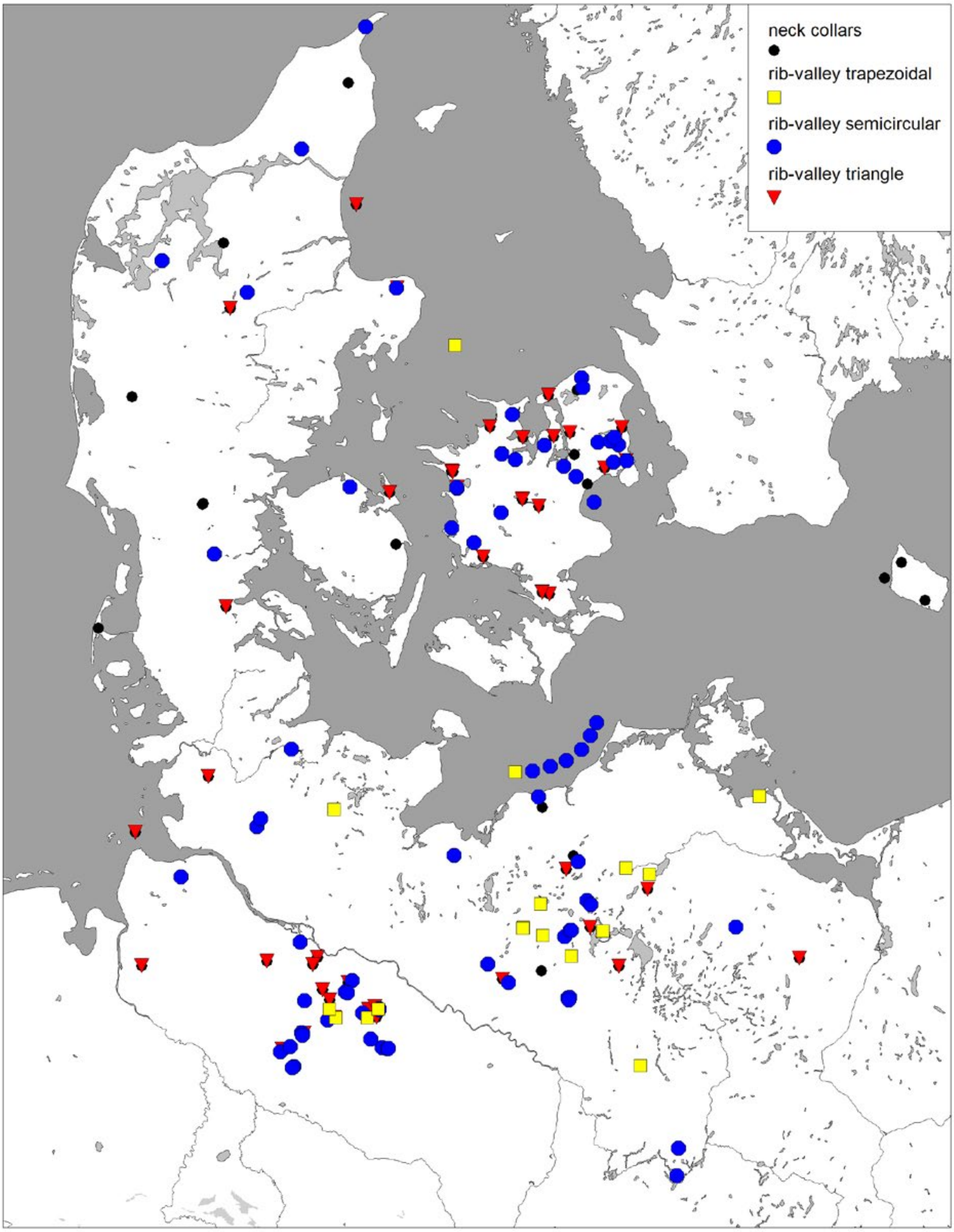
Moreover, the ribs and rib-valleys proved to be an interesting source of information. Since it is assumed to be the basic shape of the collar, so the ribbed belly part is cast in each case using the *cire perdue* technique (as evidenced in several metallographically examined pieces) and the making of the ribs comes into focus.

Three different cross sections of the rib-valleys, from half round to sharp-edged trapezoidal, could be determined. A comparison of the morphology of the rib-valley cross section and the traces documented in the valleys provided evidence for the tools used (MAPS 16 and 17). In particular on the collars, which had triangular in cross-section rib-valleys, horizontal grooves appeared regularly. Neither the shapes of the ribs or the grooves in the valley are limited to a time period, and thus do not seem to represent a temporal phenomenon. Here, the combination between the

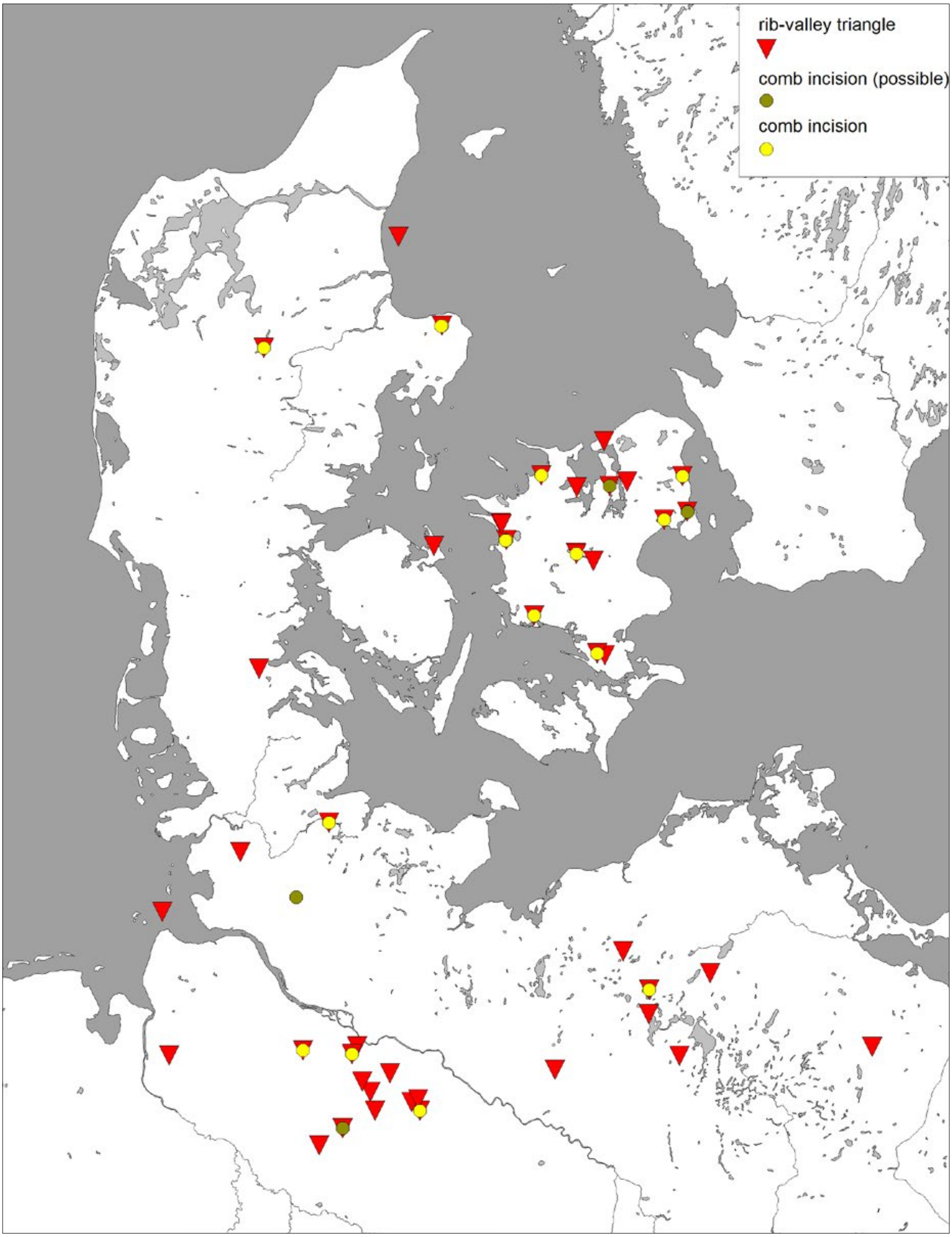


Map 15: Distribution of neck collars cast from the middle section (top-left), from the end part (top-right), from the side parts (bottom-left) and from multiple places (bottom-right).

triangle cross-section and the tool trace can point towards potential devices. Thus, this kind of rib formation may have been designed with comb-like devices that were drawn through the wax. Such a tool would explain the regularity of the ribs as well as the partially unexplained deep grooves in the valleys. Especially on the collar of the Glæsborg find (Figure 2.140), the light waves in the rib-slopes are a clear sign for their having been ribs modelled in wax (Figure 2.140, B). The deep, uniform grooves in the valleys and in some cases also on the slopes are the result of errors and small ridges on a comb-like tool (Figure 2.140, AC). Since none of the ribs differs significantly in width and none of the rib-valleys appears especially deep, an individual deepening of the ribs can be excluded.



Map 16: Different cross-sections of the rib-valleys in NBAII and III.



Map 17: Triangular rib-valleys compared to horizontal grooves in the rib-valleys – an indication for the use of a comb-like tool.

Figure 2.140: Modelled ribs from the Glæsborg neck collar (NM B9531).

However, a reworking of the ribs post-casting was shown on metallographic images of a stud-bracelet and on several neck collars, and should, therefore, be seen as a common practice. The processing of the rib-slopes was strong enough to produce strain lines in the microstructure, proving a stress rate of less than 20%. Such can be achieved through the reworking of surface-related mistakes and the rib decoration.

In addition to just such new insights, existing theories and inferences could be expanded and confirmed. Thus it was possible to demonstrate on a variety of collars (but also on belt plates) the application of spirals in the model through a spiral-shaped stamp. Of the 48 artefacts, on 20 collars exactly such identical spirals were detected, and their existence can be explained by stamp-like tools having been pressed into a wax model. On the other hand many artefacts, especially in northern Germany, were decorated freehand. These first signs allow for a correlation between the size and richness of the decoration of the piece and the use of the stamp technique.

The operational sequence presented in the first part of this section indicated how variable the application of the decoration could be. The newly added information suggests that the craftspersons responsible for the neck collars made their own tools and additionally used their hands as tools.

2.8.2 Crafting belt plates and belt discs

With regard to the crafting of the belt plates and smaller belt discs, several new insights were gained. On the small belt discs from Vognserup Enge (i.e. VM1680KJ) the casting of decorated models could be proved due to the dendritic microstructures visible on the surface. In the same manner a reworking of the decorative lines and applied notches was observed on several pieces of this hoard.

Consequently, the crafting of belt discs starts with the construction of the model, as also in the crafting of the big belt plates. The resulting operational sequence (described below) of both artefact groups differs mainly in the making of the model due to its size and the subsequent casting process. The application of the decorative elements is similar for both groups.

The *small belt discs* are believed to have been made in two ways (Figure 2.141). Especially at the beginning of NBA II it can be assumed that many of the small discs were made by hammering. However, the spike, eyelet and the base of the disc were made through casting. This probably happened using the lost-wax technique or in a two-part mould of clay (which is to be considered as lost-form casting). The disc was formed in the model as greatly shortened and thick material around the spike. After the successful casting the disc was cold-worked (hammered) and brought to its desired size.

Once hammered, the decoration was added with the help of chisel-like punches and probable round or edged punches. However this technique is expected to have been more likely in the southern fringes of the Nordic Circle. From the hoard of Vognserup it could be proved that even the small discs were cast as completely decorated models and thus began their ‘being’ as wax models. Within this investigation, several facts were delivered that emphasise the almost complete construction of the discs in the model (however, the decoration can be the exception to the rule). Here, the

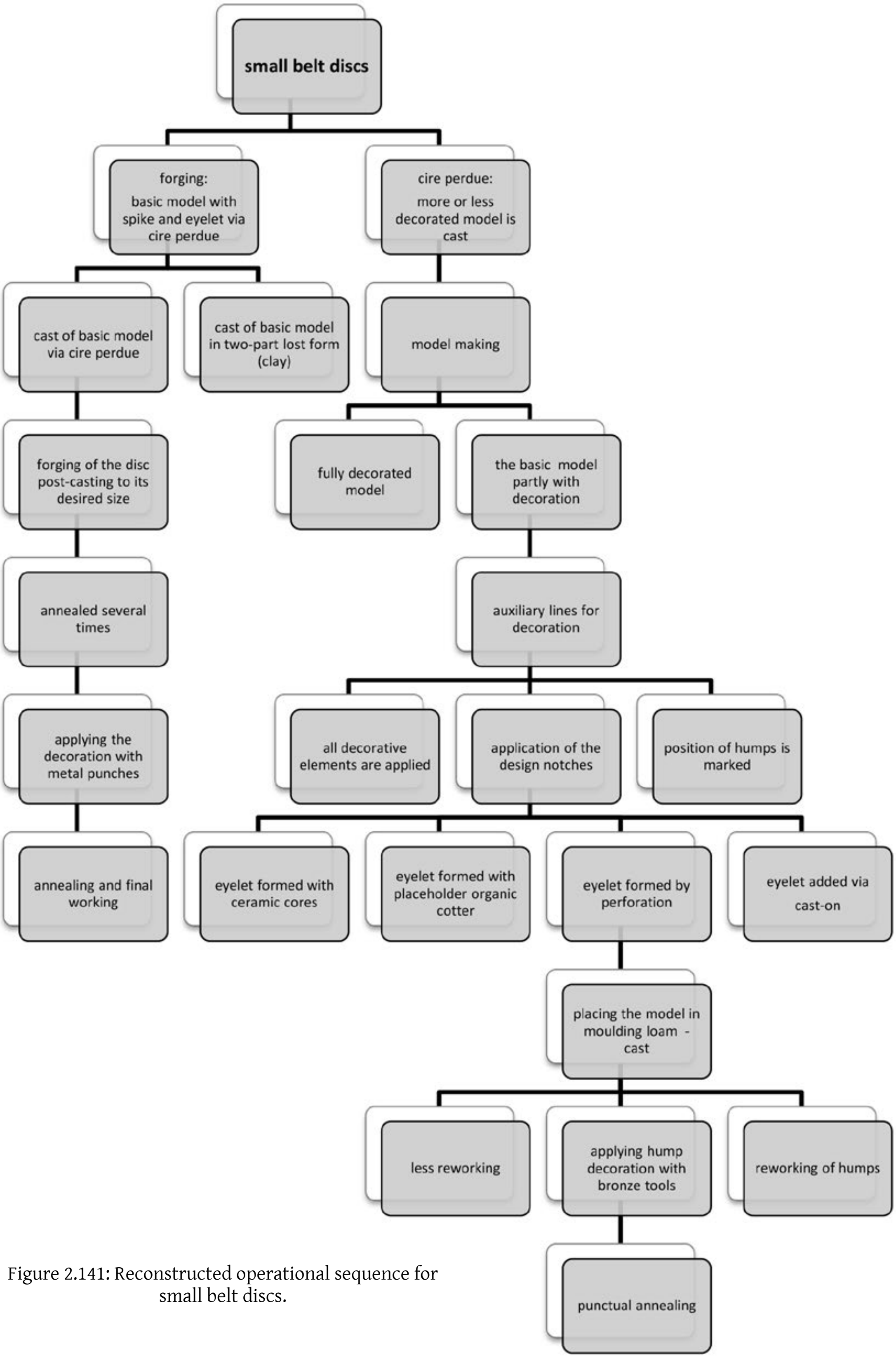
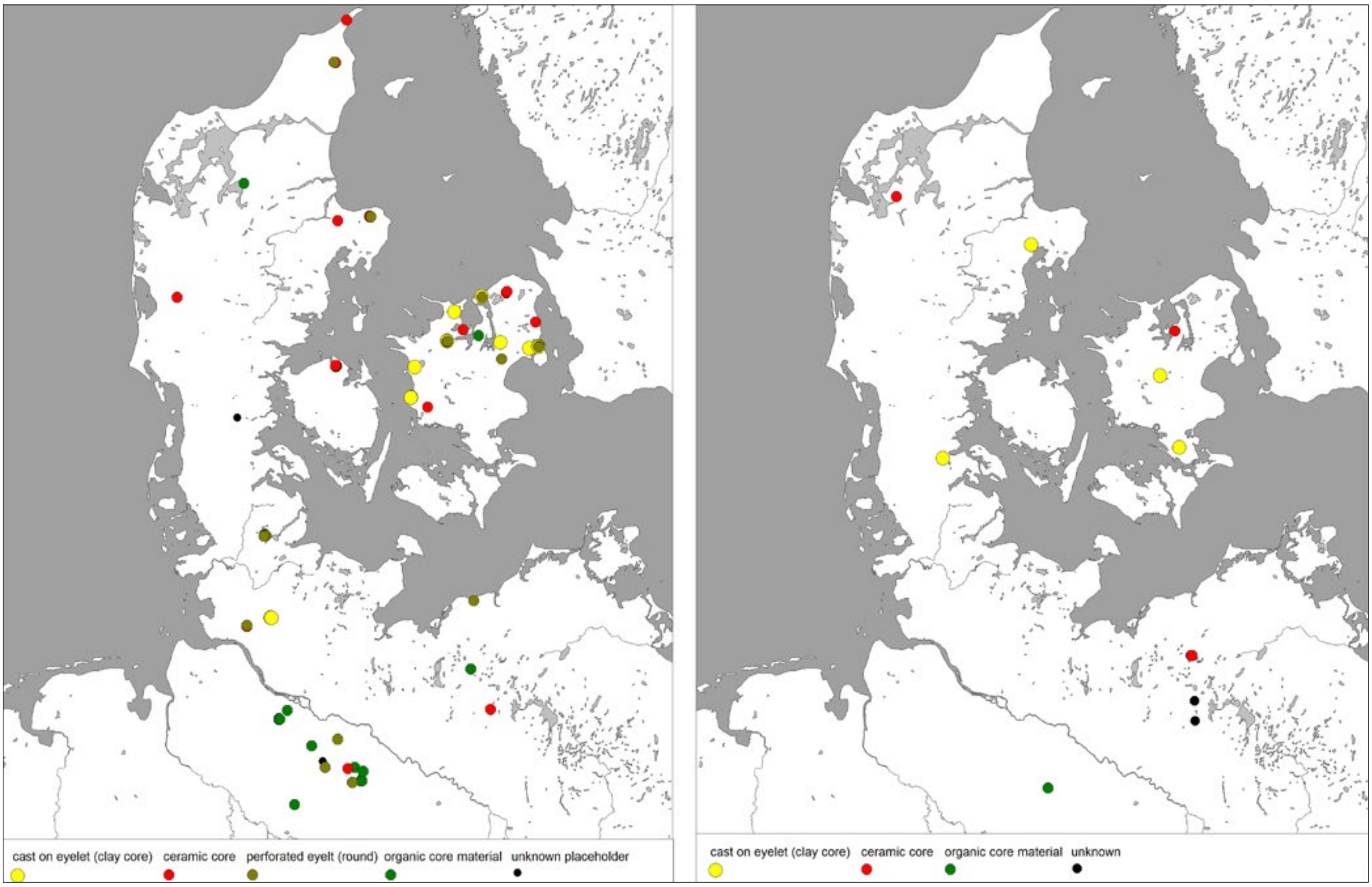


Figure 2.141: Reconstructed operational sequence for small belt discs.

crucial part of the model-making is the modulation of the rear eyelet. The studied ornaments revealed several methods by which the eyelet was backed in the model and a tapering was prevented in the cast. The documented traces revealed the use of an organic cotter (probably made of wood, bone or other organic materials), or ceramic cores on the discs with larger spikes. Furthermore, several NBA II discs have a round eyelet hole, which was probably pierced by means of inserting a round wooden stick into the solid modelled



Map 18: Distribution of the various techniques to make an eyelet in NBAII (left) and NBA III (right).

eyelet. A mapping of the possible construction methods shows a regional focus in the use of cotter in organic materials in northwest Germany (MAP 18). Ceramic cores appear to have been used increasingly in Denmark, especially in NBA II. Occasionally, the spike was attached through a cast-on technique (a technique used commonly on the big belt plates).

However, with the construction of the eyelet the model of most belt discs was not yet completed. It is likely even from a purely practical point of view that this step was carried out as one of the last steps prior to casting.

The majority of the examined ornaments display evidence of a partial application of the decoration already in the model. Often the use of auxiliary lines and measurement systems could be confirmed. It can also be assumed that the concentric decorative ribbons around the spike were made with the help of string circles fixed in the centre or with spacers, like the craftsman´s hands, taking the rim as a point of orientation. Some discs provide evidence for the sequential order in which the decoration was placed, due to the different depth of the decoration. Thus, on the belt disc (B4753-1) from Vendsyssel on Zealand the differences between the smooth transition from surface to the deepening of the design notches and the sharply defined edges of the accompanying lines are clearly visible. Additionally, some notches applied post-casting are visible through the sharp-edged profile (Figure 2.142). Another detail in the decoration of this belt disc, which can be found on many other discs, supports the inference that the individual decorative elements were already applied in the model. The humps were applied from the rear side with a broad, relatively flat, impression in the model. The cast skin and soft edges supported this belief (Figure 2.142). Post-casting, the humps were re-finished by hammering the deepening with a smaller round punch. That combination of preparation of the hump in the model with subsequent deepening was documented on a total of nine artefacts. In contrast, in northern Germany hump-decorated ornaments where the humps were deepened by multiple strokes post-casting occur more frequently (this includes the disc-headed pins). It seems that the specific technique used to apply a hump decoration was regionally specific. In northwestern Germany the technique of hump preparation in the model can be seen on discs from the early NBA II hoard from Molzen (242:84 f-g) and on a piece from Lüneburg (ML 1133), otherwise this method occurs only on Zealand. The technique common for northern Germany of punching the humps with several blows on the cast object is not very common in Scandinavia. It seems as

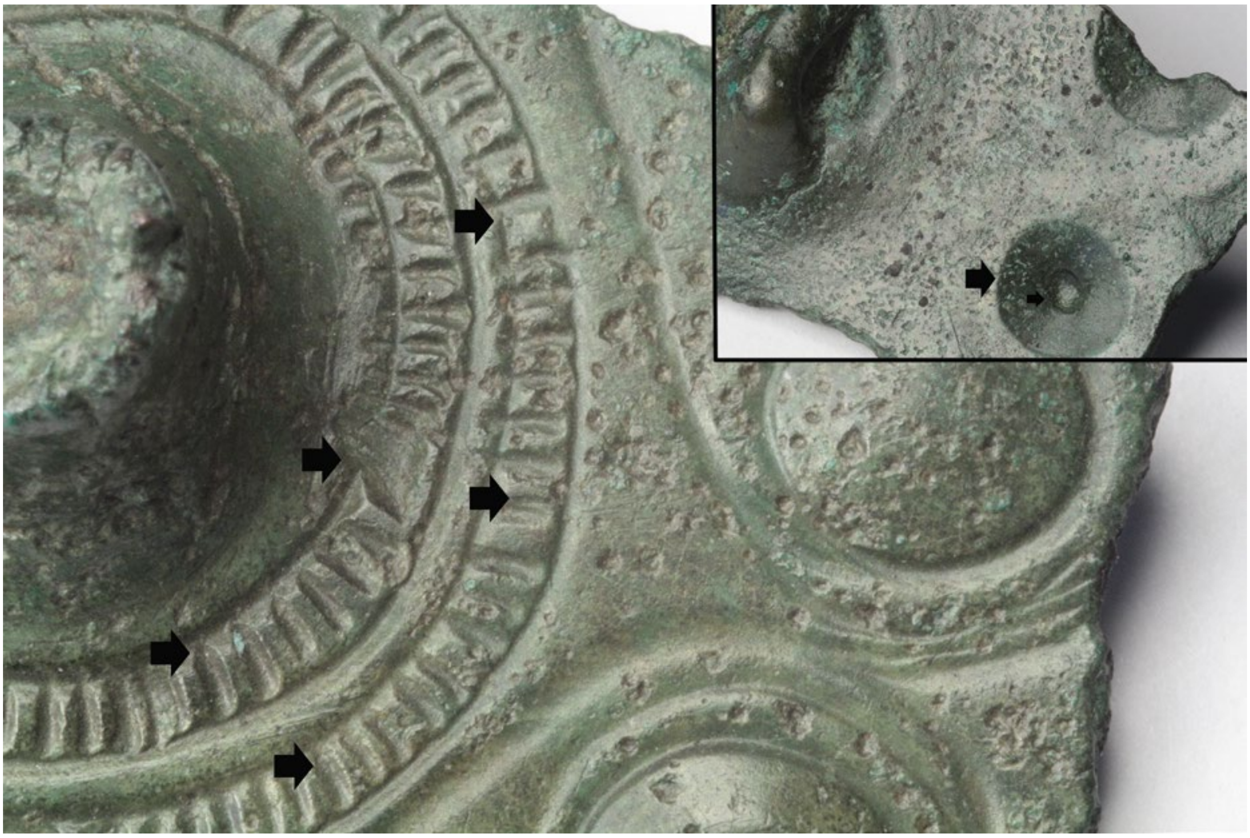


Figure 2.142: The decoration of the belt disc from Vendsyssel (B4753-1) on Zealand was applied partly in the wax model and partly post-casting.

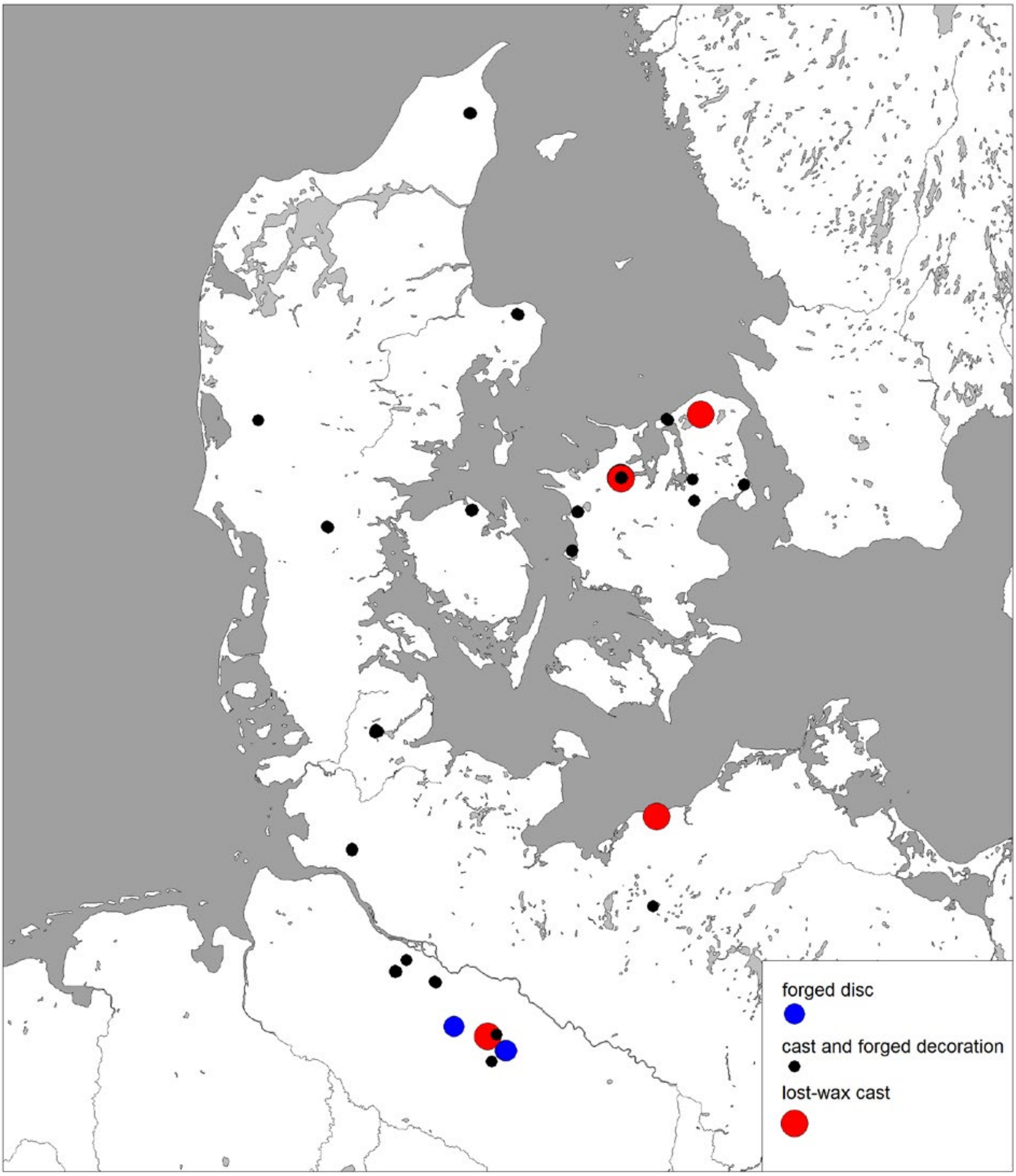
if the decorative 'hump' element, rather rare on Danish bronze ornaments, was adapted only as a form and not with the accompanying technique.

Furthermore, indications of the use of Faulenzerpunzen are mainly found in regard to the model-decorated discs. The use of such tools that could generate a plurality of decorative impressions side-by-side, however, is only applicable in the making of the wax model. Similar tools used to work bronze would leave no such uniform impressions, as an already inclined position would have a great impact on the results.

After the completion of the model a complex casting process is to be expected in a multi-layered mould, similar to the described process in the crafting of neck collars (see Chapter 2.6.1). The eyelet construction located on the back required some caution in the application of the mould material. If the cotter or spacer was worked too deeply into the model and the mould not applied everywhere this would result in interruptions in the flow of the liquid metal, resulting in holes in the cast piece (see Figure 2.035, 242:84 e).

In general, the small belt discs in north Germany and southern Scandinavia cannot be classified as cast or cold-worked artefacts. Within the 73 examined discs only seven pieces (and four of them are from the Vognserup hoard) can be considered pure-castings. Three artefacts (including two from the Molzen hoard) are identified as made purely by cold-working (MAP 19). The vast majority of the NBA II belt discs were made in the model and were at least partially decorated or reworked post-casting.

Concerning the *large belt plates* of the Nordic Bronze Age, crafting exclusively in the wax model is to be assumed. However, even here exists the exception to prove the rule. The belt plate (1161:76) from Wardböhmen in central Lower Saxony has several features, even hammer marks on the reverse side of the plate, which make it likely that an intensive cold-working (hammering) took place post-casting (Figure 2.143). On the remaining 31 plates no comparable traces could be documented. However, it can be assumed that the edges, and possibly also the enlarged edge zones, were hammered. Based on the created trace-catalogue (see Chapter 2.4.2) a similar characteristic surface structure can be found in the edge-accompanying grooves on the belt plates from Vellinge Moses (B2654; 25788) on Fyn, the plates from Glæsborg (B9530) and Skagen (MDCCCXXI) in northern Jutland, and Lavo (B11685) on Zealand, as on the cold-worked plate from the 1890 find (Figure 2.144). Thus, these grooves were very likely hammered into their final form. Other belt plates, however, display characteristic signs of a cast design.



Map 19: Distribution of the belt discs in regard to their crafting technique.

Thus, the beginning in the making of every large belt plate is the shaping of the wax model (Figure 2.145). The preparation of disc-shaped wax models was verified experimentally by Rønne and the result is considered highly probable. In this manner, liquid wax is poured into a water-filled bowl to obtain a uniform round wax disc (Rønne and Bredsdorff 2008). The decoration was applied in a similar manner as described with the small belt discs. Concerning the large plates, however, the use of circle-like tools and possibly rotating devices (see Rønne and Bredsdorff 2008: 60-61) is likely more common than with the smaller pieces. Moreover, especially with the large belt plates, the use of spiral-stamps is certified. About 60% of the investigated large belt plates are stamp-decorated. It should be noted that out of 32 examined plates, 31 were provided

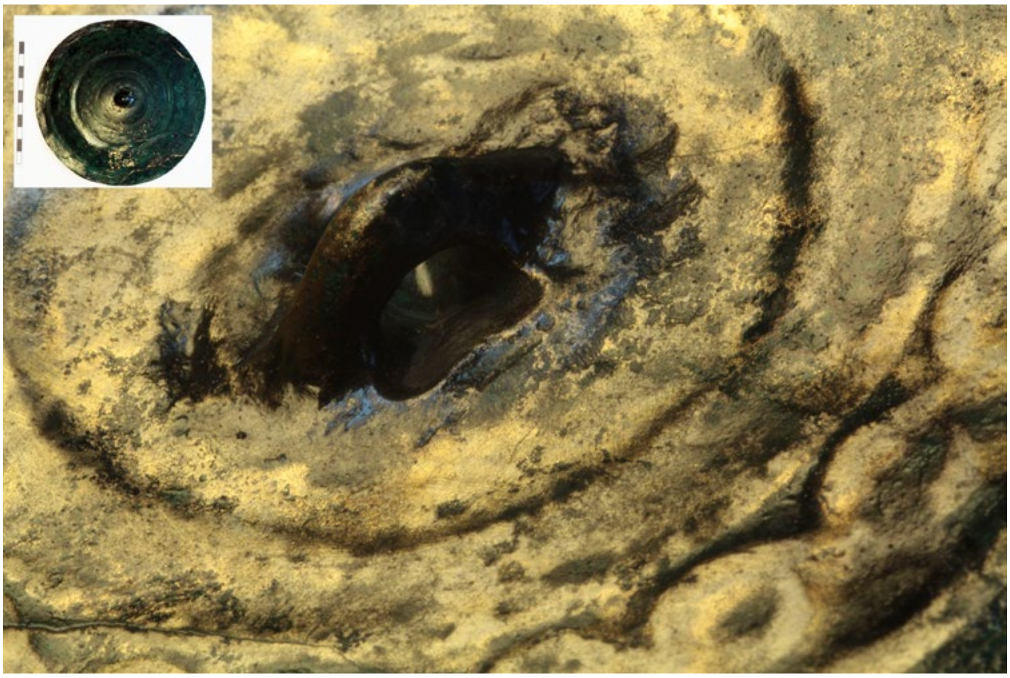


Figure 2.143: Belt plate from Wardböhmen (1161:76) in central Lower Saxony with hammer marks and indications for hammering on the reverse side of the plate.

Figure 2.144: Characteristic surface structures for hammered edge-accompanying grooves detected on the belt plates from Skagen (NM MCDDDXXI) and Vellinge (NM 25788).

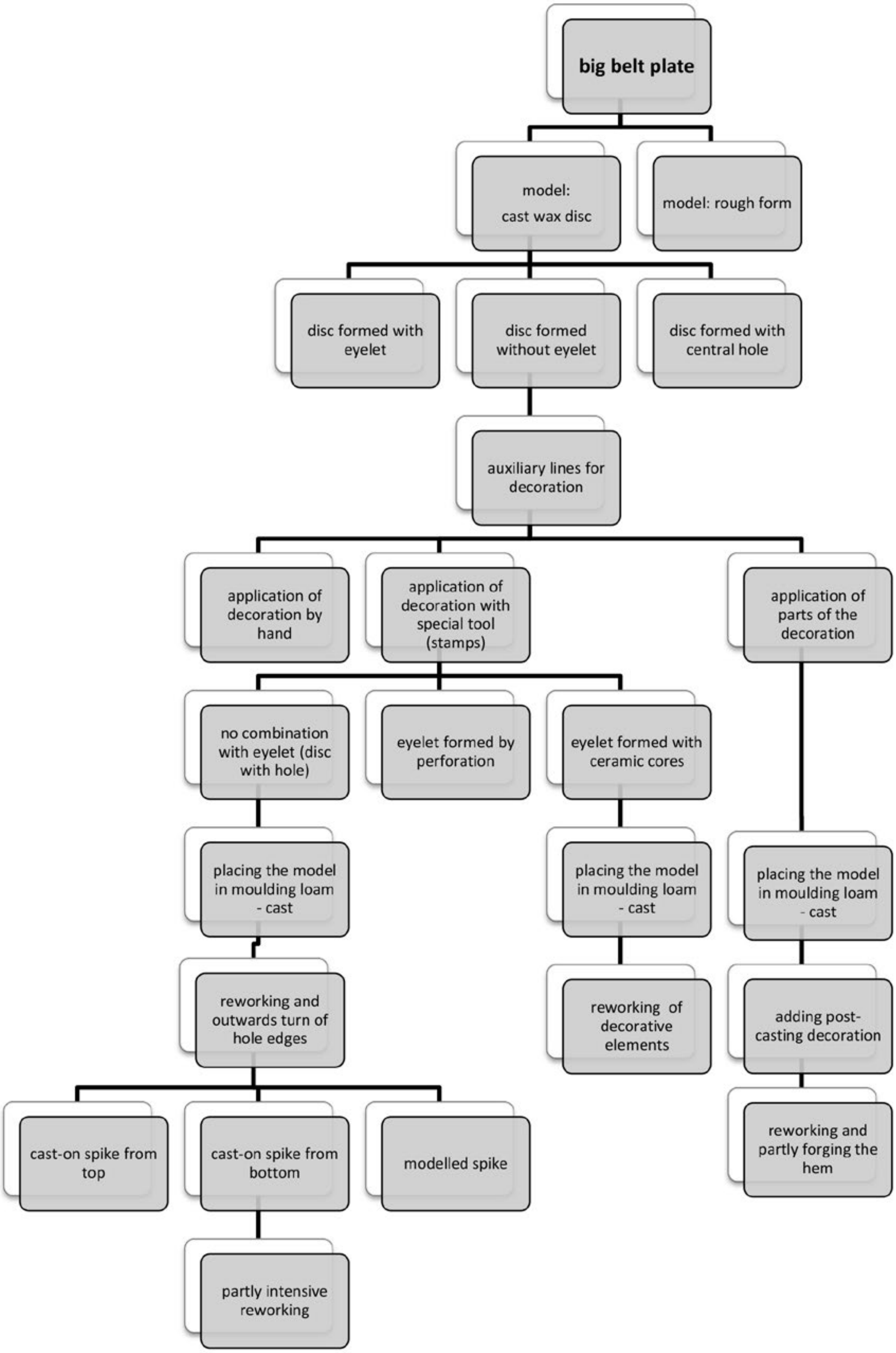


Figure 2.145: Reconstructed operational sequence for belt plates.

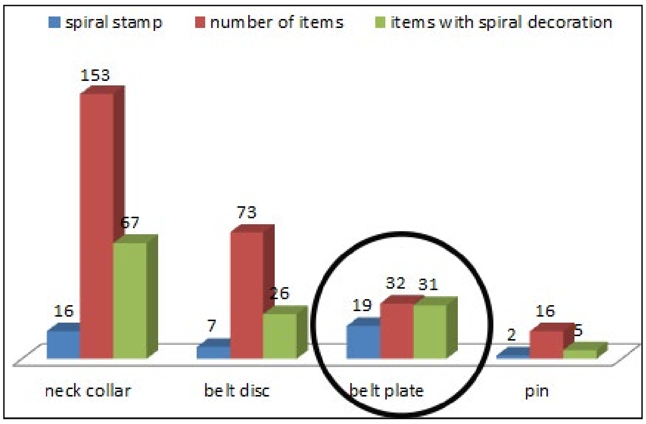
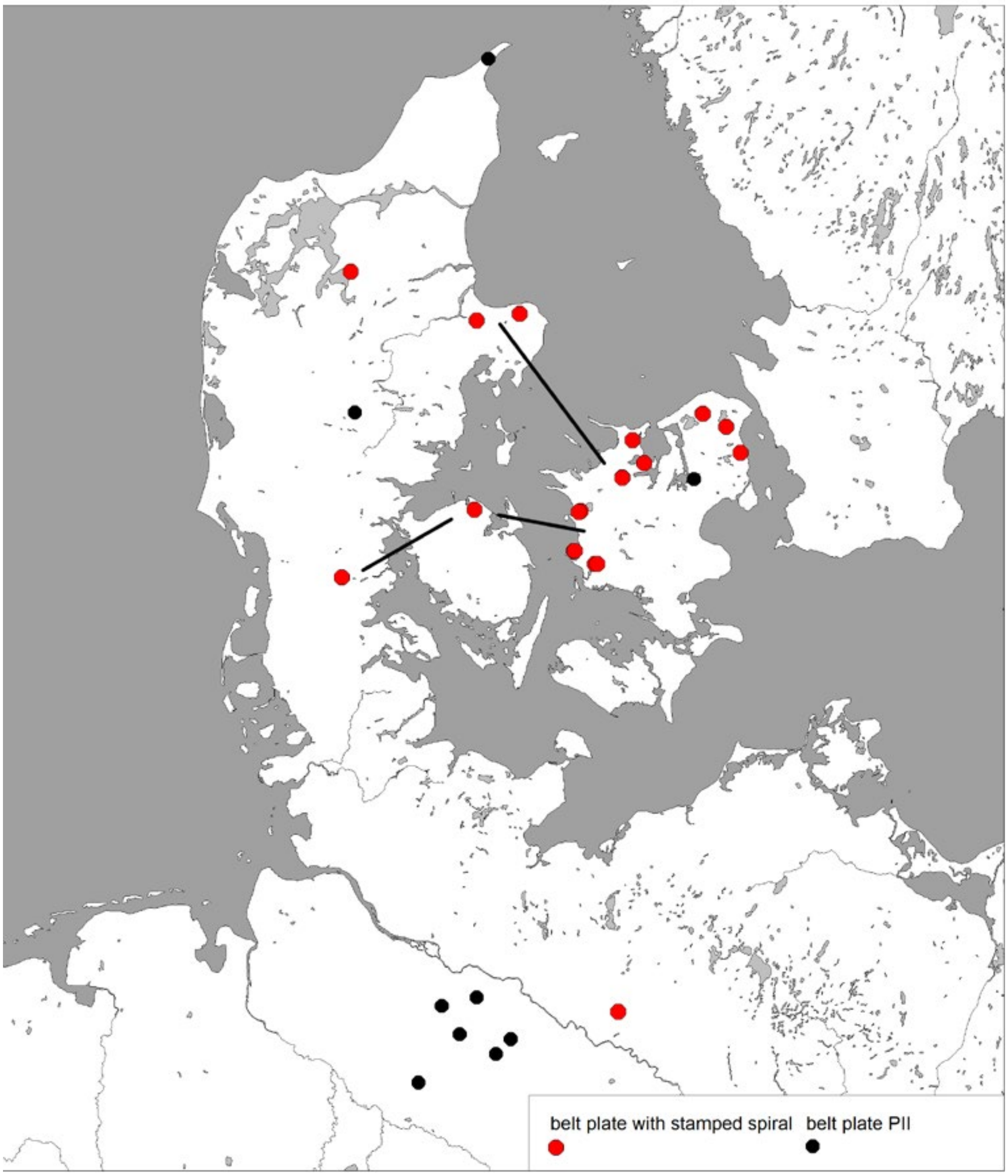


Figure 2.146: Percentage of stamped spirals compared to examined artefacts of each object group.

with a spiral-decoration. Thus, the percentage of belt plates on which the stamp-technique was applied is significantly higher here than for the other find categories (Figure 2.146). Regarding a specific regional concentration of the discussed technique, it seems again the concentration is to be seen on Zealand (MAP 20). Additionally, stamped plates were often deposited on Fyn and in central Jutland (the west-east axis). Moreover, a connection to north Jutland, which has already been noted several times, can be seen in the use of this technique. The remaining pieces are scattered over the area of research and should be taken into account when determining possible exchange networks (see Part 4).

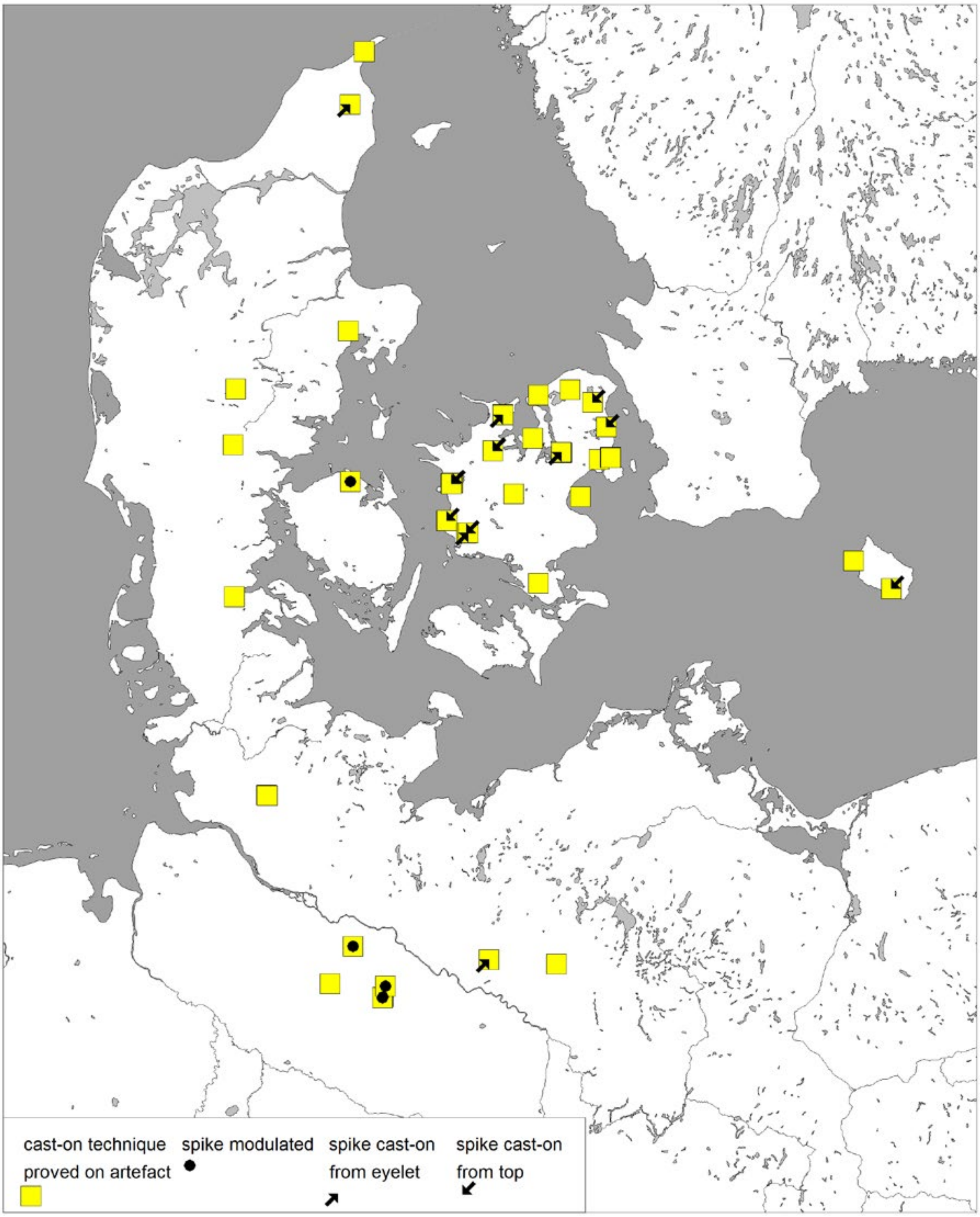
In contrast to the small discs it is not necessary to attach the eyelet-spike combination on the large plates in the model. Many of the belt plates have eyelets that are attached through a cast-on technique. Especially on Zealand this technique was often used (MAP 21).



Map 20: Distribution of NBA II belt discs with the spiral decoration applied using stamps.

Within this work the phenomena of a different casting direction (see Drescher 1958) could be confirmed while attaching the spike and eyelet via cast-on technique. Seven belt plates have traces that point towards casting from the tip of the spike. On four plates the spike-eyelet construction seemed to be cast from the bottom (eyelet). Additionally, mainly in northern Germany, were found spike structures directly modelled onto the cast disc, which displayed an almost invisible seam between spike and disc.

Accordingly, on several belt plates, within the operational sequence post-casting and post-reworking an intensive preparation of the central hole was



Map 21: Distribution of belt discs and plates made with help of the cast-on technique. The assumable direction of the second casting process is marked with the arrows.

necessary. The edges of these needed to be turned outwards to secure the connection with the spike eyelet construction. Many damaged decorative elements near the spike confirm the evaluation that the plates were already reworked before the spike was cast-on, due to leakage of material. The outwardly curved edges were exclusively documented on the face side of the plate and are thus anchored in the spike.

However, the cast-on technique is difficult and the material has clearly shown when the craftsperson was negligent in the construction of the mould. The above-mentioned damage to the circulatory decoration, as well as excess material on the eyelet-base, would have resulted in time-consuming reworking. Those large plates whose spike was added via cast-on especially show the skill and ability of the craftsperson. In the evaluation, these pieces will be the subject of more attention and will play a large role in answering the question as to what extent specialised crafts were part of a Bronze Age society.

2.8.3 Crafting *tutuli* (belt humps)

In previous research a rather neglected object group is that of the tutuli. This artefact could be, however, investigated very intensely in the course of this work. It was noted earlier in this study that the renaming of the tutuli with decorated discs into small belt discs would be beneficial from a classificatory point of view. As it turned out, these tutuli are also from the technical point of view very similar to the small belt discs. They were made commonly as fully modelled wax models and their eyelets were constructed similarly to those of the small belt discs, with wedges, ceramic cores or organic placeholders. Accordingly, the working sequence for the disc-decorated tutuli is comparable with the above-described sequence for the small belt discs.

However, two other classificatory variants can be attributed to the tutuli: the ribbed tutuli with conical spike and the tutuli with dome-like spike. Except for the rising ribs or step-like design, mostly located at the base of the spike, the first group has few other decorative elements. With the large tutuli of the late NBA II, individual decorative elements are again used.

Ribbed tutuli were mainly made in the model, wherein the eyelet-bar was held in position by means of a ceramic core (Figure 2.147). The partially clear rounded ribs, or steps, are a clear indication of crafting in a soft and malleable material. Many pieces display clear traces of post-casting reworking (Figure 2.148). It seems very likely that the step decoration was applied commonly after the cast. For NBA II tutuli it is probable that the decoration was added in the model. Making tutuli, in a direct comparison with the above-mentioned bronzes, would have been less time consuming. The focus in this specific operational sequence is clearly on the model design. However, it was shown that the eyelet construction on the small belt discs was applied with the help of various, partly regionally specific, techniques.

Another method was used for making tutuli, by means of a metal bar predominantly incorporated into the model. Here one can speak of a variation of the cast-on technique; however, the part that should be cast-on (the hump body) is significantly larger. The rod-like metal bar is incorporated into the wax model of the tutulus body, the same is additionally secured probably by spreading the wax onto the metal bar (Figure 2.149). This method prevents a complex core construction, since in the next step only the body and eyelet (metal bar) of the tutulus must be embedded in the moulding loam, and post-casting the two parts are connected.

However, the difficulty of this technique can be illustrated based on damaged metal bars. That the technique succeeded is related to the accuracy with which the moulding material was applied, as well as the casting temperature. Metal bars, made from folded sheets (see Chapter 2.6.4) indicate the variations within this technique, which occurred during Period II in north Zealand. The cast piece was reworked in a similar manner to the belt discs and plates. Especially, the edges were occasionally hammered post-casting and the decoration of the ribs was deepened.

Significantly more time-consuming was the decoration for the *tutuli with dome-shaped spike* (Figure 2.150). On the basis of the Vognserup hoard, the technique of applying decoration in advance in the wax model was confirmed also within this artefact group. The examination of these objects (with a rich spectrum of designs) only involved those pieces decorated with geometric shapes and line decoration.[72]

It is assumed that the dome-like shape of the spike was not exclusively shaped by freehand but rather by placing wax plates on a ceramic form.[73] With respect to the size of the object a spread of several thin layers of wax to the ceramic dome is also feasible. Thus, depending on the ceramic core, the shape of the dome varies.

The model would then be decorated with various tools. The required resistance is created by the core and the underlay on which the surrounding disc is placed. The material investigated showed that the majority of the dome-shaped tutuli was crafted with round, partially folded metal bars as eyelets (MAP 22). It is

[72] The presented operational sequence is thus not confirmed for the spiral-decorated tutuli with dome-shaped spike.
[73] For orientation, see the crafting of bronze bowls (Rønne and Bredsdorff 2008: 70ff.; Thrane 2009: 93ff.).

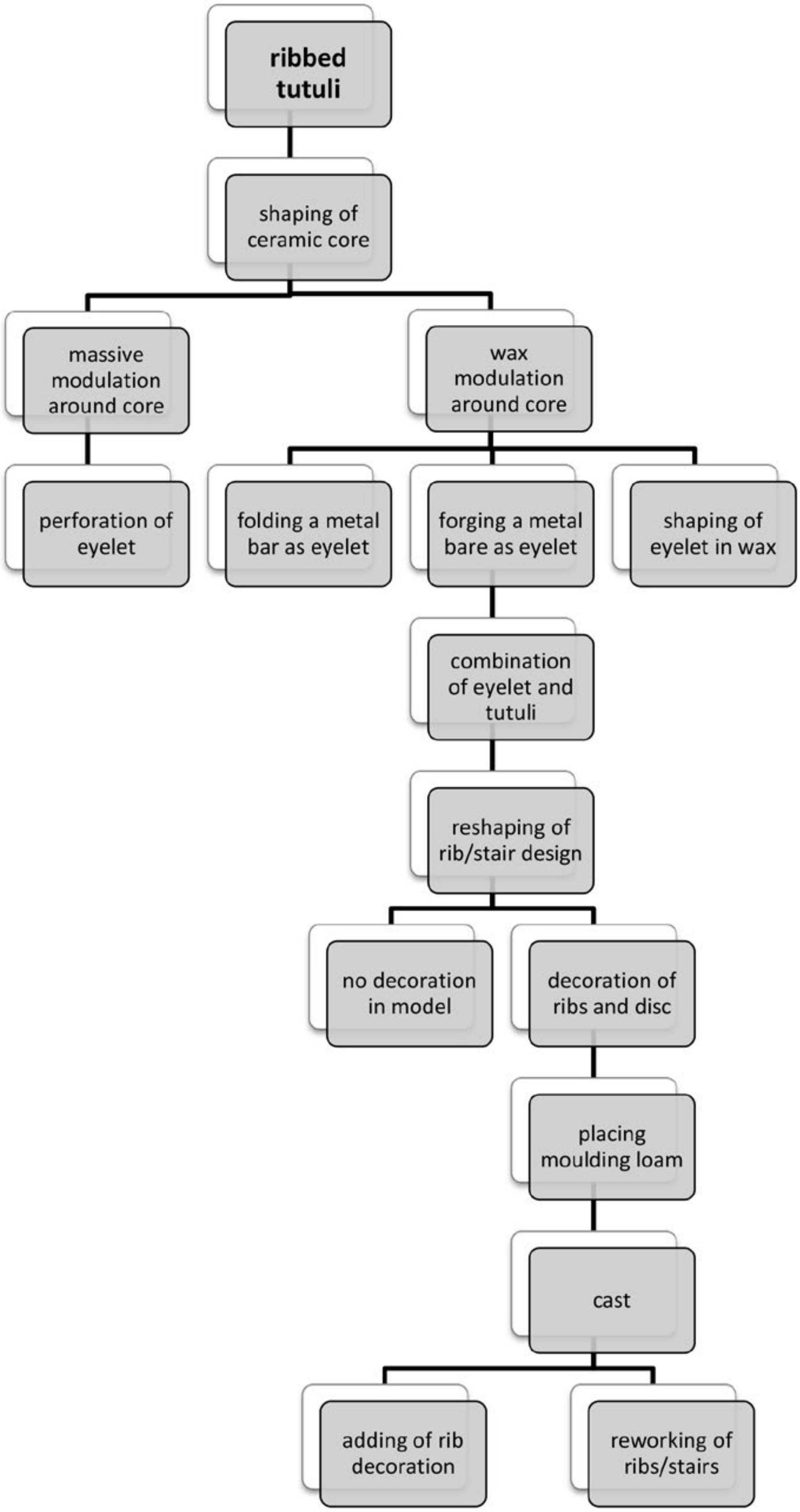


Figure 2.147: Reconstructed operational sequence for ribbed tutuli.

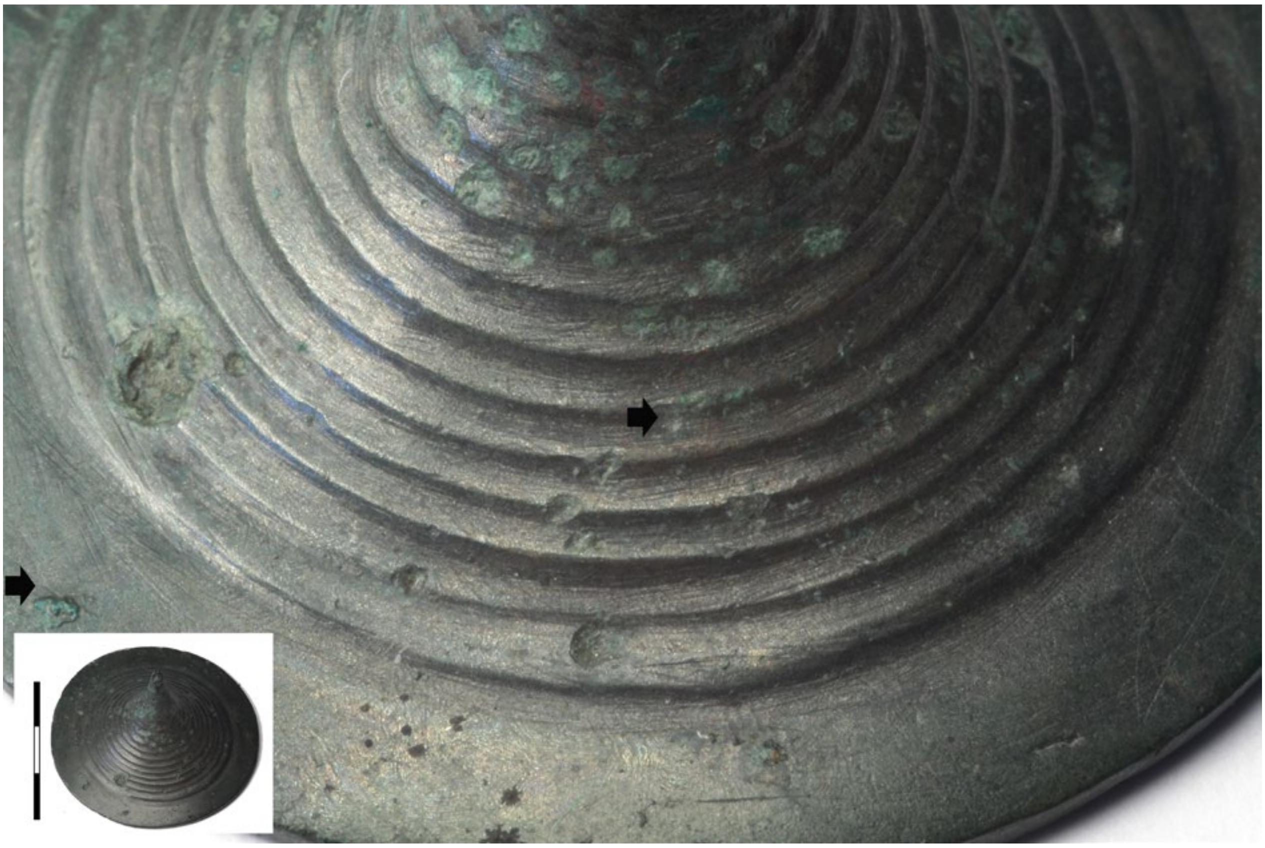


Figure 2.148: Traces of intensive reworking on the ribbed section of the tutulus from Vendsyssel (B4754_873).

assumed that they were incorporated into the ceramic core to facilitate connection with the model. Also, the vast majority of the eyelets sit in the dome-shaped spike. Applying the moulding loam on the model was facilitated by the core, which was already incorporated into the model. Nevertheless, this process needed to be executed with great care, otherwise the surrounding disc or the decoration would be damaged.

Striking with regard to the general consideration of these tutuli are the different rounded domes, where the decoration at the highest point of the dome, and partly the dome itself, show signs of damage. In particular, the tutuli from Rødovre (B13365) and Svenstrup (B10942 and B10942a) support the inference that the dome-shaped tutuli were cast from the top (with sprue attached on the dome-shaped spike). The throat at the highest point of the tutulus from Rødovre, which displays a rough surface, and the heavily reworked tip of the dome from the Svenstrup tutulus (Figure 2.151), represent the position of the sprue.

The inclusion of a metal bar into the wax model within the crafting of both types of tutuli discussed here (see Figure 2.147 and 2.150) was already used from NBA II (MAP 22) and might have originated on Zealand. Only a few pieces in the adjacent regions were made using this technique. During NBA III this technique was spread over the east-west axis towards the Danish mainland, however, in north Germany no artefacts with a cast-on eyelet occur. A detailed investigation of all tutuli within the Nordic Bronze Age could finally clarify whether the formal division of the tutuli as was done in this work (into two tutuli variants and small belt discs), would also be useful with respect to the chosen techniques.

If the picture that emerged here could be confirmed, then future typological studies would clearly profit if both formal characteristics and technical details were included.

2.8.4 Crafting Nordic Bronze Age pins (wheel- and disc-headed pins)

Pins were included only peripherally in this study, yet important insights into the different crafting processes were obtained.

Of particular interest in the present work were the wheel- and disc-headed pins, as they within the area of investigation they were the most common pin shapes. Several pieces of both object groups were examined and thus operational sequences (which can be taken as the basic sequence) could be worked out. Even within these sequences model-making takes up a large part.

Figure 2.149: Rod-like metal bar incorporated into the wax model of tutulus body and additionally secured as demonstrated on the artefacts from Vendsyssel (B4754-878) and Kolbedal (FHM 5106).

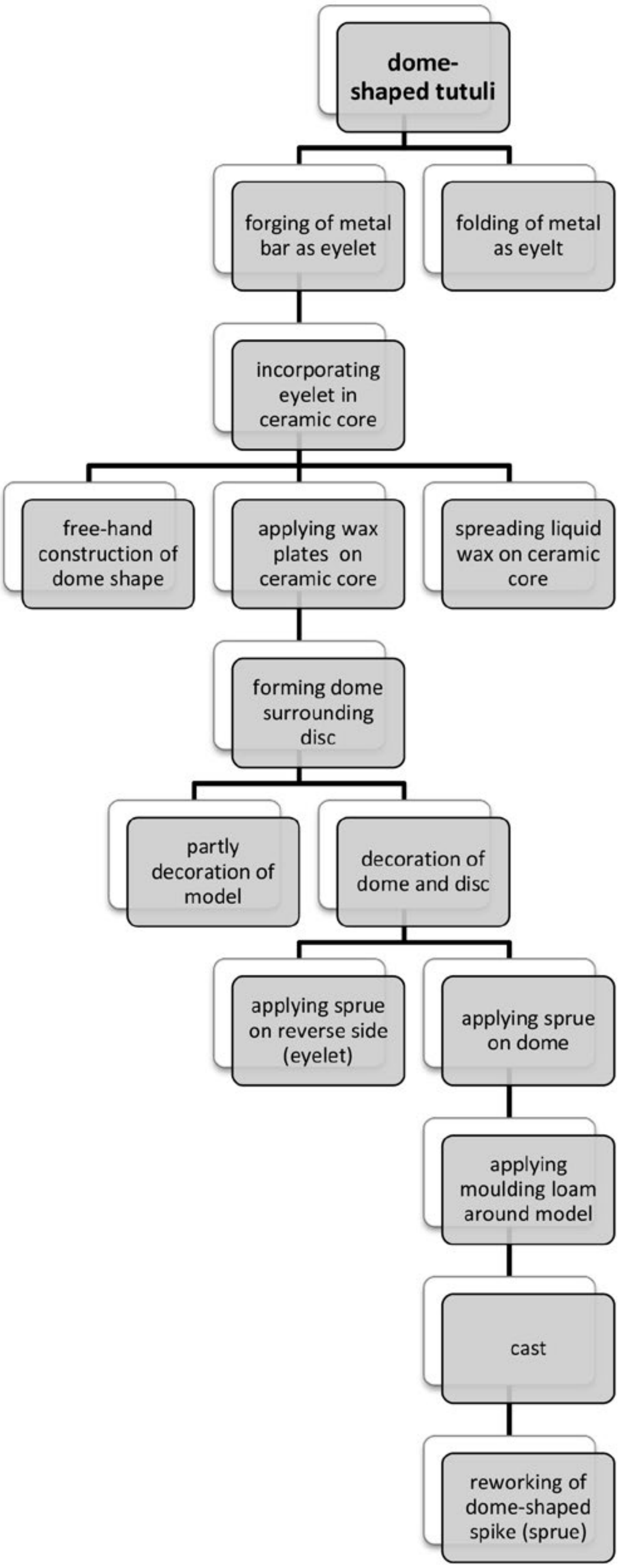
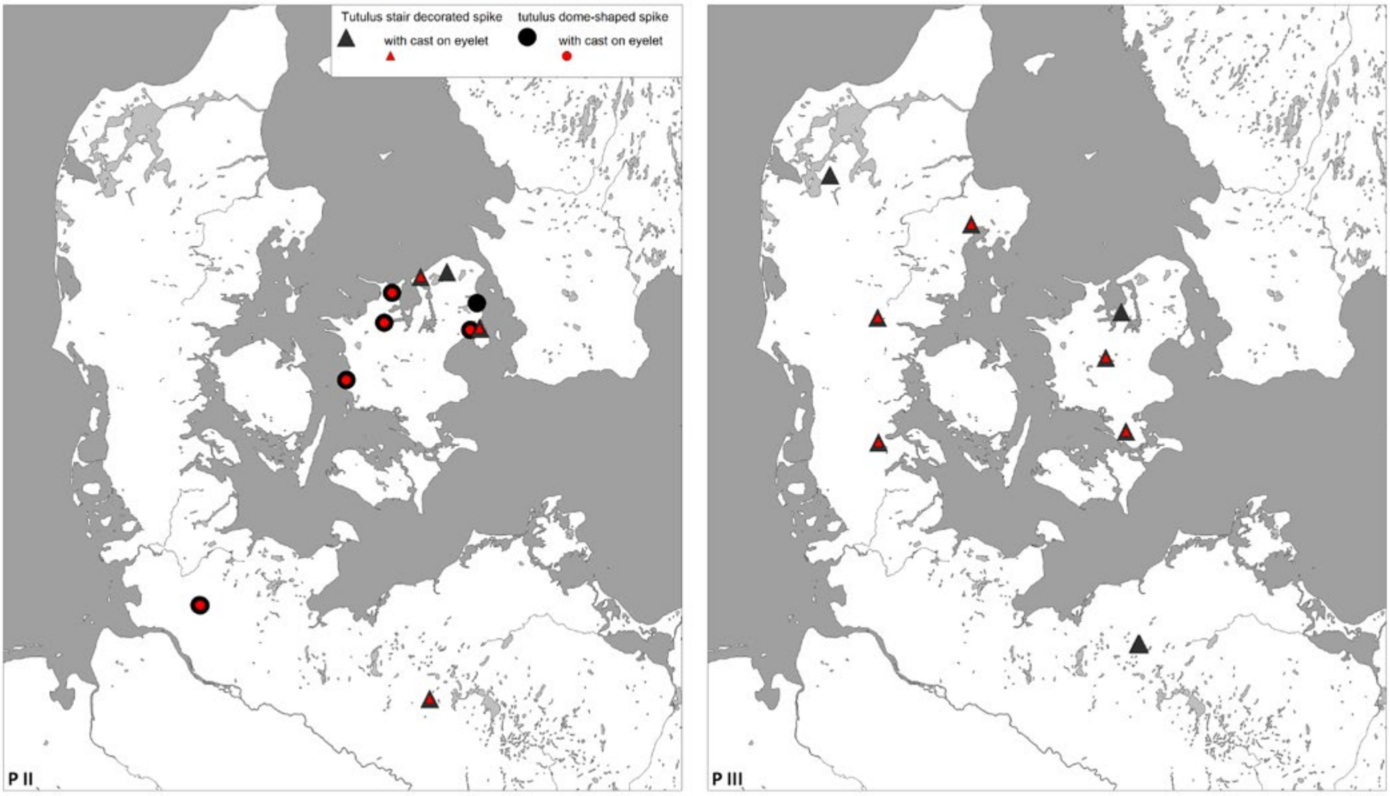


Figure 2.150: Reconstructed operational sequence for tutuli with dome-shaped spike.



Map 22: Distribution of tutuli with cast-on metal eyelet in NBA II (left) and NBA III (right).

Wheel-headed pins are not made using the *cire perdue* technique, as the majority of the artefacts in the present study, but through chill-casting (Figure 2.152). Within this study, casting using two negative mould halves, as well as casting using only one negative half with a cover plate (or even without), was confirmed. A clearly defined, regionally limited, spread of this last method to central Lower Saxony (Lüneburg Heath) could be shown, already mentioned, typologically (see Laux 1976; Kubach 1971; Miner 1970).

In regard to the technical requirements, casting using two negative halves demands a greater skill and more time invested than using only one negative mould half.

Thus, the making of wheel-headed pins begins with the model. In this case, however, it is not the modelling of a wax artefact, but the shaping of a mould. The only moulds known from northern Europe are of stone (Butler and Fokkens 2005: 381) and suggests one of the two probable materials such moulds might have been made of. Stone moulds have the advantage that, once designed, they can be reused several times. The process of formation, however, is labour intensive. Mostly with bronze tools, and probably also with tools made of hard wood or stone, a matching indentation would be inserted into the mould material. While casting in two-part moulds with two negative sides, two identical negatives should be placed in each half of the mould. Here, a high degree of skill and dexterity on behalf of the craftsperson would be needed, as both sides should be identical and should lie exactly on each other, secured with the help of notches or pins.

By contrast, if the negative of the pin were introduced into the sand-clay mixture of a ceramic form, less work is required, as this can easily be done by means of impressing an already made pin (bronze or wood). In this way identical artefacts could be made, even within ceramic moulds, although different in size. Shaping a similar ceramic mould by hand can be done using specially crafted wooden or bone tools. It is likely that the negative of the wheel-headed pin in the moulds only included a small part (the approach) of the shaft. In contrast to the pure-cast microstructures documented on the pin heads, the predominant part of the shaft is hammered into shape. To what extent, however, the shaft was hammered into its final shape while connected with the pin-head, or if the shaft was hammered from an ingot and then connected via cast-on technique, is unknown. However, it seems likely that the casting of the pin was carried out from the shaft end. In this way the sprue would be an extension of the shaft and would serve as a source of material while cold-working.

The cold-working (hammering) process was accompanied by repeated annealing, which was

Figure 2.151: On several tutuli (dome-shaped-spike) the sprue should be expected on the top, as on the tutuli from Rødovre (B13365) and Svenstrup (B10942a).

Figure 2.152: Reconstructed operational sequence for wheel-headed pins.

limited to the shaft. The existence of strain lines on the specimen sections of the wheel-headed pins from Rehlingen (LMN 5032) and Westerweyhe (LMN 12018) indicates a final cold deformation and thus a final curing of the shaft.

However, a disadvantage of chill-casting in two-part moulds is the flash, which is formed at the point where both halves meet, through leaking metal. The investigated pins make clear that removing this flash, which can influence the appearance of the pin significantly, was not important (see also Laux 1976: 28). The few metallographically examined wheel-headed pins support this evaluation, as even samples of well-replicated ribs and rings do not show traces of plastic deformation; in other words, no reworking took place. With regard to the crafting method, this flash is characteristic for casting using two-part moulds.

Another kind of pin, represented in a high number, is the *disc-headed pin*. Two major groups should be regarded differently when reconstructing the operational

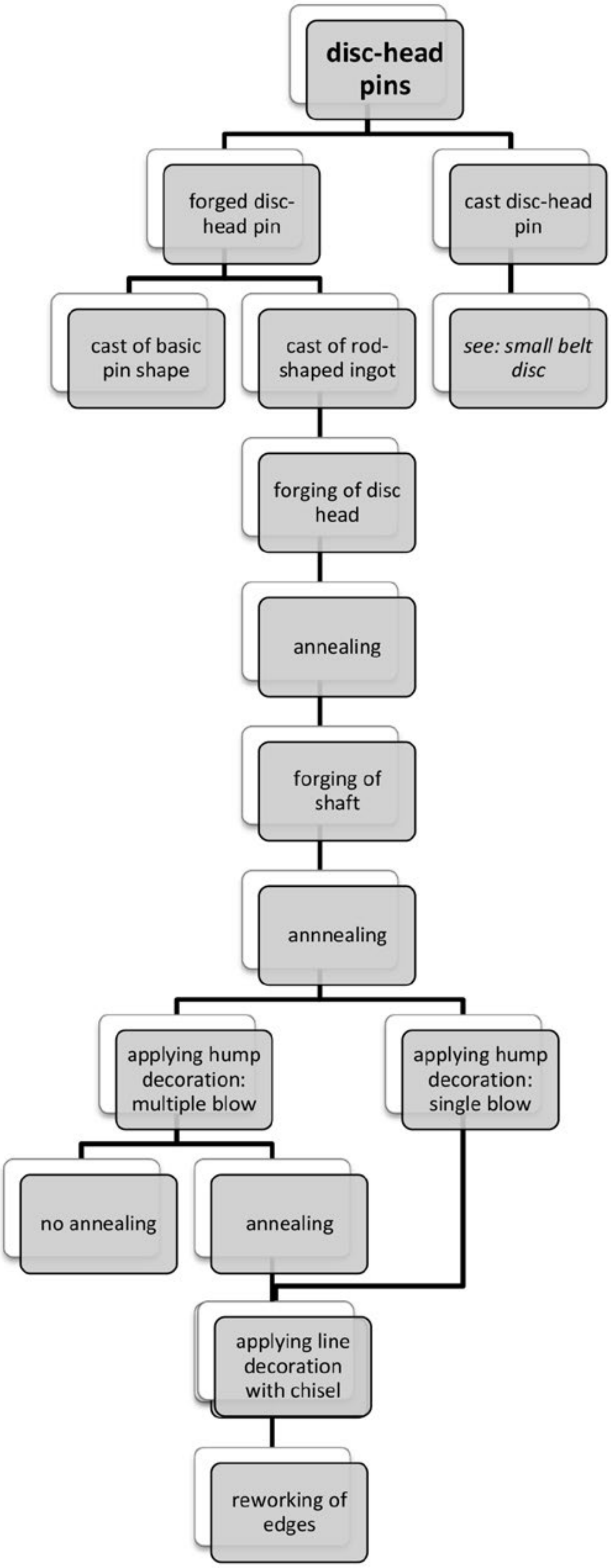


Figure 2.153: Reconstructed operational sequence for flat disc-headed pins.

sequence, the flat disc-headed pins and the horizontal disc-headed pins, which include the Weitgendorf-type pins.

Flat disc-headed pins are one of the few ornaments related to female use that are mostly cold-worked (Figure 2.153), and for which regional and chronological distinctions are to be made.

Disc-headed pins with spiral-decoration are common in the material culture of the Lüneburg Heath, and these were clearly made by decorating a model of the pin in wax, as identical stamp-decorated discs prove (see Chapter 2.6.3). Therefore, disc-headed pins are thus not be explained by only one crafting method but must be considered individually. Such a spiral-decorated disc as that found in Lüneburg (LMN 12041) was made with a similar sequence as the small belt discs, however, the shaft was made through intensive hammering.

Next, the operational sequence for cold-worked (hammered) disc-headed pins will be presented, for example such pins as found in Sparow (ALM LII Z1G, 1) and Heinrichswalde (ALM 7236b). Starting from a raw casting, which presumably consisted of a rod-shaped ingot with slightly wider and thicker top, the disc head and the shaft were hammered. During this process, a repeated annealing would have been essential as otherwise the metal would have become too brittle. Such brittleness resulted in cracks (A and B) in the case of the pin from Heinrichswalde (Figure 2.154). Furthermore, this pin displays ridges which occurred during hammering; such malformations should be removed before any further deformation (if not they would cause gaps). Here, these features indicate careless work (sloppy annealing and reworking) as a sign of the lack of skills of the craftsperson involved.

Contrastingly, the pin from Sparow, despite its poorer preservation, is of much better quality and only displays the errors just described in very limited form. Since the basic shape of these pins was hammered, or rather driven, the decoration (hump series) was also applied using chisels or punches in bronze.

An intensive investigation of these pins revealed several punch marks within one hump, however, here a pre- and post-processing of the decoration is not the reason, but rather the resistance of the metal against the penetration of external objects. These multiple strokes

Figure 2.154: The pin from Heinrichswalde (ALM 7236b) shows carelessness in the crafting process.

can also be interpreted as a lack of familiarity with the technique and material, since the force that was needed to achieve the desired depth of the hump was incorrectly selected. Such artefacts, almost exclusively crafted in metal, are particularly interesting in terms of obtaining information about the craftsperson, as here reworking is nearly impossible and every action leaves indelible traces.

The second form of disc-headed pin studied in the context of this work is that of those with a horizontal wheel-head, such as the Weitgendorf-type pins. An intensive observation of the traces left by tools and specific techniques revealed new information that led to interesting thoughts concerning the model-making of such pins (Figure 2.155).

As already mentioned (see Chapter 2.6.4), these pins could have been crafted in a technique similar to the modern sand-cast. With three examined pieces only a small portion of these pins found in northeast Germany were part of the investigation, however, pioneering discoveries were made. It seems also that this crafting process would focus almost exclusively on the production of the model. However, several features suggest that it is not necessarily a wax model, but rather a kind of model 'kit'.

The way in which these pins are configured is reminiscent of beads lined up on a rod. Based on this analogy, different ideas could be worked out. Presumably Weitgendorf-type pins were made in two-part moulds, a technique well used in northern Germany. Unfortunately there is no explicit evidence, since the preservation of the studied pieces was too poor to verify any cast flashes or the reworking of such ridges. Furthermore, mould finds for such pins are completely unknown.

Nevertheless, that this technique might have been used is very likely. The requirements for the model used to make the imprint in the ceramic mould are limited to a few points: there should be no undercuts and the model must provide enough resistance to imprint its shape in the mould material and to remove it from the mould again.

On the basis of tool traces, gaps and distinctive forms, different ideas could be developed concerning the model making. Thus, the lenticular decorative elements of the evenly rounded shaft are very similar to ceramic or wooden beads: gaps between the lens and shaft support this comparison. Lined up on a wooden stick (which would explain the uniform rounding also in the area between the lenticular thickenings) and pressed in a malleable mould they would achieve a similar pattern.

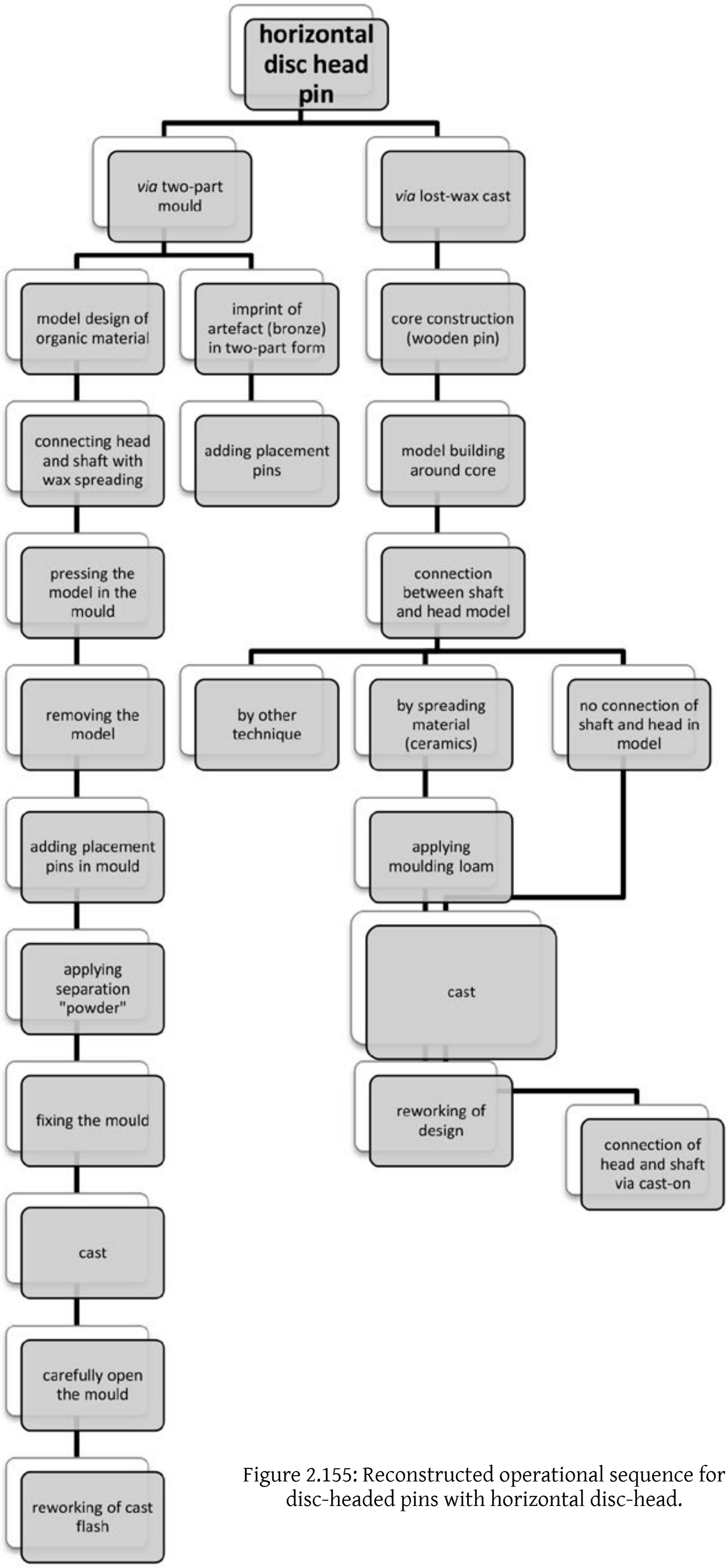


Figure 2.155: Reconstructed operational sequence for disc-headed pins with horizontal disc-head.

Moreover, the head-plate can be made of many different materials (including model wax). The relatively thick plate is combined with the shaft by means of spreading material (possibly wax) from the reverse side onto the shaft material, a technique known in ceramics. A model constructed in such a way would, when pressed into a fine grained moulding material, and after a successful casting, result in a pin with all the characteristics of Weitgendorf pins.

This assumed sequence urgently requires a review with help of those finds not examined in this work, as such pins could also be a formed exclusively in wax. However, to reject the presented sequence solely due to the lack of mould findings, should be carefully considered, as clay moulds especially have a high value as raw material for other forms (Jantzen 2008).

With the operational sequence of disc-headed pins, the technological investigation part of this study comes to an end. The close examination of the artefacts revealed new and surprising information concerning the crafting of bronze ornaments, which can be summed up in one essential statement: *model making must be seen as one of the most important parts of the sequence for crafting ornaments.*

PART 3
METALCRAFT IN A THEORETICAL LIGHT

Chapter 1

Theoretical approaches to craft in prehistoric times: a research history

Having presented the craft-technical features in the second part of this work, the next objective is to explain and understand the assumptions suggested which derive from the first visual impressions of an object. This will be done with the help of today's known and most used theoretical approaches, which shall be compared with the comparative traces in the investigated material. Given the wide range of models and methods that can be used to investigate prehistoric crafts, the following chapter will present and discuss those relevant to this work. Once more, the working sequence or *operational sequence* is in focus as the basic tool of all discussed theoretical approaches as well as its underlying question. In addition, this chapter informs about technological choices, technological traditions, the craftsperson's habitus, and to what extent technological choices can be documented in the archaeological material and are of significance for the modern observer. Of major interest is the concept of *habitus,* explained as the interplay occurring in craft between the skills of the artisan/craftsman, the relevant factors of influence and the social environment. Comparing the different approaches for studying prehistoric craft, some similarities appear as the belief that through continuous practice and repetition certain physical gestures become a part of the body, which then, if necessary, can recall them as automated actions.

The characteristic features for novice and professional work that could be defined using experimental and ethnological studies are discussed in regard to physiological and psychological models of the development of motor skills. Here, the creation of style (formal and decorative style) shall be investigated with the degree to which style is part of the *habitus*, with the development of different styles and with the significance behind the development of micro-styles.

3.1.0 Craft theory, some introductory thoughts

When examining the legacies of prehistoric cultures distinctive features can frequently be found, and amongst those some features more than others oblige questions to be asked regarding the people who created the objects or who were associated with them. Very different reactions may, therefore, be created when looking at a decorative band on a Bronze Age belt plate; one kind of viewer may notice that the spirals of the decor are of exceptional uniformity, or that individual decorative elements overlap, or that parts of the object have been destroyed by cracking, or apparent inconsistencies in its form. Alternatively, a different observer may see from the same artefact the technological traditions of a particular region. Moreover, he/she may see the symbolic meaning carried by the object, which transmits not only regional but also social information to the receiver. Both observers gain their information from a simple visual observation of the object, but arrive at a variety of statements.

Since the investigation of prehistoric technologies has in the post-processual era been the subject of increasing interest it is useful to present an introduction to previous research. This could lead to repetition of already-presented models, however, they will be presented here in a material-related context. Additionally, methods developed within this work will be compared with the discussed methods, with the aim of gaining the best understanding of prehistoric metalcraft. However, this chapter on theoretical craft studies will not include a complete list of all the works that dealt with this issue. Rather, the most important research directions for this work will be outlined and discussed within thematic groups. It is primarily about the comparison of the most well-known models, with an aim to show possible parallels and to define their weaknesses. First, the current models and theoretical approaches to the study of technology are presented and compared. Second, research concerning individual agency in technology is discussed, and here not only the connection between individual and social group should be illuminated, but also the opportunities that are given to the modern researcher to identify the executing actor(s) in prehistory. Third, apprenticeship and the training of the craftsman is in focus. In this, archaeological as well as ethnographic studies concerning learning behaviour, cognitive development and traces in material culture are presented. Finally, the study of style and technology and to what extent it might be relevant for the technological study of prehistoric artefacts is presented, in which the main focus is the relationship between style, the individual craftsman and the social group.

Within each section the material examined will be included and explained, whilst here the pertinent information for each context is discussed; a detailed description of each object and technical feature can be looked up in the second part of this research (references are given) and in the Catalogue.

3.1.1 Theoretical approaches to the study of technology

Theoretical archaeology offers many options and models that can be a great help in the interpretation of prehistoric technologies. A fundamental step for the successful interpretation of data is the splitting of a particular work process into operational sequences or operational sequence diagrams (Miller 2009: 29ff.). One of the most well-known methods that works on the basis of such diagrams, and is therefore named after it, is the concept of *chaîne opératoire* (i.a. Dobres 2010; Tostevin 2011; Ottaway 2001; Sillar and Tite 2000; Dobres 1999b; Mahias 1993; Balfet 1975). Partly it is seen as an independent theoretical method (Tostevin 2011; Sellet 1993; van der Leeuw 1993). The term *chaîne opératoire* is often used in its original form. However, there have been various attempts to introduce other terms.[1] Lemonnier used, among others, the term 'operational sequence' (Lemonnier 1992), but none of these translations has been able to prevail internationally (Coupaye 2009: 439; Högberg 2009).

The development of the concept of *chaîne opératoire* was mostly influenced by Leroi-Gourhan in his comparative study of tool production from 1964 (Leroi-Gourhan 1993).

With the help of the Lemonnier the concept, born in anthropology, could also prevail in archaeology (Coupaye 2009: 439; Sellet 1993: 107). The first mention of the term of *chaîne opératoire* in relation to a technological investigation method, and also the theoretical foundation, goes back to Marcel Mauss (1973). His statement that technological activity is built from a social and historical context, and as such that an analysis of the two fields is only useful if executed in combination, forms the basis for the concept of *chaîne opératoire* (Martinón-Torres 2002: 30; Edmonds 1990; Mauss 1973). *Chaîne opératoire* is today mainly used by the French School in the study of prehistoric (lithic) technologies (Coupaye 2009; Sellet 1993; Schlanger 1990; 1994; Pigeot 1990; Pelegrin 1990; Pelegrin *et al.* 1988; Lemonnier 1990). However, especially within the last 20 years, English-language research can be detected outside of France discussing this concept (Dobres 1999a; Eriksen 2000; Apel 2000; 2001; Wąs 2005; Apel and Knutson 2006; Sørensen 2006). Thus, the concern expressed by Sellet that 'the chaîne opératoire remains ignored by the bulk of English speaking archaeologists' (Sellet 1993: 106) can now be understood to be changing. Nevertheless, it should be acknowledged that a similar method developed in parallel with the concept of *chaîne opératoire* in America. However, the discussion of which party published the method previously and to what extent the respective groups should include the works of the other party in their works will not be discussed further, but should be noted (Schiffer *et al.* 2001). The analysis by Schiffer, presented in 1975, using a behaviour chain ('behavioural chain approach'; Schiffer 1975a; 1975b; Schiffer and Skibo 1987; 1997), is often viewed as a parallel and independent method to the *chaîne opératoire* concept (Apel 2007: 7; Sellet 1993). The concept of *chaîne opératoire* had its roots in anthropology, so the roots of the behavioural chain approach can be clearly seen in processual archaeology (Sellet 1993: 107).

Both methods are based on a detailed documentation of the operational sequence necessary for the production of an artefact. In both methods it is attempted in the same way to document the 'bodily gestures of ancient technicians' and 'real world factors impinging on artefact design as well as cognitive, symbolic and social factors shaping artefacts' (Dobres 2010: 106). The goal of both methods is to understand the connection between artefact and person as a 'sequence of interlinked stages' (Martinón-Torres 2002: 37). The main difference is, however, in the approach itself. As Sillar and Tite elucidated, *chaîne opératoire*, meaning the work sequence carried out for the production of an artefact, lies within the life cycle of an artefact (Sillar and Tite 2000: 16). The sequence of a 'behavioural chain' does not end with the finished product but only at the point when the object is completely removed from the life cycle (Martinón-Torres 2002). Not only the choice of words 'life cycle', but also the contents of the analysis of a behavioural chain are closely related to the 'object biographies' proposed by Kopytoff (1986) and are sometimes mentioned in the same breath. This close contact of a 'behavioural chain' and an 'object biography' once more illustrates the differences within the mentioned approaches. According to Tostevin, the guiding question of the two methods differs significantly (Tostevin 2011). If, using the *chaîne opératoire* method, the cognitive map of the craftsman or artist is to be understood (Tostevin 2011: 363; Bleed 2001: 105), then the 'behavioural chain' approach puts the action of the craftsman and the traces left into the foreground, with the aim being to compare them with each other (Tostevin 2011: 361).

Thus, it can be stated in summary that in using the *chaîne opératoire* concept the larger relationship between society and technology is the real aim of the study, while the action is the main aim within the 'behavioural chain' approach (Martinón-Torres 2002; Sellet 1993). In other words, the one method sheds light on the birth of an artefact, whilst the other wants to document its life (Zagal-Mach Wolfe 2013: 38; Joy 2009).

[1] The list of terms can be read in Högberg 2009.

In addition to these two main methods, further independent methods for the study of prehistoric technologies can be documented that have developed within recent years. All methods are based around more or less detailed working sequences. Several studies, grouped under the term 'production process' studies, were dealing with the object as the central point of the study (i.e. Zagal-Mach 2008; 2013). Due to this different point of view it was possible to detect the weaknesses of those methods presented above. It was shown that a production sequence does not necessarily need to be carried out by a person at the same place or with the same amount of skill. Thus, the main criticism against an analysis using the *chaîne opératoire* concept was that to look at a whole chain of operational steps could already include a false assumption. Namely, that the production took place under the same conditions (whether temporal or regional). As a result, a concept was developed in which each individual event or any part of the chain was examined on its own. Through this approach, it should be possible to reconstruct the social position and the role of the craftsman more easily, since 'although they all belong to the same craft the social position and role of the craftsman may vary according to which kind of product action process he or she is taking part in...' (Zagal-Mach Wolfe 2013: 69).

The basis of an operational sequence deliberately carried out by craftsmen are the choices that are made during the workflow, in terms of technique, sequential order, choice of tools, and more. These decisions can be traced with the help of marks left on the item. In the same way variations within an artefact group indicate different decisions during crafting (Mahias 1993: 158). A working sequence or 'operational sequence' can be seen as the basic tool of all the methods described above.

3.1.2 Individual agency in technology

Technological choices of the people involved in the production of artefacts create the structure of each technical action. These choices can be regarded as a basic tool within a study of operational sequences and were first introduced directly as such by Lemonnier, in his study on material culture (Lemonnier 1986: 149). Lemonnier defined technological choices as the 'process of selection of technical features invented locally or borrowed from outside' (Lemonnier 1993: 2). Similarly, the concept seems to have been used within 'behavioural archaeologies'. Studies that deal with the concept of 'technological choices' have been illustrated by Schiffer *et al.* (2001) to have been prominent for several decades (i.e. Schiffer and Skibo 1987).

Such technological decisions take place in five main categories (Sillar and Tite 2000): in the choice of raw materials; tools; power source; techniques used; and choices within the sequence of steps in a chain (Sillar and Tite 2000; Martinón-Torres 2002: 37). Technological choices inform, in a very broad sense, about the traditional context in which these technologies were used (Sillar and Tite 2000: 9). Thus, in the literature terms such as 'technogestures' are used in the same way (Dobres 1999b: 137).

Choices taken within a working process can be viewed as a 'sorting out of possibilities ... although usually in an unconscious and unintentional way' (Lemonnier 1993: 7). It is in this aspect of unconscious or unintentionally made decisions – as Lemonnier presented them in his early publications – that the starting point of an ongoing debate is rooted. Within this debate the research was divided into two groups: one group that argued that these individuals are never really aware of the existence of these choices, although such choices are not completely hidden (Mahias 1993: 177), while the other represented the opposing thesis – that such technical choices are conscious acts, chosen from a pool of possibilities (Berg 2007: 236; Quilici-Pacaud 1993: 400).

What value has a technological decision made during crafting, or, more precisely, to what extent has this decision, documented in the archaeological material, significance for the modern observer? Connected with discussions after 1990, several publications concentrated on the question as to which informative potential a technical choice actually has when the prehistoric artisans were not *deliberately* selecting actions from a pool of all potential options? What if the craftsman had a limited amount of possibilities to choose from (Tostevin 2011; Pétrequin and Pétrequin 1994; Mahias 1993; Lemonnier 1992: 85-103)? Here, various fronts arose. One side took the view that only choices made with the knowledge of all potential options allow a statement about the social environment of the person concerned (Lemonnier 1986; 1992: 85-103; 1993; Mahias 1993; Pétrequin and Pétrequin 1994). In contrast, the other side places the choice in relation to the cultural backgrounds, and thus ascribes them a high value (Sillar and Tite 2000; van der Leeuw *et al.* 1991; Cresswell 1990). To date, no consensus has been reached and the respective researcher is subject to the burden of absolute proof lest their conclusions become the target of violent disagreement.A basic acceptance in the research, however, is the statement that the technical choices made by craftsmen are in direct proportion to experience (i.e. Pelegrin 1990: 117).

Technological choices are indirectly connected to another concept that concentrates on the individual. The concept of *habitus* introduced by Bourdieu (Bourdieu and Sayad 1964; Bourdieu 1977) has been applied in recent years increasingly also in terms of the individual characteristics within crafting. The concept of *habitus* was already in use in philosophy and sociology before Bourdieu, by sociologists such as Émile Durkheim, Max Weber, Marcel Mauss and Norbert Elias (Krais and Gebauer 2002: 5).

Bourdieu wanted to understand why people act as they do (Krais and Gebauer 2002: 20). Inspired by his visit to Algeria and the behaviour of the Kabyle peasants, who acted 'irrationally' in Bourdieu's eyes, even if forced upon the world of modern economics under colonisation (Bourdieu 2000: 8; Krais and Gebauer 2002: 18-20). From this the *habitus* concept developed. It is defined as: 'Ein sozial konstituiertes System von strukturierten und strukturierenden Dispositionen, das durch Praxis erworben wird und konstnat auf praktische Funktionen ausgerichtet ist'[2] (Bourdieu and Wacquant 1996: 154; 1992).

With regard to the present work, the way in which Bourdieu composed the different sides of his *habitus* concept is particularly of interest. Panofsky (1951) used in his study of Gothic architecture the concept of habitus to describe the unifying principle behind Gothic architecture, Scripture and scholastic thought of the Middle Ages. The *habitus* linked the artist with the collectivism and its age. This first use of the concept of *habitus* was thus closely related to the interplay occurring in craft between the skills of the artisan/craftsman, the relevant factors of influence and the social environment. Bourdieu was heavily inspired during his translation of the same work into French and picked up the term *habitus* in the epilogue (Krais and Gebauer 2002: 23). Another important source of inspiration is the work of Marcel Mauss. He observed that physical activities within a society are carried out differently from society to society (1979: 97). These differences can be explained by different social conditioning (education). The conscious choice of the word *habitus* in this context, instead of the French word *habitude* (habit) should support the theory that these physical properties are not personal habits but socially influenced characteristics (Farnell 2000: 401; Mauss 1979: 101).

The *habitus* concept developed by Bourdieu, possibly as an alternative to the already existing role-concept, should be considered as such (Krais and Gebauer 2002: 66), and aims at far more than only the question of how the individual habits of a craftsman are explainable. In this work, however, those basics, as developed by Panofsky and Mauss, are crucial for the observation of the behaviour of a craftsman, or in other words his *habitus*. In recent years, the concept of the 'craftsman's *habitus*' has been used more frequently (Wendrich 2012; Wallaert 2012; Høgseth 2012; Zagal-Mach Wolfe 2013; Dobres 2000). The physical activities, 'das Lernen durch Mitmachen, durch Abgucken, Ausprobieren und Einüben, aber auch durch körperliches Handeln, durch spezifische Bewegungen und Gesten, spielt eine zentrale Rolle bei der Ausbildung des Habitus'[3] (Krais and Gebauer, 2002: 62) can be transferred directly to the craft. The definition by Willeke Wendrich (2012: 3) of *habitus* as the embodiment of skills, habits, taste and style, and personal experience,[4] seems to combine the already established research models with the 'body of knowledge' (Dobres 2000: 110; Roux *et al.* 1995: 65), the embodied knowledge (Sofaer 2006; Sørensen and Rebay-Salisbury 2013: 1), or 'motor know-how' (Pelegrin 1990: 118), anticipation (Sennett 2008: 154) and, in parts, also the idea of tacit knowledge (Høgseth 2012: 65; Polanyi 1958; Polanyi 1966).

Common to all approaches is the belief that through continuous practice and repetition certain physical gestures become almost a part of the body, which then, if necessary, can recall them as automated actions (Høgseth 2012: 65; Sennett 2008: 207; Minar 2001: 395; Costin 1995: 622). This statement is reflected within the *habitus* concept formulated by Bourdieu (1977: 72-95). These same actions as described in the following discussions are heavily influenced by the manner in which they were learned. Accordingly, in a study concerning the 'body of knowledge', the 'motor know-how' of a craftsman must always also be considered a kind of knowledge transmission and thus the social structure in which the craftsman is embedded. Consequently, all these kinesthetic skills (Miller 2012: 231)[5] are as much part of the *habitus* of a craftsman as his psychological skills and the sense of aesthetics shaped by the respective society. Conversely, many of the aspects formulated by Bourdieu can be valid for the above-mentioned models. In Bourdieu's *Outline of a Theory of Practice* one reads: 'The principles embodied in this way are placed beyond the grasp of consciousness, and hence cannot be touched by voluntary deliberate transformation, cannot even be made explicit' (Bourdieu 1977: 93-94). In comparison, Sennett was unable to express how the coordination between hand and eye works and how the action of the hand transfers slowly into tacit knowledge (Sennett 2008: 122).

Terms such as 'motor-habit', 'body of knowledge' and 'know-how' in a broad sense are used to describe

[2] '...A *socially constituted system of structured and structuring dispositions, which is acquired through practice and constantly aligned to practical functions...*'

[3] '...learning through participation, through imitation, trying out and practising, but also through physical actions, by specific movements and gestures, plays a central role in the formation of the habitus...'

[4] 'The term habitus (the manner of carrying or conducting oneself) denotes the embodied culture, which includes such aspects as skills, habits, style, and taste, as well as one´s history and experiences' (Wendrich 2012: 3).

[5] The term kinesthetics is the technical term for 'muscle learning', 'body knowledge', or the commonly used 'hands-on knowledge' (Miller 2012: 228-231).

automated motor-actions, which were subordinated with the term 'kinesthetic skills' by Miller (2012). At one point, the concept of tacit knowledge was mentioned, which must be considered here in more detail because it includes far more than just an automated sequence of motor-habits. The Hungarian scientist (chemist and philosopher) Michael Polanyi said: 'I shall reconsider human knowledge by starting from the fact that we can know more than we can tell. This fact seems obvious enough; but it is not easy to say exactly what it means' (Polanyi 1966: 4).

From this thesis Polanyi developed his theory of tacit knowledge. However, he never concretely defined the term, but made clear the difference to 'explicit knowledge' (Kosz 2007: 8). Explicit knowledge represents knowledge that can be expressed easily, put into words and which can be written down (Nonaka and Takeuchi 1997: 8; Kosz 2007: 3-7; Schanz 2006:11; Polanyi 1966). 'Tacit knowledge' on the other hand cannot be explained in words, it should rather be regarded as an experience composed of personal views and values as well as imitated actions (Nonaka and Takeuchi 1997: 8; Kosz 2007: 3; Polanyi 1966). Especially, the often-stated connection of tacit knowledge and practical actions (Polanyi 1966; Polanyi 1958; Schanz 2006: 9; Kosz 2007: 9) makes this concept interesting in terms of this present study.

Based on the *habitus* of a craftsman (although this term is rarely used in the following contexts), further research directions should be considered when it comes to the determination of individual characteristics within the crafting of objects. A classification of these investigations into two categories might be useful for a better understanding of this very confusing topic, of which one deals with the neurophysiological aspects (the processes taking place in the brain) while the other deals with the developmental psychological aspects (the so-called 'motor-habits'). Such studies are mostly closely linked to research on the acquisition of skills and the resulting characteristic traces in each of these phases.

3.1.3 Apprenticeship in archaeology

There is no doubting the fact that skill and ability (the combination of skills and the ability to use them) in craft develop during training and practice (i.e. Roux *et al.* 1995: 72-79). The way in which this happens and might be observed by the modern researcher is only difficult to reconstruct. A situation similar to ours within modern Western industrial society, in which traditional craft is rare and a strictly structured training relationship of master and apprentice prevails, should not be equated directly to prehistory without a thorough revision. Perhaps it is advisable that the modern scientists completely break away from this image, and inspired by ethnographic examples investigate the traces left to us through the material culture of Bronze Age people.

One approach to this topic, which is largely independent of our modern western lifestyle, was created by Minar and Crown (2001) through a basic summary of the research concerning learning behaviour occurring in the neighbouring sciences. The aim was to present the characteristics of the human learning process, thus giving archaeology a useful tool for the study of learning and teaching (Minar and Crown 2001: 371ff.). The definition of certain neurophysiological aspects occurring during a learning process, along with a specific focus on motor learning and the examples given, provides a good base and facilitates the entry into the still very complex issue. From a developmental psychology perspective, the research primarily dealt with the determination of certain stages of development in the learning behaviour of children, including their motor development (Minar and Crown 2001: 371; see also Golomb 1998; Kellogg 1969; Wendrich 2012). In archaeology this concept was used in combination with intensive ethnographic studies conducted mainly on different style characteristics within ceramic traditions that could now be explained and assigned to specific ages and levels of motor development (Crown 1999; DeBoer 1990). This approach should, however, be treated with caution (Minar 2001: 372), since the development of children is influenced by the social context in which the learning took place (see Rogoff 1995; 1984). First, Rogoff´s classification of a learning process into three levels, where the social context was combined with the development in learning, resulted in a model that had an applicable form for archaeologists (Rogoff 1995: 161). The three levels are: the community activity plane (the education); the interpersonal plane (with guided participation); and the personal plane (with active participation). The classification of human learning into four classes by Boyd (1985) is along similar lines. The different categories are detectable in reality to varying degrees. Boyd's first category involves learning by copying known patterns and behaviour and modifying them. Within his second category (direct bias) possible alternatives are tried, of which the individual chooses the one that is considered most appropriate. In the third category (frequency -dependent bias) situations are included in which learning is restricted to the most popular alternatives and, therefore, only a limited repertoire is learned. This is similar to the fourth category (indirect bias) where only of these elements are included in the learning process, and which are connected to successful or attractive models or techniques (Boyd and Richerson 1985: 81ff.). It is of particular importance when working with the presented categories that they are not results from well-documented research, rather a theoretical construct (Boyd and Richerson 1985; Bamforth and Finlay 2008: 13), and should also be treated as such.

Additionally, the neurophysiological theories that deal with the different types of learning and the concurrent processes in the brain can offer important approaches to archaeology. Here, a distinction between the learning of motor skills compared to other skills is made in the first place. Based on these studies (i.e. Scheider and Fisk 1983; Connolly 1977; Hergenhahn 1988; Mixon 1980; Singer 1982), the archaeologist can now consciously trace specific error images in the material, which can be explained by the different stages of development. Among other things, a direct link between the error rate and the level of motor skills is detectable, since at the beginning of the learning process, each task is performed with full concentration under constant mental repetition of the necessary steps within the sequence. Only after several repetitions do the single steps join together in the brain to become sequences which can be retrieved at the next similar act, allowing the actor now to work more quickly (Schneider and Fisk 1983; Bamforth and Finlay 2008: 8; Minar 2001: 394). Thus, continuously repeated steps were linked in the brain to sequences of flowing movements that require no conscious control and are, therefore, regarded as automated actions – in archaeological theory as a body of knowledge, as tacit knowledge or as 'body know-how' (Wendrich 2012; 2006; Høgseth 2012; Sennett 2008; Apel 2007; Minar and Crown 200; Minar 2001; Costin 1995; Pelegrin 1990). Consequently, once automated, actions are hard to wean and remain preserved as a reflection of the social upbringing. Minar and Crown assumed that 'such activities as rolling fibers up the thigh instead of down, coiling pottery or baskets to the right or to the left' (Minar and Crown 2001: 373) are such kinds of automated actions, reflecting the social environment (see Minar 2001; Creese 2012; Connolly 1977; Hergenhahn 1988; Mixon 1980; Singer 1982).

Even neurological studies have come to a similar conclusion, namely that learned behaviour is unique and once acquired is difficult to change (Minar and Crown 2001: 374; Caine and Caine 1994). Such deeply rooted behavioural sequences can, over time, lead to an expression of stylistic 'micro variables' (Creese 2012: 57; Muller 1977: 25; Hill and Gunn 1977b: 1), which form a significant part of the craftsman´s *habitus*, and are observable for us.

Apparently, there is a close link between social influences and learning a craft. In other words, the social environment has an influence on the technologies and ways of working within a craft, and in particular the way in which craft is mediated, that should not be underestimated (Sillar and Tite 2000: 7; Bourdieu 1977: 87). The influence can result in technological decisions that cannot be explained by the observer. Thus, the different social influence on craft could be illustrated within the study presented by Wallaert-Pètre (2001) about the Dii, Duupa, Doayo and Fali in Cameroon (all these ethnic groups belong to a linguistic family). The study was mainly concerned with the differences in the production of ceramics and with the skills acquired through this kind of work. Dii, Duupa and Doayo are half Christian-animist and Muslim, whereas the Fali are predominantly Muslim. Within the Dii, Duupa and Doayo there is a close connection between forging and pottery, which no longer exists within the Fali since the Islamisation of the 19th century. The Fali differ in their social *habitus* compared to the other groups, which is also reflected within the craft. One of the most significant differences is the use of the left hand, which is frowned upon within the Dii and is a sign of evil. Working with the left hand is therefore suppressed from the stage of infancy with the help of iron arm rings. Within the training to become a potter, the use of the left hand is completely denied and the instructors are not able to judge correctness of the work performed by the left hand. Within the Fali it is allowed to work with the left hand and also within training the instructor is able to control the actions executed with the left hand and can thus rectify them (Wallaert-Pètre 2001: 485-486). The non-use of the left hand is irritating for the observer and can be regarded as absurd, not knowing the social background. If the left hand were to be integrated into the workflow this would have quite a positive impact on many activities. The presented behaviour is taught from infancy, and only explainable by the religious background of an apparently restricted ethnic group.

In addition to the psychological and physiological, approaches to learning behaviour can increasingly be found in the archaeological literature of ethnographic studies in which the above-presented theories are applied. This combination of theoretical models and ethnographic examination provide a very important source for archaeology, as they now show the variety of possibilities. Additionally, ancient written sources increase our understanding of prehistoric apprenticeships, including philosophical works,[6] training contracts of the Hellenistic and Roman Egypt, as well as signed artefacts that appear around 700 BC in Greece (Hasaki 2012). In terms of craft learning the thesis postulated by Sennett is to be taken seriously: 'in craftsmanship there must be a superior who sets standards and who trains...(because) no one working alone could figure out (how the things work)' (Sennett 2008: 54).

There are repeatedly within literature indications of a possible transfer of knowledge through self-study (Crown 2001: 452; Hasaki 2012: 194), it can nevertheless be assumed that within specialised craft there is teaching.[7] Several studies were able to

[6] Among other things, Plato reported in the 4th century BC about the way in which the potter's knowledge is shared (Hasaki 2012: 187-188).

[7] As already discussed in the first part of this research, specialised

show the importance of intensive training, as a short apprenticeship often results in unorganised operations and a significantly lower adaptability (Roux *et al.* 1995: 79; Crown 2001). As an example, Sennett postulates that, to become an expert, at least 10,000 hours of practical activity are required (Sennett 2008: 172; Stout 2002), although the general consensus also recognises that a craftsman never stops learning (Wendrich 2012: 12). The distinction of novice work and professional work is often difficult to make, due to the fact that poor-quality pieces are often destroyed, reused or re-processed, and in addition the most talented craftsperson does not continuously accomplish masterpieces (Bamforth and Finlay 2008: 7; Milne 2012: 126; Hasaki 2012: 172). Therefore, John Creese (2012) tried to extract characteristic features of novice and skilled labour through different experiments[8] that were based on work by James Hill (1977) and other archaeological research (see Milne 2012: 126-137; Bamforth and Finlay 2008: 6; Mills and Ferguson 2008; Miller 2012; Weedman 2002; Crown 2001). The identified traces are for this present study of particular importance and will be intensively examined later, since the existing material can be checked specifically for these errors/traces and thus otherwise rather neglected defects can be identified as a sign of unskilled labour. In addition Creese was able to confirm with the help of his experiment that the micro-variables linked to the motor skills of a person will change with increasing ability and clearly depend on the type of training (Creese 2012: 56).

How training was structured within Bronze Age society in northern Europe can only be assumed due to the lack of written sources. Within the current literature various models are discussed, from techniques taught through playing within the family, up to strictly structured authority systems, in which the hand of the teacher can lead the novices (Larsson 2008; Hayden and Cannon 1984; Bamforth and Finlay 2008; Wendrich 2012; Kamp 2001; Crown 2001; Molander 1996; Hasaki 2012; Miller 2012; Greenfield *et al.* 2000). In addition to the above-mentioned characteristic errors of novice work, Patricia Crown (2001: 464) documented the visible differences between different teaching situations on the material. During her study on decorated ceramic forms of the Mimbre and Hohokam in New Mexico (between 700-1500 AD), she worked out crucial differences within the ceramics of one region by means of ethnographic comparisons. She saw a tight connection between the training situation and the finished pieces. For example, within the ceramics which were crafted under the supervision and guidance of experienced teachers, a significantly smaller deviation in style and execution was documented than within the pieces created within a free, non-guided training situation (Crown 2001: 464).

In the archaeological and anthropological literature various concepts of knowledge transfer within prehistoric societies are discussed, including that of 'communities of practice'. A 'community of practice' is defined by the presence of differently skilled craftsmen, of different crafts, who learn and work together and share their knowledge and pass it on. This group of interest is strongly influenced by the social environment and consists mostly of related crafts (Wenger 1998; Minar 2001; Cooney 2012). As Wenger (1998: 45) writes: 'We interact with each other and with the world and we tune our relationships with each other and with the world accordingly. In other words, we learn....this collective learning results in practices that reflect both the pursuit of our enterprises and the attendant social relation...property of a kind of community created over time...therefore, to call these kinds of communities, communities of practice.'

After Minar (2001: 392), a 'community of practice' can be formed by an ethnic group but also by a specific social group. With respect to the above-discussed properties of human learning, such a learning community would be able to take into account all stages of motor-development by distributing the necessary tasks and in addition give the possibility to reinforce just such motor skills by imitation (see Minar 2001: 393; Ryan *et al.* 1986). As an example, a case study of Magdalenian flint production in the Paris Basin, Pincevent (Seine-et-Marne), showed that three determinable quality groups could be determined within the material found. One of these quality groups represented products which apparently were only made for the acquisition of specific skills and were not of the usable material (Karlin and Julien 1994: 162).

Within family structures there seems to be another motivation behind the learning of a craft. Many ethnographic studies are primarily concerned with the learning of practical skills during childhood and confirm the developmental learning processes presented above. Hélène Wallaert shows in study of pottery crafts in Cameroon and New Mexico, in particular, the relationship between the learning of social skills and craft skills, such as the fact that they can occur only within a family network. In addition to strictly organised training, which is carried out in different stages matching the motor skill level of the girls, the real goal is the mediation of social rules and conventions (Wallaert 2012: 38).

craft is defined as a reduced repertoire of crafts executed. For example metalcraft is seen as specialised craft in contrast to the different crafts that are used within a household, i.e woodworking, smithing, farming, and cooking.

[8] The experiment was carried out with the help of eight students from the University of Toronto, who were divided into two groups, and were advised to draw always the same line pattern on a total of 15 clay pieces. The operation was instructed differently and the deviations on the ornaments with respect to the increasing skills over time were documented and evaluated (Creese 2012: 48-56).

Written sources confirm that, in archaic and classical Greece, the transmission of craft knowledge was going on mainly within family and kinship structures (Hasaki 2012: 191), supporting the above-developed thesis. Direct evidence that similar structures prevailed in Bronze Age Greece is not available. Such evidence as could be used as a direct analogy to possible structures in Bronze Age northern Europe, however, does not exist to date.

For the European Bronze Age, therefore, the only possible sources that allow conclusions on the nature of training in craft are the Late Bronze Age Linear B tablets from Knossos. These tablets confirm the contribution of children to their making. Furthermore, it can be speculated that novices contributed within the production of Minoan conical cups (Hasaki 2012; Knappett 1999; Sjöquist and Åström 1991).

The characteristic features for novice and professional work mentioned above, that could be defined using experimental and ethnological studies, and based on the physiological and psychological models of the development of motor skills, are an excellent repertoire from which this current research will draw.

3.1.4 Style and technology

As already touched upon in the previous sections, the development of motor skills is closely linked to the expression of individual characteristics, which are summarised in the *habitus* of every craftsman, and which are resulting micro-styles. The studies presented in this section should not be another fundamental discussion on the topic of style and its position and importance in archaeological research. This was already considered in detail by S. Plog and a decade later presented by M. Hegmon (Hegmon 1992; Plog 1983).[9] The research discussed next is concerned primarily with the creation of style (formal and decorative style), with the degree to which style is part of the *habitus*, with the development of different styles and with the significance behind the development of micro-styles.

The creation of style within craft is closely linked to technological choices and the way in which technical knowledge is passed (Wendrich 2012: 5; Lemonnier 1992: 89). The aspects of style, however – which part is represented by the form, the function, or only a subsequently attached ornament, or, indeed, a mixture of all three functions – are debated heavily in literature and here only presented briefly. For some, the shape of an object, and all of the properties that comprise the object, are socially conditioned, while style is an applied element attached after completion of the actual artefact (Berg 2007; Binford 1965; Dunnell 1978).[10] Through this, the same authors also support the concept that technological choices are to be regarded as cultural choices that have taken shape within the artefact (Berg 2007: 235; also Lemonnier 1993: 14-23; Collins 2012: 323). That will mean that the style would have been incorporated already in the shape and form of the object due to these cultural choices, because, as Hughes shows, those choices culminate in adaptation to the environment (be it geographic, or technological) in a new style (Hughes 2012: 61). Furthermore, geography can also be the founder of a technological style (Hughes 2012: 63). In other words, variations in different features of an object should be considered as the mirror of different aspects of economic and social behaviour of a group (Costin 2000: 383; Ingold 2000: 347).

That style is a carrier of information is recognised within archaeological research ever since Wobst´s 'information-exchange' theory (Wobst 1977; 1999). However, whom the recipients of the transmitted information are, whether they are intended for people who do not know the person sending the information (i.e. Wobst 1977), or if the smallest variables in the style possibly are used as an information carrier within kinship groups (David *et al.* 1988: 378; Hodder 1988; 1982: 55; Wiessner 1983: 257; Sackett 1990: 33), has been much discussed in archaeological and anthropological theory. As a preliminary conclusion, the statement expressed by Michelle Hegmon (1992: 521) can be taken: 'Material, visible only in private is more likely to convey messages about ritual or belief systems, whereas highly visible material often indicates group or ethnic boundaries.'

In addition, however, the observer should also be aware that artefacts can have several stylistic features, and these often have diverse backgrounds and statements, a consensus found among today's researchers. The connection between style and technology is also no longer questionable. In the 1980s, Sackett presented his concept of 'isochrestic variation' (1982: 105; 1985; 1986) that shows, in fact, that stylistic variation can also be caused by different technological choices. Additionally, even within technological gestures there lies the potential to create style (Lechtman and Merrill 1975).

[9] However, some studies should be mentioned which contributed important aspects to the discussion of style in archaeology (Binford 1986; Conkey and Hastorf 1990; Dunnell 1978; Muller 1971; 1977; Prown 1980; Sackett 1973; 1977; 1982; 1985; 1986; 1990; Wiessner 1983; 1984; 1985; Wobst 1977; 1999), or presented different aspects of style in a regional and specific manner (Asingh and Rasmussen 1986; David and Kramer 2001: 168-224; Miller 1985: 51ff.; Miller 1994; Rønne 1987; Vandkilde and Olausson 2007: 7-10). Further, of interest for this study are also the studies concerning technological style (i.e. Lechtman 1996; 1977; 1984; Lechtman and Merill 1977; Lechtman and Klein 1999; Gosselain 1992; Hegmon 1998; Hegmon *et al.* 2000).

[10] The vast majority of studies on style (as well as regarding many other craft-oriented theoretical subjects) is engaged in the production of ceramics and clay artefacts. In this work an attempt is made to express the theories developed so far as it is universally possible.

Representatives of the 'New Archaeology' saw in the decorations of artefacts primarily information which could be decoded (see Schiffer and Skibo 1987). In a similar direction is Lemonnier's assumption (1993: 10) when he postulates: 'variations of shape and decoration which are of little material consequence ...are conveying a message'.

However, ethnological studies were concerned with the emergence of such subtleties within styles, especially on ceramics, and have come to the conclusion that they are not always consciously used as a means of communication. As such, meaning as an information carrier for observers outside the social realm is not the only possible meaning within a stylistic feature limited to an ethnic group. A locally spread decorative element can also exclusively serve as an internal factor for recognition within a group of craftsmen, or it might be a sign of unskilled labour (MacEachern 1998; David *et al.* 1988; Hodder 1988; Kintigh 1985; Longacre 1970). The training situation, especially (see above), has a great effect on the creation of style (Wallaert 2012; Longacre 1991; Graves 1985; Graves 1982; DeBoer 1990), although this should also be investigated in a context-oriented process (Hegmon 1992: 526). As already discussed, within family, or strictly hierarchically organised systems, in which a close relationship between students and instructors exists, the objects produced are virtually error free. This is due to the fact that errors will be corrected by the experienced craftsmen (the 'four-hands-on-the-loom' method, according to Greenfield (2000)), and thus the items crafted appear closely aligned to one style. In such strictly organised systems, a variation in style is mostly associated with different teachers or families. As an example, Hardin was able to point towards a strong connection between a style and teacher at the Zuni, Pueblo (Hardin 1991). In contrast, high style variability is closely associated with a training situation based on trial and error. In such a system, in which the novice becomes familiar with the craft through trial and error, innovations are more likely because the individual steps are probably presented, but, however, not corrected if they are not performed correctly. As Miller (2012) was able to show, it is precisely the change from traditional controlled training conditions to communities of practice which causes an increase in the variety of styles (Miller 2012: 226; also Greenfield *et al.* 2000). Further studies, such as those of M. W. Graves (1985) also noted such variation in the ceramics of the Kalinga (northern Philippines), which could not be equated with the individual production communities, but possibly could be explained with the training relationship.

A conclusion which can be drawn from the many ethnographic studies is that stylistic behaviour[11] is created during apprenticeship and can be changed later by external influences (Wallaert 2012: 22). In other words, form-generating processes are, within a work sequence, stylistic (as they are passed on in training), and this basic stylistic *habitus* can be changed by new technological innovations, by a change of the social environment, or even by fashion.

The quick association of style and decoration may be due to the fact that in the decoration of an object a visible change can most rapidly be made. Here is also the greatest potential for innovation and, therefore, the creation of new styles (Basalla 1988: 104; Minar 2001: 390; Miller 2012: 226). Thus we can suggest that the potential information an artefact carries occurs on several levels and that the highly visible stylistic attributes most likely contain the information related to the direct identification of a social group (Minar 2001; Wobst 1977: 321; Hegmon 1998: 265). However, the style of an artefact usually carries not only the information concerning the social grouping in which the object was created, and the technological and organisational peculiarities, but in most cases it also bears information concerning the person who created the piece. As Wobst (1999: 121) says: 'Style can be seen as reflexive and discursive, saying as much about the individual as it does about the social group...style always talks loudly about individuals.'

[11] Wobst (1977: 321) suggested that stylistic behaviour is a strategy of information exchange where messages are transmitted through the shape and decoration of artefacts and these messages are received and read.

Chapter 2

The craftsperson’s *habitus*

In this chapter, the meaning of *habitus* is defined: the roots of the term are illuminated, and based on this, attempts are made to transfer the concept to craft in general and Bronze Age metalcraft in particular. The idea, that the *habitus* of a craftsman can be seen as a mirror of the technological knowledge of a group frames the *habitus* within the context of tradition as also the body of knowledge a specific technicians uses. Thus, the *habitus* is formed through the learning process and the direct transfer of gestures and steps by imitating others. As such, tacit knowledge is transferred and the traditions and ideologies are handed on. However, the way in which knowledge is received by the craftsperson is not solely responsible for the personal aspect of the *habitus*.

The taste, the sense for style and curiosity shape, in addition, every individual’s *habitus*, and make it individually. To identify individuals in craft, several aspects that form the *habitus* are to be investigated separately, such as the phenomenon of automated actions, as here individual style is expressed. Furthermore, this chapter will address the aspect of training, as first repetition allows the establishment of automated actions. The perfect collaboration of tacit knowledge, automated actions and individual ability is an indicator of the skill of the craftsperson. Much of the repertoire of automated actions, knowledge and skills cannot be explained and only be acquired through face-to-face actions and imitation. This part of the ‘body of knowledge’ represents the fingerprint of the craftsman and can be traced in the material through micro-stylistic deviations in operational sequences. Technical traditions differ from region to region due to differences in group ideologies, training activities and, occasionally, religious beliefs. As the *habitus* is thus fed by the technological traditions living within the group, the craftsperson´s work will mirror the named differences already on a macro-scale.

3.2.0 The explanation of ‘inexplicable action’

In the development of the *habitus* concept by Bourdieu the body played an important role as a tool of expression of cultural aspects (Bourdieu 1977; Wendrich 2012: 3; Mauss 1979). In craft, individual behaviour is expressed in the tool traces, variations of the decoration, or in repairs. However, only when *habitus* is seen as a combination of the craftsperson’s capabilities with the experiences and imprinting[12] that happens to every craftsperson within his/her life, is the concept suitable for the explanation of underlying behaviours in craft. The definition of the *habitus* of a craftsman by Wendrich was based on Panofsky’s (1951) basic idea that making was connected with the ‘Zeitgeist’ and the surrounding influences, and on the aspect of imprinting, which Mauss connected with the development of the *habitus* (Mauss 1979: 101). Wendrich (2012: 3) defines it thus: ‘[The] term habitus (the manner of carrying or conducting oneself) denotes the embodied culture, which includes such aspects as skills, habits, style, and taste, as well as one´s history and experiences.’

This combination of knowledge, skill and ability was also used by Dobres (2000: 138) for defining the *habitus*: ‘the body of knowledge technicians use is the part of the craftsman´s habitus that is framed within the context of tradition.’

Consequently, the *habitus* of a craftsman can be seen as a mirror of the technological knowledge of a group due to the fact that, through the learning process and the direct transfer of gestures and steps, traditions and ideologies were handed on. Accordingly, this technological knowledge creates the frame of the *habitus* (Figure 3.001). The individual aspect is given by the craftsman’s skills and his abilities to receive and process knowledge. Knowledge, which is only received and internalised by imitation, is known as ‘tacit knowledge’ (Kosz 2007; Polanyi 1966; Schanz 2006; Nonaka and Takeuchi 1997; Høgseth 2012; Collins 2012; Ray 2009). Tacit knowledge provides a significant part of the individual *habitus*, since it is bound by the structures and mechanisms of the body. However, it can change and adapt to new circumstances continuously (Polanyi 1966: 9ff.; Kosz 2007: 30-31; Sexl 1995: 24-26; Ray 2009: 11; Ingold 2000: 360). The techniques that will be mediated by the craftsperson during his/her training are part of the technological tradition of the specific society. However, tacit knowledge is more than just the adoption of these technologies: it is the internalisation of this knowledge and the feeling for the situation. This personal or individual part of the *habitus*, which includes tacit knowledge, can in certain ways be compared to the ‘body of knowledge’ (Dobres 2000: 138; Roux *et al.* 1995: 65; Wendrich 2012). However, an even better correlation can be found in the concepts of ‘know-how’ (Apel 2007: 8; Karlin and Julien 1994: 156-162; Høgseth 2012: 65; Pelegrin 1990: 118), motor know-how (Pelegrin 1990: 118; Minar 2001: 395; Costin 1995: 622; Creese 2012: 48; Wallaert-Pètre 2001: 481), and in anticipation (Sennett 2008: 154; Caine and Caine 1994: 5). All of these terms describe the conversion of a learned and imitated knowledge in craft which is, through repetition, deeply ingrained in the body and becomes

[12] The German term ‘Prägung’ cannot be transferred exactly into English. Therefore the chosen term ‘imprinting’ should be understood as the influences (all kinds of) that changed the craftsperson’s way of doing things. Willingly or not the actions he/she learned are deeply ingrained and become habits.

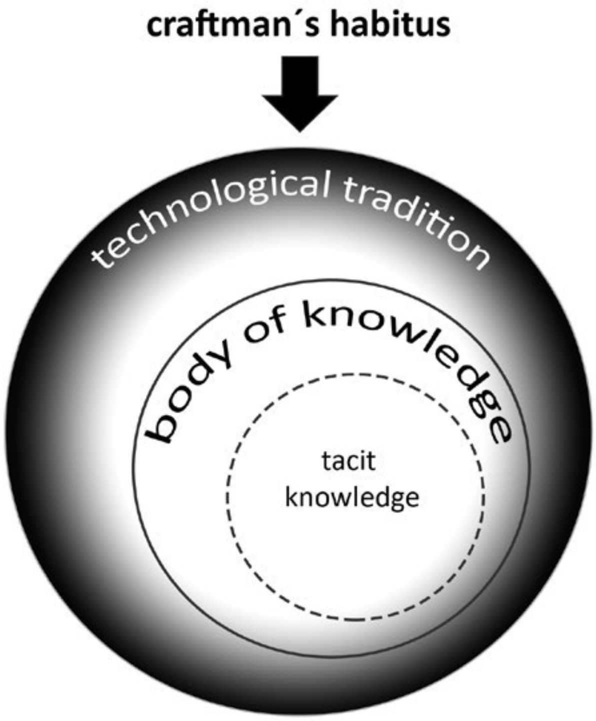


Figure 3.001: The scheme displays single components of the craftsman's *habitus*.

part of the person. Actions executed out of the repertoire of automated knowledge cannot be explained at the moment when they are used. Individual areas can also later only partly be put in words: they all represent tacit knowledge. Additionally, they are part of the *habitus*. However, the way in which knowledge is received by the craftsman is not solely responsible for the personal aspect of the *habitus*. Additionally, taste and the sense for style and curiosity (which may lead to innovations) shape the individual part.

The concept of the *habitus* of the craftsman is the theoretical access to explain why things are done a certain way. All the unexplainable actions executed during making (see Wendrich 2012: 93-94; Minar 2001: 388; Høgseth 2012: 84) seem so logical when done, provide the embodied knowledge of the craftsman, and are part of his/her *habitus*.

3.2.1 Body of knowledge and 'tacit knowledge'

Apart from the technological traditions of a society that influence the craftsmen (and create the frame of the *habitus*) there are several aspects that shape the individual aspect of the *habitus*, including the unconscious actions. In the following the creation of this 'body of knowledge' (Dobres 2000; Roux *et al.* 1995) and tacit knowledge (Polanyi 1966) are looked at and an attempt is made to explain the unexplainable. It should be clarified why intuitive and unconscious behaviour shapes the individual aspect of the *habitus*.

The already-mentioned phenomenon of automated actions is a concept often used in art history in order to identify individuals (Berenson 1962; Panofsky 1981; Muller 1977). According to Berenson (1962: 129), individual style is especially expressed in situations that are performed more intuitively than consciously controlled, or: 'that the artist tends to fall back into habitual or conventional patterns when painting items he considers to be unimportant – in Italian painting, the ears'.

Such habitual actions are part of the *habitus* of a craftsman. Techniques, actions and the choice of the tool, operational sequences, as well as specific gestures, once learned, become what amounts to a part of the body through endless repetition. Similar to the way in which one signature differs from another, motor actions also differ (Muller 1977: 27). Projected onto the material examined, the different 'signatures' would be visible in slightly different steps within an operational sequence of, i.a., Mecklenburg-type neck collars.

At this point, the important difference between the 'body of knowledge', which contains the entire repertoire of internalised behaviours, and 'tacit knowledge' must be explained (see Figure 3.001). Characteristic, and in many places the definition, of tacit knowledge is the fact that its origin seems inexplicable. Attempts have been repeatedly made in research to explain this inexplicable phenomenon (i.e. Polanyi 1966; 1958; Sexl 1995; Kosz 2007; Hill and Gunn 1977b). One of the best trials was presented by Botwid (2013). She examined an Iron Age pottery find from the perspective of a professional craftsman and defined the core of the unconscious part in a craft work with the help of colleagues: 'It´s that point where you stop trying to do a thing... (the teacher) sees when it´s happening, and then we don´t need any words...' (Botwid 2013: 34).

When passing on knowledge, the relationship between teachers and students (between technique and the performing agents) is crucial. Although tacit knowledge cannot be put into words and cannot be explained on the basis of rules (Wendrich 2012: 93-94; Høgseth 2012: 65; Kosz 2007: 27; Polanyi 1958: 88), it can still be copied by imitation (Kosz 2007: 42).

The automated knowledge that is joined in the 'body of knowledge' includes tacit knowledge, but also includes the parts that are quite explainable as techniques and 'tricks'. Appropriate ways of working, hand postures and gestures are experienced through practice and repetition, and can be performed at a certain point without thinking; they are automated (Sennett 2008: 154; Minar 2001: 395; Costin 1991: 622; Dobres 2000: 110; Apel 2007: 9; Hill and Gunn 1977b: 2).

The personal signature (see Muller 1977), that is imprinted on all techniques and knowledge incorporated while creating the body of knowledge, forms the crucial part of the individual *habitus* of the craftsman. One of the clearest examples is that of a piano player, as illustrated by Polanyi (1958: 51). It clarifies that perfect tone is interlinked with the manner in which the key is touched, and this 'feeling' cannot be copied. Technique and practice might be on the same level, but the difference lies in the way in which the key is touched (see also Kosz 2007: 27).

The perfect collaboration of tacit knowledge, automated actions and individual ability is an indicator of the skill of the artisan (see Botwid 2013; Budden and Sofaer 2009).

The above-mentioned technological tradition of specific social groupings causes operational sequences for the production of artefacts that are formed by the rules and traditions of the group. The craftsman unknowingly takes this technological tradition on. It becomes part of the *habitus* through participation in social life (see Wolfe 2013: 56; Karlin and Julien 1994). The extent to which the individual part of the *habitus* may be similar between different individuals (with the body of knowledge and tacit knowledge) is directly connected to the situation in which knowledge is acquired.

In a face-to-face situation, which is essential for the learning of tacit knowledge (see Botwid 2013: 34; Kosz 2007: 28), the amount of similarity between the crafted objects will be pronounced, and the individual is only identifiable by micro-stylistic deviations. Objects crafted in a non-personal teaching situation may vary much more, here major deviations between the novice piece and the teacher's piece are probable (see Chapter 3.4.1). If tool movements, gestures and steps are only rudimentarily conveyed, a large degree of internal activity is required, which results in different gestures.

Back to the material, such micro-stylistic deviations that point towards the individual (see Hill and Gunn 1977a) would be visible in an occasional reversal of steps within the above-mentioned sequence for the crafting of Mecklenburg-type neck collars. Were this sequence to have been independently developed, as for example while copying an object, then the techniques used, and thus the visible traces, would differ. Due to the material properties and individual interdependent steps within an operational sequence there is, in sequences of similar objects, only limited variation possible. However, specifically the Mecklenburg-type collars demonstrate a breadth of techniques used that are believed to have originated from different degrees of information exchange.

Also, concerning the repair of objects, the individual craftsman's 'body of knowledge' is visible (see Sennett 2008: 199). While repairing an object, the craftsman must respond to a situation without resorting to processes experienced, and will subconsciously take the appropriate steps. Accordingly, the *habitus* is reflected in the execution of a repair (i.e. Hardin 1977; 1991). On the material being studied in this present study, it was possible to trace different technological traditions within the way a repair was executed; furthermore, references to individual behaviour could also be obtained.[13] A repair requires imagination, technical knowledge and an understanding of the material which, Sennett (2008: 248-249) suggests, distinguishes the expert: 'the expert...a person who had developed analytic powers that could be applied to any field ... today an expert is seen as someone who can equally make and repair.'

Transferred to the investigated material, two types of repair on artefacts could be documented: (1) the repair of broken spikes on belt plates, and (2) the repair of broken end plates on collars. Interestingly, only a few variations show up in the execution of this repair. The spikes of the belt plates are either connected again with the plate by using the cast-on technique, or have been attached with the help of staples (Figure 3.002). Concerning the end plates, one other variant occurs in addition to the possibility for reworking and smoothing the breaking point and the insertion of holes as a replacement for the end-rolls. Here, the broken parts are placed onto each other (slightly overlapping) and connected with staples (Figure 3.003). Mapping the few variants illustrates the relationship of the chosen technology with the technological traditions of a larger social unit (MAP 23). In particular, the distribution of the dominant methods for repairing broken end plates (rounding and punching holes as opposed to attaching with staples) shows two distinct regions that repeatedly attracted attention because of deviant behaviour – northern Germany and Jutland. The uniform use of a specific technique on the Danish mainland (Jutland) suggests an intensive exchange between the different workshops and also, in a similar way, of craft training. Likewise, an exchange of techniques can be assumed between central Lower Saxony and Zealand as a result of the use of staples in repairs. Interestingly, the staple with which the collar from Soltau is repaired is attached vertically, whereas on Zealand staples are placed horizontally and commonly in a large number (Figure 3.003).

Since we can only work with the end products of prehistoric craft technical behaviour (Muller 1977: 23),

[13] In this case it is useful to talk about 'analytical individuals', who can be specific individuals but also individuals working in a workshop with a similar technical repertoire and following similar gestures. Through the traces left on the material a distinction between the specific individual and a group of people working in close relationship is difficult to achieve (see Muller 1977: 25; Redman 1977: 44), however, in some situations it is possible to define a single individual.

Figure 3.002: Repairs require imagination, skill and a great amount of knowledge. The plate shows two examples of the repair of broken spikes on belt plates. A) Belt plate from Frankerup, Sorø Amt (NM CMXIII) was repaired with the help of staples. B) Belt plate from Grabow, Mecklenburg (ALM LI H16) was repaired via cast-on.

we can only assume the scope of the tacit knowledge of the craftsperson. Due to the personal way in which every human being organises gained knowledge, internalises the same, and, if necessary, converts it (Kosz 2007: 4; Nonaka and Takeuchi 1997: 72; Sexl 1995: 25; Polanyi 1966), stylistic variations occur on the artefact which are indicators of the individual; and 'sometimes more or less than one actual person' (Muller 1977: 25; Redman 1977: 44).

It is the differences in artefacts that are, *prima facie,* similar that allow the modern researchers an insight into the prehistoric craftsmen's knowledge (see Hill and Gunn 1977a). These differences are grounded in

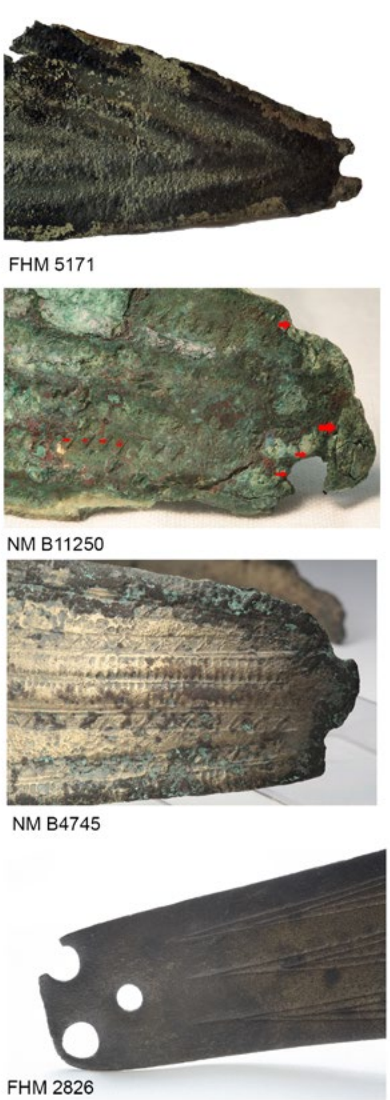


Figure 3.003: The examples show different possibilities for repairing collars. Collars from Ballemose, Viborg Amt (FHM 5171); Bustrup; Viborg Amt (NM B11250); unknown site probably in north Germany (NM B4745), and Sulsted, Ålborg Amt (FHM 2826) were repaired with additional holes. The collars from Ferslev, Frederiksborg Amt (NM B4237), Soltau, Niedersachsen (LMN 14156) and Secklendorf, Niedersachsen (ML H107) were repaired with the help of staples.

the individual part of the *habitus* of the craftsman, which includes the 'body of knowledge' acquired by each craftsman. Much of this repertoire of automated actions, knowledge and skills cannot be explained, and can only be acquired through face-to-face actions and imitation. This part of the 'body of knowledge' represents the fingerprint of the craftsman and can be traced in the material through micro-stylistic deviations in operational sequences.

3.2.2 Learned and adopted technical behaviour

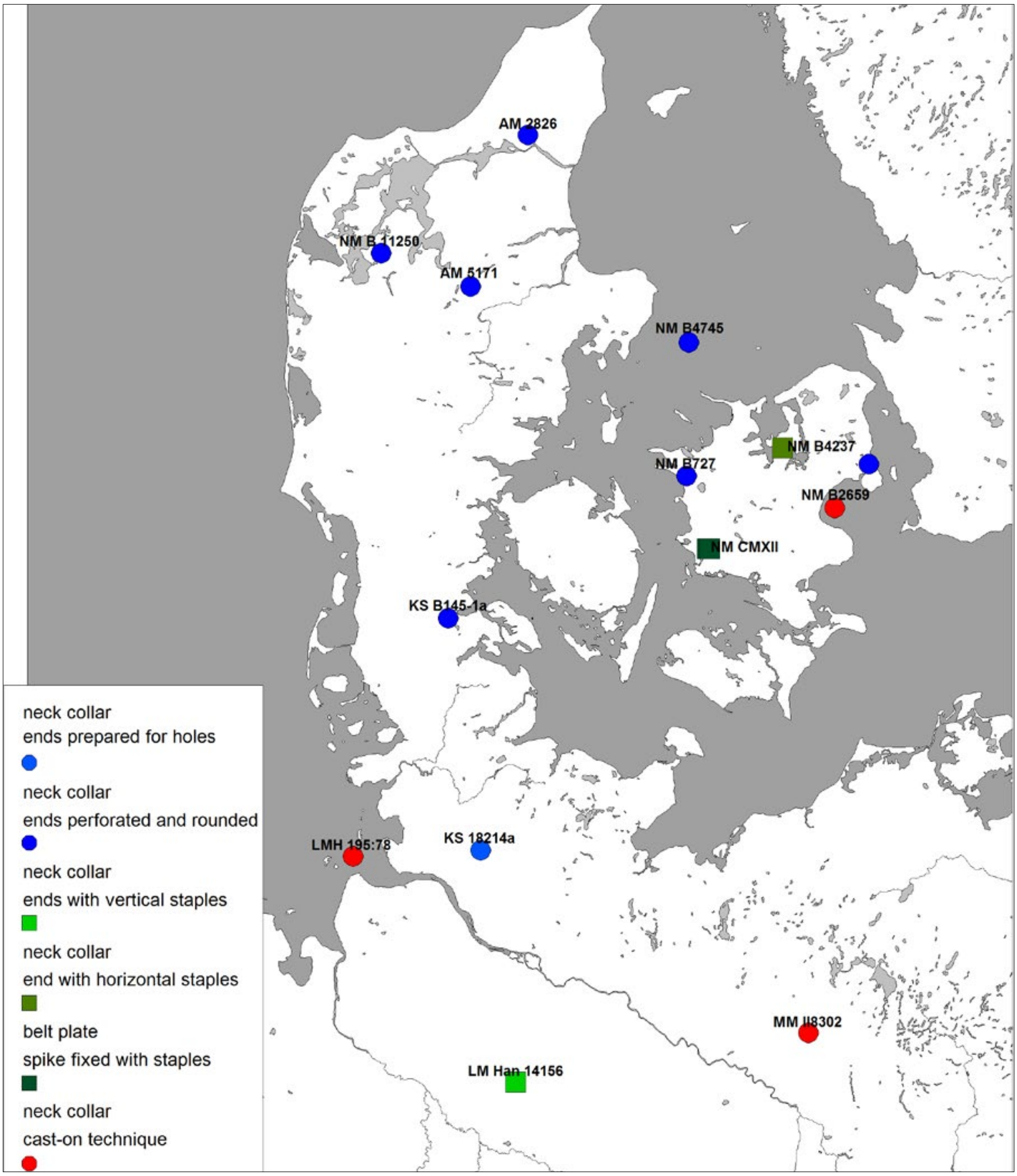
Having gotten close to the individual aspects of craft action, it is additionally necessary to discuss the framing parameters, i.e. the technological traditions that are passed on from generation to generation to every craftsperson by his/her mere presence and participation within a social group. As craft requires training and guidance by reason of the proportion of tacit knowledge that must be experienced (Kosz 2007: 4; Nonaka and Takeuchi 1997: 72), these social parameters are given during training especially. Sennett (2008: 54) refers to it as: '[In] craftsmanship there must be a superior who sets standards and who trains...(because) no one working alone could figure out (how the things work).'

The fact that in the material culture of the northern European Bronze Age no evidence of a continuous invention of the same techniques can be documented, a specific, organised, training of novices can be inferred.

What impact has training on the development of the *habitus*? As already noted, the *habitus* applies as a combination of personal and cultural dispositions, and is expressed in behaviour and appearance of a person (Bourdieu 1977: 72ff.; Wendrich 2012: 3). An important aspect is the mutability of the *habitus*. New influences, experience, practice, and a change in the social framework lead to its constant change (Bourdieu 1977: 72-95; Wallaert 2012: 21-22). According to Mauss, there are two basic points that are responsible for the formation of the *habitus*. One is the imitation of others (including tacit knowledge), the other is training (Mauss 1979: 97; Farnell 2000: 401; Bamforth and Finlay 2008: 9).

Despite the manner in which training is carried out (the options are described in detail in Chapter 3.4.0), while training, next to techniques, the sense of style and right and wrong practices within the society are also mediated (Dobres 1999a: 127; van der Leeuw 1993: 240; Sillar and Tite 2000: 16; Leroi-Gourhan 1988; Dobres 2000: 138). In other words, the technological traditions of the surrounding social group are mediated.

This also includes actions whose execution or rejection is justified by religious views (Dobres 2010: 106; Ottaway 2001: 95; Minar 2001: 392). Accordingly, potters from



Map 23: Different kinds of reparation detected on artefacts during NBA II and III.

Golkonda or Kirasta Velar in India will not use a different method than firing clay in kilns (Mahias 1993; Behura 1964b: 37; Lemonnier 1993: 165). The potters of the Dii in Cameroon perform their work without using the left hand, as this is a sign of evil (Wallaert-Pètre 2001: 485). The spinners of the Navajo in southwest America believe that only yarn spun towards the body brings happiness to the spinner (Minar 2001: 392; Thomas 1996; O'Bryan 1956). All of these actions are deeply rooted in the traditions of the groups and anchored in their faiths; they are passed on from generation to generation, although a change in this behaviour would have a positive impact on the technologies.

One characteristic of the craft is the slow and continuous learning of the individual elements until they become a habit (Sennett 2008: 265; see also Mahias 1993: 165; Dobres 2000: 137). It is this aspect of habit (nothing else amounts to automated actions) that should be seen as the framing part of the *habitus* of every single craftsman, here the tradition of a grouping lives on. A once-adopted technique that is incorporated into the communal memory is not readily changed (i.e. Larsson 2008: 86; Minar and Crown 2001: 373; Mahias 1993: 165). In most cases one technique leads to another, and accordingly a fixed sequence exists (see Chapter 3). However, the craftsman also contributes to the expression of technological traditions (Zagal-Mach 2008: 188), by ability he/she is responsible for the evolution and developments of techniques.

Since, however, belief, religion and habits may vary between different groups, this is also reflected within technological traditions (Pfaffenberger 1993: 344; Minar and Crown 2001: 393; Wallaert 2012: 20). Conversely, if a strong change, in terms of technology, is visible in the material then some social restructuring may be probable (van der Leeuw 1993: 240; Minar and Crown 2001: 370). A similar situation could be recognised at the transition from the Neolithic to the Early Bronze Age with the appearance of new types of weapons in a new material (i.e. Vandkilde 1996). However, even smaller changes would be recognisable in the artefacts and in the order of steps necessary for their crafting (Martinón-Torres 2002; Wallaert 2012: 20; Arnold 1975).

The *habitus* is thus fed by the technological traditions living within the group. The way the information is recorded, combined and embodied constitutes the personal part of the *habitus*. Accordingly, techniques and their combination (in an operational sequence) are to be regarded as identifications of social units. Within the examined material a variety of different techniques was documented, partly as the solution for one and the same problem, and thus represented indicators for technological traditions.

A feature for the identification of social units with a different technological repertoire is the use of the lost-wax method in the making of decorated ornaments, relative to other casting techniques. Sprockhoff made clear a difference between northern and southern Europe (Sprockhoff 1940: 28). The investigations executed in the current work confirmed the view expressed by Sprockhoff's hypothesis of a dominance of lost-wax casting in the core zone of the Nordic circle (see Chapter 2.5.5; MAP 11). Additionally, this investigation suggested that castings in two-part moulds, as well as pure cold-working, are represented in strikingly high numbers, although, however, concentrated in the southern part of north Germany (Lüneburg Heath and west Mecklenburg). Especially, the use of one-side moulds in central Lower Saxony makes the contrast in the technological orientation compared with the rest of the Nordic circle clear.

Furthermore, the placeholders needed for the crafting of the eyelet on small belt discs are different from region to region and can be cited as an example of different technological traditions. Within the area of interest, mostly organic placeholders are to be found in northwest Germany; in northeast Germany, additionally, ceramic cores; and on the Danish islands there are finds of ceramic cores, organic placeholders and cast-on eyelets; each of these techniques with a regionally distinct focus (see Chapter 2.8.2; MAP 18).

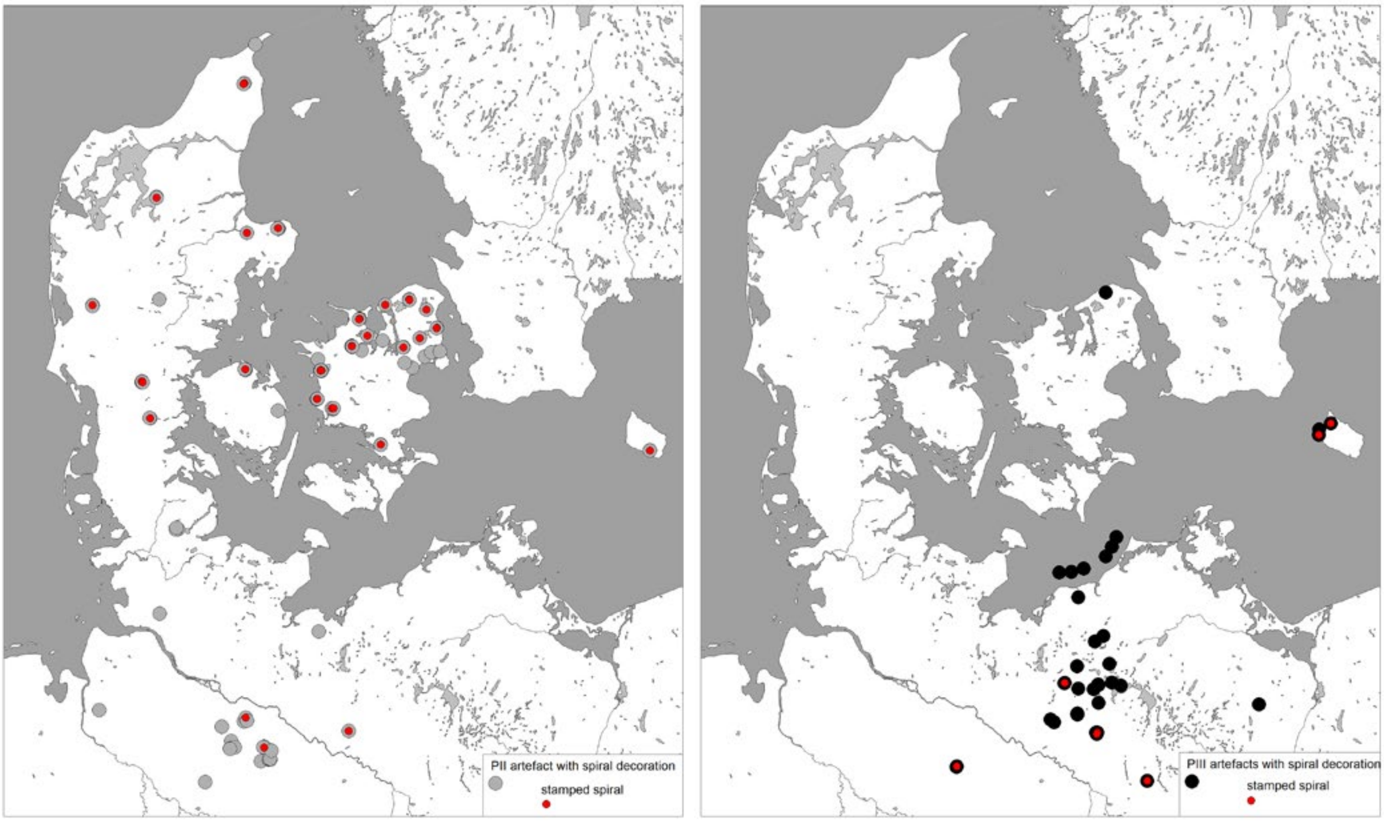
Additionally, the use of spiral-stamps should be explained by technological tradition. A high diversity there of techniques used to make spirals could be traced (as decorative elements on bronzes), as shown in the second part of this current research (see Chapter 2.4.2). Use of spiral-stamps in the making of spirals is not, as initially assumed, associated with the use of the lost-wax process. Rather, the distribution of this special technique should be seen as a connection to a cultural grouping (MAP 24). The intensive use of spiral-stamps in Jutland and northern Zealand during the NBA II is striking, while apparently in the south the artefacts were spiral-decorated using other methods. At a similar stage in north Germany a concentration of this technique is apparent south of the Elbe, and during NBA III in southwest Mecklenburg many objects were also decorated with spiral-stamps.

Technological traditions are to be regarded as indicators of different social groups. In the present material the regional differences (technological traditions) are apparent, identified through the regional use of spiral-stamps, a regionally specific technique to attach and form eyelets on belt-discs, and the basic casting technique used. Even micro-regional different technological traditions should be assumed. Here, especially, deviations in rule-based operational sequences (objects within object groups) can illustrate individual features.

3.2.3 The influence of social environment on craft and crafting

The development of technological traditions in an area takes place in a slowly progressive process. Once the techniques contained in this repertoire are integrated and internalised a change to other techniques is unlikely (Connolly 1977; Mixon 1980; Singer 1982; Minar 2001; Creese 2012; Larsson 2008; Minar and Crown, 2001). Larsson (2008: 6) expresses in simple terms why in craft, especially in the crafts whose perfection requires a high degree of skill and practice, an aversion to innovation exists: 'Few potters like to take chances with a proven process: this means the work is too hard for the easy adaption of new techniques.'

Nevertheless, innovations also exist in crafts that are most directly related to a change in the social environment (Creese 2012: 43; Kuhn 2004: 561). Changes



Map 24: Distribution of spiral decorated artefacts with a special labeling of the pieces which are made in stamp-technique.

in the lifestyle of the people, within their religion, or economic position, are reflected in the organisation of the craft, especially in the teaching of crafts (Miller 2012: 226).

Therefore, the adoption of new technologies is gradual. The affected craftsman has to deal consciously with the new technique, in its execution the craftsman's motor know-how remains unused and the work requires more concentration, control and time (Minar and Crown 2001: 373).[14] Thus, the study and involvement of new techniques mean a change in the *habitus*.

The key factors leading to the acceptance of new techniques, and in a second step to new technologies within a society, are explained by Miller (1985: 186) in his emulation model (Figure 3.004). Here, the driving factor is the desire of a minority for social differentiation. Motivated by this desire new forms and technologies are introduced into a society. Once the new form has been established, the new technique accepted and spread, the desire arises for a re-differentiation. This can lead to a local modification of the new techniques and the adoption of new technologies. Such a process may contribute to the change of technological traditions, once the new techniques are anchored in the local memory.

Also transferred to the metalcraft of the Bronze Age, it should be assumed that the social elite greatly influenced the development of metal technology. Within the investigated material, the effects of various influences can be identified at the macro as well as at the micro level. Amongst other things, the development of neck collars in the periphery of the Nordic Bronze Age (northeast Germany), which took place around a time (NBA IB) when social restructuring had just occurred (see Vandkilde 1996; Harding 1984; Gröhn 2004: 101ff.; Kristiansen 1989; Larsson and Lundmark 1989; Sherratt 1981: 298), can clearly show the direct influence of two technological traditions. The bronze and gold artefacts occurring in NBA IB are in the research unanimously attributed to be the material culture of a socially higher-ranking group of people, which had exchange networks that even allowed the possession of the still rare metal – bronze – in areas where no local copper resources were available (see Ling *et al.* 2012; Ling *et al.* 2014). In Poland, northern Germany and Scandinavia, lunula-shaped bronzes (neck rings and belt applications) are, as well as 'Ösenhalsringkragen', among the items deposited in hoards or as single finds. These forms appear within NBA IA and B (Blajer 1990; Reim 1995; Vandkilde 2005).

[14] 'When change is required, the brain cannot continue to function in automatic mode and must downshift again to controlled processing, which is much slower, requires more attention and effort, and is more prone to error' (Minar Crown 2001: 373).

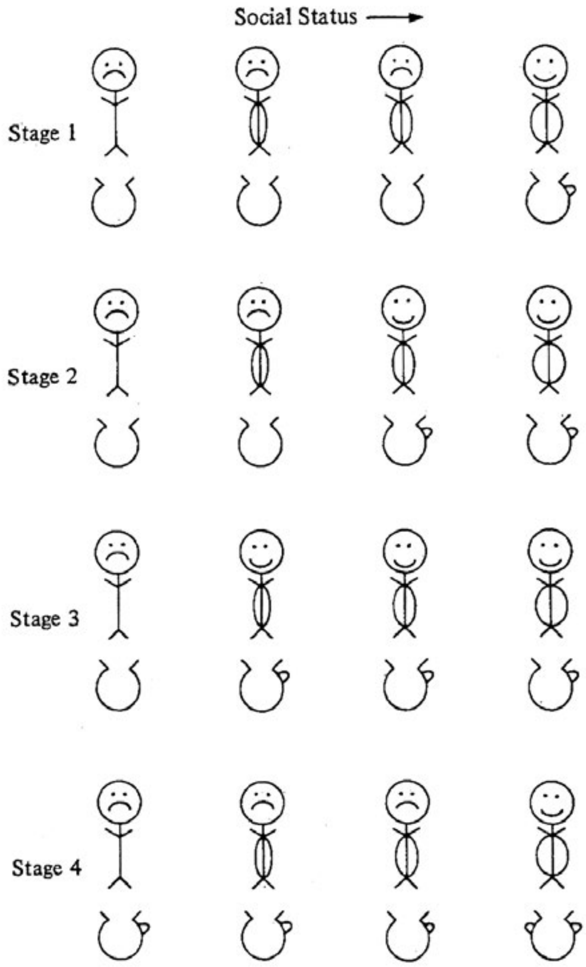


Figure 3.004: The process of emulation (after Miller 1985: 186).

The bronze ornaments shaped in lunula-style seem to have been influenced by British gold artefacts (see Hachmann 1954: 94; Sprockhoff 1939: 4ff.; Taylor 1979). However, they are crafted differently to lunulae (Taylor 1980; 1979; 1994), through casting in one-sided moulds and being cold-worked to gain the final form. 'Ösenhalsringkragen' represent an early Bronze Age tradition, occurring mostly on the contact zones between the Danubian FBZ (where Ösenhalsringe originate) and the area of the Únětician culture (Vandkilde 2005; Nørgaard 2011: 24; Wels-Weyrauch 1978: 140; Peroni 1971: 71) and are thus considered in a similar fashion as 'foreign' artefacts in northern Europe.

In northeast Germany this foreign influence resulted in the creation of the ribbed neck collar, which occurred for the first time in hoards in NBA 1B (Schubart 1972; Gedl 2002; Blajer 1990). It seems as though neck ring sets, as well as lunula-shaped artefacts, set the tone for the shape of the collars (Figure 3.005). For the purposes of the Miller model, it was the pursuit of foreign valuable goods that provided a compound of foreign elements with indigenous techniques, which was followed by the creation of a new form. The demand for this 'new' artefact led to the gradual change in local technological traditions.

In addition, the production sequences of individual artefacts also include indications of various influences on the technological traditions of a group. In the illustrated scheme, the technological diversity in the basic techniques used to craft decorated ornaments is shown. Marked are the steps necessary for the production of the already known neck collar types (Figure 3.006), to display the variety within the techniques. This ranges within one and the same object group and is a direct reference to the technical repertoire of a specific social grouping.

Furthermore, the present study contained bronzes which combine the characteristics of several technological traditions. These so-called technological hybrids allow conclusions on the influence to which the social units are subject while developing their own technical repertoire.

The collars found at Wildberg (MM II 4381) and Werder (MM II 6284), in Brandenburg, are among the spiral-decorated bronzes typical within the area of the Mecklenburg group around 1300 BC (see Nørgaard 2011: 62-64). The piece from Wildberg is made with by lost-wax casting, within this region presumably the traditional method. The other, morphologically very similar, collar shows, in contrast, traces of intense cold-working/hammering (Figure 3.007). Despite the same decorative elements and the similar shape, also with regard to Mecklenburg-type collars, these two pieces are crafted by different techniques. Moreover, they could be seen as a transitional form crafted within a society where the technological tradition was in transition. Based on the prominent spiral-decoration a Scandinavian influence is likely. The way in which the spirals are constructed contains a further indication of the variety of technological influences. The spirals on the Wildberg piece have little evidence for the use of spiral-stamps (as often seen on Scandinavian artefacts). These spirals seem to be punched (using chisel-like tools) or drawn in the pre-casting model. Accordingly, although this collar shows the formal characteristics of Scandinavian design, its crafting is clearly influenced by techniques used in northwest Germany during NBA II. The decoration of the basic collar modelled with spirals post-casting, as is likely on the piece from Werder, reflects the procedure of Lüneburg craftsmen. The Wildberg collar is indeed completely decorated in the wax model, but the spirals are applied with a comparable technology. The traces documented require the contact and the exchange of knowledge between these three regions, central Lower Saxony, northwest Mecklenburg and the Danish islands. The kind of contact, however, is unclear. Based

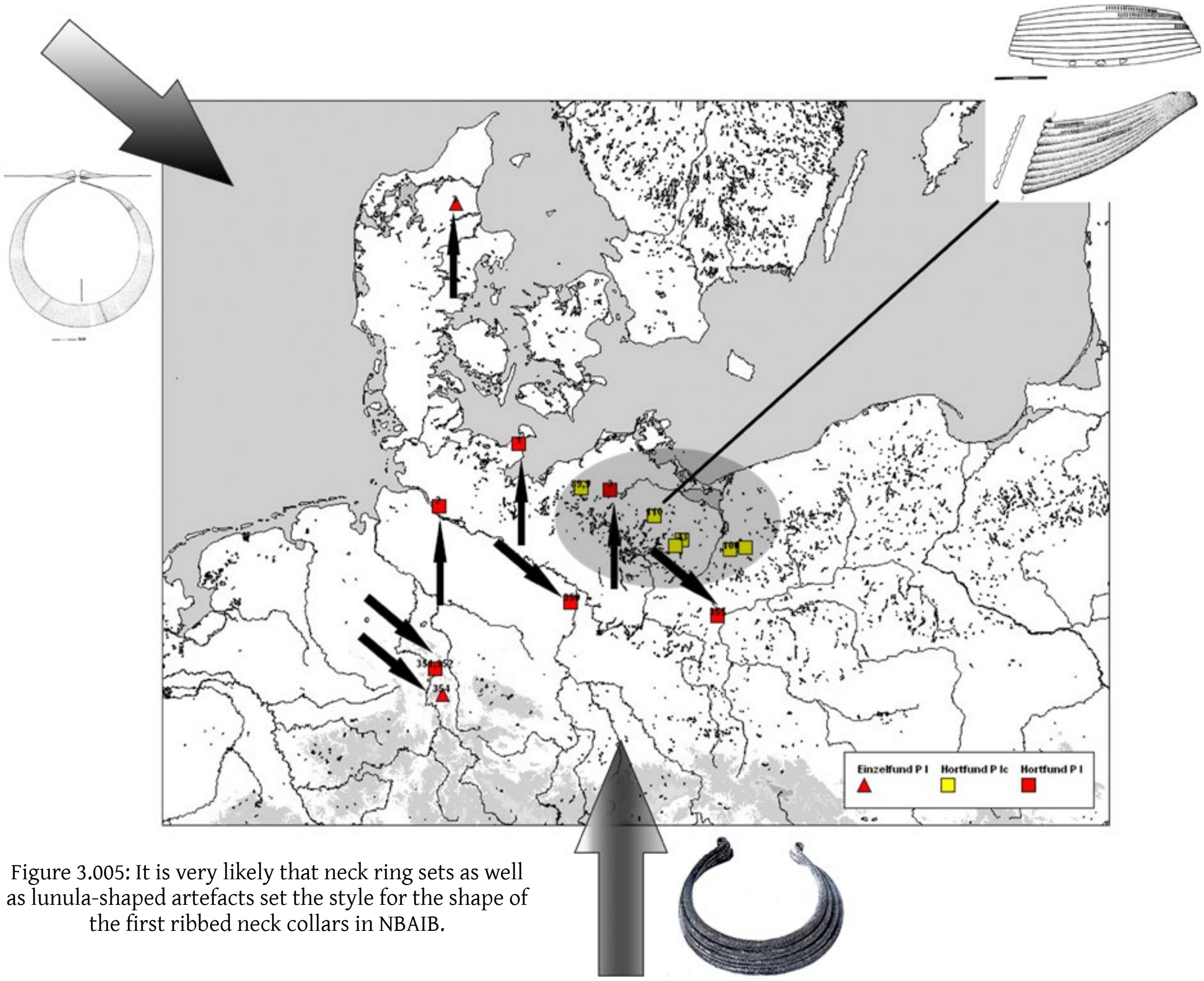


Figure 3.005: It is very likely that neck ring sets as well as lunula-shaped artefacts set the style for the shape of the first ribbed neck collars in NBAIB.

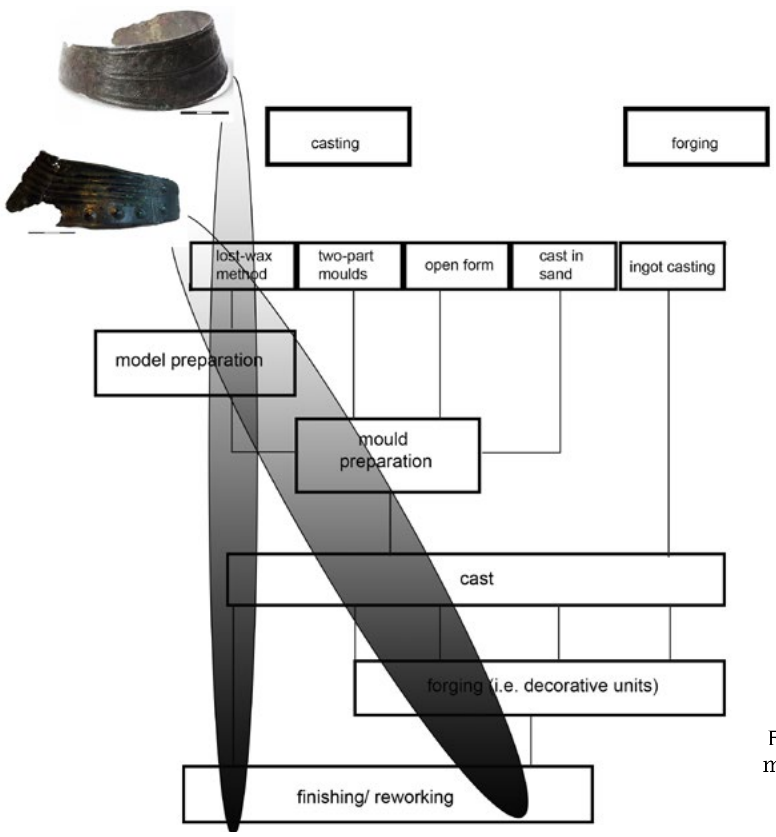


Figure 3.006: Two different artefact types were made using different techniques, although they are very alike in their formal appearance.

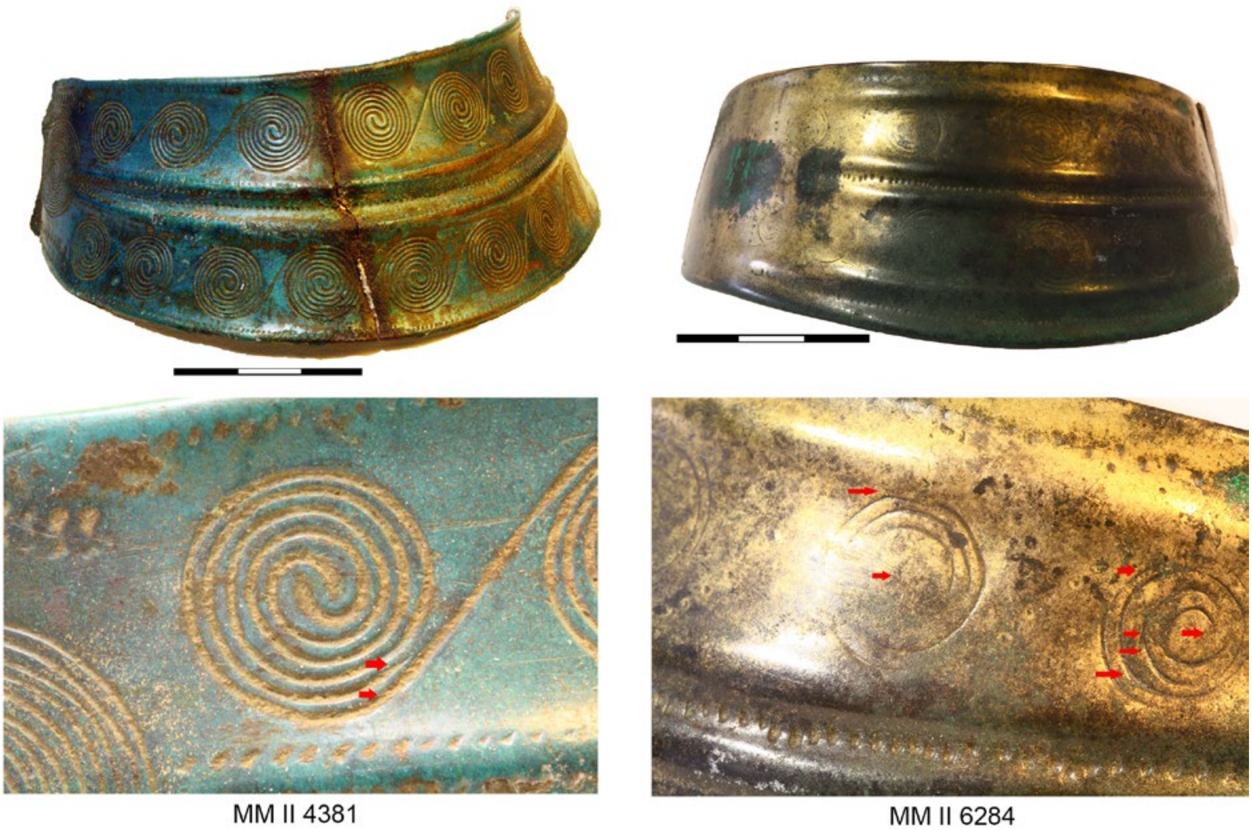


Figure 3.007: Collars found in Wildberg (MM II 4381) and Werder (MM II 6284) were crafted by different techniques mirroring different technological traditions.

on the formal similarity of the discussed collars and the further spiral-decorated ornaments in Mecklenburg, a direct mobility of northwestern German craftsmen might be possible. Or, in other words 'the agents of diffusion may be but a small number of knowledgeable persons' (Basalla 1988: 81).

Technological traditions as such are formed through several factors. They are seen as a result of the adoption of new techniques, their transformation and subsequently possible innovations by the craftsmen, and the combination of new techniques with the established technical repertoire used within the same society. Technical traditions differ from region to region due to differences in group ideologies, training activities and, occasionally, religious beliefs. Finally, technological traditions are mediated through training and become the frame and essence of every craftsman's *habitus*.

Chapter 3

Technological choices

Having defined and discussed the craftsperson's *habitus*, this chapter continues the search for the motivations of the choices within working sequences. Technological choices are important for our understanding of prehistoric crafting as they allow us an insight into the thinking of prehistoric craftspeople. So, for example, the order in which the individual decorative elements are installed in the model is not determined by technique, but rather is part of the 'body of knowledge' of the individual craftsperson. Even if such highly decorated bronzes, as investigated within this project, are not made on a daily basis, the craftsperson still favours a certain way based on the 'body of knowledge'. Even craftspeople who are not familiar with crafting such elaborated items as the large belt plates, will, set by the technological traditions of their surroundings and his/her imprinted behaviour, choose a similar order of steps.

Within such a sequence, there is only little room for individual acts of creativity. At this point, this chapter will discuss an issue, already raised in the introductory part of this study, concerning the controversy between craft and art. The material under investigation is used as an example of the difference between free choices and culturally or socially influenced choices within the working sequences of art objects and commodities. While studying the underlying influences that affect every technical choice during the crafting process, the difference in the production of both object categories are illuminated. It is shown, that the basic technique used is responsible for that the successive steps, which are directed by the requirements of the material, are similar. However, crucial to the shape of the artefact are not the tools and the requirements of the material, but the technological choices made.

3.3.0 Choices within operational sequences

As already defined by Sillar and Tite (2000: 10), there are various types of choices within an operational sequence: '"individual choices", the innovative way in which people can alter and extend existing material practices, and "cultural choices", the underlying technological traditions from which a substantial portion of each individual's experience and knowledge is derived.'

This 'process of selection of technical features' (Lemonnier 1993: 2) is known under the term technological choices and can be seen as a direct expression of the *habitus* of a craftsman. To illustrate this more clearly the categories of technological choices described by Sillar and Tite (2000) will be presented again. Thus, in any kind of technical action,[15] choices are necessary with regard to the selection of raw materials, the possible tools, the energy sources, the techniques used and the order of the steps within the working sequence (Martinón-Torres 2002: 37). Some of these choices are influenced by the social environment and others, as outlined above, can be regarded as choices of the *habitus*.

Additionally, individual technical choices are connected to each other, meaning that one action is followed by a further action if the task is to be fulfilled (Lemonnier 1993: 13, 165; Mahias 1993; Balfet 1975: 52). This can be explained by the fact that certain technical acts are composed of several phases, which are logically and sequentially self-contained. In other words, if the metalworker selects lost-wax casting as the basic technique for the production of an artefact, then a basic operational sequence is prescribed by this decision. Furthermore, there should be no major deviation from this sequence; otherwise the process fails.

To understand the choices made within a technical sequence, it is advisable to take into account ethnological sources, especially in order to illustrate that technological choices are not always subject to the laws of logic. As Martinón-Torres noted, often the most natural or easiest way is not chosen (Martinón-Torres 2002: 35; Quilici-Pacaud 1993: 399; Costin 2000: 382; Longacre *et al.* 2000), but the decisions are made rather for ritual reasons (Ottaway 2001: 98) or established habits, which are partly justified with religious omens (Mahias 1993: 165; Behura 1964b: 37). So, for example, Bédoucha, in his study of the use of technical equipment for the distribution of water within the oasis settlements in Nefzawa, Yemen, came to the assumption that the chosen system was explained only by the fact that this method allowed a peaceful contact of two adjacent villages on a controlled basis (Bédoucha 1980: 86). In the previous chapters, such technical choices caused by the social environment were repeatedly presented. They do not represent the simplest and quickest way to the goal, however they are not called into question (see Minar 2001; Sennett 2008: 63ff.; Mahias 1993; Saraswati 1978).

Technological choices are important for the understanding of prehistoric crafting as they allow us an insight into the thinking of prehistoric craftsmen. The questions asked by Lemonnier (1993) are next examined with reference to a simplified operational

[15] Here, also technical actions executed in rituals, dancing or other activities are included.

sequence: (1) where are the choices visible; (2) what kind of influences are they subject to; and (3) to what degree are these technological choices influencing the technology?

Figure 3.008 presents a schematic sequence of steps within an operational sequence needed to craft ornaments using the lost-wax method. The decorative elements are in this case arranged as in a sequence for Mecklenburg-type neck collars, which should give an idea of the influences to which the single technical choices are subject.

The piece to be crafted already exists in the mind of the craftsman before it is made (see Ingold 2000: 342). The type of object is defined by the demand or order. It is rather unlikely in Bronze Age societies that such elaborate works were created without direct order. If it is a well-known form, the necessary operational sequence is, in basic steps, internalised within the *habitus* of the craftsman (Sennett 2008: 50). The choice that the spiral-decorated neck collar is (in a specific region for example) to be cast using the lost-wax method is therefore not a choice made by the craftsperson. The mediated technological traditions of his/her craft guide the choices and create the connection between the object (collar) and the necessary technology. Therefore, the casting technique used can provide information about the origin of the object, provided the researchers are aware of the regional differences. The next step in the sequence is the making of the model. Due to the technique chosen, the subsequent working step is thus determined (Lemonnier 1993: 13).

The order in which the individual decorative elements are installed in the model is not determined by technique but rather is part of the 'body of knowledge'. Even if such highly decorated bronzes are not made daily, the craftsman still favours a certain way. Here, the gestures and hand actions learned, the skills and abilities of the person, and also the internalised knowledge all play crucial roles. The sequence of these small steps is bound to individual choices, due to the fact that their order does not affect the completion of the object. It is exactly this feature that contains the information about workshops and craftspeople. However, the pictured sequence includes within these individual choices one that is determined by technological traditions. The technique used to create spirals is not individually selected, whether spiral-stamp or manual construction, it is deeply rooted in local knowledge and a mirror of the technological tradition.

The steps following from the completion of the model result from the chosen technology, such as packing the model in clays and, after drying the form, the casting of the artefact. Accordingly, the operational sequence for objects of an object group, which can be interpreted as having a representative character (neck collars and belt plates for example), is set by the technological traditions of the craftsman´s surroundings and his/her imprinted behaviour. Within such a sequence there is only little room for individual acts of creativity.

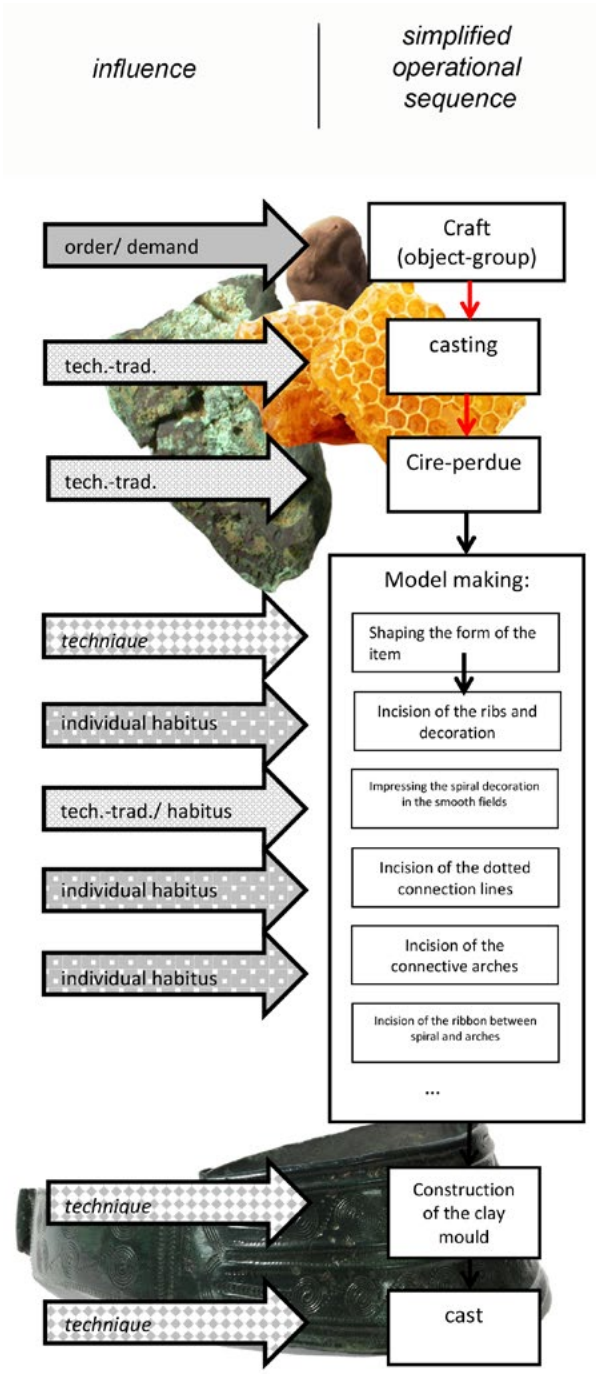


Figure 3.008: This scheme displays the influences which shape individual technical choices.

Before focussing on this aspect, it is necessary to comment on a discussion important for prehistoric craft research. As already mentioned in the introduction, researchers disagree as to whether within the documentable technological choices there is any valuable information provided concerning the organisation of craft when the craftsman does not consciously chose from the pool of all possibilities. However, that a Bronze Age craftsperson was aware of *all* technical possibilities for the making of an artefact (see Tostevin 2011: 355; Lemonnier 1992; Lemonnier 1986; Mahias 1993; Pétrequin and Pétrequin 1994) is rather unlikely, and that the very moment of choice is also not significant when technological choices are regarded as intuitive actions (Lemonnier 1993: 7). The choices made reflect the *habitus* of the craftsperson, and thus also the technological knowledge of his/her social environment. Therefore, it is not a requirement that the Bronze Age craftsperson was aware of all possible techniques for the solution of the problem in order to gain information about the social context in which the craft was executed. Rather, the researcher who deals with the topic should be familiar with all alternatives (technical and regional) in order to place the specific technique or sequence in their social context. So, a proper investigation would gather the existing technological knowledge in a specific region at a specific time and can then interpret the individually determined deviations as an individual action (see also, Zagal-Mach 2008: 194). Accordingly, any technological choice detected is first to be considered comparatively and then, in a second step, interpreted.

The above has clearly shown the extent to which technological choices necessary during the making of an artefact are influenced by the *habitus*, by the society, and by the technology itself. At first sight it appears as if the choice of technique to be used rests with the craftsperson. At a second glance it becomes clear that, especially with automated actions, 'tacit knowledge' and the deep-rooted feeling that there is only one way to solve a problem are behind the decisions. In other words, the craftsman decides based on his/her imprinted habits. However, some questions remain unanswered: Are all the following choices set in a working sequence from the outset? Are there no individual decisions, no unexpected steps in such operational sequences?

3.3.1 Free technical choices – a characteristic for art?

In the introductory part of this study, an issue was raised about the controversy between craft and art. In the subsequent discussion the overall opinion was represented that technological choices are culturally or socially influenced choices. By specifying the motivation behind the technological choice and the possible alternatives, the difference between the production of socially representative artefacts (ornament bronzes) and art objects is shown (Figure 3.009) as the difference of free choices in operational sequences.[16]

The idealised and reduced operational sequence for crafting spiral-decorated ornaments is an ideal starting point for the discussion. Two similar sequences are compared, one presenting a sequence for art-objects (or religious, meaning unique, artefacts), the other representing a sequence for artefacts of an object group (Figure 3.009). While studying the underlying influences that affect every technical choice during the crafting process the difference in the production of both object categories can be studied, provided that art objects are seen as being created without predetermined ideas. In the latter, only the agent decides which technique to choose and which direction to follow. It seems that 'making' in art is free of external influences, due to the fact that there is neither a demand that must be satisfied nor a tradition to be followed. Even decisions of the 'body of knowledge' can be overcome by curiosity and the will to experiment (see Ingold 2010: 6; 2000: 349-351).

In contrast, the operational sequence of an object that must meet certain specific criteria (part of a group of objects, such as belt plates) is, as already shown, fixed before it is finished. In such a fixed sequence individual and unbound technological choices are limited (see Dobres 2000: 137). Another difference of craft and art can be addressed with this example: the freedom behind technological choices. Due to the technique, both sequences have only the successive steps and the requirements of the material in common. However, crucial to the shape of the artefact are not the tools and the requirements of the material, but the technological choices made (van der Leeuw 1993: 241). In other words, in *craft* the society determines the shape of the object, in *art* it is the individual.

Nevertheless, as mentioned above, some technological choices in craft can also be documented that are not influenced by society, demand, or other economic factors. However, they are fed from the individual part of the *habitus* and thus also reflect parts of the local technological tradition.

The repair of errors that occur during making through free choices can especially be observed in craft. For example, the occurrence of superficial shrink-holes, the repair of which could be detected in the examined material. Such an error requires an individual response. And yet ... 'while finding a solution, the thoughts are focused on a certain area and are hardly free for new

[16] The thereto relied upon and highly simplified sequence is to be understood as an ideal version. Art, defined in the modern sense, is expressed only in exceptional cases as absolutely free from any influence. Innovative and creative actions are also possible in crafts, and are often visible (as will be discussed in Chapter 3.4.2).

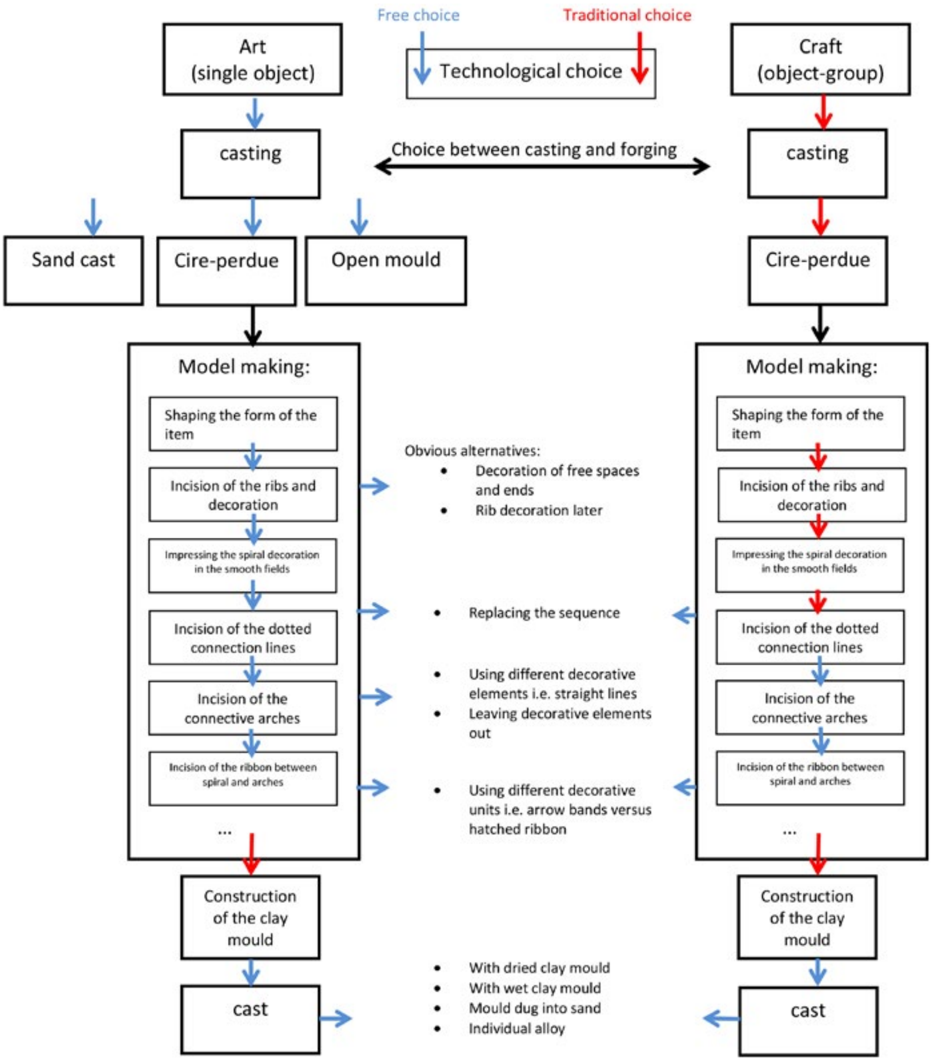


Figure 3.009: Reduced production sequence of Mecklenburg-type neck collars displays the sorts of choices made by the craftsperson within the creation of a singular object (as it might be in artistic or religious circumstances) and a piece from an object group (i.e. the neck collar type groups or belt plates investigated in this project). Possible alternative techniques which could be used during such a sequence are added. The arrows symbolize the type of choice.

ideas' (Bijker 2012: 164-166). Unlike within art, in such a case the craftsman is also not deliberately finding new solutions but making choices out of the existing repertoire for an appropriate technique.

In most cases, such changes lead to small deviations from the planned operational sequence and, as a result, also to stylistic changes. If such amendments are adopted and further developed they can be seen as innovations (Basalla 1988: 104). Thus, free decisions are strongly linked to the way in which the craft is taught: '...teaching may encourage innovation and experimentation or it can emphasise submission to authority' (Larsson 2008: 84).

Chapter 4

Apprenticeship and Bronze Age craft

This chapter demonstrates the characteristic traces of novice work on the basis of ethnographic examples and sociological studies concerning learning behaviour, and contrasts these with traces and mistakes of professional work. Projected onto the material under investigation, distinct features of novice work are defined as the use of inefficient gestures and sequences expressed in many small movements, repeated tool marks, or the repetition of the same mistake. The reference to novice work is mainly included in the decoration of the artefacts, since here the quality of motor skills is best expressed. Notably, such traces appear within the area of interest, predominantly in combination with traces of more highly skilled craft.

This allows assumptions concerning possible training situations during the Bronze Age in northern Europe, where the direct participation (part of the sequence) of novices in crafting is to be expected. However, in learning craft, absolute theories cannot be applied and several other possibilities in craft learning are discussed, such as participation in technical activities as a game, or training as part of an authoritarian relationship, or learning by observing and imitating.

Furthermore, patterns of regional behaviour are detectable, showing an accumulation of professional work with errors and signs of cooperation on the Danish islands. Traces of unskilled work, on the other hand, occur in Jutland and in Lower Saxony, mainly on objects where the close cooperation of different levels was detected. In NBA III in Mecklenburg, a distinct use of regionally distributed styles and different levels of skilled work suggest an authoritarian training method. The investigation of traces illuminating training and teaching activities results in a first statement on the organisation of metal crafts during the Early and Middle Nordic Bronze Age, from kinship-based to different skill levels in craft and cross-craft activities. Additionally, a special group of craftsmen might have been organised in a different way, based on highly skilled professional work. A regional difference is visible where the Danish islands show less novice activity, and in northern Germany further facts will allow us to clarify whether more family-organised workshops or communities, similar to a community of practice, are to be expected. Thus it will be stated that, when searching for the novice, interruptions in decoration, or deviations in alignments caused by carelessness, must be distinguished from errors that can be explained by a lack of motor skills.

3.4.0 Craft training and apprenticeship – a multidisciplinary research field

> '[D]ifferent crafts can be learned in different ways and ... different individuals can learn a single craft in different ways.' (Bamforth and Finlay 2008: 10)

Relationships between the training situation, the establishment of the *habitus*, and a possible change in the technological traditions of a social grouping, have been mentioned several times in the previous sections. The influence that training has on the craftsperson's character can only be understood with the help of ethnographic parallels. In the introduction to the third part of this study, it was shown that this relatively young field of research can already produce amazing results using multidisciplinary approaches.

Initially, however, the concept of training or apprenticeship needs to be explained. It cannot be assumed that a training situation in prehistoric societies was comparable to our modern systems. Sennett (2008: 63) could clearly demonstrate that the master/apprentice relationship, regulated by religion and rules, was a result of the craft guilds in the Middle Ages and exists, with slight changes, in traditional crafts up to the present day.

However, due to a variety of ethnographic studies of pre-industrial societies more systems are familiar to us today. The way in which knowledge (especially knowledge in craftsmanship) is passed on reflects the ideologies and ideas of a society (Larsson 2008: 84; Hayden and Cannon 1984: 331; Bamforth and Finlay 2008: 9; Redman 1977: 45; Coy 1989: 9). Therefore, strong variations are to be expected between different regional groupings, but also within such a unit.

Five different systems can be defined in which craft knowledge beyond home use can be mediated (see Larsson 2008: 84; Hayden and Cannon 1984: 331-332; Bamforth and Finlay 2008: 10; Wendrich 2012: 9; Kamp 2001: 428; Minar 2001: 392; Wenger 1998: 45; Wallaert 2012: 24; Miller 2012: 227; Gosselain 1992: 564):

(1) The demonstration of techniques without verbal support – meaning the participation in technical activities as a game, mostly in childhood, also known as 'informal apprenticeship'.

(2) Training as part of an authoritarian relationship, in which techniques are partly taught by leading the hands of the apprentice. This method is also known as 'four hands on the loom' or 'formal apprenticeship'.

(3) (3) Participation in an informal training situation. Here, learning by observing and imitating is understood. Assistance and detailed explanation is possible on demand. Such a system is often described as a 'community of practice'.

(4) Training or apprenticeship within a family or kinship context. Here, craft technical knowledge is taught to the same degree as social and ideological knowledge. This training method may include variants of the first three possibilities.
(5) Explaining without practical exercise represents a hypothetical, and ethnographically rarely detectable, method of the transmission of knowledge. It should be considered as a possibility (see especially, Mills and Ferguson 2008).

While discussing the phenomenon of the *habitus* within craft, it was shown that an important component within the training of craft technical abilities is direct contact with the 'instructor'. Tacit knowledge (that which makes gestures logical and allows workflow) cannot be communicated through words. Also, in one of J. L. Creese's experiments he showed that the students who actively communicated with each other and make comparisons with the original object should reproduce more similar items compared to those who worked individually, and to whom the item was only briefly shown (Creese 2012: 48-50).

Craft learning, and especially practical exercise, involves the use of all senses. However, in the introductory quote it is clearly shown that, in learning craft, absolute theories cannot be applied.

In particular, the type of learning (see Rogoff 1995; Boyd and Richerson 1985) depends on the motor and mental skills of the novice. Children learn differently than adults, their skills develop with age. Consequently, the learning of technical skills can only happen in a certain sequence, which is adapted to the cognitive development (Wendrich 2012: 9; Crown 2001; Piaget 1972; Wallaert 2012: 29).

In prehistoric societies, one should assume that active contact with craft was already promoted during childhood. Thus, pictorial representations of the Aztecs (*Codex Mendoza*) show children involved in hunting and weaving activities (Shein 1992: 31ff.; Baxter 2005: 66). In classical Greek representations and frescoes, children are pictured in the execution of various crafts, for example spinning (Golden 1993; Baxter 2005).

The first contribution of children within craft may be the result of games and experimenting with materials (Kamp 2001: 435; Wallaert 2012: 24; Högberg 2008). In the next step, the gestures executed by the craftsperson (Bourdieu 1977: 85) are imitated by the 'apprentice', as is the technique itself. In such a way, the children of the Shipibo-Conibo in eastern Peru learn pottery craft; they redraw the decorative lines that have been weakly sketched out by the adults on the ceramics (DeBoer 1990; Kamp 2001: 428). Nevertheless, even to children, techniques are directly explained as soon as their cognitive development allows (Figure 3.010), in addition to practical demonstration (see Karlin and Julien 1994).

However, the type of knowledge transmission varies greatly and is, as already stated, dependent on the ideology of the respective social grouping. Furthermore, the age of the novice determines the type of learning. As such, a novice in craft probably experiences several of the above-mentioned systems and learns by copying gestures and operational sequences in the traditional craft behaviour (the first kind of learning, after Boyd and Richerson 1985), as well as by trying several approaches and the conscious choice of the most pleasant technique (direct and indirect bias, after Boyd and Richerson 1985). Despite this, it is also conceivable that, particularly for crafting of such fine metalwork as occurred in the Nordic Bronze Age, novices with evident abilities were selected and trained in a strictly authoritarian situation.

Before the material is examined for possible references, the importance of apprenticeship in craft should first be illustrated with the help of a study conducted by Roux (1995). It is not only that the passing on of techniques is easier than a repeated reinventing (Sennett 2008: 54), within 'making' a striking difference was also found. Through studying the manufacture of beads in Khambat, India, it became clear that during training it was not the learning of the right moves that was primary, but rather the learning of the right combination of moves and

Stage	Function	Approximate Age (years)
Sensorimotor	Development of sensory perceptions and motor skills	0-2
Preoperational	Language development	3-6
Concrete operational	Logical thinking	7-11
Formal operational	Logical and abstract thinking, deductive reasoning, systematic planning	12 to adult

Figure 3.010: Cognitive development of children (after Piaget 1972).

actions (Roux *et al.* 1995: 79-80). Therefore, apprentices with shorter training periods exposed deficiencies in these sequences; they could not correctly identify the individual intermediate goals and were not able to adapt to unfamiliar materials. Only after an extended period of training, in which the individual sequences and gestures (the tacit knowledge), as well as the explained techniques, could be internalised, was the bead maker able to be flexible in his work. The ability to adapt the technology and tools to the material led to a consistently high quality within the crafted artefacts. This and similar studies came to the conclusion that unskilled craftsmen use inefficient gestures and sequences, with the consequence that the resulting artefacts are below average (Roux *et al.* 1995; Crown 2001: 452; Karlin and Julien 1994: 162). Conversely, the knowledge (brain and body knowledge) of qualitative craft can only be obtained by intense observing, recording, and learning in order to reproduce it (Rowlands 1993: 143; Molander 1996).

In summary, in quality-oriented craft some kind of apprenticeship is to be assumed. Even if the same is not ended after 'ten thousand hours (the) common touchstone for how long it takes to become an expert' (Sennett 2008: 172), and probably continues for a lifetime, in craft there should definitely be assumed to be a direct transmission of knowledge (face-to-face). In what way this occurs depends on the social environment, whether it is a community of practice, in which the training of the novice is guided by experienced students, or an authoritarian family structure, in which in addition to the craft also ideology and religion are taught. Probably house-craft needs to be considered separately from professional craft, as well as seasonal craft from possible full-time craft.

3.4.1 Traces of apprenticeship within the material of the Nordic Bronze Age

Traces of novice work are difficult to determine. It must be assumed that novice work is rarely detectable, as it is usually destroyed and not recorded in the material culture (Hasaki 2012: 172). Particularly with respect to metal craft, one should be aware that the rare raw materials required special attention (see Milne 2012: 126). While newcomers will, however, have worked with the material, melting and re-use of products is to be expected. Several studies support the notion that novice work in various crafts is rarely documented (Mills and Ferguson 2008; Bamforth and Finlay 2008: 19).

Also, conversely, not every 'misshapen' or strange artefact might be the result of novice work (Milne 2012: 126; Crown 2001: 452). It is almost even more likely that this is the failed work of professional craftsmen. The possibility that such work is preserved thanks rather to its value is a given. Additionally, the objects crafted within certain training strategies such as the 'four hands on the loom method' do not show any sign of novice work. The direct interventions of the teacher in the action, in the work of the novice, result in error-free pieces which are embedded entirely in the technological traditions of the group (Greenfield *et al.* 2000). In a similar category should be placed the work of the Shipibo-Conibo (Peru), whereby novices draw the sketched decorations made by experienced potters (DeBoer 1990). Nevertheless, it is exactly this type of learning that has potential for modern research.

If the characteristic features of novice work are clarified, then an assignment of objects, such as the work of unskilled craftsmen, is possible:

I. The decorative elements are constructed of many small movements that are irregular and overlap (Crown 2001: 452).
II. Repeated tool marks and repeated openings in decorative lines are to be expected, in particular in the construction of spirals (Crown 2001: 452).
III. Line widths vary and are sometimes shaky (these features are especially visible on painted ceramics) (Crown 2001: 462; Creese 2012: 51).
IV. Repetition of the same mistake (Milne 2012: 126).
V. Irregularity in form and shape (Bamforth and Finlay 2008: 6; Mills and Ferguson 2008; Creese 2012: 51).
VI. Deviations in the operational sequences (Bamforth and Finlay 2008: 6; Högberg 2009), and thus different results or designs are produced.
VII. The use of only a few different and simple decorative elements (Crown 2001: 461-463).
VIII. Misuse of the tools – particularly within flint studies, hammer marks and failures are identified as characteristic of novice work (Bamforth and Finlay 2008: 6; Finlay 2008: 77).

In contrast, however, the carelessly executed artefacts of skilled craftsman would in similar situations indeed have left traces, but of another kind:

I. Decorative elements which are executed in a few gestures, and thereby may have gaps or missing elements, can be interpreted as a sign of haste or lack of concentration (Crown 2001: 452; Hagstrum 1985; Wendrich 1999: 391-393).
II. Spirals may have occasional inappropriate or staggered connections that cause gaps in otherwise regular helical structures. Similar to (I), a lack of concentration or hurry might be the reason for such inaccuracies.
III. Different depths in the decorative lines can be caused by interruptions in the workflow and new approaches of the tool.
IV. Errors are made only once; 'experts are less likely to repeat the same mistake' (Milne 2012: 126).

V. Small inaccuracies in otherwise high-quality decoration can be an indication of lack of concentration (Miller 2012: 228; Wendrich 1999: 391).

Accordingly, the reference to novice work is mainly included in the decoration of the artefacts, since here the quality of motor skills is expressed. Additionally, within the decoration any deviation from the optimal operational sequence is evident from subsequent errors. Within the investigated material the spiral-decorated artefacts proved to be a fruitful source. Figure 3.011 illustrates still how difficult it is to distinguish between the characteristics of unskilled work and skilled work performed under stress. Nevertheless, distributed over the area of interest, six bronzes could be determined which showed within their decoration characteristic traces of novice work (Figure 3.012-13). In contrast, similar errors could be detected on at least ten artefacts and interpreted as a sign of haste and lack of concentration by skilled craftsmen (Figure 3.014-15).

However, more often objects were detected on which a combination of highly skilled and unskilled labour is evident: i.e. the belt plates of Sludstrup, Hjørring in Jutland. The NBA II burial containing a neck collar and two small belt discs displays similarities in the crafting of these ornaments that allow the inference of their concurrent crafting by one individual. The spiral-decorated neck collar and belt plate show very similar connection points of the spiral and the connective line, as well as comparable lines (Figure 3.016). The second belt disc has, in parts, similar lines. However, this disc displays strong differences in quality in terms of the execution of the decoration, not only compared to the other objects but rather within the decoration of the same disc (Figure 3.017). The changed line structure (slightly shaky), the changing line widths and varying distances, as well as significant interruptions and multiple new tool approaches in the decorative units all suggest that this piece is the work of a novice. Furthermore, the change of evenly spaced line groups to this strong variation in the spacing of the lines indicates the direct cooperation of a skilled and an unskilled craftsperson.

In fact, many of the examined pieces bear evidence of a similar direct interaction between the skilled, experienced craftsmen and the novice (MAP 25). In addition, the piece illustrated above from Heitbrack can

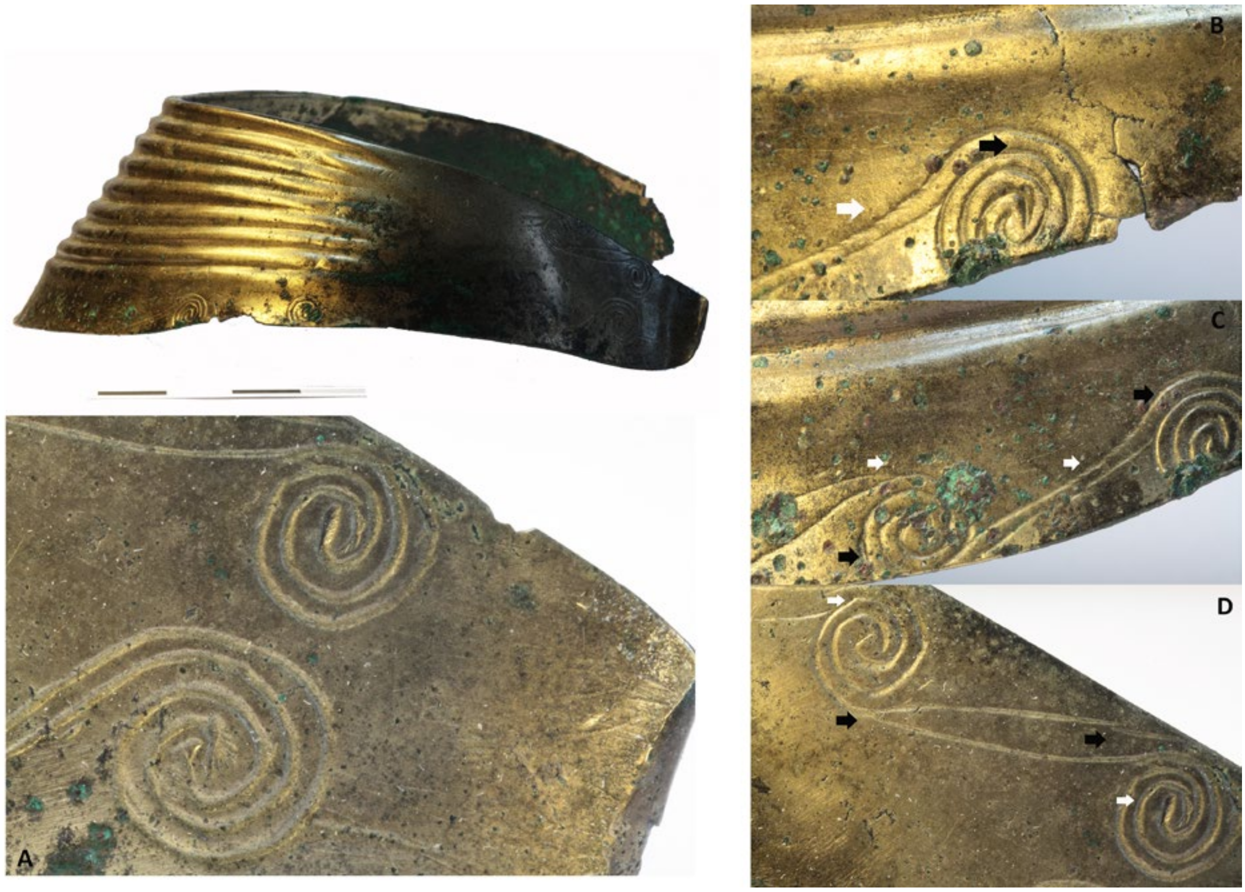


Figure 3.011: Distinction between the characteristics of unskilled and skilled work performed under stress can be difficult. The collar from Heitbrack (LMN 148:81) shows the parts of the decoration made by professionals and the part made by unskilled people. Black arrows symbolise mistakes made by professionals and white arrows symbolise novice work.

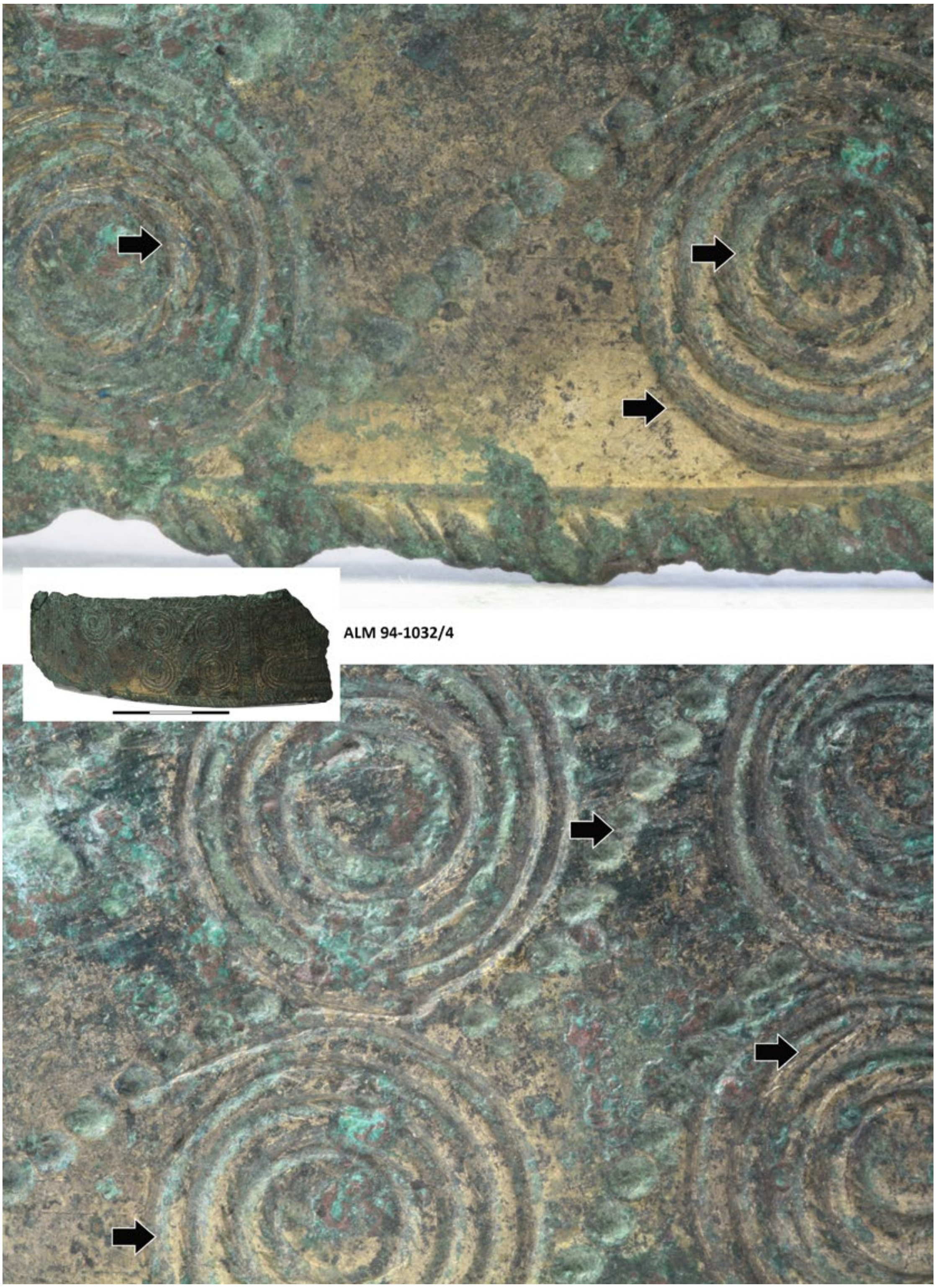


Figure 3.012: Characteristic traces of novice work on a neck collar from Mecklenburg (ALM 94-1032/4).

be interpreted as joint work. On this piece especially the change of uniform line widths (Figure 3.011, A) to strongly fragmented lines and the variation within the spirals is decisive (Figure 3.011, B and C).

Artefacts crafted in joint work appear in concentration in the areas where high-quality bronzes are distributed. Objects of lesser quality that show typical errors of novice work are limited to the Jutland area (in NBA III such objects are also distributed in Mecklenburg). A possible explanation of this distribution picture

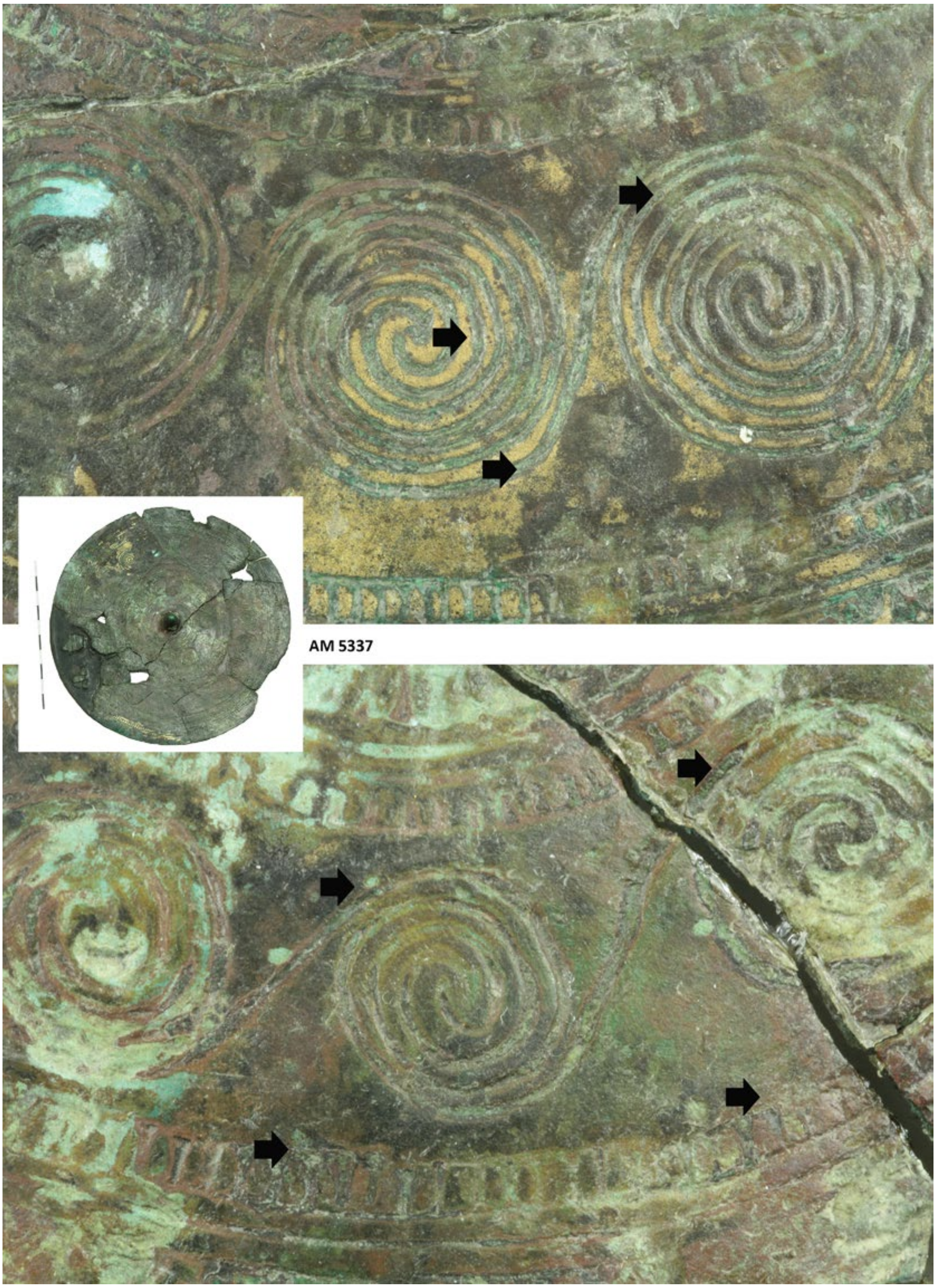


Figure 3.013: Characteristic traces of novice work on the belt plate from Norre Snede (AM 5337).

may be that, within the Jutland region – less rich in bronze compared to the islands – even lower-quality bronze ornaments were attributed a high value and, therefore, the work of newcomers was not destroyed (see Milne 2012: 126). When comparing artefacts with traces of novice participation to artefacts crafted by professionals showing results of haste and carelessness, an interesting distribution can be detected. Only on Zealand is there a bundled appearance of both kinds of artefacts. This interaction makes it possible to draw

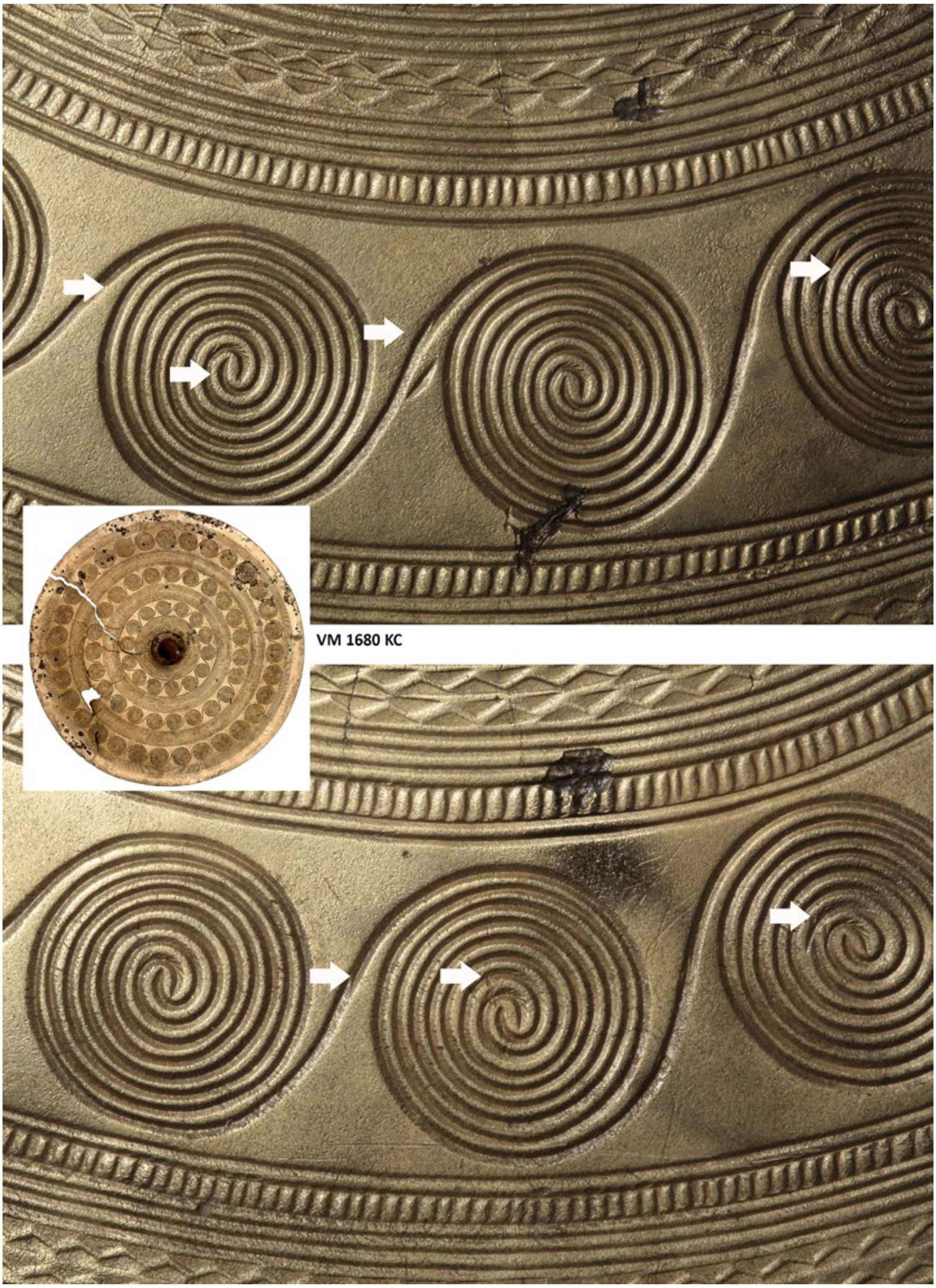


Figure 3.014: Errors documented on the belt plate from Vognserup (VM 1680KC) on Zealand can be interpreted as a sign of haste and the lack of concentration by a skilled craftsman.

conclusions about the organisation of training within this area (MAP 26). Especially the fact that in west and northwestern Zealand an accumulation of errors due to carelessness and haste (see above) occurs, makes a greater accumulation of craftsmen who worked at the same time inferable. Within such a collective workspace, also defined as 'community of practice', interaction and productive stress can cause inaccuracy. In such a working community, the interaction between differently skilled craftsmen is based on the

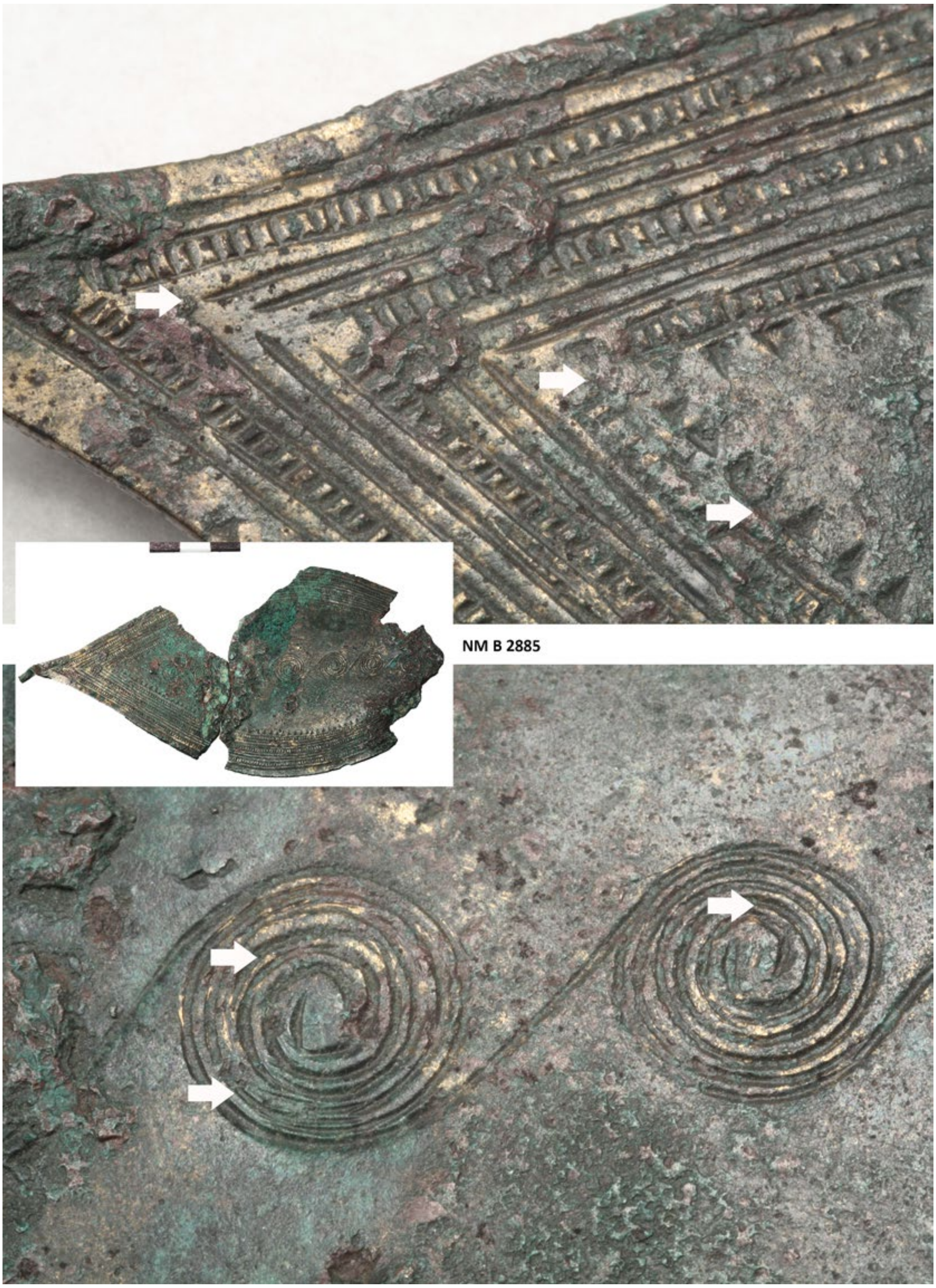


Figure 3.015: Errors documented on a fibula (NM B2885) found on Bornholm can be interpreted as a sign of haste and the lack of concentration by a skilled craftsman.

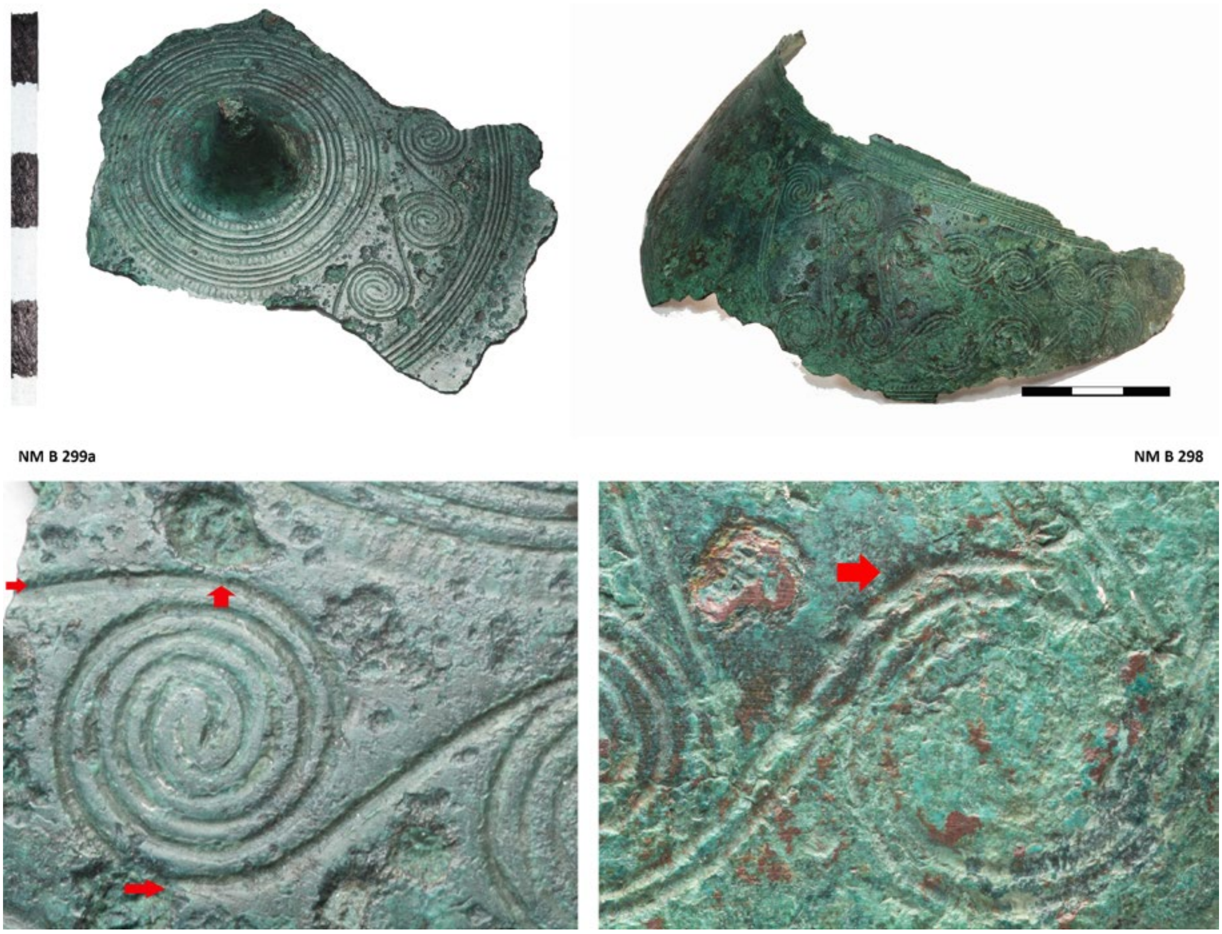


Figure 3.016: Belt disc (NM B299a) and neck collar (NM B298) from Sludstrup show very similar connection points of the spiral and the connective line, as well as comparable lines.

technological knowledge of the specific social unit and is developed within the same community (Wenger 1998: 45; Minar 2001: 392; Wendrich 2012: 5; Cooney 2012: 146). Such a form of craft organisation would produce fewer items that might be considered to be pure novice work rather than suggesting the participation of newcomers. In a community like this, an accumulation of errors caused by interruptions and a lack of concentration is explainable because of the skilled craftsmen involved in training activities. This assumption should be tested on the material in relation to the use of similar techniques, due to the fact that a 'community of practice shares a belief about which physical motions of spinning are considered right or proper' (Minar 2001: 392; Minar and Crown 2001: 375).

A community of practice as a form of craft organisation on the Danish islands would be possible if the basic techniques were also identical, as well as the selection of decorative elements. The extent to which the data in central Lower Saxony can be explained by a more authoritarian form of training would have to be clarified by evaluating a detailed study of the decorative elements. Within the adjacent regions further analysis will show how far the lack of material, or the unknown discovery site, will influence the results.

However, in conclusion, it can be stated that when searching for the novice, it is shown that interruptions in decoration, or deviations in the alignments caused by carelessness, must be distinguished from errors that can be explained by a lack of motor skills. The latter are a direct indication of the less trained craftsperson, namely the novice or trainee. Errors, however, that are caused by carelessness, can hide another kind of information. They can be viewed as signs of increased production as well as an indication of different skill levels (i.e. Wendrich 1999). Bronzes with such types of errors could allow a direct conclusion about the organisation of the craft. A final statement is, however, only possible if the technology and style are also included in the investigation.

3.4.2 Innovative individuals – the creation of style

> 'Individuals in similar situations have typically learned similar sets of responses to those situations' (Plog 1977: 16).

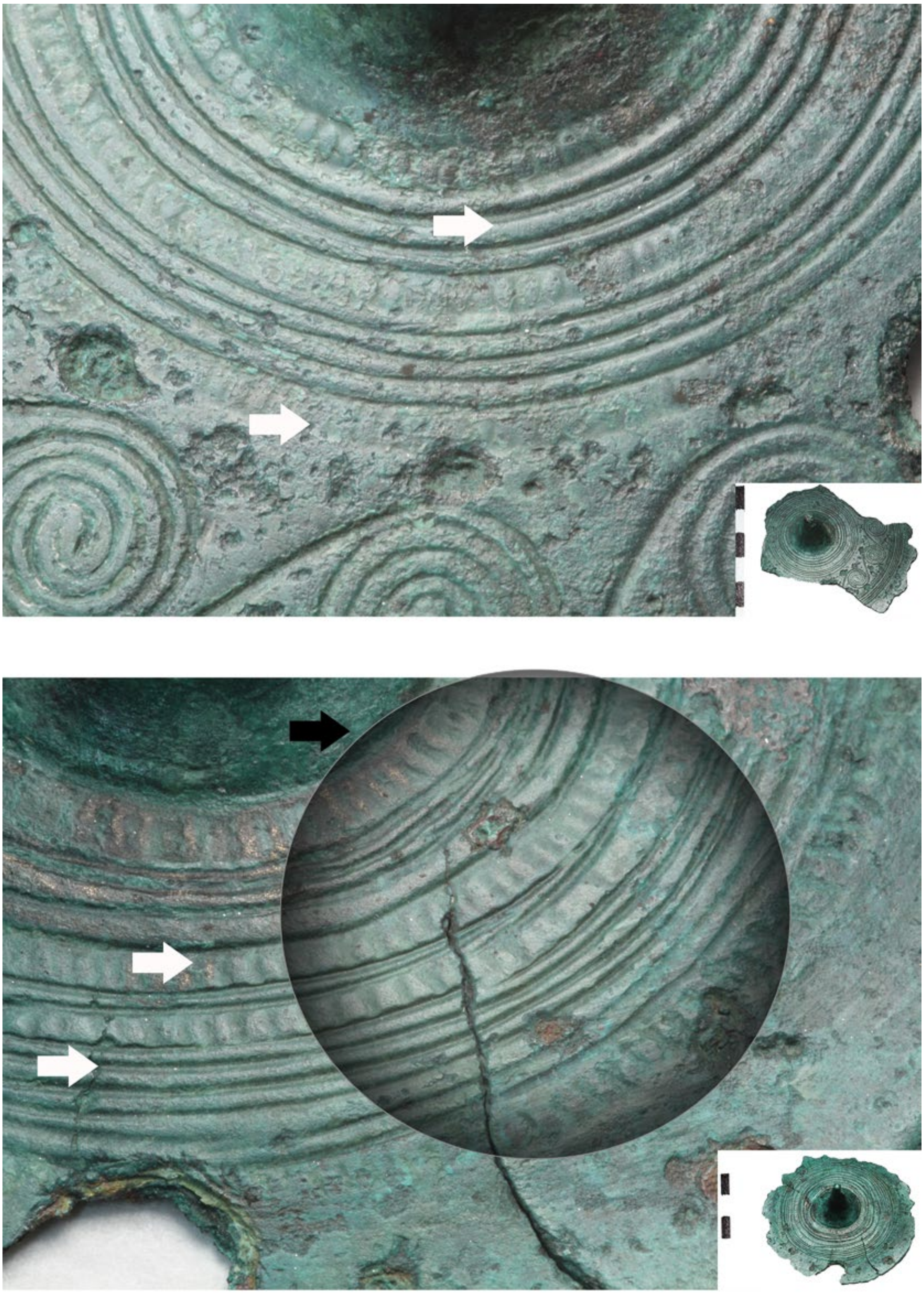
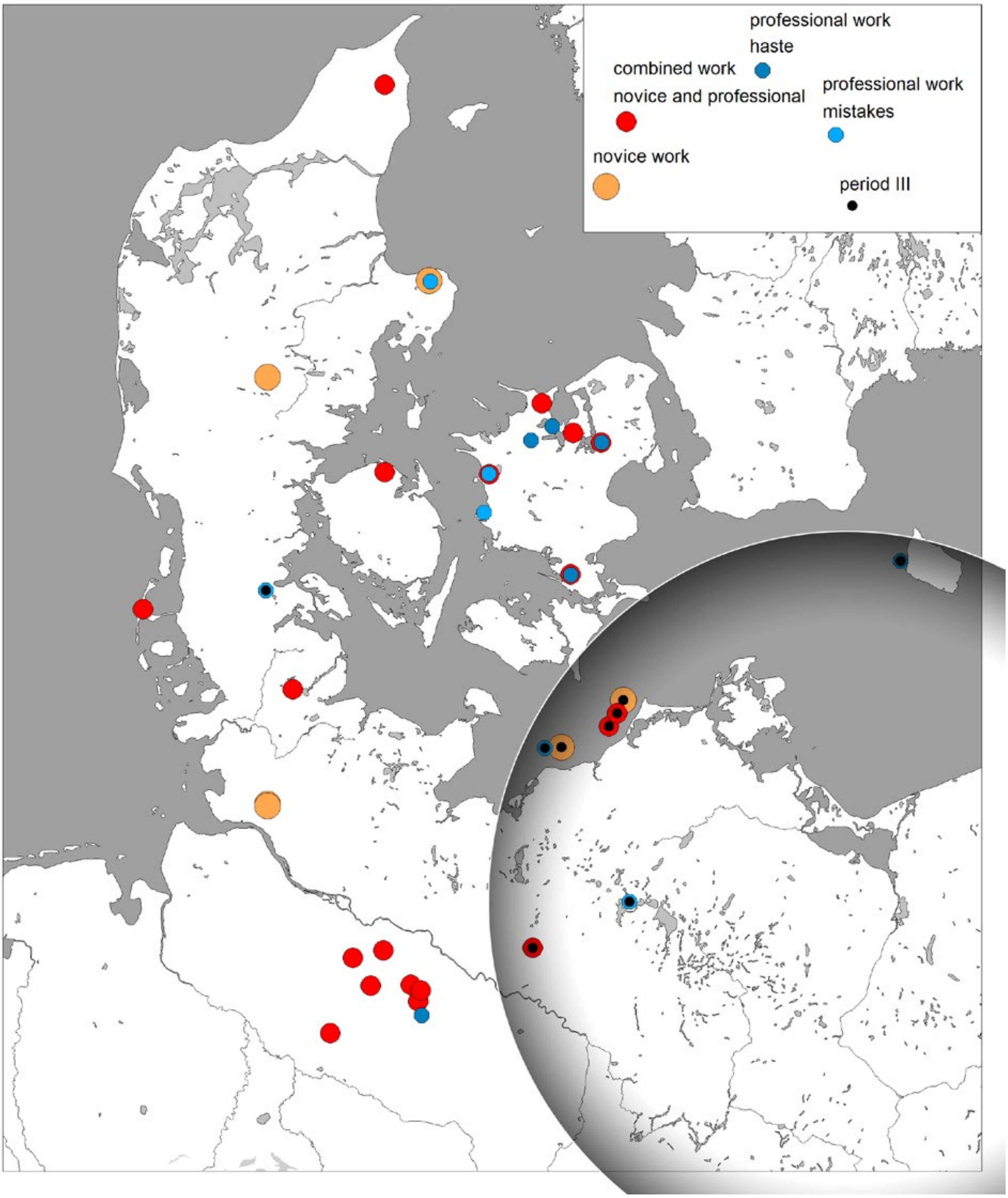
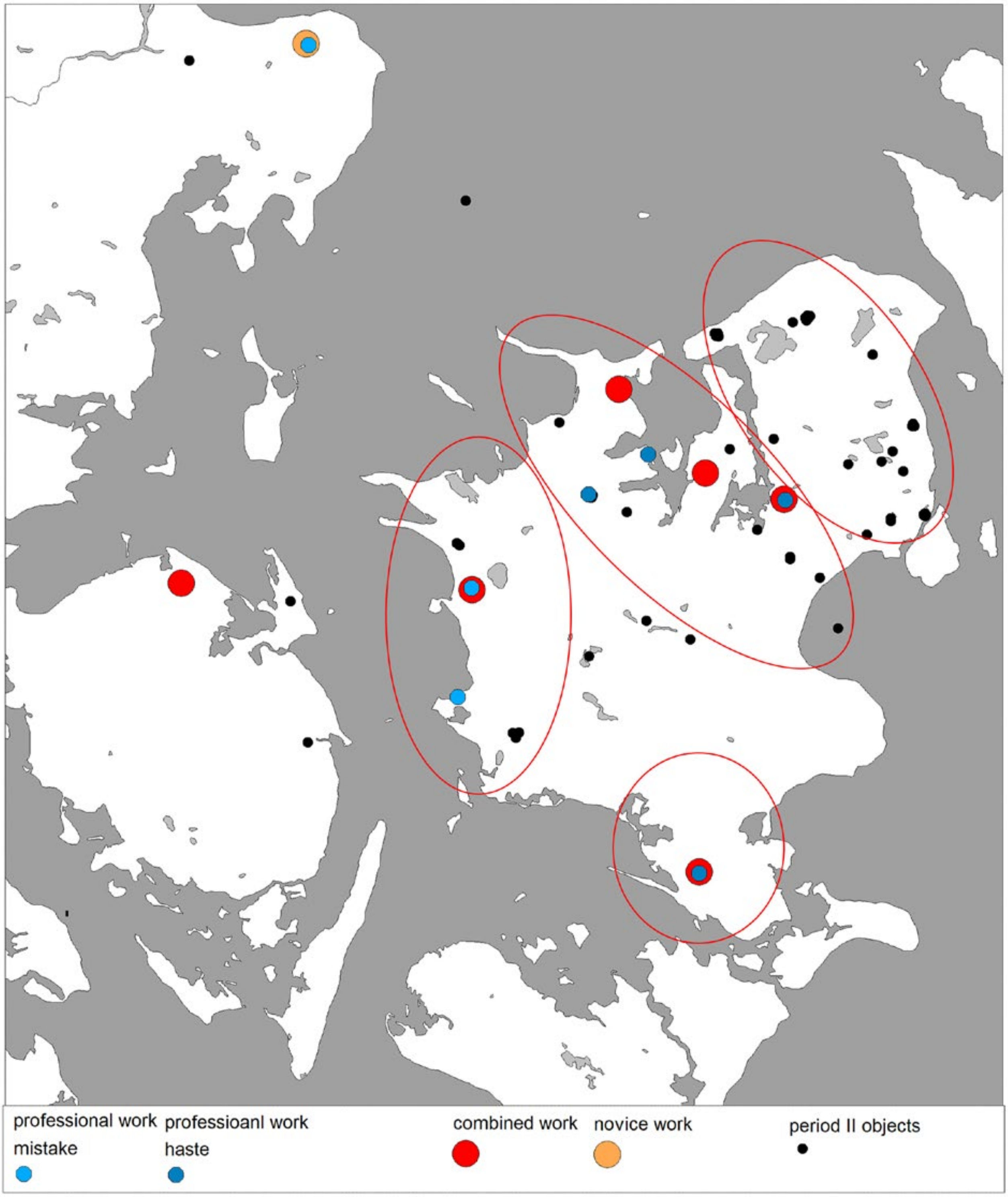


Figure 3.017: Within the decoration of the belt disc
(NM B299b) from Sludstrup distinct changes in the way the decoration is made are visible.



Map 25: Artefacts showing signs of novice work, signs of an interaction between novice and skilled craftsmen and signs of professional mistakes.



Map 26: Artefacts showing interaction between skilled craftsmen and novices on Zealand. Distribution allows first interpretations to the workshop organisation on Zealand as the northeast part shows neither novice work nor mistakes by professional craftspeople due to haste.

As already indicated, style is the result of technological craft traditions. Training, especially, shapes style (i.e. Lechtman 1975: 5; Sackett 1990; Gosselain 1992: 560; Longacre and Stark 1992: 126ff.; Hegmon *et al.* 2000: 218-219). Accordingly, variations in style can not only illustrate differences in technological traditions, but also allow conclusions concerning the organisation of training. In the following discussion the necessary factors under which stylistic innovations can occur are discussed. Additionally, ethnographic as well as examples from the examined material will be presented.

Several ethnographic studies have proven that beginners who learned their craft in a trial-and-error environment were more innovative in their respective decorative design work than those who learned their craft under close monitoring (see Greenfield *et al.* 2000; Muller 1977: 34; Larsson 2008: 84).

One of the reasons is that social groups have also included their ideologies within their technological knowledge (see Chapter 3.2), which is reflected in the functional and decorative aspects of the artefacts. A similar appearance of objects is not only a signal of identity to the observer, but also to the members of the group (Wallaert 2012: 21; David *et al.* 1988; Hodder 1988; MacEachern 1998). Thus, the regional-specific technological and decorative style is rooted in the specific technological traditions, and thus becomes, during training, part of the *habitus* of the craftsmen of this particular social unit.

The training situation determines to what degree the individual components are internalised; the more interaction between professional craftsperson and novice, the more similarity within the decorative and technological style of the artefact (Redman 1977: 51; Muller 1977: 34). In addition to a group-specific significance, the decorative style of an artefact, especially, also bears information about the individual (Creese 2012: 44; Wobst 1977: 127). Free technical choices are also allowed in craft – in the decoration of objects. Thus, a change within the individual steps of a sequence of operations might cause a slight variation in the decoration and in a similar way also change the reaction to mistakes during crafting.

Such repairs (the response to mistakes during crafting) are the result of automated knowledge. The craftsman relies, in such a moment of maximum stress, entirely on his feeling as to how the situation can be saved. The probability that a person repeats the same operation in a similar situation is high. In addition, while reacting, the craftsperson shows ability to adapt to new situations (a criteria of expertise) and thereby makes the result unique.

Such traces have been documented within the investigated material, such as the rib-waves visible on some neck collars from Mecklenburg and Zealand (see Chapter 2.6.5). For the purposes of the assumption just postulated, these ten neck collars should, therefore, have been made by one person. However, this would be neither regionally nor chronologically possible (five collars are from Zeeland NBA II, the other five were deposited in Mecklenburg during NBA III; MAP 27). Nonetheless, if this stylistic feature is seen as a reaction of the *habitus*, and thus seen as influenced by technological traditions, this similar reaction (stylistic feature) refers primarily to the parent cultural unity – the Nordic circle. Additionally, in both regions the same material (wax and bronze) is used; similar forms are created and, thereby, also the variety of possible errors is rather similar. A response to an error during making, such as the bulging of the edges on the notches pressed in the ribs, due to the malleable material, would now tempt the craftsperson from other regions to a comparable reaction, provided they share similar ideologies. Nonetheless, due to personal skills and abilities, a micro-stylistic difference would emerge (see Hill and Gunn 1977a).

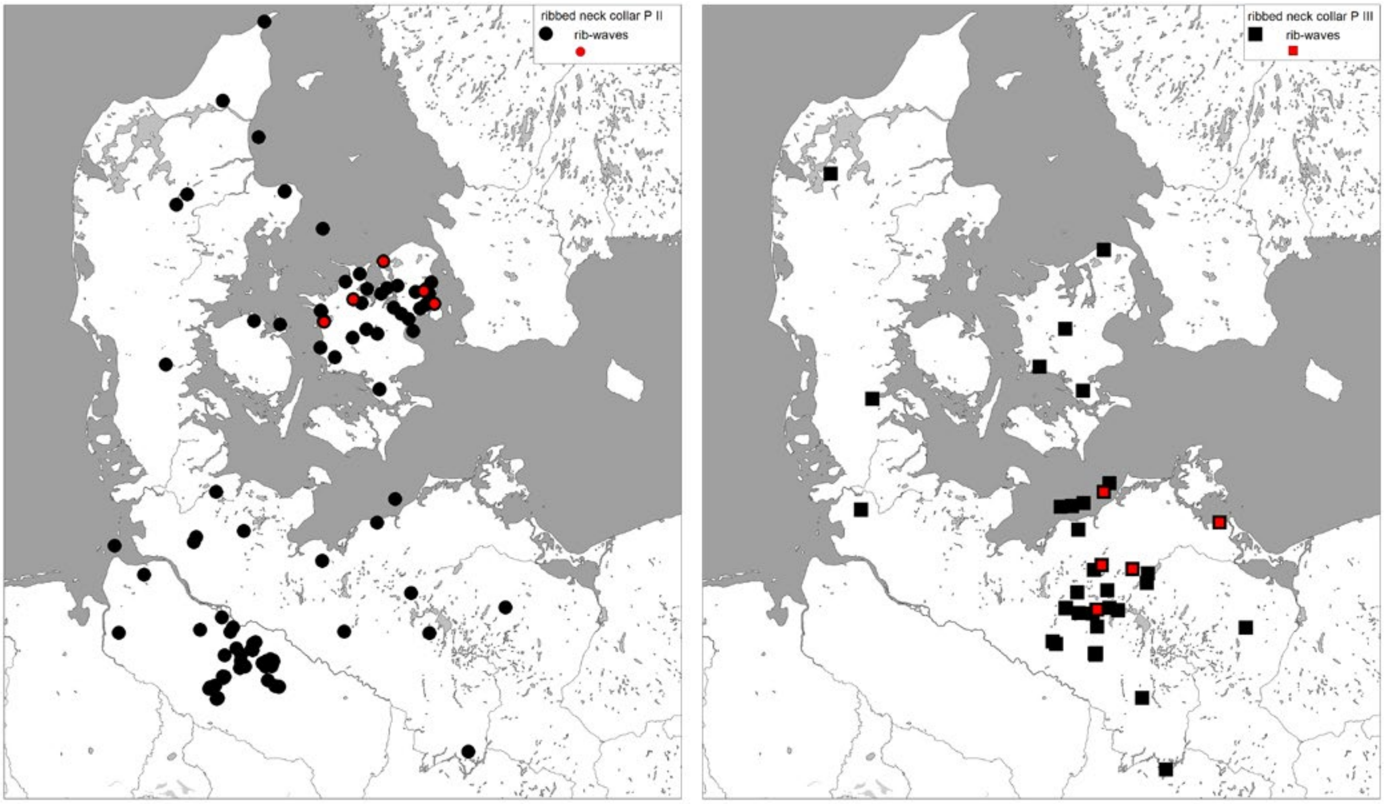
If one now considers the discussed material again, two groups can clearly be distinguished in regard to micro-stylistic derivations within these ten objects, of which the artefacts of one group display rectangular and elongated grooves with an isolated waveform, while artefacts of the other group show a significant deformation of the elongated notches (see Figures 2.102-05).

Due to the possibility of free technological decisions within the decoration of an artefact, this part of the operational chain has also the greatest potential for innovations (see Basalla 1988: 104).

Within metal technology, another factor should be added. The tools needed, especially in the making of wax models, predominantly from organic materials, are usually made individually and thus partially stylistically relevant.

A unique example is given by three neck collars from north Mecklenburg, which were probably decorated with the help of fingernails.[17] During NBA III in Mecklenburg different types of so-called arrow-ribbons can be documented (Figure 3.018). The three most common types, ladder-like notched ribbon – arrow-ribbons – stacked-arch ribbon, could rarely be documented in combination in the area

[17] The neck collars from Kragen aus Lübz (ALM 2000/1277,3), Poltnitz (ALM Br. 949) and Sparow (ALM LIIZ1g1) in northeast Germany (Mecklenburg); see for more detailed description and information, Chapter 2.5.3.



Map 27: Distribution of artefacts with rib-waves which are caused by spreading of surplus material while crafting the collar.

of the Mecklenburg Lake District (the centre of the Mecklenburg group). A region-based focus of the specific decorative elements is emerging, with increased appearance of hatched bands in the northeast, an accumulation of stacked-arch ribbon in the west, and in the centre of the Lake District, as well as on the southwestern edge, the arrow-ribbon predominately used as decorative element. Objects decorated with ladder-like notched ribbons are distributed in a loose semicircle around the Lake District. Combinations of these elements do not occur within the Lake District but do occur sporadically in the wider area. It can be assumed that the difference in this small decorative detail was visible and important for the members of the specific group, perhaps especially for the craftsperson. Due to the prevailing position and widespread use of the stacked-arch ribbon, the discussed decorative elements may act as specific information on workshops. Within the objects decorated with the stacked-arch ribbon, the above-mentioned three bronzes directly point to one craftsman. The use of fingernails to make these arch-ribbons resulted in a very individual style and is definitive innovative behaviour.

However, even bronze tools may inadvertently have a similar effect. Thus, for example, the antler-like notches from the Svenstrup bronzes provide a striking detail that could be identified on another artefact from a distance of 100 km away. Additionally, the shoe-like notches on the belt disc from Glæsborg are a stylistic feature that allows an unambiguous assignment to one craftsman (see Chapter 2.6.6).

A deviation from traditional behaviour and regionally specific style elements is very limited within an authoritarian training situation. In the example of the Mecklenburg bronzes in NBA III, it was possible to illustrate the importance of decorative style for the communal identity. It is likely that in this area the transmission of such specific elements was secured by an authoritarian form of training situation. A break in this behaviour is documented as micro-stylistic derivation and is mostly connected to repair or the use of special equipment.

As already mentioned, craft organisation, such as in the so-called ‘community of practice’, can be seen as fertile ground for innovation (Minar 2001: 392; Wendrich 2012: 5). Cooperation within a craft, as well as cross-craft cooperation, is considered by many ethnographic studies as inspirational. An example is provided within the investigated material. The elapse-grooves on some belt discs and Weitgendorf-type pins (presented in Chapter 2.6.4) inform the observer not only about the

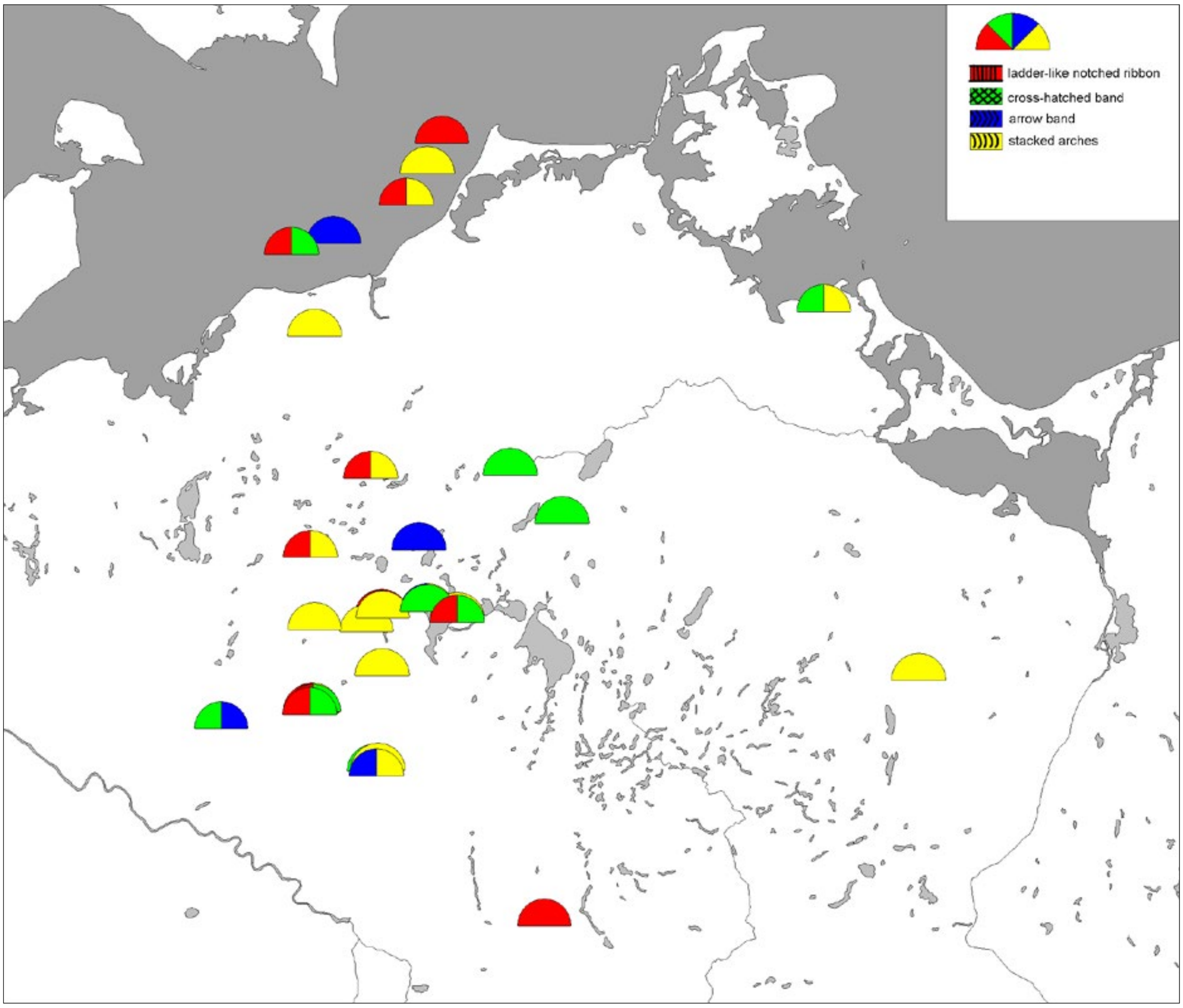


Figure 3.018: Distribution of bronze ornaments decorated with arrow-ribbon in Mecklenburg. Most popular patterns were stacked arches (yellow), cross-hatched (green) and ladder-like notched (red) ribbon, and stacked arrow ribbon (blue).

basic technique used (wax model and cast), they also point towards intensive contacts between various crafts (pottery and metalwork), most likely already during craft training.

It could be shown that individual style is expressed in individual derivations from operational sequences, in repairs executed as part of an automated reaction on mistakes, and through tools made for a distinct purpose and individually used. Each of these circumstances results in specific individual stylistic expression, in micro-styles, recognisable in the material when carefully investigated, and of high importance for the identification of the individual craftsperson.

Chapter 5

A new approach to the study of craft in prehistoric times

Within the following chapter the theoretical methods discussed are assigned to different levels of information based on an operational sequence. Thus, the operational sequence, formerly seen as a basic tool for investigating prehistoric craft, itself becomes a key theme throughout the investigation. The visualised sequence is now defined by guiding questions, such as who were responsible for the creation of the richly decorated bronzes of the Nordic Bronze Age. As such, a very detailed sequence is needed showing any traces of the *habitus* that can be recognised, and the sequence itself would have to be limited to the actual making of the object. To avoid, however, an accumulation of information that is difficult to differentiate, the approach presented here aims to add information on separate levels by asking distinct questions, such as 'How?', 'In what way?', 'Where?' and 'Whom?'. Combined, they all inform about the organisation of craft.

On the first level, the technical information is asked and the basic order of steps revealed. The second level asks about the technological tradition and the individual involved in the craft. Here, tools provide significant information about the individual and his abilities, especially when the hand is used as a tool itself and thus a direct link to the craftsperson can be drawn. Marks on the material left by tools thus allow conclusions on the respective techniques. The tendency in the craft towards traditional behaviour allows conclusions about the technological traditions of different regions. On the third level, regionally specific differences and styles as innovative actions and developments are illuminated. Here, variations in the operational sequences of the neck collar types are used to explain different technological imprinting. In addition, innovative deviations from the usual behaviour in the form of style-influencing repairs, when detected, allow us to suggest different organisational forms in metalcraft. Asking after the people involved, finally, allows on the basis of ethnographic studies of traditional crafts, for researchers to make statements regarding the preliminary work, the participation of several persons, or the relationships between various crafts – in other word its organisation.

3.5.0 Operational sequences: a basic tool and even more

An investigation of prehistoric technologies is mostly based on a reconstructed operational sequence or working-step sequence of the artefact under investigation. However, such a reconstruction requires a comprehensive knowledge of the technologies used, the material properties of the material employed, and its capabilities, and should not be underestimated. The artefacts under investigation are all made of bronze (a copper-tin alloy). While reconstructing the operational sequence that led to the production of such bronze ornaments, there needs to be clarity about the possible basic techniques used before the individual sequences can be created (see Chapter 2.4). Additionally, within an operational sequence there can be different emphases, depending on the initial question. Basically, an operational sequence can be charted so as to link the data and the analysis and interpretation of this information (Miller 2009: 29). However, such a visualised sequence can only be used properly if the frame is defined. The description of the individual steps within the circulation of metal (Figure 3.019) is a sequence pictured for those researching the prehistoric craft and its diversity (Ottaway 1994; 2001), but it contains no information about the techniques used. A comparison of the steps necessary within metalwork and pottery pictured in a schema is of a totally different nature (Figure 3.020) than a sequence that aims to represent the differences in the production of a particular artefact group (see Figure 2.061 and 2.063). Thus, important in creating a sequence is the question behind it: the scientist must be aware of the point at which the sequence starts before creating it; how detailed it should be; and at what point it ends. By answering these questions the researcher also chooses his/her favourite approach, since the life history of an artefact begins far ahead of its actual production, and, furthermore, is ended only with its complete removal from 'the world' (Kopytoff 1986). The actual production sequence or *chaîne opératoire* is, however, within this overall cycle (Sillar and Tite 2000: 16), and is, therefore, based on a sequence that starts with the first step of making and ends with the same.

The questions on the material are decisive. In the present case the guiding question relates to the individual behind the creation of the richly decorated bronzes of the Nordic Bronze Age, and their sphere of influence (provisionally assuming these objects are crafted by only one individual). Therefore, a sequence that can help answer this question would have to be very detailed (thus, any traces of the *habitus* would be recognised) and would have to be limited to the actual making of the object (presumably because the extraction of the raw material was not only executed by other people but also possibly took place far outside the area under investigation). The more detailed the sequence shown the more likely it is to determine the 'analytical individual' based on individual characteristics (Wendrich 2012; Hill and Gunn 1977a). Within the bronze ornaments of NBA II and III, it is primarily the rich decoration that contains the highest diversity of individual characteristics (see Chapter 3.4.2), as well as the technical 'tricks' that leave their traces.

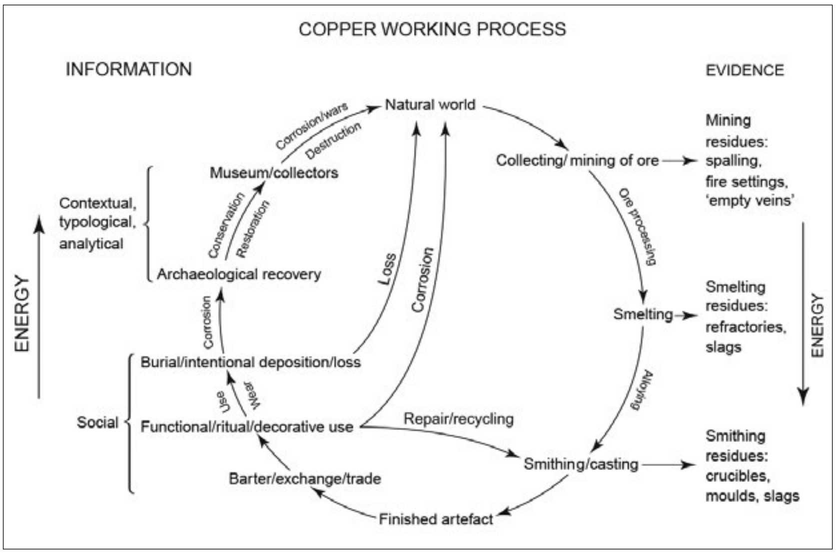


Figure 3.019: Circulation of metal (after Ottaway 2001: 88).

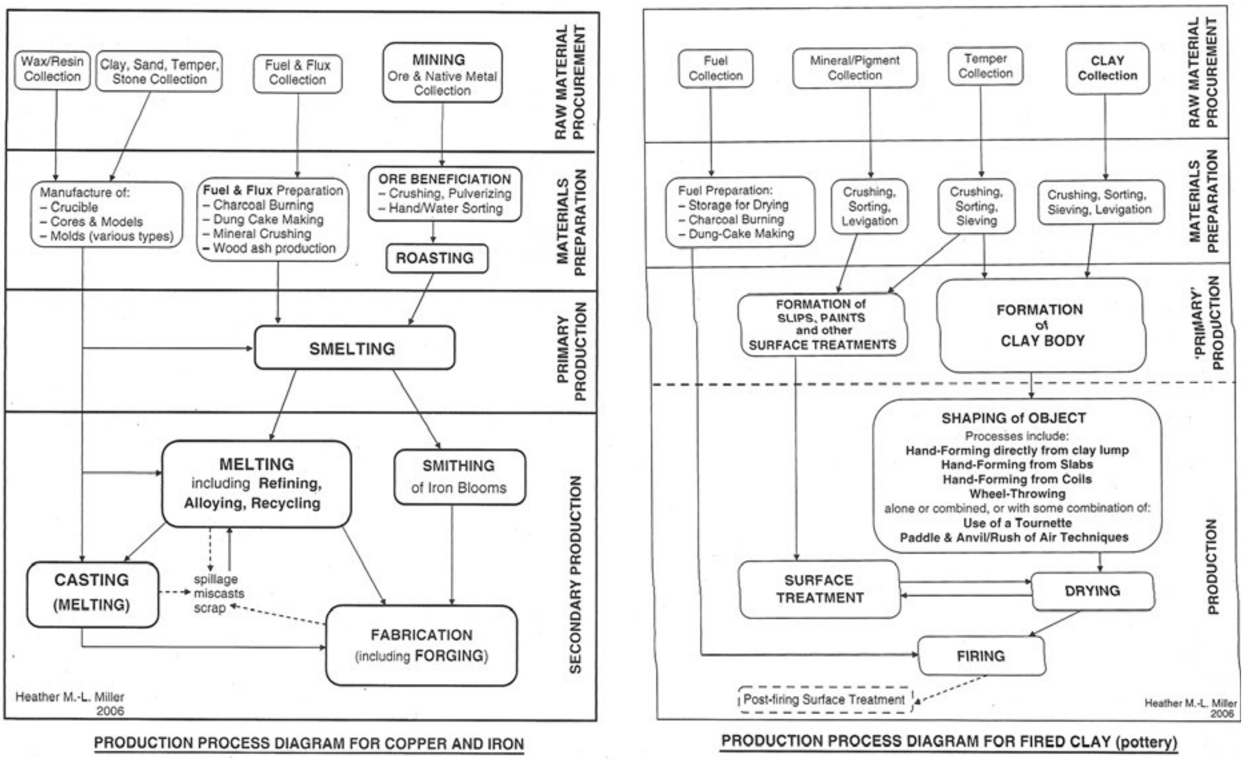


Figure 3.020: Production process diagram for copper and iron, as well as for fired clay (after Miller 2009: 29, 108).

Such a detailed sequence has already been used several times to explain the problems faced. This shows that operational sequences can contain information from several levels and answer different questions. In addition to the documented sequence of the individual steps of 'making', further information can be extracted: information about the metallurgical processes, information concerning the tools used, and evidence of the influence of several persons or crafts. An operational sequence (illustrated in a chart) can thus be used not only as a neutral visualisation of the data obtained (Miller 2009: 29) but, furthermore, used properly can act interpretively.

3.5.1 Asking 'how', 'where' and 'whom' – specific questions and information on several levels

This section attempts to look at the construction of an operational sequence as an independent concept. Properly applied an operational sequence is a tool for the interpretation of prehistoric craft. The detailed sequence scheme of the Mecklenburg- and Hollenstedt-type collars (already known from Chapter 2.6.1) serves below as illustrative material for the presentation of the tools used, the working space, the people involved and the social environment, next to the simple sequence of steps required for the crafting.

In a comparison of the different models that deal with the interpretation of prehistoric technologies (Chapter 3.1), not only does the question arise of the differences and similarities, but partly also to what extent a single model is sufficient to answer such crucial questions, such as the person behind the artefacts or the decisions made (see Sellet 1993: 110). Hence, the term 'operational sequence' was used as a neutral term. The basic operational sequence contains no valuation, or should not contain any, and just represents a tool for further operations (see Chapter 2.6). First, when distinct questions are separately asked, operational sequences can contain far more information, which should be presented on several levels. Applied in such manner, they provide a visualised theoretical model for analysing prehistoric craft. However, it is important to look at the respective levels separately, as shown below.

The selected sequences (Mecklenburg- and Hollenstedt-type neck collar) are suitable for this demonstration, since they represent the production of an object group (after Zagal-Mach Wolfe 2013: 41) and so demonstrate the crafting of multiple objects. Thus, the representation of the different level of information is possible, as well as the study of individual characteristics on the basis of this sequence. How should such a differentiation of information contained in an operational sequence be imagined? What kind of information can be seen from such a basic tool other than the simple order of steps?

The first information asked for is the operational steps of the crafting process, so that the question 'how' can be answered. It was possible to present clearly the respective steps of crafting within the sequence of the presented collar types through detailed imaging and a correlation with the metallographic investigation (see Figure 2.062 and 2.064). The goal of Chapter 2.6.1 was to show the fundamental difference in the work process. This operational sequence contained information about the different steps or workflows and their position within the sequence. It was demonstrated that the process of casting is very similar in both sequences, however casting occurred at different times in the sequence. This purely technical information can be referred to as the information of the first level.

3.5.2 Asking about technological traditions and workshop areas: the second information level

If the examined traces are interpreted, for example in relation to the possible used tools, then the sequence can be added to a second information level (Figure 3.021).

Tools contain a high amount of information about the individual and his/her abilities, especially when the hand is used as a tool itself and thus a direct link to the craftsperson can be drawn. An object, however, should be first addressed as a tool when it is knowingly used in the making process (Zagal-Mach Wolfe 2013: 197).The human body can thus also be included in this process (Leroi-Gourhan 1943; 1945; 1993). The knowledge of which way a tool is used is an important part of the *habitus* of a craftsman and is furthermore traceable in the material. In traditional crafts there is a close connection between craftsmen and their tools (Mahias 1993; Saraswati 1978), which passes partly into the mythical (Mahias 1993: 168; Behura 1964b: 37). Tools are customised to the movements of the agent or honed in the literal sense.[18] Therefore, a similar tool trace contains a high predictive value in determining the craftsman (Høgseth 2012: 62; Zagal-Mach 2008: 189; Hill and Gunn 1977b: 2).

Thus, in this interaction of materials, tools and craftsman, information is contained that can give provide an insight into prehistoric craft.

In many crafts a deep-rooted tradition in the use of various tools, as well as in the use or negation of certain techniques, is recognisable. This traditional aspect of craft allows conclusions concerning tool marks and related techniques with the help of modern examples. Accordingly, Høgseth pointed towards the similarity of the scores seen in the production of a Bronze Age boat with those of the 'gleep-hugging' method still known today for the production of plank work, in a study of the traditional wooden crafts in Norway (Høgseth 2012; 2007).

Marks on the material left by tools thus allow conclusions on the respective techniques. The tendency in the craft to traditional behaviour allows conclusions about the technological traditions of different regions.

The comparative analysis of the two operating sequences (Figure 3.021) shows on the second information level two different craft traditions, based on the assignment of different tools for the machining steps. Taking into account the chronological and regional factors, the different tool repertoire reflects the different influence the respective groupings have been exposed to. The NBA II collars of Hollenstedt-type were crafted with

[18] There are several studies dealing with the myths about the connection of tools and their owners. Mahias could find several references to a connection between the tools and divine gifts in the study of Indian pottery techniques: 'many myths present the potter's tools as the gift of a higher god' (1993: 174) ...' this association goes as far as identifying tools with gods' (1993: 175).

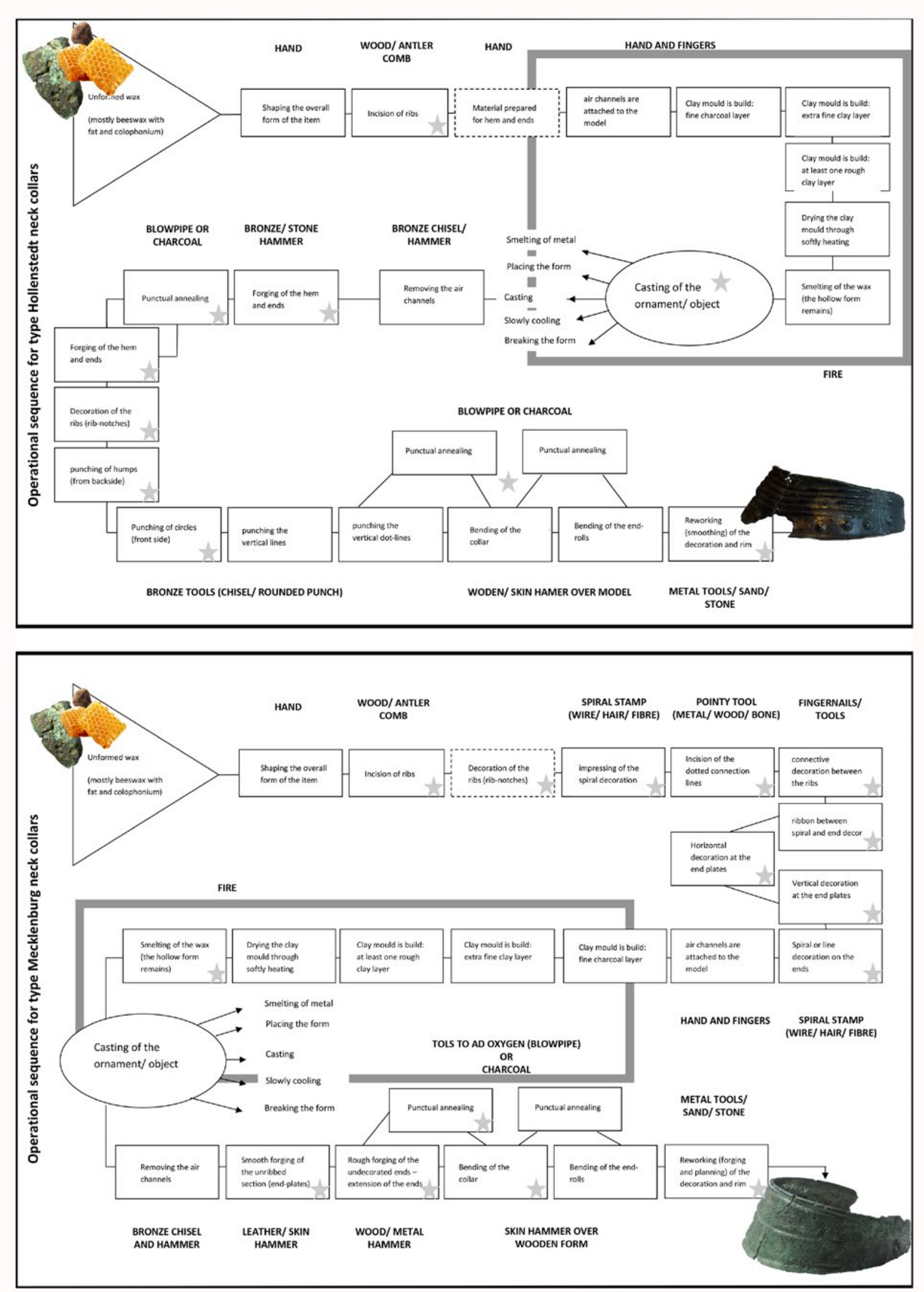


Figure 3.021: Visualisation of the second information level in the operational sequence of the Hollenstedt- and Mecklenburg-type neck collars. Possible tools used to execute single steps are named above in the sequence.

a focus on the use of bronze tools, stone and leather hammers – devices that are in the tradition of the metalwork of central Europe, as the discussion of tool deposition in southern and central Europe illustrated. The operational sequence of the NBA III Mecklenburg-type collar displays a focus on model production. The collars were mostly (with exceptions) made using tools made of organic materials. However, in the intense reworking the equally talented use of metal tools is shown. This sequence contains information that refers to a very different technological tradition. Based on the diversity of the tools, as well as the use of additional techniques (spiral stamp), it can be assumed that the influence came from two divergent traditions (northwest Germany and Scandinavia), and that both led to the development of a unique culture slightly offset in time.

In addition to the assumptions on the technological traditions with the knowledge of the tools used, the specific craftsman can be identified. Particularly when hands are actively used as tools, statements concerning the person behind the object can be made (Hasaki 2012: 176; Kamp 2001: 433). Thus, the direct reference to the craftsperson who crafted the three artefacts from Mecklenburg was possible due to the finger-nail notches in the decoration. Furthermore, even simple tool marks can be used to identify the analytical individual (see Redman 1977) and define his/her distribution area.

Simple tool marks can give information as to the craftsperson and their workshop area. It is also possible to trace technological units through the use of certain tools in combination with specific techniques. Accordingly, the tool traces display the technological tradition in which the artefact was created and reflect the *habitus* of the craftsman in the use of the tools.

3.5.3 Asking for innovative actions and individual behaviour: the third information level

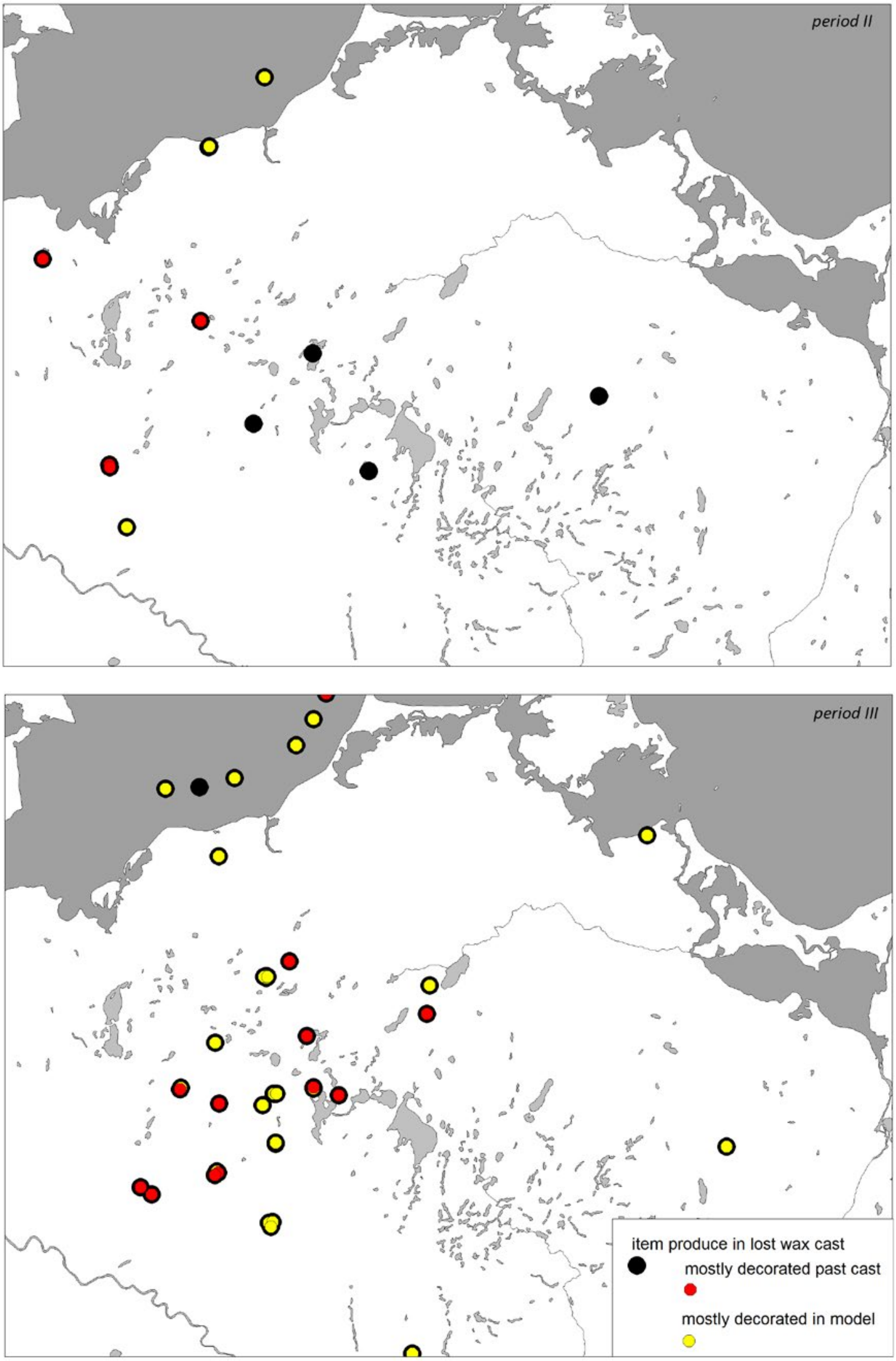
Within the variations in operational sequences, a further level of information is hidden. Internalised sequences can be seen as a fingerprint of a craftsman. Learned, imitated and acquired knowledge is described by the *habitus* and shows itself in an individual way of working. Many processes within a sequence have their origin in the technological knowledge of the broader social unit and are conditioned by training. However, the skills and abilities of the craftsman shape his/her *habitus* and the way of working. Seen from above, the variations in the operational sequences of Hollenstedt- and Mecklenburg-type neck collars are explained through the different technological imprinting of craftsmen. Considered more closely, individual peculiarities within a sequence (mostly in the decoration) are the indicators for the craftsperson behind the object.

Therefore, it can be stated that variations within a sequence of morphologically similar artefacts (object group) are an indication of different craftspeople. Furthermore these variations may show regionally stylistic traditions or individual innovations.

Especially with the help of the Mecklenburg-type neck collar, the diversity of these deviations and their significance can be well demonstrated. It has been shown in the technical part of this study (Chapter 2.6) that these collars were mainly manufactured using wax models, so within the third information level the differences can be presented. Many collars have distinct traces of a post-casting cold-working (hammering) of the decoration, and other items seem to have been decorated only after casting (MAP 28). The basic method seems regionally specific and, similarly to the use of the different decorative elements (arrow-ribbon versus arch-ribbon; see Fig. 3.018), three areas of different behaviour are visible. In particular, the decorative peculiarities show the regional variations, due to the fact that the greatest potential for change exists within the decoration (Basalla 1988: 104).

A closer look at the decoration and the order in which it was applied resulted in a grouping of the Mecklenburg-type collars, wherein the first group was crafted with the rib-connecting decoration and then the stacked-arch ribbon attached after the application of the spirals in the wax model (Figure 3.022). The horizontal decorative ribbons on the end plate followed, and then the vertical ribbons were applied. As a last step, the spirals of the end plate were emplaced. The collars of a second group were decorated in a different way to those of the first group. An overlap of the spirals on the rib-decoration clearly shows the sequence order (spiral after rib-decoration) and the rib-connecting arches were added after the stacked-arch ribbon. Additionally, the horizontal lines on the end plates were placed after the vertical decorative ribbons. The third group, however, has the largest deviations in the sequence, since the rib-connecting arches were added first, and then the stacked-arrow ribbon and, finally, the spirals were applied. Additionally, an overlap of the edge-accompanying decorative-ribbon on the end-plates is a clear sign of the application of the spirals (on the ends) before the same ribbon. However, all three sequences are mostly working with the wax model of the item, even if, within the three groups, there are significant variations in the execution of the spirals (Figure 3.022). A geographical distribution of the detected micro-styles (Figure 3.023) in the operational sequences coincides with the patterns developed above in the use of decorative elements and techniques (Figure 3.024-25).

In addition to these region-specific variations in the technological style, the third information level



Map 28: The difference between artefacts in Mecklenburg which were processed post-casting and those that were cast as fully decorated models in regard to the specific periods.

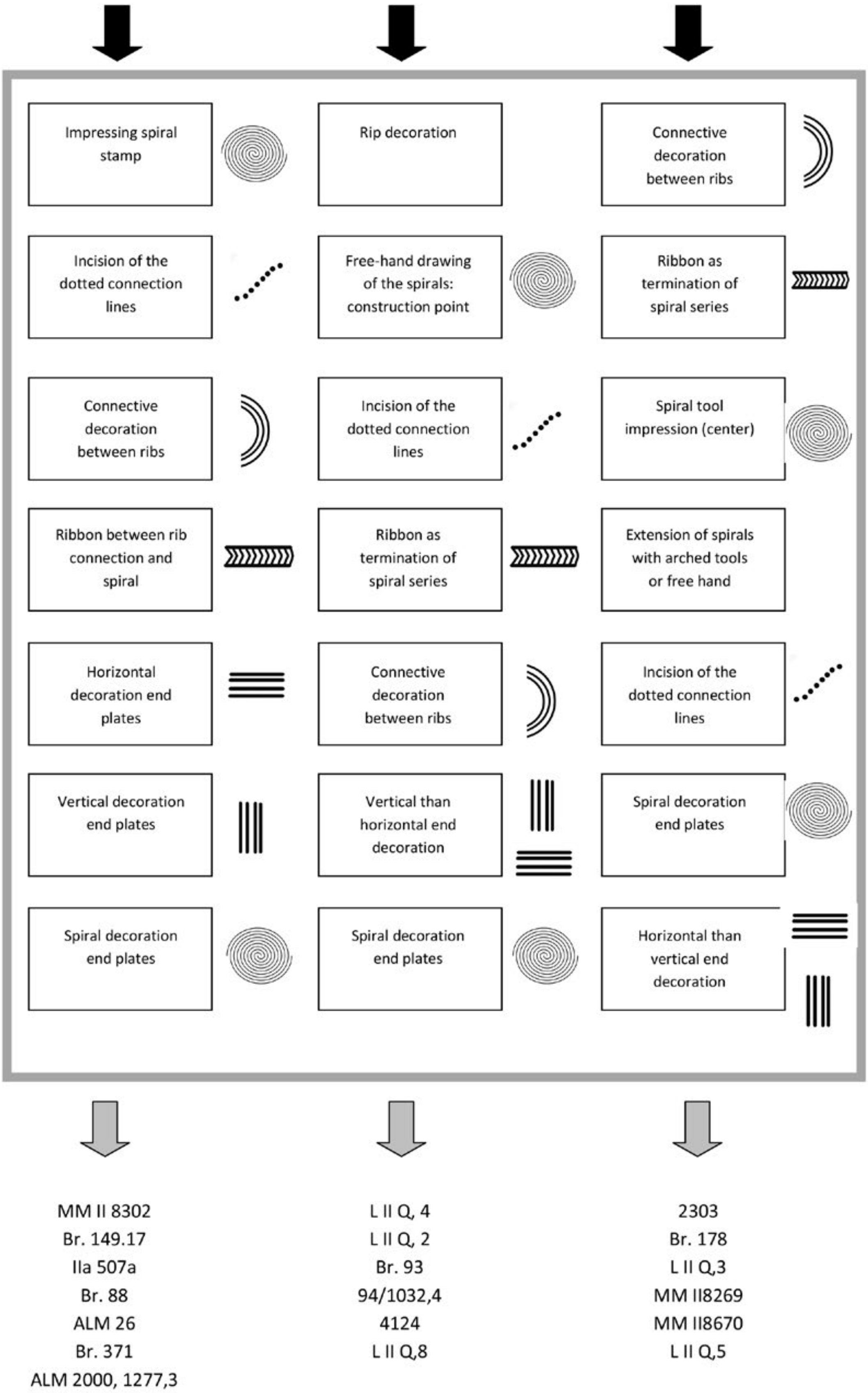


Figure 3.022: Three main groups of sequence variation within the Mecklenburg-type neck collars.

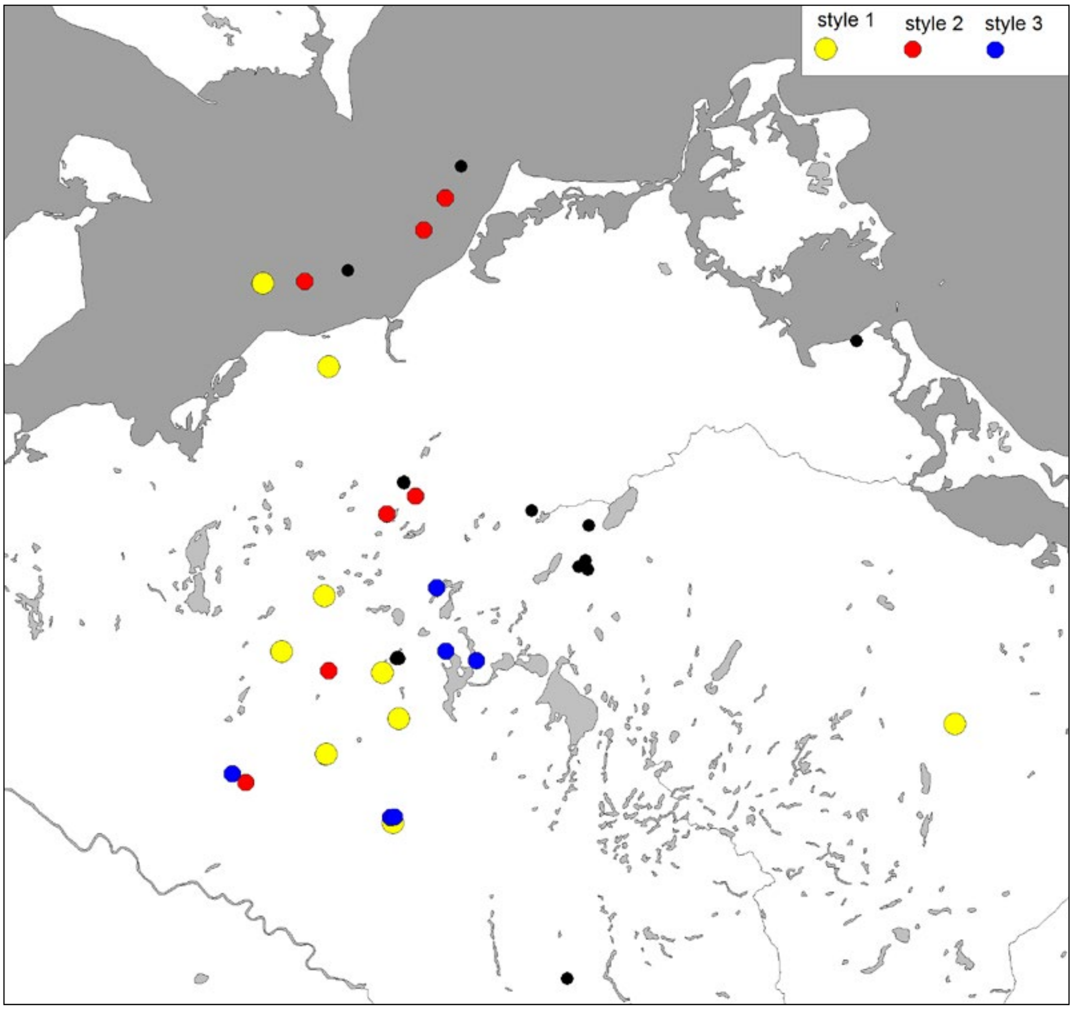


Figure 3.023: Resulting from the deviation within the operational sequence, three stylistic groups could be distinguished with a clear regional specific behaviour (see colour codes). Black dots indicate neck collars of a different, not spiral decorated type.

also contains innovative deviations from the usual behaviour in the form of style-influencing repairs, such as rib-waves.

Information regarding the individual can be obtained through the detailed examination of the sequence order, which might contain hints as to style variations, their regional characteristics and innovative actions.

3.5.4 Asking for the organisation of craft: the fourth information level

Mainly on the basis of ethnographic studies of traditional crafts, it is possible to make statements regarding the preliminary work, the participation of several persons or the relationships between various crafts.

To illustrate this line of thought, again, the operational sequences are used and this time potential areas are highlighted, and for which the knowledge of other craft directions is required (shown as red arrows in the figure) and any form of preliminary work or division of labour (shown as blue arrows in the figure) would be possible (Figure 3.026).

Within the work, several examples could be re-developed in which the knowledge of other crafts was transferred to metalcrafts. Thus, elapse-grooves on NBA III Weitgendorf-type pins in northern Germany (Chapter 2.6.4), which also occurred during NBA II on some belt discs, point towards techniques that were known from pottery. Additionally, the modelling of the ribs may have been heavily influenced by this same craft. Smooth grooves in the rib-valleys of several objects make probable the use of combs during production (see Chapter 2.8.1). Similarly, the idea of the spiral-stamp may be derived from pottery, where stamps occurred frequently. Already, the high proportion of operations with soft and easily deformable materials within the model-building point towards an influence of the direction described above. Furthermore, close contacts of the metalworking craft and pottery are indicated by several ethnographic studies (Wallaert 2012: 25-31)

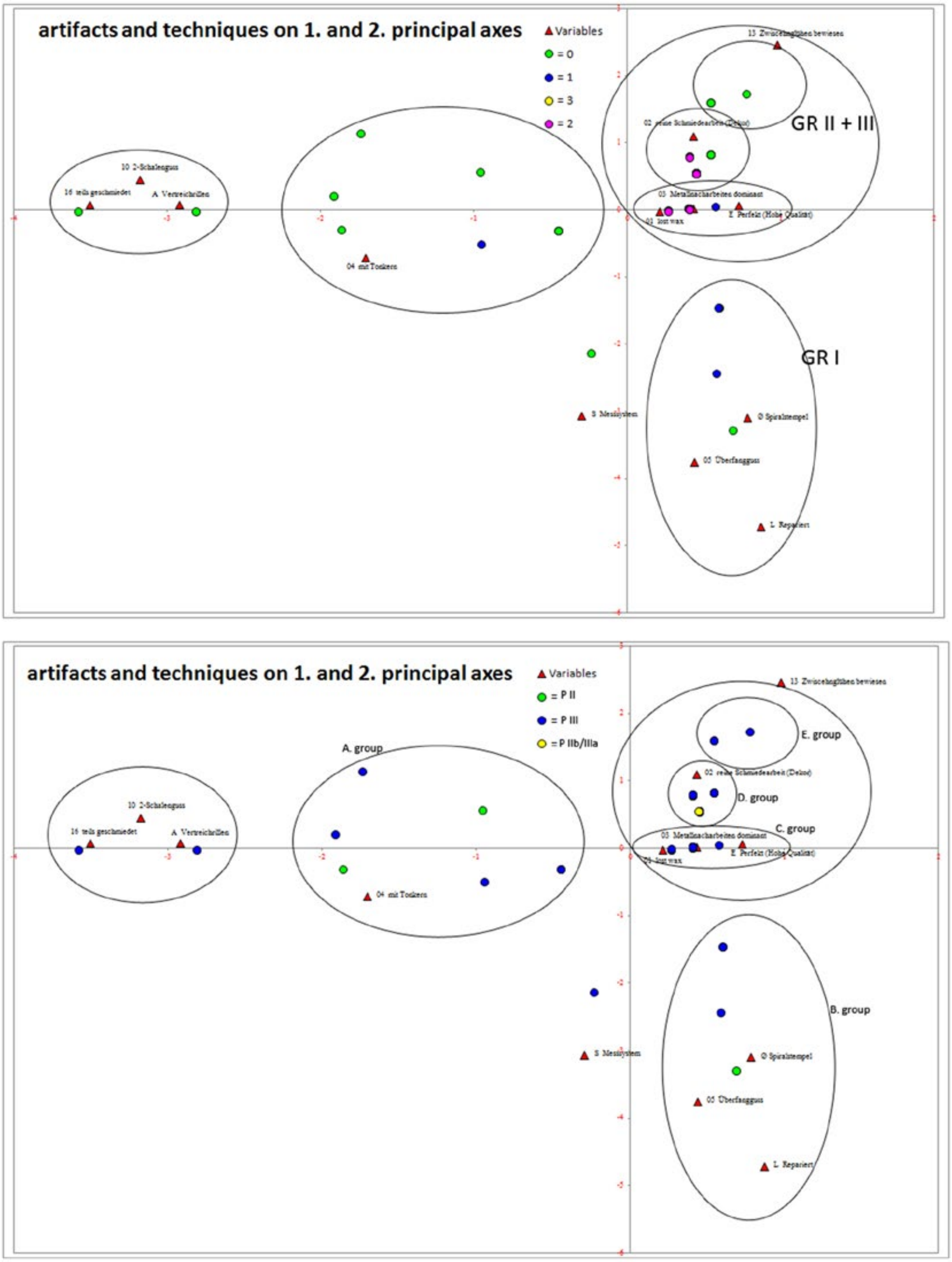


Figure 3.024: Combination statistics of bronze ornaments in Mecklenburg, as variables. Different technical characteristics were chosen. Three style groups can be well recognized in this general presentation. The other artefacts, placed outside the groupings, represent predominantly cold-worked bronzes.

with respect to similar craft abilities as well as social and religious bonds; as Wallaert-Pètre (2001: 473) remarks: 'A strong relationship exists between potters and blacksmiths, for potters can only be the wives and daughters of blacksmiths'.

In addition to inspiring cooperation in terms of technical solutions, another kind of cooperation between crafts is to be assumed. Addressing just a few areas, the wood and charcoal required to operate the stoves or fireplaces was probably not self-produced by the metalworker. Beeswax is a by-product of different craft

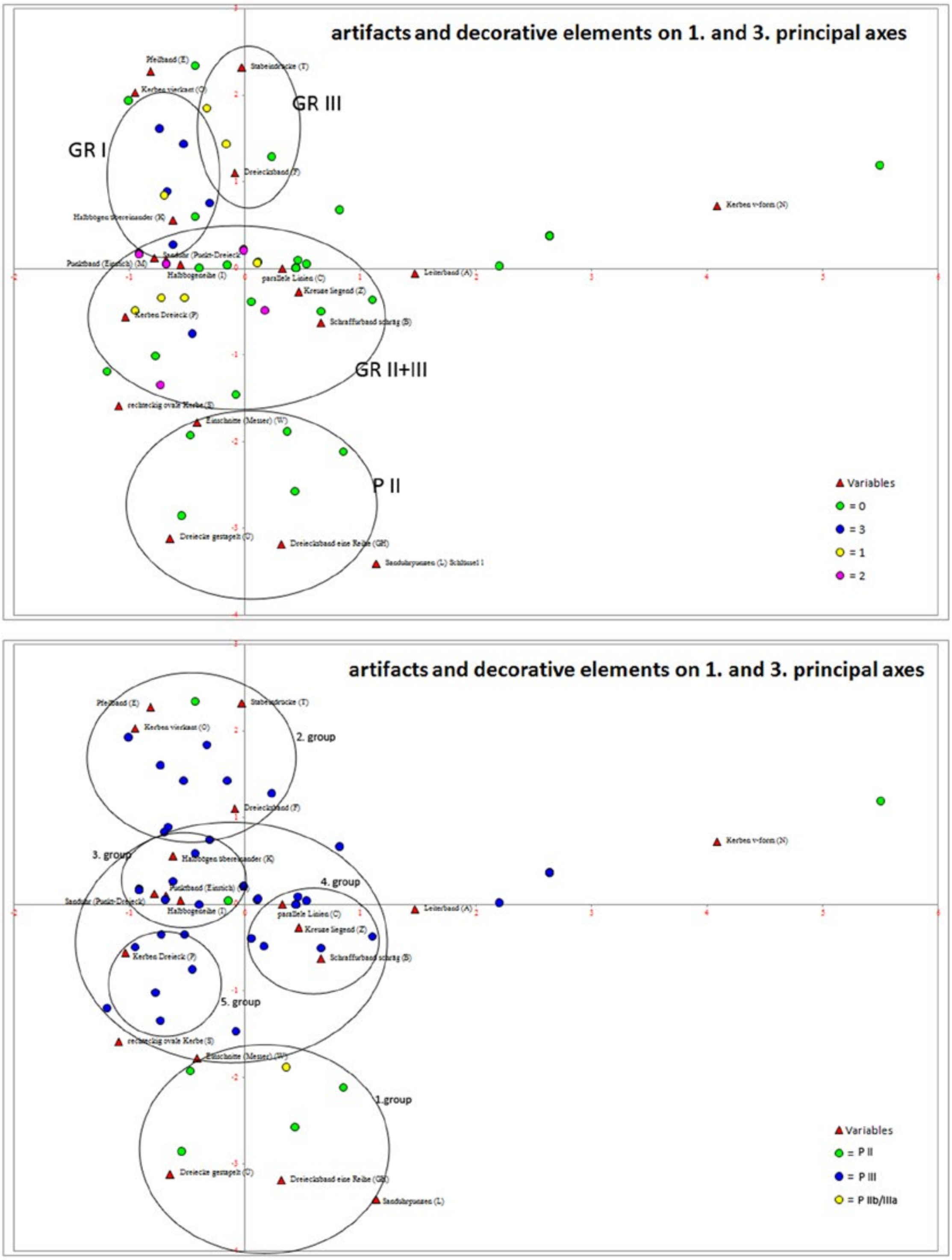


Figure 3.025: Combination statistics of bronze ornaments in Mecklenburg, as variables. Different decorative elements are chosen. Three style groups are visible within this pattern and it is very likely that a finer distinction is possible.

activity and was probably offered by exchange with the metalworker, whilst the repeated high consumption of clay creates a direct contact to ceramic crafts.

The assumption that a conditional division of labour already existed within metalcraft in the Bronze Age has been repeatedly expressed in this work. However, a breakdown of actions, as within manufacture (the division of artisanal activities in highly specialised fields of work), should not necessarily be expected in prehistoric times. Nonetheless, a division of labour can be expected especially with regard to training.

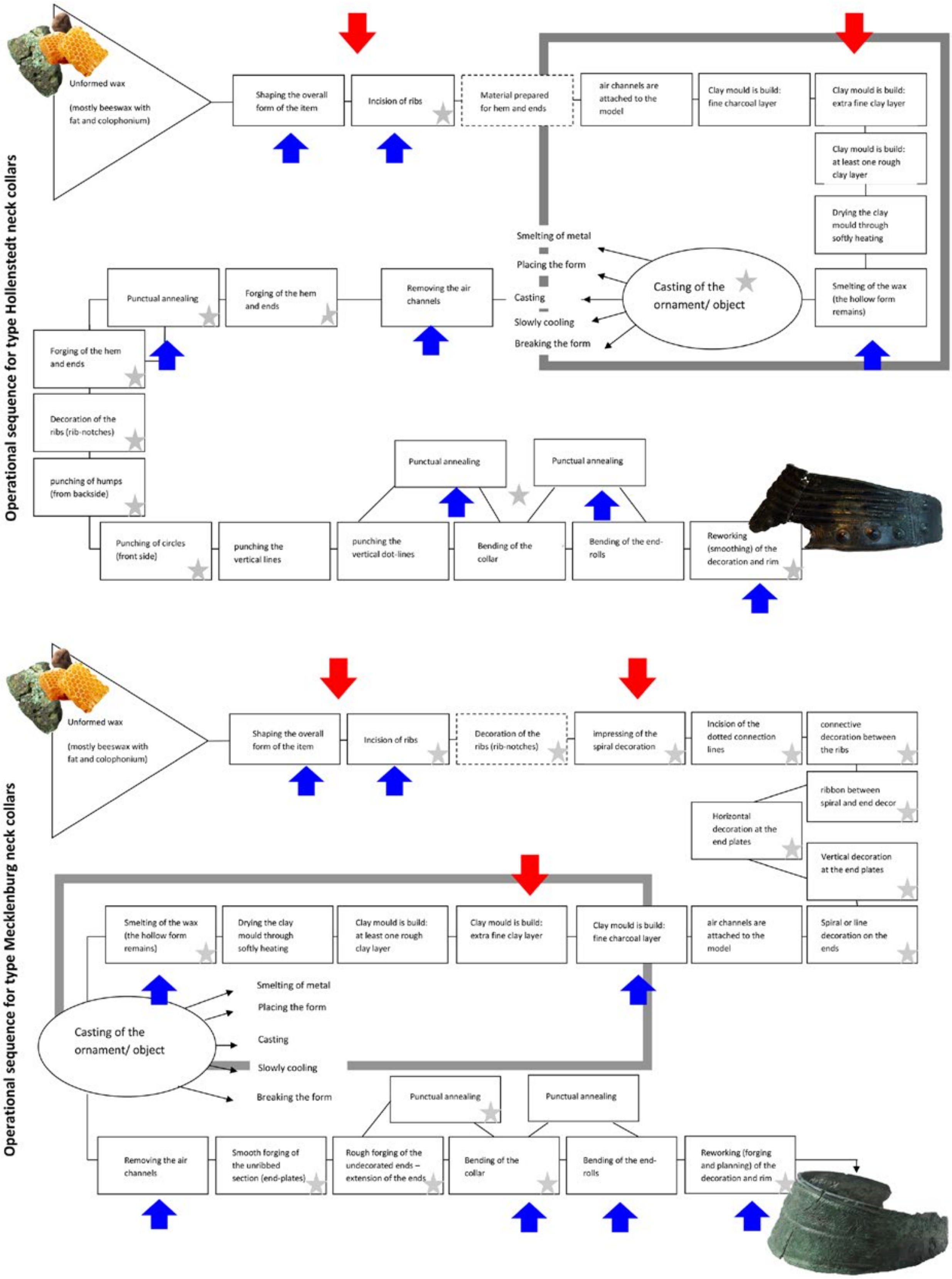


Figure 3.026: Within the known operational sequence of Hollenstedt- and Mecklenburg-type neck collars potential areas are highlighted in which the knowledge of other craft directions is required (red arrows), and any form of preliminary work or division of labour (blue arrows) would be possible.

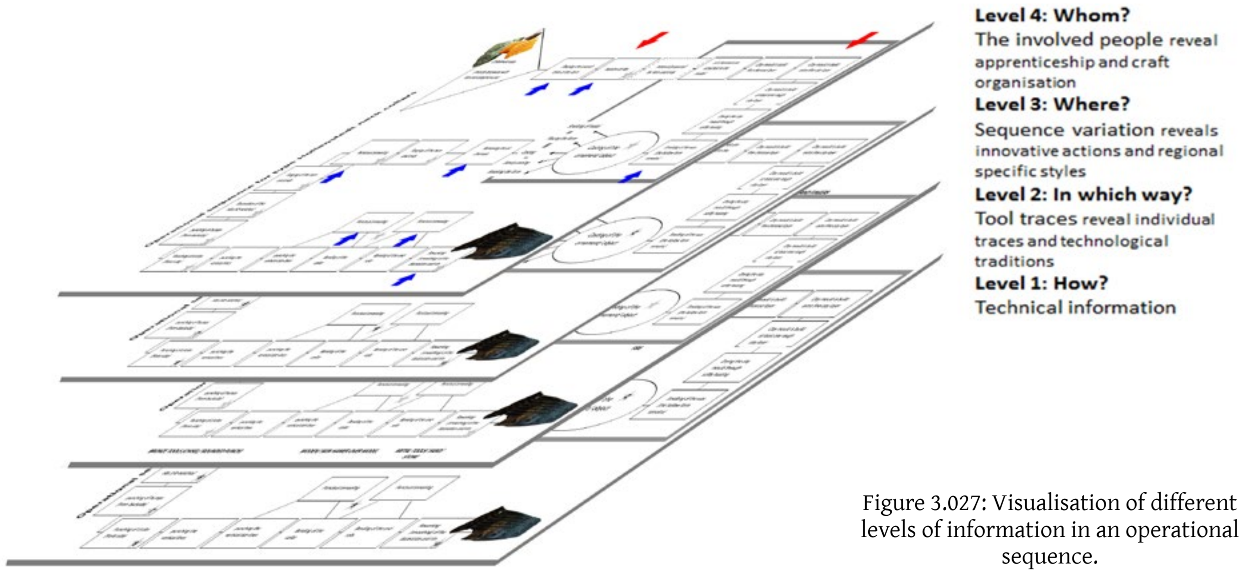


Figure 3.027: Visualisation of different levels of information in an operational sequence.

The apprentice might have been used to execute first preliminary work and later single parts of the sequence, where less skilled motor actions were required, as suggested through the development of motor skills (see Figure 3.026; Piaget 1972). It is also conceivable that a specialisation occurred regarding wax model construction and mould preparation (Levy *et al.* 2008).

Nevertheless, a participation of unskilled people in the crafting of such highly decorated artefacts as those investigated in this study can be expected during several steps within a sequence as shown below:

- Preparation of the wax (mix of several ingredients)
- Pre-forming of the model
- Giving shape to the simple formal elements (such as the ribs of the collar)
- Drying and preheating of the completed mould
- Retrieval of the beeswax
- Removal of the sprues on the cast object
- Operation of the bellows
- Polishing of the finished cast

To what extent unskilled persons were actually involved in the crafting cannot be determined with certainty. However, the present study showed a partly intensive participation of novices in the making of such elaborate bronze ornaments, and ethnological studies suggest the active participation of unskilled workers also within metalwork (see Costin 2000: 391; Wright 1991; London 1991; Kramer 1991). Additionally, the specific craft organisation plays a crucial role in the number of people involved. Within a family-organised workshop, an operational sequence might be divided into several parts, where every part is executed by a member of the family with special talents regarding this work, or the respective social position within the family to be responsible for this specific task (also regardless of the skills). In a community such as an organised craft group, it may be assumed that the entire sequence is performed by one person, who is given assistance depending on qualifications.

The visualisation of the different levels of information in an operational sequence allows taking the sequence itself as the starting point for an intense interpretation of prehistoric craft (Figure 3.027). On a first level, the crafting of the artefact is to be analysed and presented step-by-step. This level should contain purely technical information. At the second level, the visible tool marks lead to conclusions regarding the technological traditions and the habitus of the craftsperson. Information on the third level will add to the existing data variations in style. The examination of deviations in the sequences provides information as to regional peculiarities and innovations in decorative and technical style. The information gained in the fourth level regarding the interaction in craft allows definitive statements on the organisation of the craft. All assumptions are based on traces left by tools, techniques and the people involved, and are explained and supported by ethnographic and modern aspects of traditional crafts.

PART 4
METALWORK WITHIN THE NORDIC BRONZE AGE: CONCLUSION AND DISCUSSION

Chapter 1

Pattern of regional behaviour

The following part of this investigation aims to use technical features in combination with the theoretical models built within this research to create an understanding of the organisation of metalwork within the Nordic Bronze Age (NBA). Several times within this study it was possible to trace regional patterns and restricted distributions of technological behaviour which point towards several technological traditions during the period. Additionally, regionally specific decorative styles could be defined as well as several common elements. Three major regions showed distinct stylistic preferences and a large variety of decorative elements, such as Zealand and central Lower Saxony in the NBA II, and Mecklenburg in NBA III. The defined decorative styles presented in this chapter enabled the tracing of the first contact networks between regions. On Fyn and Jutland no specific decorative style is discernible; however, this area is influenced by the south as well as the east with regard to its decorative elements. The regional groupings, mentioned in the first part of this study, have been identified, by several researchers through intensive observation of the material culture. However, technical features should also be used to pinpoint groups within these cultural units. Within this chapter an analysis of regional patterns defines smaller social groupings, with a similar technical repertoire and a united technological behaviour. In such a restricted community, the identification of analytical workshops and individuals is possible.

Following on from this, patterns of regional behaviour are identified and workshop circles illuminated. The definition of workshop circles suggested here, as the area of influence of a single workshop or closely related workshops within one technological tradition, allows a first separation. Different circles in the material culture are defined, based on similarities within the decorative and technical style, as well as through specific technological behaviour.

4.1.0 Tracing regional behaviour in the metalwork of the Nordic Bronze Age

Regionally distributed social groupings are, within the archaeological record, identifiable through different features. As demonstrated in Chapter 3, technological traditions, especially, can be used as indicators. This is due to the close interaction within a social group, and the shared ideology and shared educative systems, in short, within the same social structure a shared way of doing also appears. This is, in regard to craft, united in the technological traditions of a specific group, which should be seen as the framework of every craftsperson's *habitus*. The similarities increase the smaller the specific grouping becomes. However, the wider the geographical distribution area of the specific group, the fewer similarities can be observed. Only a well-structured society can achieve a unity in technological and social behaviour over wide distances, such as those of the Nordic Bronze Age. Thus, the present study has already revealed several regional characteristics within the NBA as a cultural unit itself. Formal characteristics, technological behaviour, stylistic features and behavioural features should be compared to identify unities that could be named 'Werkstattkreise',[1] or in other words, smaller technological units within the ideological community of the NBA.

There is no doubt that a probably similar world-view, extensive contact and likely cross-regional relationships and obligations produced the specific material culture of the NBA, singular in the European Bronze Age with its spiral-decoration and magnificently decorated items. On closer inspection several regional peculiarities are visible in regard to construction, burial rites and costumes, to mention just a few (i.e. Rønne 1987; Ansigh and Rasmussen 1989; Larsson 1986; Olausson 1989; Willroth 1997a; Laux 1997; Geschwinde 1996; Fendel 2006). Furthermore, the crafted items display significant differences in size, shape and proportions, a clear sign for regional technical behaviours (i.e.

[1] The term 'workshop centres' has long been under discussion in research. Occasionally workshop centres are defined as the distribution area of identical artefacts (from the same cast) which led to the assumption that they were produced under the same conditions; here also casting moulds are included (Jockenhövel 1991: 51; also Aner 1962; Torbrügge 1965: 98; Jankuhn 1969: 89). Additionally, the assumption was spread that the area where an artefact is concentrated can be related to the workshop where the specific artefact was crafted (see Kossak 1959: 111; Werner 1961: 312). However, workshop centres should rather be defined as an area where products occur which are crafted under the same technological conditions from craftsman displaying a similar *habitus*. Due to the fact that the *habitus* can be seen as a mirror of the society in which the craftsman grew up, objects from one workshop, or an area where craftspeople are in close contact and exchange, will be alike in basic technical features as well as stylistic ones.

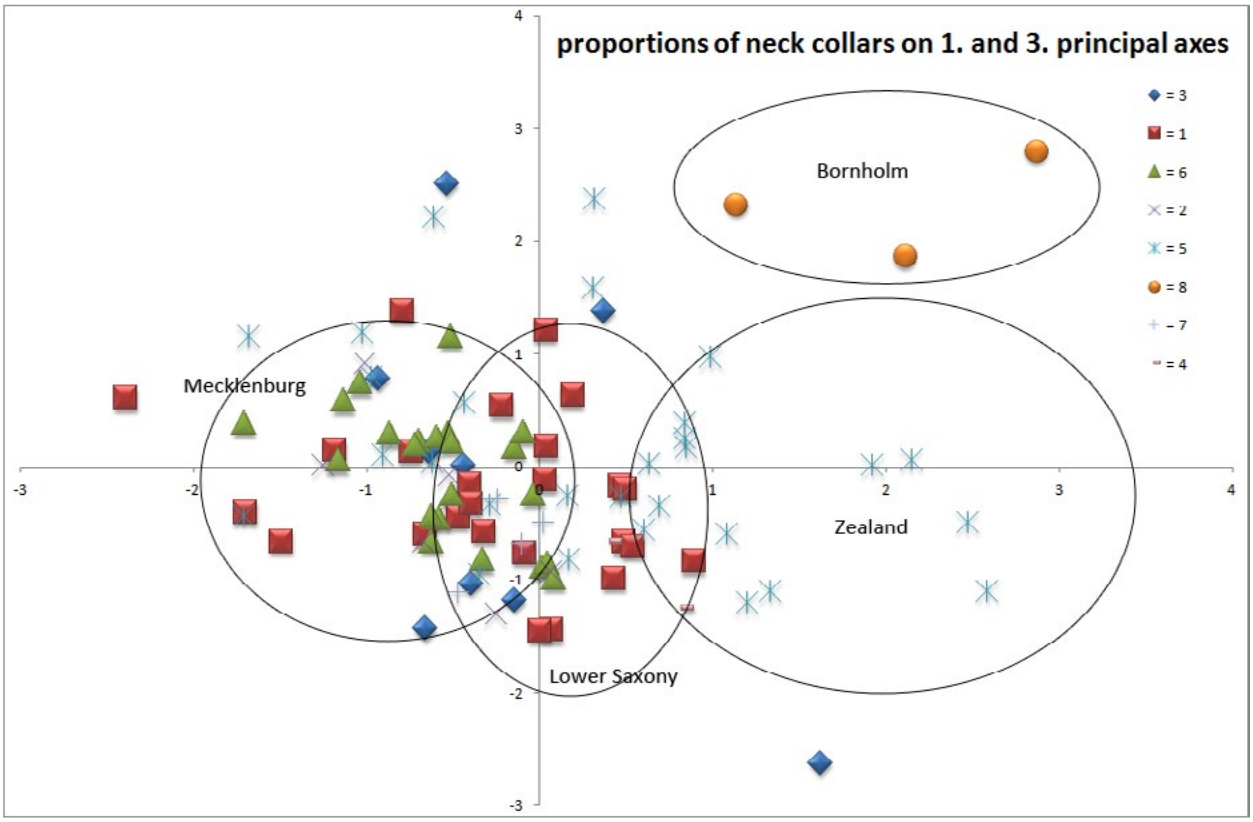


Figure 4.001: Correspondence analysis of the neck collars in regard to their proportions and the measured weight. The achieved groups support the assumption of stylistic differences between the regions.
1 -Lower Saxony, Germany; 2 -Fyn, Denmark; 3 -Jutland, Denmark; 4 -Scania, Sweden; 5 -Zealand, Denmark; 6 -Mecklenburg, Germany; 7 -Brandenburg, Germany; 8 -Bornholm, Denmark.

Lechtman 1977: 5; Lechtman and Merrill 1977; Gosselain 1992; Hegmon 1998: 267; Sackett 1990).[2]

Especially for neck collars and belt discs, an inference that on Zealand the items seemed to be bigger and heavier than in Niedersachsen was made during the technical investigation. A corresponding analysis of the specific object groups supported this suggestion (Figures 4.001 and 4.002). Both object groups, namely neck collars and belt plates, show variations in their proportions that could be related to different regions. Most evident is the difference in diameter and height of the belt plates deposited on Zealand and in Lower Saxony (Figure 4.002). The same distinction is visible with the neck collars. Here the Mecklenburg region in NBA II and III also shows deviating proportions which should be interpreted as a regional sense of formal style. Interestingly, the overall shape of the objects on Bornholm seems to have no connection to the surrounding objects. Here the neck collars as well as the belt plates show specific proportions only occasionally found within the rest of the NBA. Furthermore, regarding overall shape, the Danish mainland and Fyn are more oriented towards the smaller, lighter northwest German artefacts (Figure 4.001) than the magnificent objects deposited on Zealand.

This analysis revealed that the technical style of the elaborate, decorated bronze ornaments in NBA II and III supports the division of the NBA as single, ideological community into several smaller units, such as central Lower Saxony (Lüneburg group), Zealand and probably northwest Mecklenburg within NBA II. In NBA III northwest Mecklenburg (including north Brandenburg) and Bornholm are the most distinct units. These regions display specific technical and stylistic characteristics which mirror the technical repertoire of the society in focus. By this means, bronzes such as those investigated in this study can be assigned a general area by their formal appearance alone.

4.1.1 Decorative-element distribution

Another stylistic feature that is somehow related to the technological style investigated above is the decorative style. In a similar way to functional attributes, decorative elements can be typical for specific communities (i.e. Berg 2007: 234; Wendrich 2012: 5; Lemonnier 1992: 89; 1993: 10).

[2] '...not just the artefact has style, the activities themselves which produce the artefacts are stylistic' (Lechtman 1977: 5).

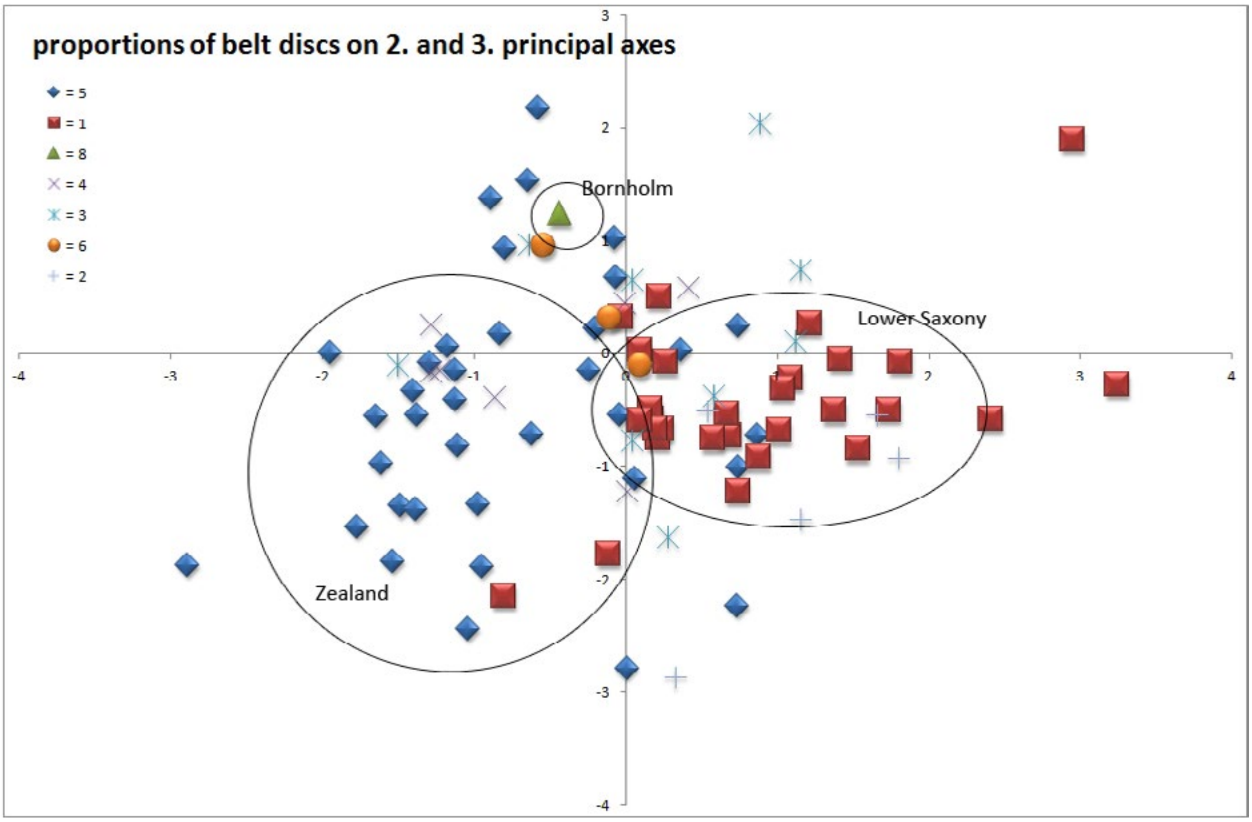


Figure 4.002: Correspondence analysis of the belt plates in regard to their proportions and the measured weight. In a similar manner as the neck collars, the belt plates also support the assumption of stylistic differences between the regions.
1 -Lower Saxony, Germany; 2 -Scania, Sweden; 3 -Jutland, Denmark; 4 -Fyn, Denmark; 5 -Zealand, Denmark; 6 -Mecklenburg, Germany; 7 -Brandenburg, Germany; 8 -Bornholm, Denmark.

> 'principles of design rest on traditional ways of doing things - on artisans skills and on bodies of tacit knowledge' (Collins 2012, 323).

The investigated material clearly showed that NBA II especially was rich in various decorative elements (Figure 4.003). The frequency of the individual elements slightly declined towards the Middle Bronze Age, as too did the frequency of the investigated objects. Furthermore, some decorative elements seem to be common elements and show no temporal or regional preferences, for example lines (4), parallel lines (5), incisions such as rib-decoration, or rectangular notches.

However, some decorative elements clearly show regionally restricted dissemination areas, which should help to identify the smaller communities within the NBA. Especially on Zealand, the variety of decorative elements (17 of 19 basic elements) is impressive. For example, diamond-shape motifs and axe-shaped notches are mostly restricted to this area (MAP 29). The few objects deposited outside this area displaying the mentioned elements may have also originated on Zealand. Furthermore, the distribution of artefacts decorated with hatched bands and triangles composed of lines (MAP 29) points towards a motif that has its

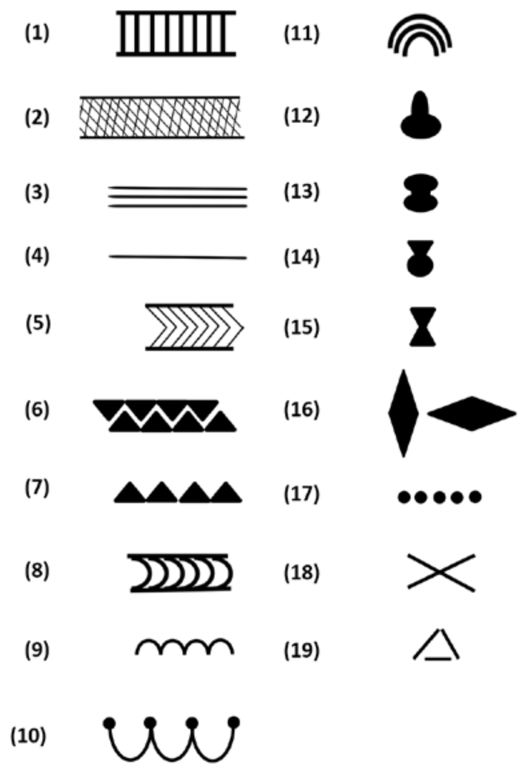
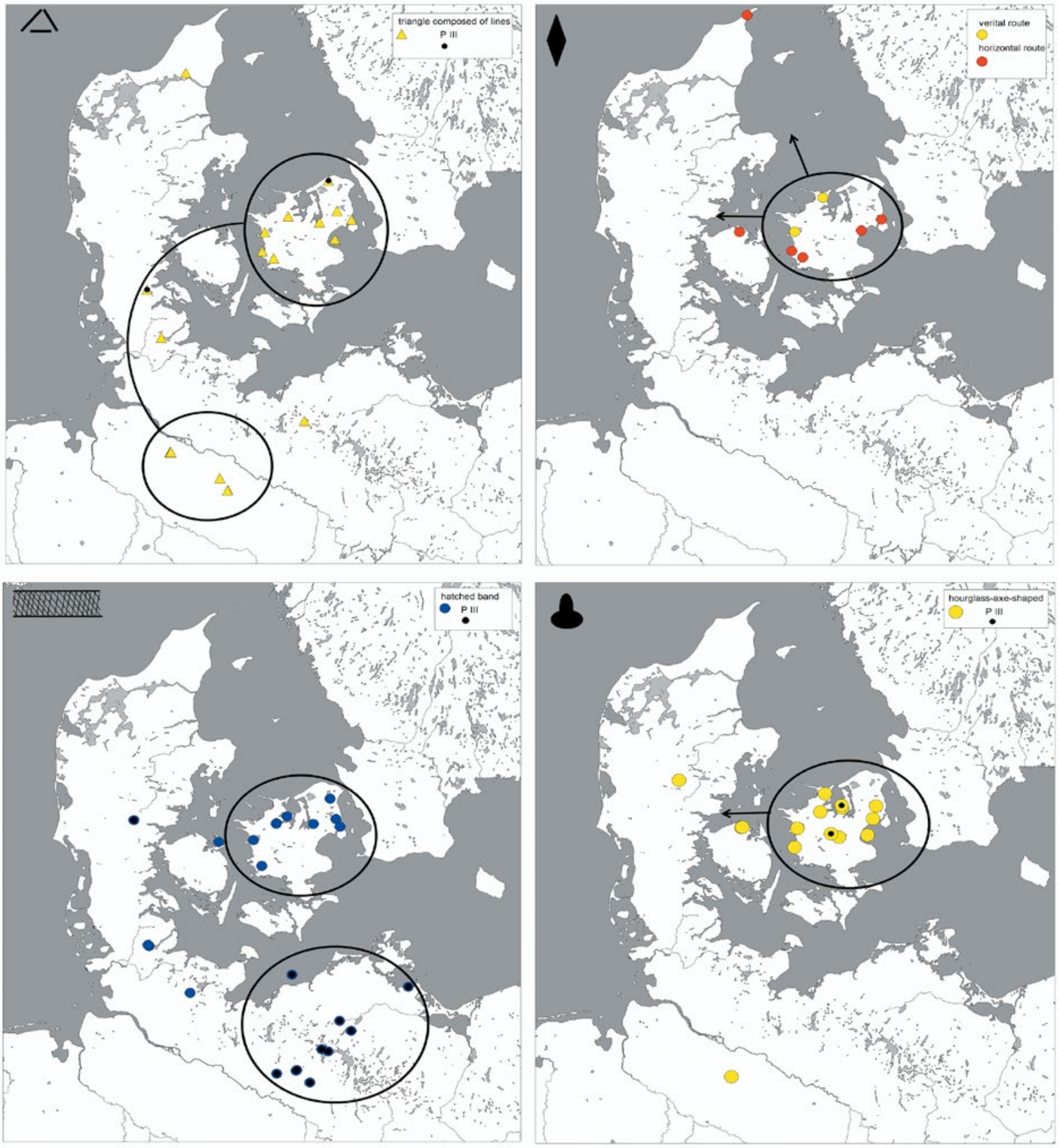
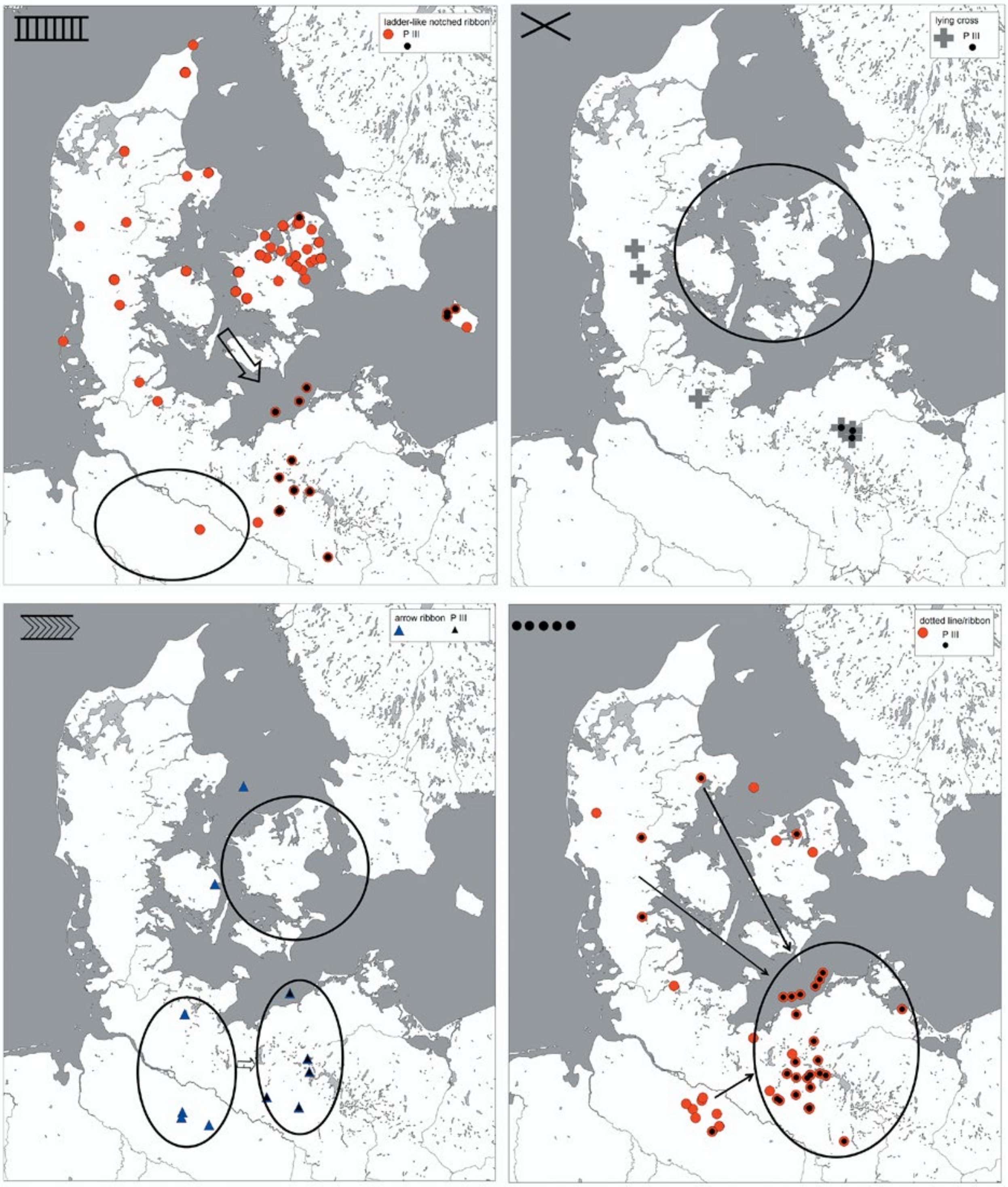


Figure 4.003: Single decorative elements detected on investigated material of NBAII and III.



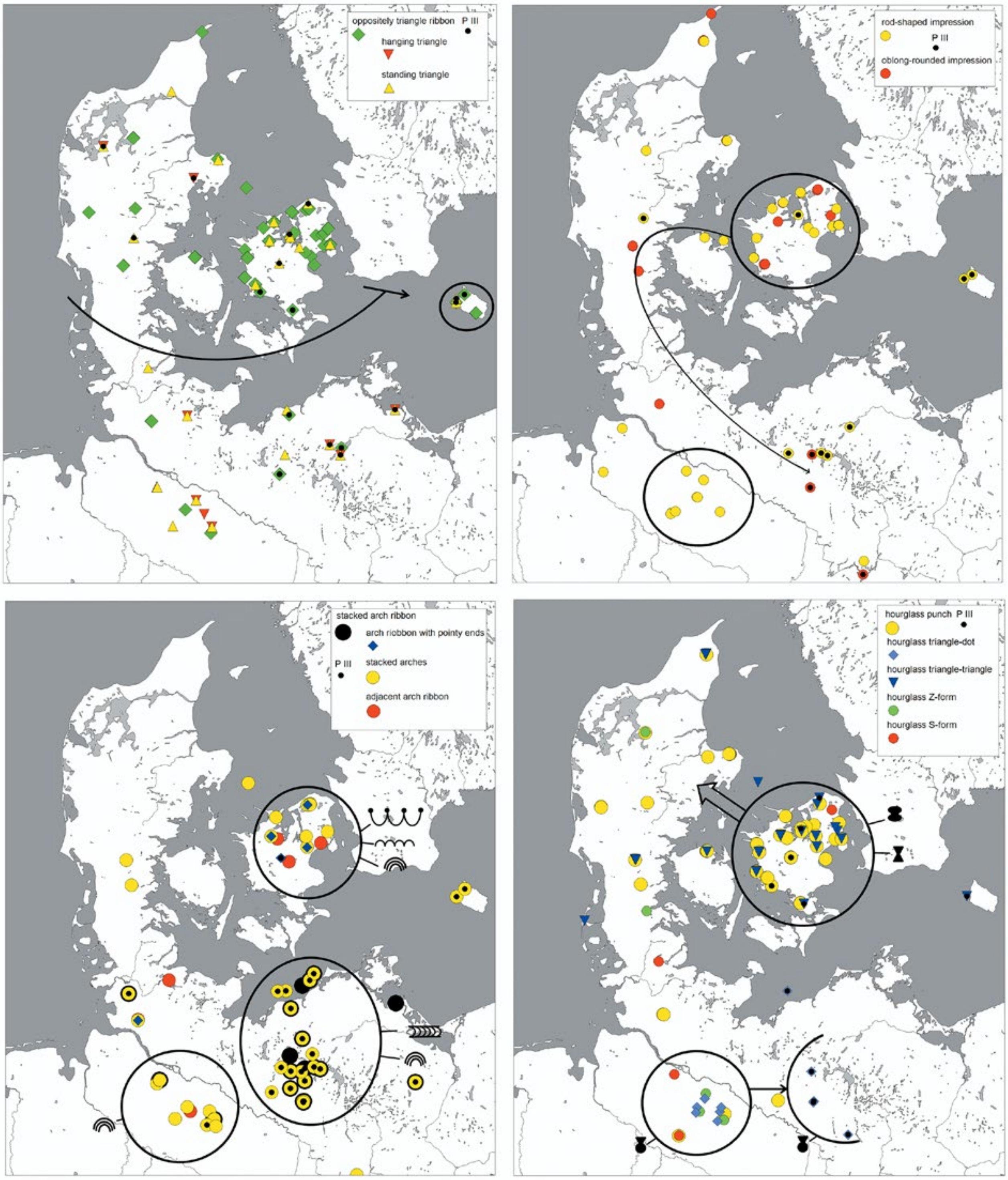
Map 29: The variety of decorative elements on Zealand (17 of 19 basic elements) is impressive. Some elements occur predominately on the Danish Island as triangles composed of lines, hatched bands, routes and axe-shaped hour-glass notches.

origin on Zealand. Both elements show their main distribution on the island, however, single items with the same decorative element are spread over Jutland and in Lower Saxony (triangles composed of lines), or show a similar loose distribution in Jutland and a concentration offset in time in Mecklenburg (hatched band). On the other hand, single motifs such as arrow-ribbons, lying crosses and dotted lines are not, or are only sporadically, represented in the material found on Zealand. The elements that are decisive for the decorative style in central Mecklenburg in NBA III, and which also occurred in the previous period, seem to have no connection to the decorative repertoire on Zealand (MAP 30). In Mecklenburg, it seems that a unique decorative style first developed in NBA III. The few richly decorated bronzes within NBA II were decorated with widely known and simple elements. Additionally, in this region the slight offset in chronology referred to earlier in this study allows the influences that affected the formation of this specific



Map 30: Specific decorative elements could not be found on artefacts of a specific region (such as Zealand or central Lower Saxony), although they were common in the Nordic Bronze Age.

style to be traced. In this manner the dotted lines, for example, were used on artefacts during NBA II in Lower Saxony and also occasionally on Jutland and the islands. The accumulation of this decorative motif in NBA III in Mecklenburg was definitely influenced by the decorative behaviour southwest of the Elbe (MAP 30). The same can be said for the use of arrow-ribbons, triangle series and hourglass-shaped notches (MAP 31). Clearly, Nordic influences can be traced in the use of elements such as ladder-like notched ribbons, rod-shaped impressions, and the very prominent spirals (MAP 31).



Map 31: Some decorative elements are used in different variations in the different regions.

Interestingly, some of the otherwise common decorative elements are not represented in the area of the Lüneburg group. In some cases this might be a result of stylistic reasons (as in the case of the ladder-like notched ribbon), in others a technical explanation might be more realistic. The hourglass-shaped notches are a common decorative element, however, with distinctive differences in their form and, even more important for this work, their technical execution. These notches can be produced using an hourglass-shaped tool that, for example, can have mistakes and thus produce a unique pattern (see Chapter 2.6.6). Furthermore, the same motif can be made with small triangle-shaped tools, a triangle- and a circle-shaped tool, or different kinds of oval-shaped tools (MAP 31). The method or tool used to produce the motif can be similar in a workshop as well as in an area with the same technical behaviour. The items originating in central Lower Saxony are decorated with hourglass-shaped notches produced through diverse methods, but not by placing two triangles opposite each other; this technical solution is restricted to the Danish islands.

In regard to the decoration present on the investigated ornaments several common elements were detected, as well as regionally specific elements. Three major regions could be identified which showed distinct decorative styles: Zealand and central Lower Saxony in NBA II; and Mecklenburg in NBA III. In these regions the greatest variety of decorative elements in use is found on Zealand. On Fyn and Jutland no specific decorative style is discernible; however, this area is influenced by the south as well as the east in terms of decorative elements. North Jutland especially was strongly influenced by Zealand, while northwestern Germany shows elements typical for the area of the Lüneburg Heath.

Examining the distribution of decorative elements, some exchange routes become visible. Thus, artefacts with style elements originating probably on Zealand are distributed commonly from Fyn over south Jutland to northwest Germany (Flensburg-Eckernförde-Lübeck) and to north Mecklenburg. In contrast, the influence from central Lower Saxony spread towards the north via Dithmarschen and towards the east via the Elbe.

4.1.2 Regionally restricted technical behaviour

Similarly to the use of decorative styles, technical behaviour also seems to show regionally specific tendencies, from the variety of casting techniques to the use of special methods to produce models. Furthermore, in the same way as the different decorative elements, the techniques used also point towards cultural units (e.g. Sillar and Tite 2000: 10; Minar 2001: 388). Together they form the technological traditions of a group of people related through kinship, ideology, and their place of residence.

This investigation revealed several patterns of technological behaviour, of which some are distinctive and display the overall technological influences, while others are minor differences and display innovations within a small group of related craftsmen. All of these characteristics are of particular importance in the definition of analytical workshops.

The lost-wax technique can without doubt be seen as a characteristic of the NBA (e.g. Sprockhoff 1940: 28). However, the preparation of a fully decorated wax model (proved at the Vognserup hoard) was restricted to only a few regions. Again, Zealand shows – compared to the southern regions – a high frequency of objects which were nearly completely decorated in the wax model, including the only documented pieces that were cast without reworking. Again, northern Jutland seems to be closely related to Zealand.

South of the Flensburg Fjord the volume of objects decorated as models decreases rapidly (see Chapter 2.8.0, MAPS 13 and 14). This picture is supported by the variety of different casting techniques used to produce the material investigated (see Chapter 2.5.5, MAP 11). Northern Germany, especially Lower Saxony, shows the use of two-part moulds and lost-wax casting, as well as intensive cold-working. In Denmark only occasionally was a technique other than the lost-wax method used. Regarding the variety of basic metalworking techniques, the area of the Lüneburg group clearly exhibited the greatest range.

As with the distribution of basic technologies, the use of spiral-stamps (see Chapter 3.2.2, MAP 24) can also be restricted to the northern regions of the area under investigation. Despite a relatively high volume of spiral-decorated ornaments, in northern Germany the artefacts are only occasionally decorated with the stamp technique.

These basic techniques picture the separation that Kersten was aware of when separating the NBA into zones (1936: 2). In NBA II, Denmark – and especially Zealand – is characterised by the intensive use of the lost-wax method for crafting highly decorated ornaments. Specialised techniques, like the use of spiral-stamps to achieve identical spirals, were widely disseminated on the Danish mainland and the islands. A clear separation to the area south of ‘Kieler Bucht’ is detectable, where the volume of basic techniques used increases and the ‘typical’ Nordic elements are less dominant (Figure 4.004).

As well as the mentioned peculiarities, more specific techniques could be documented, with more distinct dissemination. These techniques, for example the way in which the eyelet was attached to the body of the tutulus or belt disc, should be seen as technical innovations due to the craftsmen’s *habitus* and, as such, a mirror of social habits. Saying that within the *habitus* the technological traditions of the craftsman´s social environment are embedded, one could presume conversely that technical peculiarities are *due* to the *habitus* and to the specific technological tradition. Taking the earlier-mentioned example of the five possible methods detected for making a model for a belt disc with eyelet (see Chapter 2.8.2, MAP 18), a regional diversity is clear. During NBA II all five methods were used in equal volumes. The craftsmen on Zealand, however, concentrated on applying the eyelet through the cast-on technique and with the help of a ceramic

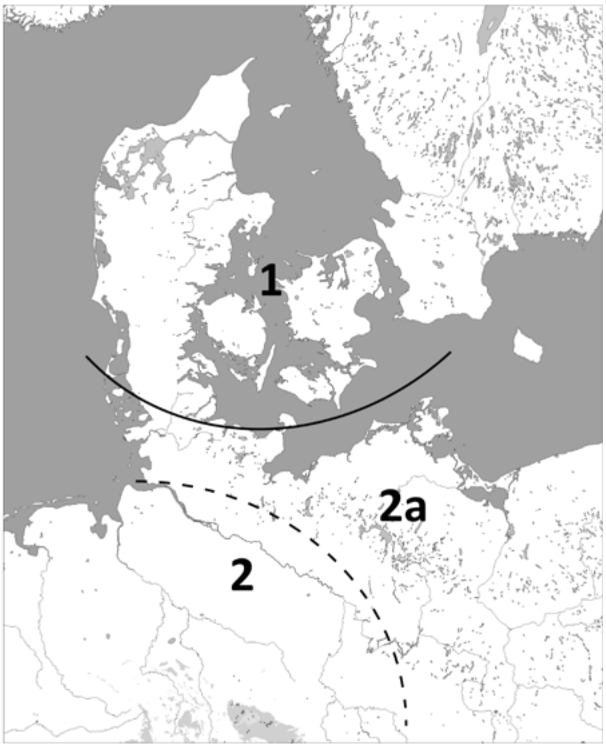


Figure 4.004: Separation of the Nordic Bronze Age into three main regions, with deviations in the use of the basic crafting techniques, such as casting and cold-working.

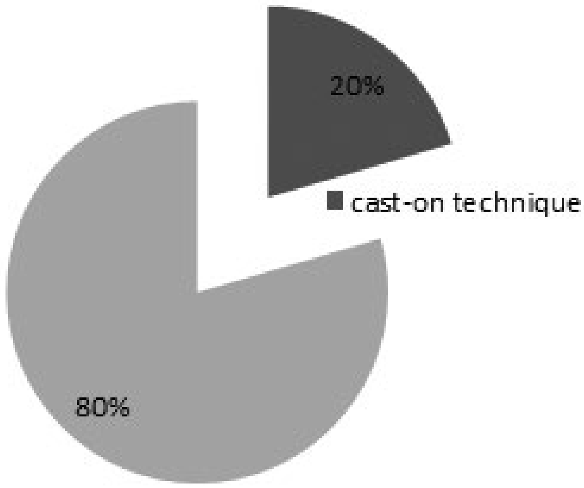


Figure 4.005: Around 20% of all belt plates were made using the cast-on technique to attach the spike to the disc.

core embedded in the wax model. In central Jutland it is mostly the traces of ceramic cores that are found, while in northern Jutland the eyelet was modelled to be massive and perforated. The area north of the Elbe shows similar techniques used on Zealand, while south of the Elbe the use of organic core material dominated. Furthermore, on Zealand metal bars were occasionally worked into the wax model of the tutulus and were thus cast into the item. The distribution of this technical detail is of interest, insofar as it clearly shows regionally specific technical solutions within a morphologically united material culture.

Another technical solution that shows regionally specific tendencies is the way in which the ribbed section of many neck collars is achieved. The diameter of the rib-valley itself allowed conclusions on the different techniques used (i.e. the use of comb-like tools to achieve triangular rib-valleys) and revealed differences between Zealand (having semicircular and triangle rib-valleys) and central Lower Saxony (displaying all documented forms) already during NBA II. In NBA III the regionally restricted appearance of trapezoidal rib-valleys could also be observed in Mecklenburg (see Chapter 2.8.1; MAP 17). It seems as though comb-like tools were mainly used on Zealand, and additionally similar traces were found on neck collars in north Jutland, Lower Saxony, and in one case also in Mecklenburg during NBA II. Again, the direct connection between metalwork on the easternmost Danish island and the area of the Lüneburg group is noticeable.

However, there are more indications that these two regions were actively exchanging technical knowledge, possibly through direct contact of craftspeople, as unknown techniques cannot be understood by copying objects and reliably internalised. A good example to help distinguish between the techniques seen, or explained and copied afterwards, and such techniques that were copied only through observing an object, is provided by the spread of cast-on spikes on belt plates. In NBA II, on 20% of the investigated belt plates the spike is attached through a cast-on technique (Figure 4.005), and objects crafted in this manner appear from Zealand, over Jutland, and into central Lower Saxony (MAP 21). However, on three plates south of the Elbe the spike is attached with a different technique than that used on Zealand. On these the spike is modelled onto the previously cast disc. There is no 'step' or spike base, as is commonly found on plates from Zealand. It might be assumed that these two variations of the cast-on spike developed separately, however there is a need, first, for knowledge that a similar method was used in the other region.

In contrast, the above-mentioned way of modelling the ribs needed more than a template. More likely is it that craftspeople of both regions were exchanging ideas and knowledge about technical peculiarities. This assumption is supported by occasionally appearing repairs on the investigated objects. As Sennett mentioned, 'today an expert is seen as someone who can equally make and repair' (Sennett 2008: 248); also in prehistory the ability to repair an artefact should not be underestimated. Therefore, it is not surprising

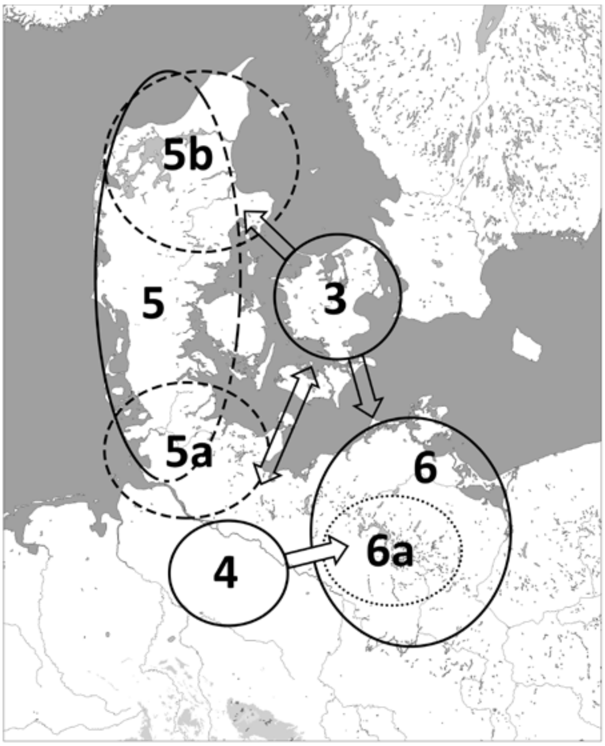


Figure 4.006: The distinctive geographical distribution areas of technical peculiarities (technical traditions) correspond roughly to the stylistic groups.

that in the same region where the most, and excellently decorated, artefacts occur (i.e. on Zealand), the greatest variety of repair techniques also occurs (see Chapter 3.2.1, MAP 23). However, of interest is the fact that only the area between the Elbe and Aller rivers, in addition to Zealand, displays repairs using staples. The material from Jutland is exclusively repaired by physical reworking, a technique also spread on Zealand and in Lower Saxony. Thus the question arises as to why only this technique was used on Jutland and not the second, more advanced technique? The craftspeople on the Danish mainland no doubt could have acquired the knowledge needed to repair using staples. Does this phenomena stress the different skill groups in the respective regions, or is the decision to repair by rounding the edges and inserting holes a decision based on the technological traditions that, in this case, differ between the islands and further south?

All the technical solutions to the common problems mentioned above, the individual inventions such as rib-waves (see Chapter 2.6.5; Nørgaard 2015a; 2015c; 2014), comb-incised ribs, or modulated spikes, have shown distinctive geographical dissemination areas that roughly correspond to the stylistic groups (Figure 4.006). Clearly evident is an area with a high technical variety on Zealand and between the Elbe and Aller in Lower Saxony. Here, a strong tendency to develop individual solutions to common problems occurs, as well as an intensive exchange of technical knowledge between these two regions. Furthermore, with the use of special techniques, such as the widespread use of perforations as a repair technique for neck collars during NBA II, Jutland shows distinct technical behaviour and separates itself from the adjacent areas. Additionally, several technical peculiarities which occurred on Zealand and south of the Elbe (knowledge exchange) had only a minor effect on crafting in Jutland. However, some regions do show an influence of the two major metalworking centres of NBA II. Despite the fact that Jutland displays a united resistance to new innovative techniques, within the northern part artefacts occasionally appear which were clearly influenced by ‘Zealandic’ metalcraft, or might even have originated on the Island itself. The southern part of Jutland occasionally displays a similar picture, where the influence from Zealand seems to be slightly more dominant than from south of the Elbe (see Chapter 4.2.3). However, an independent pattern is not visible, possibly due to the small number of finds that falsify the picture.

Clearly the Mecklenburg region already displayed regional behaviour in NBA II. As in Lower Saxony, several basic techniques are also spread there, and cold-working (hammering) seems to have been an important alternative in crafting to the lost-wax casting of ornaments. Within NBA III and the establishment of the Mecklenburg group (see Rassmann 2004a; Hundt 1997; Beltz 1902), a distinct technological tradition demarcates the area from the adjacent regions. It seems that central Mecklenburg used technical elements developed in the two previous centres of production (south of the Elbe and on Zealand) to create its own technological tradition. Further north and west the centres of craft decrease and an established technical repertoire is used without displaying the uniqueness of NBA II.

4.1.3 Decorative and technical similarities – regional technological behaviour or workshop circles?

The previous investigation revealed several patterns in stylistic and technical features that can be explained through group-specific behaviour. When projecting these clearly technical features onto the groups identified through classification of objects, burial rites and architecture, a high degree of similarity can be traced (Figure 4.007).

It seems as though, in the research area under discussion, during NBA II and III the cultural groups developed their own technical repertoire, which is visible in the making of artefacts (Figure 4.008). However, the units detected in the decorative styles appear to be smaller than the technical units. This picture might point towards an organisation of craft where the mobility

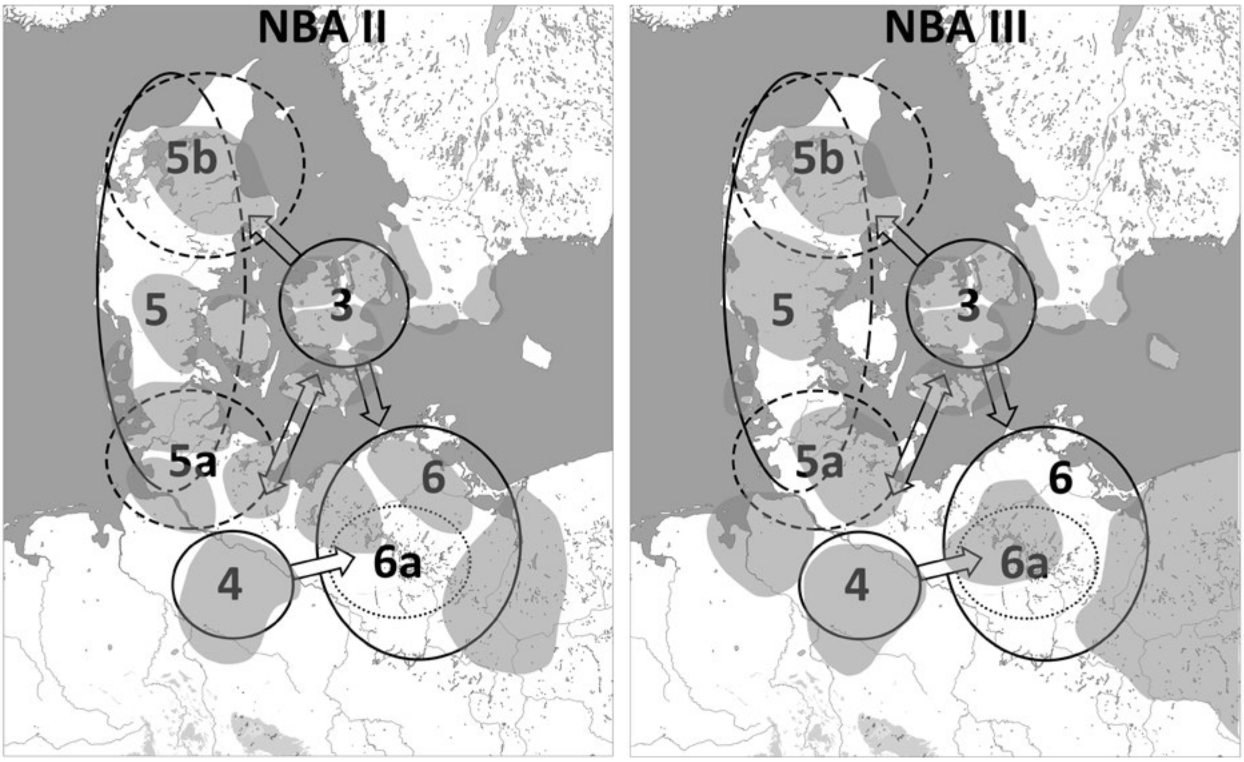


Figure 4.007: When projecting technical similarities onto the groups identified through classification of objects, burial rites and architecture, a high degree of similarity can be traced.

Behavioural and typological GROUP after Rønne 1986; Asingh and Rasmussen 1989; Willroth 1997; Kneisel 2013; Geschwinde 2000; Laux 1971; Fendel 2006; Jockenhövel 1991; Sprockhoff 1941;	**Technical GROUP** **Workshop circle**	**analytical workshop** **NBA II**	**NBA III**
NE Zealand NBA II-III		AW7	AW7
E Zealand NBA II		AW10	AW10
SE Zealand NBA II-III			
NV Zealand NBA II-III	Group 3	AW8	?
V Zealand NBA II			
central Zealand NBA II		AW10	
SV Zealand NBA II-III			
S Zealand NBA II-III		?	
Fyn NBA II	Group 3/5	?	?
South Denmark NBA II-III	Group 5a	?	?
Islands "Skagerak"(Sylt) NBA II-III			
central Jutland NBA II-III	Group 5	AW6 AW9 AW11	AW9
NE Jutland NBA II-III	Group 5b		
Culture groups at Elbe NBA III	Group 5a	AW2	AW2
Dithmarschen NBA III			
Elb-Weser group NBA II-III	Group 4	AW1-5 AW4	AW4
Luneburg group NBA II-III			
Pomeranian group NBA II			
Östliches Mecklenburg NBA II	Group 6	AW1-3(?)	AW1-2
Nordwestliches Mecklenburg NBA II			
Mecklenburger Gruppe NBA III	Group 6a	AW(3)	AW1-4

Figure 4.008: Comparison of the regional groupings, the regions with a similar technical tradition and the detected workshops.

of craftspeople was an important factor. However, the technical style should be seen as purely region-specific and not object-specific, as possibly inferred through typological studies.

Thus, within the area of interest, we can expect there to be during NBA II approximately six, and during NBA III five to six workshop circles. Every region that could be defined on the basis of decorative style, the technological repertoire used to craft the ornaments, and specific innovative techniques, extends over an area of not more than 250 km (see Figure 4.007). Jockenhövel (1991: 60) stated that personal contact between Bronze Age people was possible over such a distance and assumed that the area of influence of single workshops might have been of a similar range. At this point, the present study could show that social groupings with a similar technological style can be traced within the cultural 'Nordic Bronze Age' unit, and their area of influence equates to the distances stated by Jockenhövel. However, these technical groups should not be aligned with workshops (see Chapter 4.2.3).

Therefore, the results of the former investigation require a different definition of a workshop circle than has been provided by previous research. Commonly the dissemination of a classified group of artefacts (type) is equated with a workshop circle (see Jockenhövel 1991: 51; Torbrügge 1965: 98; Capelle and Vierck 1971: 42; Jankuhn 1969: 89; Laux 1971: 65; 1976: 45; Aner 1962; Werner 1961: 312). However, several studies pointed towards the importance of crafting traces and residues in order to name actual workshop areas (Neipert 2006: 26; Driehaus 1983: 50ff.; Driehaus 1961: 22ff.; Biel 1985: 89ff.; Willroth 1997b: 70ff.; Kossack 1959: 111; Mozsolics 1967: 102ff.; 1973: 84ff.; Megaw 1979: 50). Defining a workshop circle as the area of influence of a single workshop, or closely related workshops where artefacts occurred, and crafted in one technological tradition, means this circle is recognisable in the material culture through a similar decorative and technical style, as well as through the use of specific technical tricks and habits (technological behaviour). In turn, this means that the objects have technical features in common which point towards the same repertoire of techniques used despite their typological classification. However, this does not mean that they were crafted by one individual or one single workshop. It should signify that the involved craftsmen were in close contact and had a similar set of techniques and, as we have seen, it means that they are all part of the same social grouping.

Thus, two regions in particular stand out during NBA II for their technological repertoire – Zealand (Figure 4.007-4.008, group 3) and the Lüneburg Heath (group 4). Both regions display a rich repertoire of decorative elements and specialised techniques (spiral-stamps, bent collar casts, several parallel cast methods, and organic cores as placeholders). Additionally, several specialised methods, such as the use of spiral-stamps, point towards an intensive exchange of knowledge between those two regions. A similar pattern arises when taking the distribution of Lüneburg costumes into account (Bergerbrant 2007: 118-122). The contact seems to have taken place over the east-west axis of Zealand-Fyn-Jutland, however, as mentioned above, some technical peculiarities which seem common on Zealand and in central Lower Saxony never occurred in this region (i.e. rib-modelling by comb incision). Here, a direct transfer from Zealand to central Lower Saxony might have happened. Nevertheless, both regions have their own specific characteristics, as seen in tool use (hourglass shapes), techniques (space holders in eyelets), or with regard to specific decorative elements, such as diamond shapes.

As well as these distinct groups, several further regions display specific technical behaviour during NBA II, but were, however, strongly influenced by the regions under discussion. Jutland (group 5) in general has fewer richly decorated artefacts. Additionally, on several objects traces of novice work were detected, which was interpreted as a possible sign of the different perceived values of artefacts between Zealand and Jutland (see Chapter 3.4; Milne 2012: 126). Additionally, the percentage of mistakes in professional crafting due to haste is exceptionally high on Zealand, a further indication of differences between the adjacent regions. Nevertheless, the documented influence of the two metalworking centres during NBA II creates a division of the Danish mainland into three possible areas, each with slightly distinguishable technical behaviour. In north Jutland (group 5b) a significant influence from Zealand can be recognised in the decorative element distribution, such as standing triangles and diamond shapes (typical NBA II elements nearly restricted to Zealand). However, significantly more elements originating on the island are distributed on Fyn and central Jutland, forming the east-west axis that seems to mark the exchange route from Zealand to Jutland and towards the east to Scania (Nørgaard 2011: 116). For characteristic techniques, such as the application of spirals using spiral-stamps, or the use of cast-on techniques, the evidence of influence becomes much more conclusive (see MAP 24). Taking the specific decorative ornaments that are most common in Lower Saxony, for instance hanging triangle series or different arch-ribbons (see MAP 31), another region – south Jutland and northern Germany (group 5a) – with a different technological tradition becomes apparent. It seems that this region was technologically more affected by the Lüneburg Heath than by the Danish islands, supported by, among things, the use of various techniques for producing eyelets (see MAP 18).

Finally, in NBA II the Mecklenburg region displays some characteristics in material culture that might support the inference that also here one or two (eventually northwest and north Mecklenburg) social groups with a slightly different technical behaviour were situated. Similar to the Jutland region, Mecklenburg also shows an influence distinct from both the north and the east (see MAP 30). Especially, the technical influence from the west is visible in the use of various cast techniques for the production of ornaments, as well as in the appearance of trapezoidal rib-valleys, which are the result of a specific crafting method first used in the Lüneburg Heath. However, due to the first appearance of ribbed collars already in NBA IB in northeast Mecklenburg (Nørgaard 2011: 30ff.; Blajer 1990), it might be possible that many of the basic techniques used to craft such items had their origin in this area.

The items investigated decrease in number towards NBA III (see Figure 2.001) and thus it becomes more difficult to define regions with a similar technological tradition. Striking, however, is the accumulation of highly decorated artefacts in the Mecklenburg region. In the majority of these artefacts a technical influence from Zealand and central Lower Saxony can be seen, as demonstrated on the spiral-decorated collars from Werder and Wildberg (see Chapter 3.2.3), which could be seen as hybrids of foreign techniques (spiral-stamp; hammering) and the techniques starting to become dominant in the technological development of Mecklenburg (lost-wax casting).

That the metalwork in Mecklenburg becomes as elaborate as that of Zealand or the Lüneburg Heath could be demonstrated by several artefacts showing signs of professional mistakes, as well as artefacts with traces of novice work (see MAP 25). Characteristic of the Mecklenburg metalwork is this mix of different technological traditions that might derive from an extensive import of artefacts (tutuli) and the selective adoption of foreign techniques (lost-wax casting). This resulted in a characteristic mix of techniques and materials, as the spiral-decorated collars prove. The majority of these elaborate pieces are made via *cire perdue*, however, traditional cold-working techniques were used to decorate the model. Furthermore, hammering was still dominant in the Mecklenburgian technical repertoire. In contrast to the previously discussed workshop circles, this region seems to have been extremely innovative in transferring foreign forms into local techniques. Thus, the Weitgendorf-type pins might have been crafted as model-kit in two-part moulds, inspired by the significant technological possibilities.

Within the mentioned areas with a similar technical behaviour, also described as workshop circles, several features point towards individual workshops or craft communities. Occasionally, specific individual metalworkers are detectable. During NBA II the main centres of production were on Zealand and in the Lüneburg Heath. During NBA III the chosen material provided clear evidence only in terms of Mecklenburg, however, an extension of the artefact categories within a future investigation will surely result in the identification of more than one centre.

Chapter 2

Traces of individual behaviour

Within this chapter, the aim is to identify the individual smith and his/her affiliation to other craftspeople and specific metalworkshops. Redman suggests that the same features which were formerly used to identify individuals are much more useful in defining interaction groups, as objects displaying great similarity are made by the smallest of interactive groups – a family or mother/daughter combination. As such, interactive groups, analytical individuals, skills and individual behaviour in crafting are all discussed based on the discovered evidence.

A first step to investigate the technical skills needed for the crafting of decorated bronzes is the division into categories based on quality. Within this chapter, a new methodology is presented in which two different approaches were used to evaluate the quality of the examined artefacts. The first approach measured the skill-unit by defining the assessment of the texture and quality of the surface, the difficulty of the decoration and the workflow, as distinctive criteria for skilled work. The second approach aims to measure the labour investment using the production unit. The measuring of production steps in the operational sequence is a known approach to give an indication of the amount of work used to craft a specific artefact. Combined, the skill and production unit allow further assumptions to be made in terms of craft organisation; they show regionally restricted technological behaviour and highlight the different skills of the metalworker. It could be shown that highly skilled craftspeople crafted all ranges of artefacts, giving an important insight into the possible repertoire of a metalworker.

Detecting traces in crafting resulting from identical ways of doing is rare, however, it is not impossible, as several artefacts within this study show. A similar situation applies for the innovative techniques which occurred due to repairs or cross-craft inspiration, providing further arguments for identical individual behaviour. The items connected through these distinct features (including tool traces) are commonly represented in a single find, however they might also be distributed over a radius of 120-150 km. In the case of the antler-like notch-decorated artefacts, the pieces were deposited in hoards 100 km away from each other on Zealand, and the ox-hide-shaped notch appeared on objects on Zealand in a hoard context and in a burial in Jutland.

4.2.0 An approach to measure skill and productivity

When investigating individual behaviour in craft the most obvious variance occurs in the quality of the artefacts. High quality is to be equated with high skill. Skill shall be explained as a product of the *habitus* of a craftsperson, his/her 'Fertigkeiten' and 'Fähigkeiten',[3] and training. Skill can, to a certain degree, be measured in the material culture.

A first step to investigate the technical skills needed for the crafting of decorated bronzes is the division into categories by quality. In this way the ability of the craftsman to apply personal skills in creating an artefact is categorised. In doing so, the categorised artefacts can inform about the rating of the quality and length of training, the specialisation of the craftsperson, and the amount of time involved in the making.

With the simple classification into quality groups based on a controlled evaluation, an evaluation regarding the possible social circumstances in which the craftsmen worked is possible. Furthermore, the ability to use one's skills is fixed in every craftsperson's *habitus* and was described earlier in this study as the 'fingerprint' of the craftsperson. The combination of the characteristics of every fingerprint, with quality being one of these characteristics, can lead the modern researcher closer to the individual Bronze Age metalworker.

For the evaluation of the quality of the examined artefacts two different approaches were used. The first approach measured the *skill-unit*. For this purpose, an evaluation of the pieces was made on the basis of three essential criteria. All these criteria are visible to the naked eye and assessable even for a non-metalworker.

The three main points are: the nature of the surface; the difficulty of the decoration; and the execution of the decoration (as the decoration is the most easily accessible point of measurement).

The assessment of the texture and quality of the surface is based on the classification fine - medium-coarse (1/2/3) and is of importance because a fine surface (such as a fine-pored, free surface, carefully monitored for scratch and grinding marks) means a considerable amount of time spent on reworking and an excellently executed cast. The ability to create such a surface (including the effort put into it) is increasingly proportional to the skill of the craftsperson. In other words, with increasing experience, the ability to remove the traces of previous work on a surface without having a negative effect on the decoration grows. However, while investigating prehistoric bronzes the millennia

3 In English both German terms are included in the word 'skill', however, they are to be seen as something different and are as such used here to explain skill. *Fertigkeiten* are skills gained through hard work, through the repetition of actions, and are part of the *habitus* that is related to the technological tradition. *Fähigkeiten*, however, are skills that are related to the craftsperson's ability to coordiante hand and brain, the motor habit, and can only be learned to a certain level. High level *Fähigkeiten* provide the reason why some metalworkers are better than others: ong training makes good specialists (see Introduction).

Figure 4.009: Modern traces of restauration influence the surface structure of the neck collar from Weisin (ALM 2199).

in the ground have deeply affected the artefacts and thus the objects have not only a developed patina but also modern traces of excavation and reworking (Figure 4.009). Hence, in assessing the surface, the extent to which any one statement can be made must be carefully weighed. In regard to the material investigated, for most objects, however, it was possible to make a statement (see Tables 2-3).

The next category is the difficulty of the decoration, meaning the number of elements used and their combination. However, the nature of the individual elements is also of interest when simple tasks are to be separated from elaborate ones, as, for example, a single line is easier to accurately draw than a group of parallel lines, which should be identical and the same distance apart. Additionally, novice craftspeople tend to use simple decorative elements due to the fact that their skills are not developed enough to execute complicated patterns (see Kamp 2001: 431; Crown 2001: 462). Thus, while dividing the difficulty of the decoration in the categories high - medium - low (1/2/3), the number of elements used is crucial, as well as the type of element.

The last category of interest is the quality of the decoration. This includes not only the execution and the thoroughness with which the decorative elements are applied in the model, or to the cast piece, but also the workflow with which this occurred. Interruptions in the decoration, such as in the spiral lines and decorative ribbons, point towards inefficient handling and a lack of motor habits, which are indicators of unskilled and untrained work (see Crown 2001: 452). Furthermore, the quality of the workflow is to be seen as evidence of skilled work; it is an indication of the connection of thoughts and limbs, and often a product of the anticipation of certain movements (see Karlin and Julien 1994: 161; Sennett 2008: 238; Bamforth and Finlay 2008: 6; Mills and Ferguson 2008). Such an ability and 'the key to (a) fluent performance' (Ingold 2000: 356) is the result of recurring repetitions and years of practising, a recognised research criterion of quality work (i.e. Wendrich 2012: 13). However, even the work of highly skilled craftsmen shows signs of interruptions in the workflow, which can be interpreted as a sign of haste (Hagstrum 1985; Crown 2001: 452; Miller 2012: 228; Wendrich 1999: 391), and are, in terms of this registration of quality, of similar importance as mistakes which were due to a lack of skill. Thus, the workflow, the distinctive criteria for skilled and unskilled work, and the amount of overlap as well, are all registered and evaluated in this category. Taking these features into account, a definitive statement about the quality of work can be given, indicated by the categories good – middle – low (1/2/3).

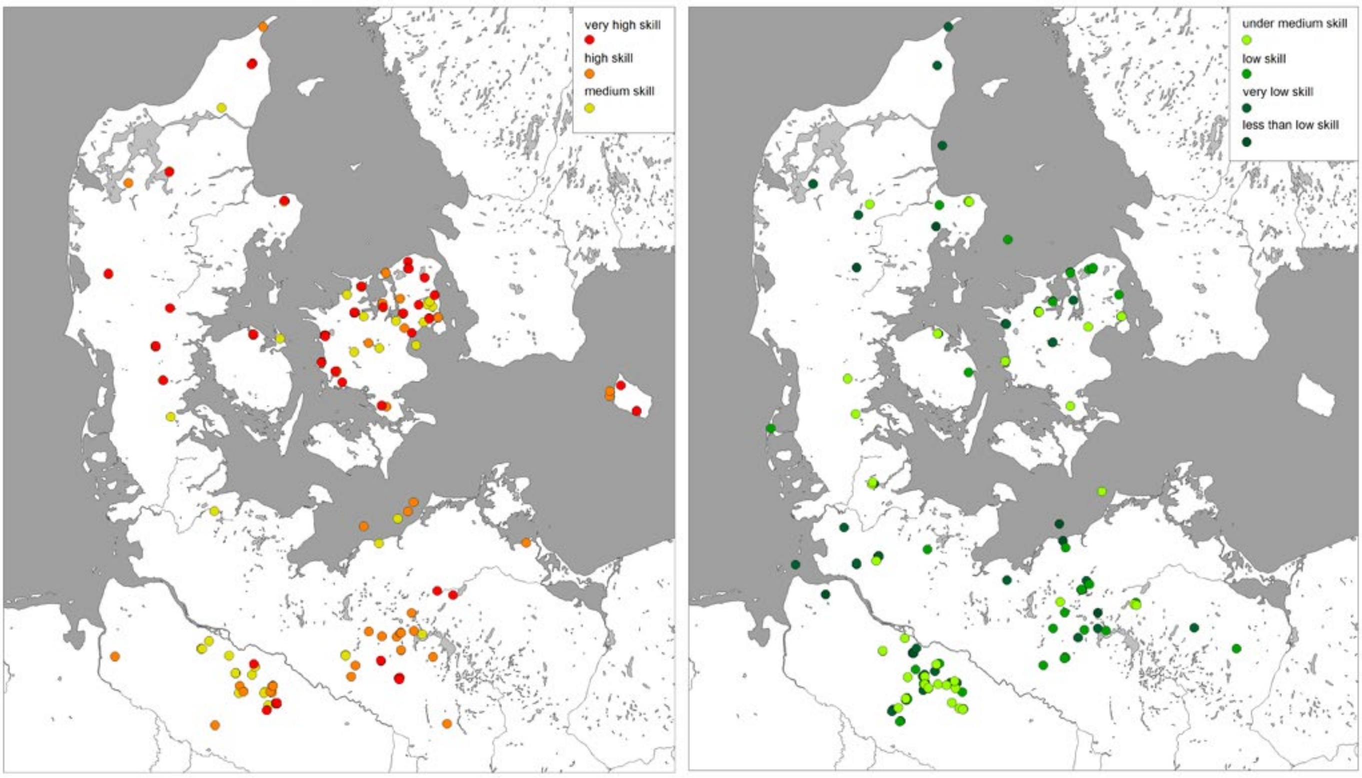
The second approach measures the *Production Unit* (PU), which has been introduced in a similar way by Feinman as the 'Production Step Index' to measure the labour investment in producing ceramics (Feinman *et al.* 1981; Costin 1995: 630ff.). Feinman (1981) and Costin (1995) use this method to correlate the time spent producing ceramics with the complexity in production, measured through the tasks involved. The aim is quite simple, complex operational sequences with tasks that require a great amount of time and high skills are to be seen as of 'more value' than artefacts with a lesser Production Step Index, and thus having had less time spent upon them (Feinman *et al.* 1981: 872). However, there are some limitations, as Feinman pointed out in his fact that 'certain steps are more time-consuming than others', meaning that this method should be seen only as ‘a rough indicator of production complexity’ (Feinman *et al.* 1981: 873).

Concerning the present study, some additional limitations appear which should be further developed. However, the measuring of the production steps in the operational sequence of every artefact should give an indication of the amount of work used to craft the specific artefact. Therefore, for each object an operational sequence was reconstructed counting every assumable step (see Tables 2-3) and the result was listed as the artefact’s specific PU. A reliable result is given for only 70% of the artefacts due to the fact that they are the items most completely preserved. The PU values for the remaining 30% were calculated based on comparable artefacts.

The limitations of measuring the PU in metalwork lie in the single decorative elements which can be produced in different ways, and, therefore, no distinct amount of time spent can be inferred. For instance an hourglass-shaped notched ribbon applied using a punch is crafted with less power, reworking and concentration in wax than it is in metal. If this ribbon is made with the help of a specially designed tool that reproduces several notches with one blow (‘Faulenzerpunzen’) then the specific decorative element is produced even more quickly. As a result, decorative ribbons of such shape are counted as one unit. In contrast, spirals, circle groups and humps are seen as one unit, and thus the spiral series are occasionally made up of as many as 32 units. However, here the technique with which the spiral is made is not counted. A stamped-spiral is produced more quickly than a handmade one even if the spiral-stamp itself needs to be made. A hump made with several blows (and perhaps prepared in the model and reworked several times post-casting) is counted as one unit even if several actions were needed.

Therefore, the PU only provides rough indications as to the time spent making such an item. It should not be taken as a criterion for skilled work; however, as the investigation shows, it can, in combination with the analysis of the skill involved, give an insight into the organisation of craft.

The results of this examination are two-fold; they show regionally restricted technological behaviour and highlight the different skills of the metalworker. In particular, the measuring of the skill unit pointed towards a high variation in skill between different metalworkers. On the other hand, the distribution of artefacts crafted by highly skilled craftspeople shows a similar pattern, as already known from the technical and stylistic examination, where a concentration appears on northeast Zealand. Here, the connection to



Map 32: Skill unit highlights the variation in the skill between different metalworkers. Distribution of artefacts crafted by highly skilled craftspeople shows a concentration in the already known metalworking centres on Northeast Zealand, in the eastern Lüneburg Heath and in Mecklenburg during NBA III.

the Danish mainland, especially the north, is notable (MAP 32). Altogether, except for on Zealand, an equal distribution of artefacts of all skill levels could be registered. On Zealand the picture of a different kind of specialist-orientated craft is becoming even more apparent.

Interestingly, the examination resolved that the majority of artefacts made were quality products, rather than the result of common-skilled people producing ornaments as part of their domestic activities (see Schlesier 1981; Olaussen 1993). During both periods, NBA II and III, some artefacts were crafted by highly skilled craftsmen and some could be assumed to have been made by novices or domestic craftspeople, but the majority display all the characteristics of artefacts made by people familiar with, and trained in metalcrafts (Figure 4.010-11).

Thus, metalcraft should be seen as a profession, a conclusion supported by at least 68% (NBA II) to 65% (NBA III) of the artefacts. Taking the artefacts displaying lower skills of the related craftsperson, then in NBA II, in contrast to NBA III, another category of metalcraft seems to have been apparent (Figure 4.011). As seen on MAP 32, such artefacts appear concentrated in north Jutland and central Lower Saxony during NBA II, and in Mecklenburg during NBA III. The objects made by less skilled craftspeople in the vicinity of the Lüneburg group can be related to novices in metalwork (see MAP 25, Chapter 3.4.1). The same can be said for the few items on Zealand, and in north Jutland also some lower-quality artefacts are explainable through novice work. However, of interest in north Jutland is the occurrence of both high- and low-quality work without an equal coverage of all skill levels. As previously seen, several artefacts on Jutland are connected to Zealand material, due to tool traces, or patterns of technological behaviour, and they are all of high quality. Thus the difference in items deposited in this region might be reasoned to be related to the import of goods and a local metal production that was less specialised than on the Danish islands.

Can we say, however, that in these regions where we assume the presence of highly skilled craftspeople that they also had full-time metalworkers? Costin (1995: 631) suggested that the time spent on crafting artefacts can be related to the context of production, and thus the employment relationship of the craftsperson. Therefore, high labour investment (PU over 160) will point towards a full-time metalworker, while lower values might suggest domestic activities. Figure 4.012 supports the idea that labour investment and skill are related to each other and develop through time, as, especially during the early NBA II, artefacts of very low quality and labour input are registered. Additionally the percentage of artefacts with a high PU is significantly lower than the average (Figure 4.013). However, it could be shown that highly skilled craftspeople crafted all ranges of artefacts (MAP 33).

This gives an important insight into the possible repertoire of a metalworker and thus does not support

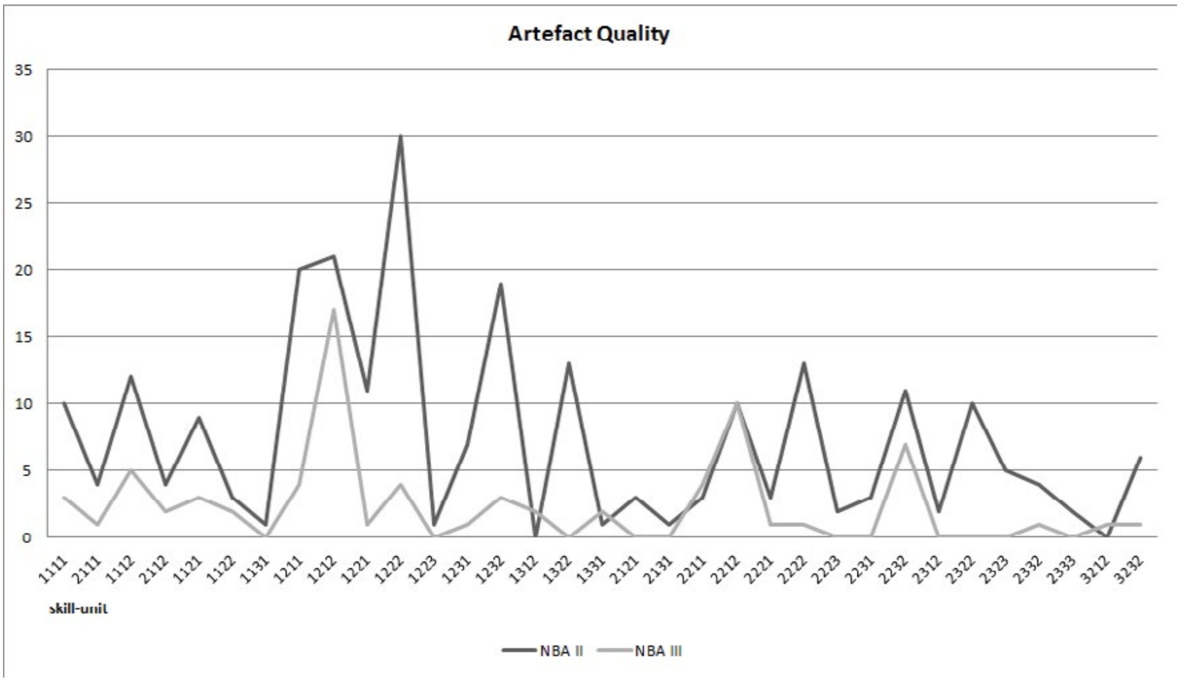


Figure 4.010: The graph shows the measured skill-units from high skill (1111) to very low skill (3232) with regard to the time period. The majority display all the characteristics of artefacts made by people familiar with and trained in metalcrafts.

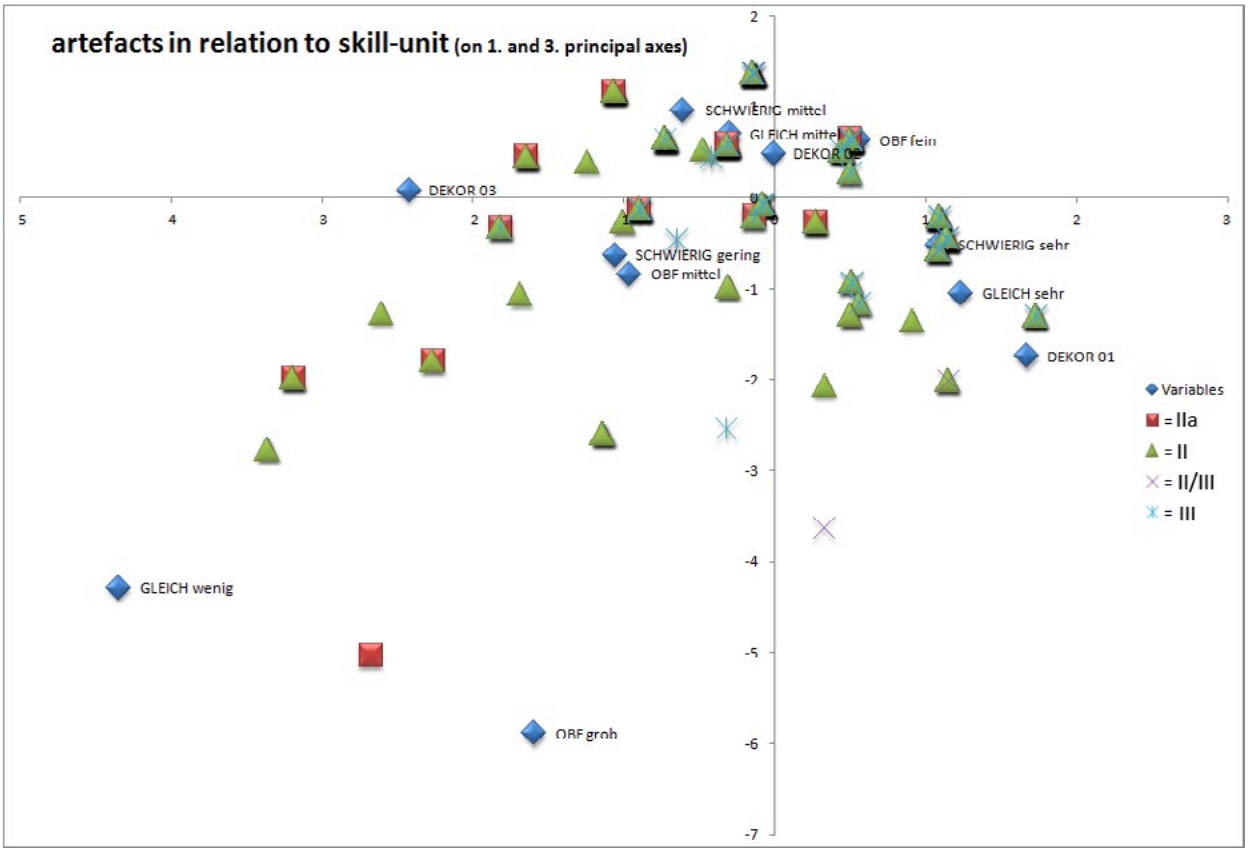


Figure 4.011: The correspondence analysis highlights the slight chronological tendency in the highly-skilled crafted artefacts. The majority of artefacts, however, gathers around medium-skilled craft.

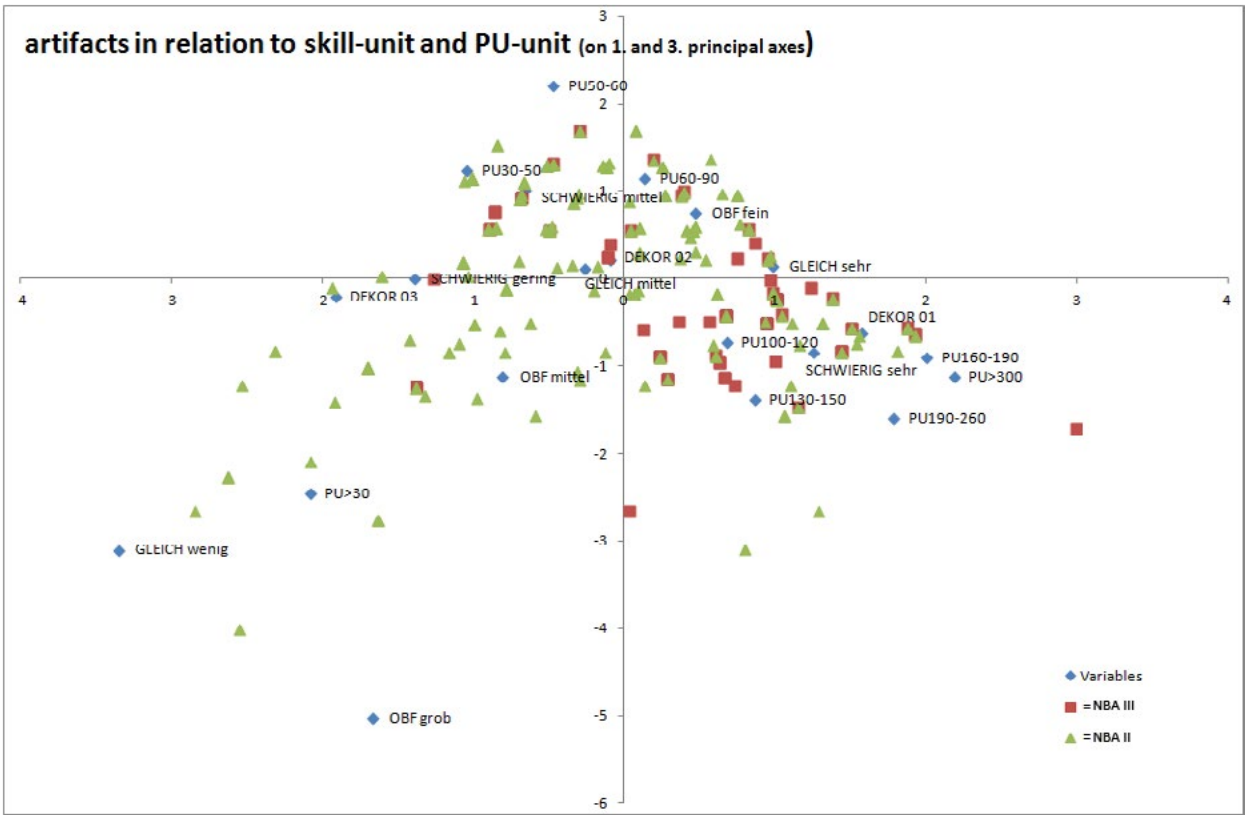
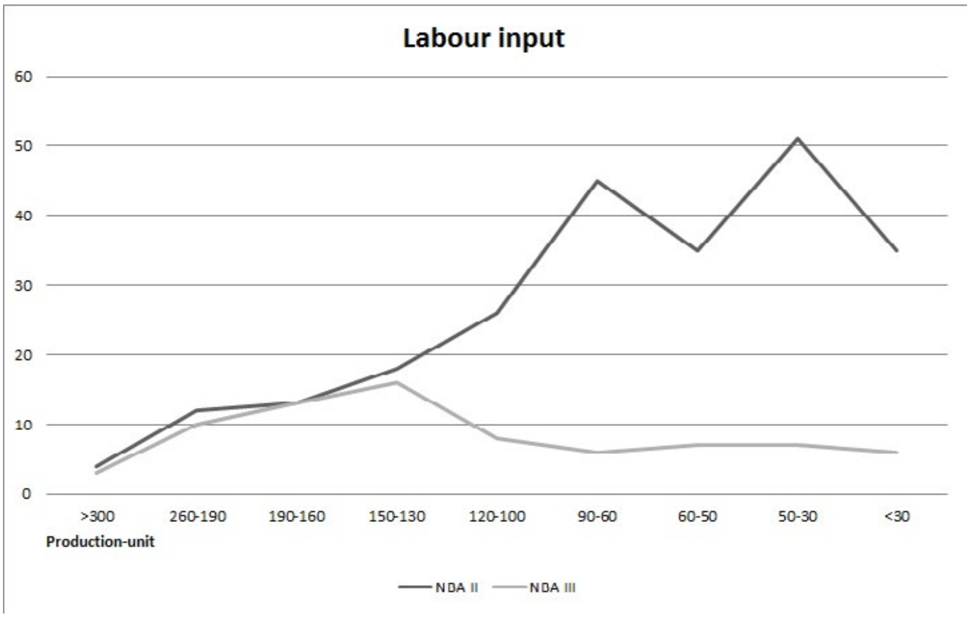
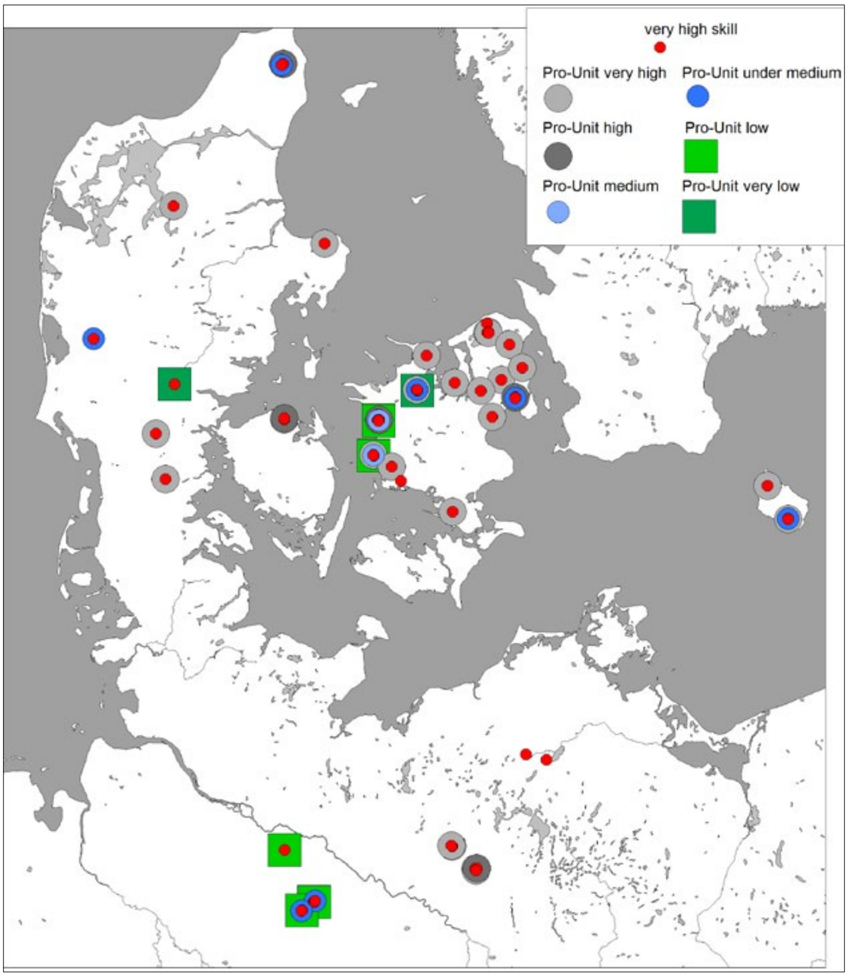


Figure 4.012: The correspondence analysis in which the production-unit and the skill-unit are put in relation to the artefacts in time, supports the assumption that high labour input is related to skilled craft.

Figure 4.013: The graph demonstrates that artefacts made with a high labour input (PU over 160) represent only a small portion of the total amount in both periods. In contrast to NBAII, where artefacts with a very low PU are represented in a high number, only a few artefacts with similar low PU are represented in NBA III.





Map 33: The map shows that highly skilled craftspeople crafted all ranges of artefacts and occasionally regional specific patterns are visible.

the connection between high-quality work, a big labour investment and a full-time profession, as for example in the Lüneburg Heath highly skilled work was detected on simple artefacts. As already stressed on several occasions, no uniform statement can be applied. It is rather that the picture of regionally specific craft organisation is supported. Again, the evidence from the northern part of Zealand points towards a high specialisation in artefact production (MAP 34) and an accumulation of highly skilled craftspeople, whereas the west of Zealand has very skilled metalworkers who, however, were involved in the production of various artefacts. Conversely, in NBA III in Mecklenburg (MAP 34) less high-quality work can be detected, and also artefacts requiring a great amount of time in their creation were crafted by less skilled craftspeople.

4.2.1 The Bronze Age smith: traces of individuality

> 'Individuals are always somewhat different from one another in their motor habits or motor performances; the artifacts they make or use will exhibit slight stylistic differences in execution or use-wear' (Hill and Gunn 1977: 2).

Theoretically an identification of an individual through traces left during crafting is possible (Muller 1977: 23-26; Hill and Gunn 1977: 7; Creese 2012: 45; Martele 2002; Redman 1977). As discussed, the combination of training, skill and ability leads to a development of micro-stylistic behaviour and a distinct fingerprint of every craftsman on its object.

Actually, the identification of the person who crafted the object, only with the help of the traces of crafting left on the object, is more difficult than assumed. As seen in the Kalahari Desert, within the San, even the maker of the arrows, despite being sure to identify their own work, was in fact not able to recognise their own arrows or those of other craftsmen one year after their crafting (Wiessner 1983: 262, 269).

This information given by Wiessner supports the doubts Redman (1977: 42) expressed. The *habitus* of every craftsperson can change due to influences from outside or even due to growing in its habits. Therefore individual characteristics in artefacts are difficult to identify. Redman suggests that the same features which formerly were used to identify individuals are much more useful in defining interaction groups, as objects displaying great similarity belong to the smallest interaction group – a family or mother/daughter combination (Redman 1977: 44). In doing so, the tasks within an operational sequence which are executed by individuals other than the main identifiable craftsperson (i.e. novices) are no longer hidden (see Costin 2000: 391; Wright 1991). Thus, in most cases Redman´s (1977: 44) suggestion to name the identified 'smallest interaction group' should also be applied to the investigated material. Muller (1977: 25) adds that: 'the "individuals" we recognize may sometimes be analytical individuals – our 'individuals' may sometimes be more or less than one actual person.'

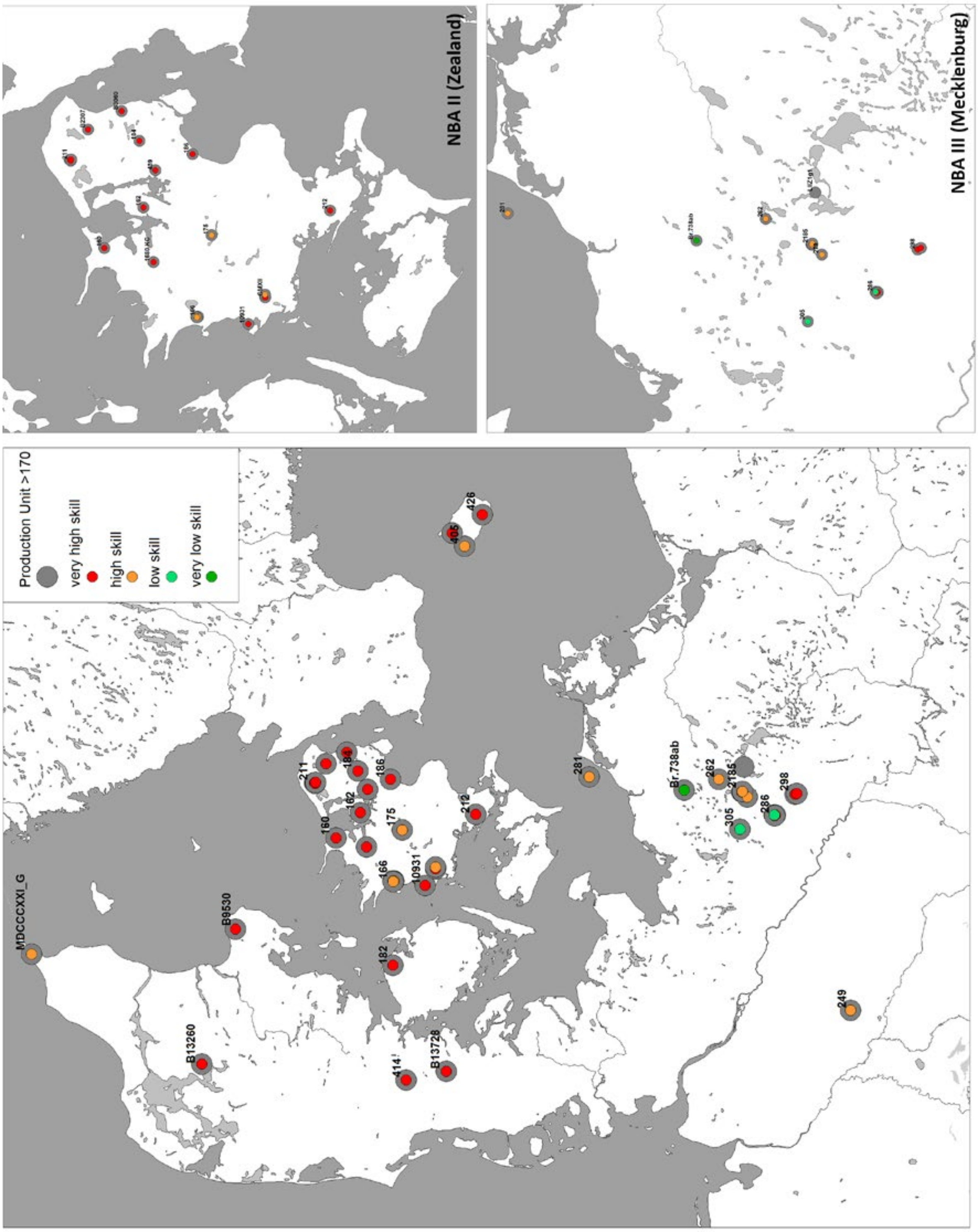
However, when the 'range of variants' (Redman 1977: 42) in the technological behaviour is known the identification of the individual Bronze Age smith is possible.

Within this study several traces of individual behaviour in crafting could be discovered (MAPS 35 and 36). They can be divided into tool traces, identical innovative techniques, traces of similar habits, and occasionally also artefacts from the same mould were identified.[4] Commonly these closely related objects appear in the same context (i.e. Falkenstein 2012: 92); however, Jantzen showed that also ranges of up to 110 km could exist between the related objects (Jantzen 2008: 307).

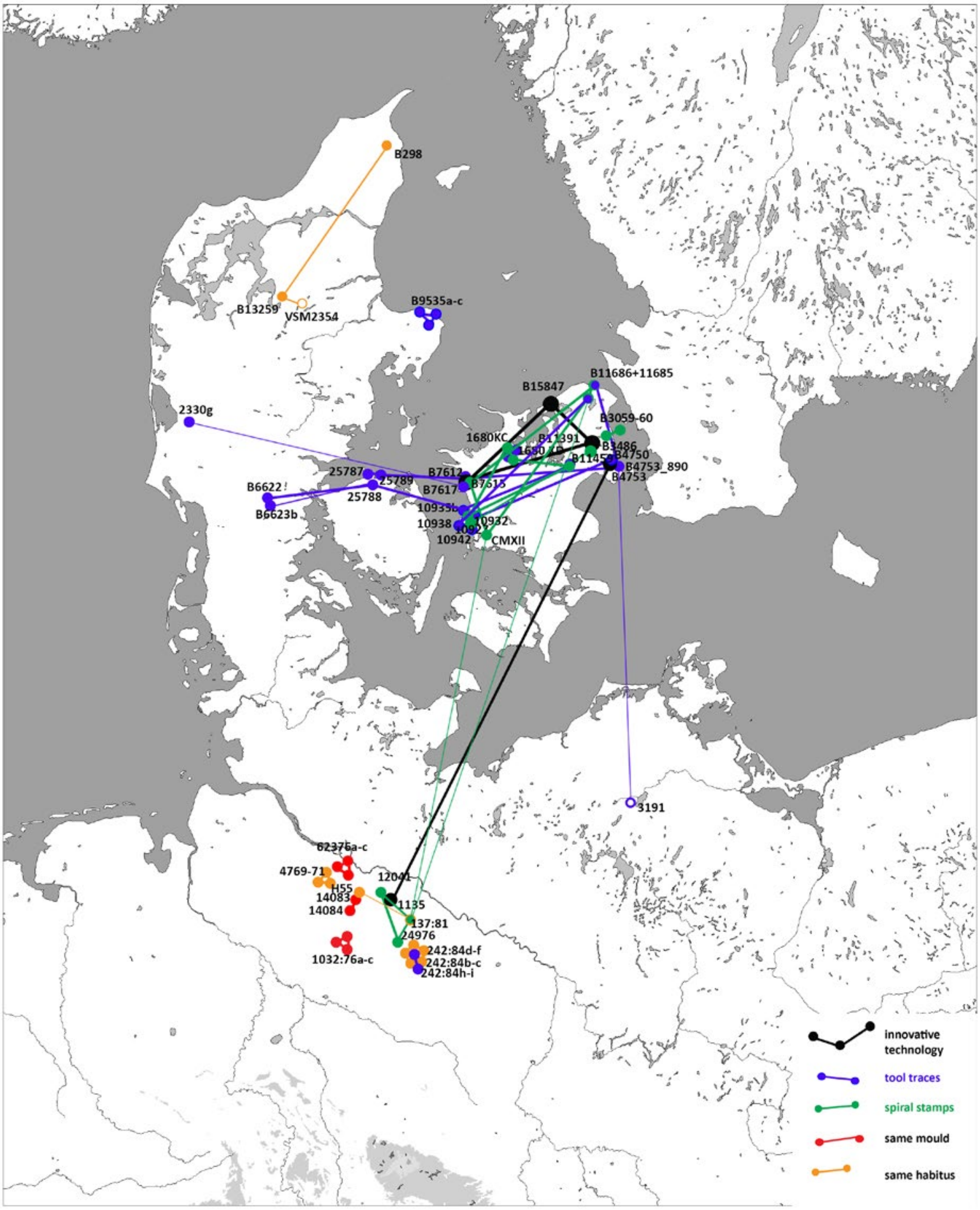
Due to crafting in lost-forms the means of identifying individual work as just described is quite rare in relation to ornaments. Only in central Lower Saxony could several investigated spike-discs with concentric rib-decoration be related to the same mould. These small discs were mainly produced in one-sided moulds and were heavily reworked after casting. However, the distinct traces and interruptions in the ribs (Figure 4.014) are a clear sign for crafting in the same mould. Even if within this study only a few spike-discs were investigated, it can be postulated that this kind of ornament was commonly produced as a set. Within three locations (Becklingen, Raven and Toppenstedt in Lower Saxony) these types of rib-decorated discs were found and the artefacts from each site produced in the same mould (Figure 4.015). However, they differ greatly from site to site. In regard to the question asked, the related objects (these, cast in the same mould) were definitively produced in the same workshop, quite likely by the same person and at the same time. Each site, however, contains objects each crafted in a specific analytical workshop in central Lower Saxony due to the significantly different decorative and formal styles (see Figure 4.040.1-3).

Another kind of similarity was found in artefacts with similar decoration, such as displayed on the belt discs from Appel (Lower Saxony). The way in which the triangle-decoration was applied is similar on all three discs. This similarity is not explainable through the use of the same tool or the same mould (the discs are produced through lost-wax). Here, the similarity lies in a similar way of doing. In several parts of the decorative design of these discs it is clearly visible that behind this decoration the same hand can be inferred (Figure 4.016). The way in which the triangles are arranged around the centre of the disc and their line-filling is characteristic for these three items, and, compared to other triangle-decorated discs, unique (Figure 4.017). Thus, the similarity is explainable through the *habitus* of the craftsman, his fingerprint in the making. In the same way are the discs from Molzen, another hoard from central lower Saxony related to each other.

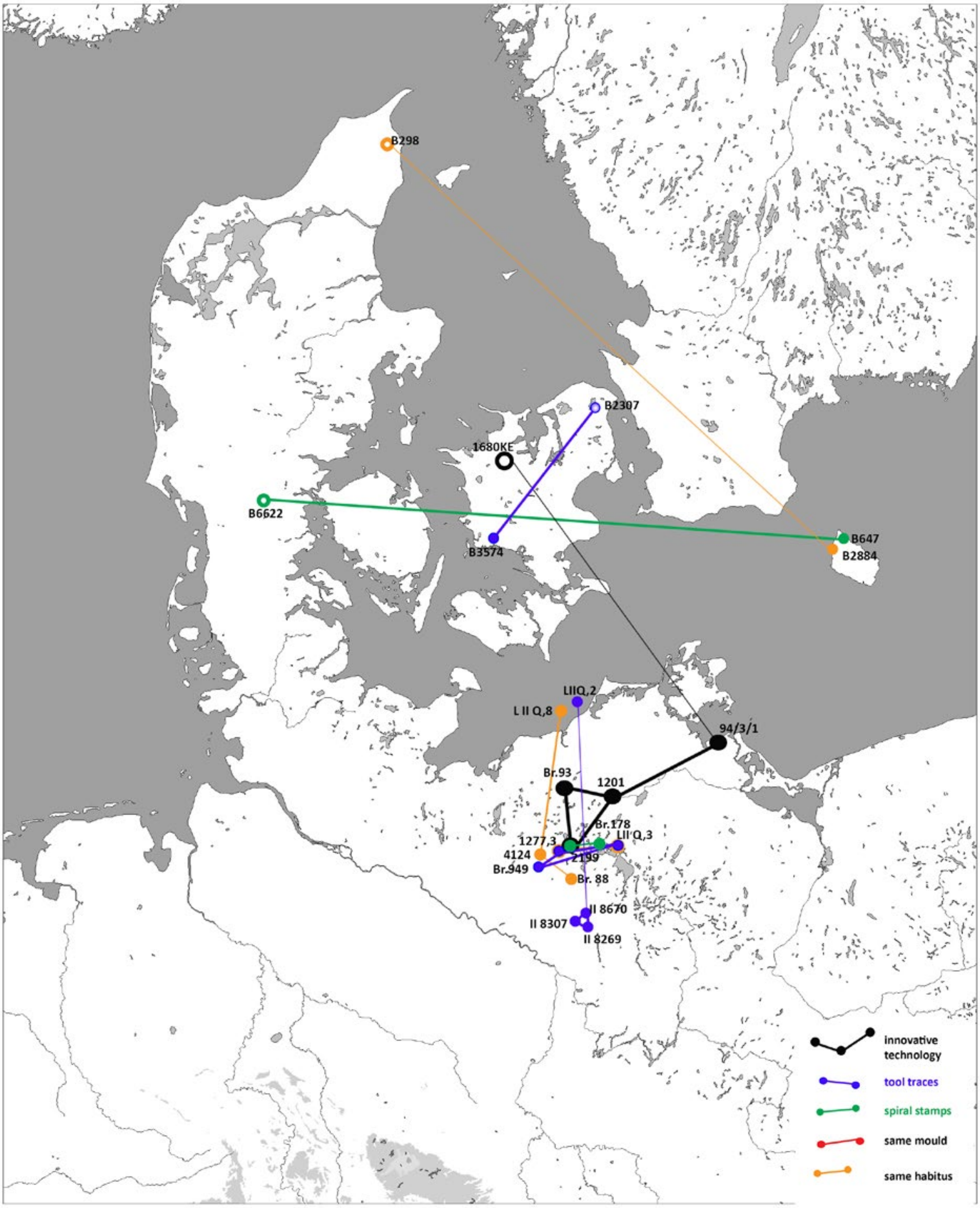
[4] In many studies, objects that appear identical in layout and dimensions are referred to as pieces from the same mould (i.e. Kubach 1977: 551). However, some studies with the potential to identify pieces of the same mould detected such mostly in weapons or tools, for instance the Homburg-type winged axes found on the Bullenheimer Berg (Wirth 2002: 79ff.) or the winged axes from Oberhaid (Falkenstein 2012: 92).



Map 34: While mapping artefacts produced with a high labour input in regard to the skill detected it is obvious, that all skill levels are represented and only on Zealand a direct relation between both factors is visible.



Map 35: The map shows the NBA II artefacts with traces of individual behaviour in crafting divided into tool traces, identical innovative techniques, traces of similar habits, and artefacts from the same mould, and their connections.



Map 36: NBA III artefacts with traces of individual behaviour in crafting are divided into tool traces, identical innovative techniques, traces of similar habits, and artefacts from the same mould, and their connections.

Figure 4.014: Spike-discs from Toppenstedt (HH62376a-c) were cast in the same mould as several identical interruptions in the rib-groves and a similar reworking support.

Figure 4.015: Spike-discs from Raven (LMN 14083-84) are of much better quality and reveal also distinctive signs of a cast from the same mould as the edges on the rib slope and the very flat rib at the top.

To detect traces in crafting resulting from an identical way of doing is rather rare, however, several artefacts could be found within this study. Thus, the belt plate from Eyendorf (H55) and the spiral-decorated disc-head pin from Heitbrack (137:81) are very alike in the way the spirals are constructed (Figure 4.018). Interestingly, the spiral on the disc-headed pin could have been applied using a stamp very similar to the stamps used on all three NBA II artefacts on Zealand. The spirals on the belt plate were drawn by hand or constructed otherwise, but were not stamped. However, the similarity is striking and, if the same person was not involved in the crafting of both items, then in every case the pin should be seen as the item that was copied, having the disc as a direct model.

Figure 4.016: Several parts of the decorative design of the belt discs from Appel (LMN 4769-71) show that behind this decoration the same hand can be inferred.

Another example for similarities which are explainable through the same *habitus* are those innovative techniques which occurred due to repairs or cross-craft inspiration. As illustrated in MAP 27, artefacts with rib-waves spread during NBA II in northwest Zealand, and another group appears in NBA III in Mecklenburg. That these chronologically different groups should be seen as independent innovations was discussed in Chapter 3.4.2 of this study, however, they are distributed over a radius of 120-150 km in each group. The artefacts on Zealand should be considered as being produced within the same analytical workshop due to the similarity in the shape of the notches and the way in which the repair is done, the same is valid for those in Mecklenburg. The collar from the Vognserup hoard (NBA II, Frost 2008), has traces similar to those documented on the collars from Mecklenburg. Thus, these collars are distinctively later (NBA III) than the artefacts on Zealand and should not be seen as related to each other. Within the artefacts that display characteristic features which can be related to a specific craftsperson due to the *habitus*, the discs from Appel and Molzen were definitely crafted in different analytical workshops. However, because they are deposited in a hoard, the analytical workshop from which they originate is still in question. The artefacts with rib-waves, in contrast, can be related to two different workshops of which one might have been in east Zealand during NBA II, the other in the Mecklenburg Lake district during NBA III.

An even more distinct trace for the same craftsperson behind the object is an identical tool trace. The fact that the majority of objects under investigation are crafted to a certain extent in wax allows the use of unique tools which were not to be reshaped and, therefore, kept their shape over a long use life. When unique tools were identified, an allocation to a specific craftsman is without doubt (Figure 4.019). Several of such unique tools have been found and described in this study, such as the antler-like notches in Svenstrup on Zealand, the shoe-shaped notches from the Glæsborg discs, and the ox-hide-shaped notches from Rye and Assing. The items connected through these distinct features are commonly collected in one and the same find (Glæsborg), however, geographically distant objects could also be assigned to a specific tool. In the case of the antler-like notch-decorated artefacts, the pieces were deposited in hoards 100 km away from each other on Zealand. The ox-hide-shaped notch appeared on objects on Zealand in a hoard context and in a burial in Jutland. The geographical distance between these two items is over 200 km, with one object deposited in a grave context. The mentioned artefacts can be connected to one and the same craftsperson, however, due to the deposition in hoard contexts, this does not include the mobility of the same. Here, it is rather inferred that the ox-hide-notch decorated belt disc (AM 2330g) was crafted in Assing and its counterpart, the plate found in Rye (B7617), was probably sent to Zealand to be deposited there.

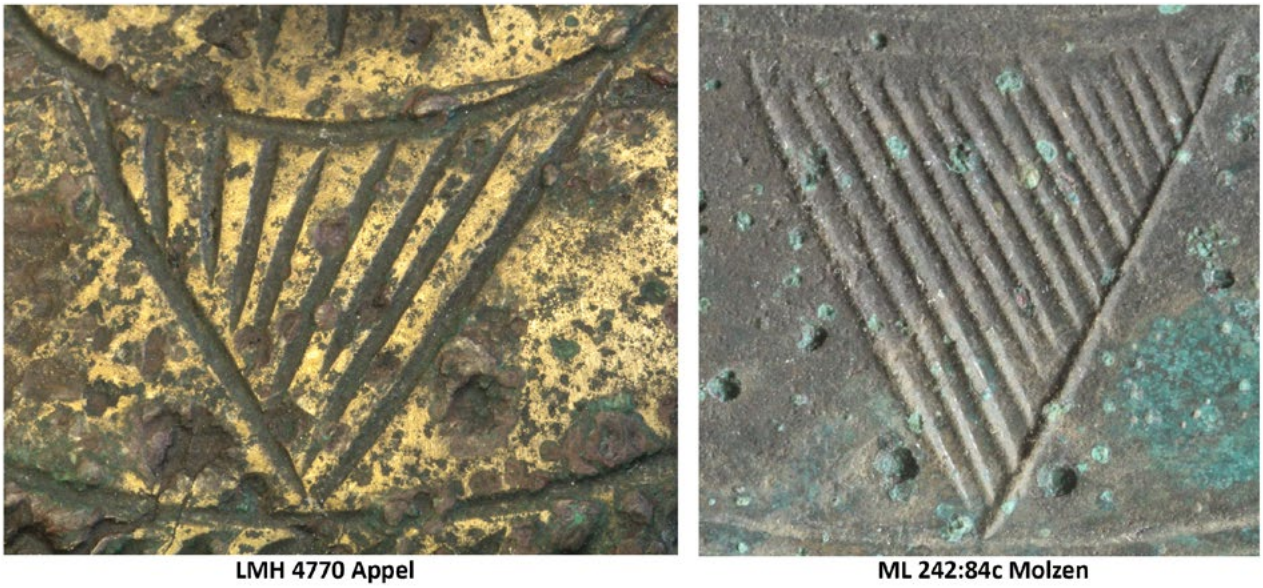


Figure 4.017: Comparison of line-filled triangles from Appel (LMN 4770) and Molzen (ML 242:84c). Characteristics of both ornamental details are clearly recognisable.

Figure 4.018: The spirals on the decorated disc-head pin from Heitbrack (LMN 137:81) and the belt plate from Eyendorf (H55, small picture projected onto the disc-head pin) are clearly not made with the same stamp. The spirals on the belt plate (H55) are probably hand-drawn, however both spirals are very alike in their construction, as seen in the spiral centre, with the screw ending as the equal wide groove. The idea of the close relationship of both artefacts is even more striking when seeing that the underlying spiral (LMN 137:81) has distinct traces of post-cast reworking in the grooves.

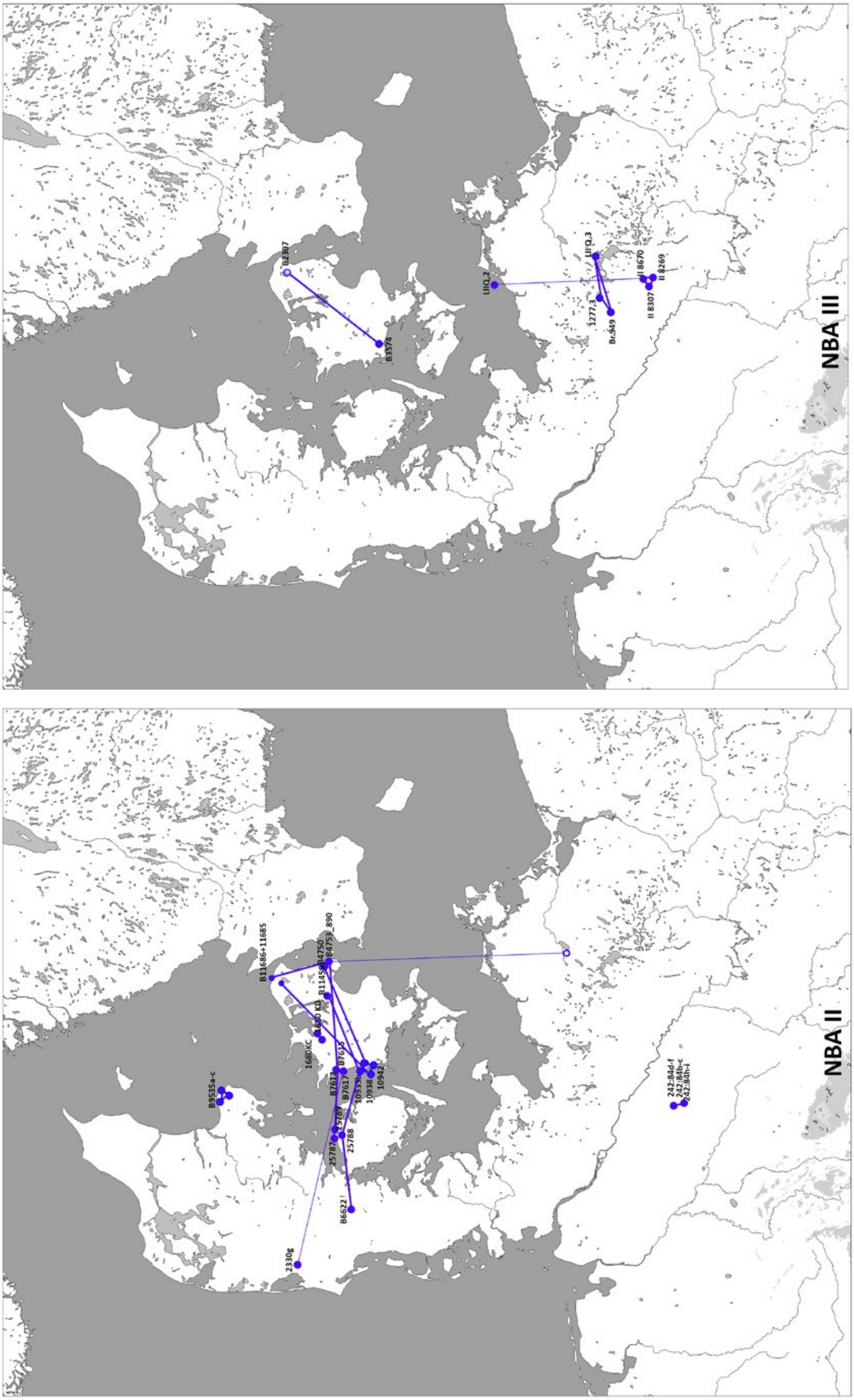


Figure 4.019: The allocation of unique tool traces to a specific craftsperson in NBA II (left) and NBA III (right).

Thus, a separate analytical workshop in the area around Assing on Jutland is possible and the already pictured analytical workshop in east Zealand seems to have had wide-reaching contacts.

Next to the specific tools, where a mistake in the tool or the tool itself leaves a unique trace, handmade geometric tools can also be compared. Here, especially, triangles are so distinct in their ratio between height and width that a comparison is possible. However, if long-distance connections occur, two similarly made tools are probable rather than the use of a single tool on these artefacts. Such a case could be detected in the triangle decoration on the belt plate from Vendsyssel on Zealand (NBA II) and a neck collar with typical NBA III decoration from Pisede in Mecklenburg (Figure 4.020). In contrast to some other artefacts on Zealand and Fyn, such as the belt plate from Lavø (B11686), and the neck collar (NM 25787) and belt plate (NM 25789) from Vellinge, which show nearly identical triangle imprints, the piece from Mecklenburg should be seen as a random parallel rather than the result of crafting by one hand. The other four artefacts, however, were probably decorated with the same tool (Figure 4.021).

Similarities could be detected between the three belt discs from the Vognserup hoard, where distinct traces support the use of an identical tool on three triangle-decorated discs (Figure 4.020), the fourth artefact, however differs in the triangle shape.

It can be assumed that the four pieces with related triangle-decoration were made in the same workshop. In this case the items were moved over wide distances prior to being deposited. The Vognserup artefacts are special, as previously suggested. These artefacts were mostly not reworked and should, therefore, be considered as having been crafted in relation to each other, possibly from a workshop at a nearby location.

Similar assignments to a craftsperson can be made when identical spirals appear. Due to the occasional application of spirals with the help of spiral-shaped stamps (see Chapter 2.4.2), several related artefacts were found (Figure 4.022). In this case, however, the connections appear within the same find (mostly in hoard contexts) as well as over distances of up to 160 km.

Also here, the artefacts on Zealand are in focus because two groups of related objects could be detected. The first group consists of probably four pieces which show distinct characteristics that point towards the same spiral stamp having been used during crafting. The related ornaments are part of the very rich NBA II hoards, such as the Vognserup Mose (VM 1680 KC and KD) find and the Svenstrup hoard (NM 10932), and additionally are found in a burial (B11459, Gerdrup) in central Zealand. The evidence is striking, as seen on Figures 4.023-24. The spirals are of extraordinary quality and even the size is very similar. Interestingly, in both hoards several further items are decorated with spirals which are not related to these four artefacts. In Svenstrup, however, a further connection appears (Figure 4.025) between the NBA II neck collar and a similar collar from Bringe (B3486).

The second group in which the use of the same spiral-stamp is seen very likely consists of four, probably five, artefacts and connects in a similar way three exceptional NBA II hoards: the Rye hoard (B7615) in west Zealand; the Lavø hoard (B11685+11686) in northeast Zealand; and the Frankerup hoard (CMXII) in southwest Zealand. Moreover, a high similarity between these spirals and the extremely large ones from Vorup (B6622), Krasmose (B647), and Frankerup (CMXIII) suggests an even larger group of related artefacts.[5]

The spirals are, as seen in Figures 4.026-28, very alike in shape and size and also in small mistakes within the single turns. They are, however, not identical with the former group, even if the quality is comparable. Additionally, here a similar pattern can be detected where further spiral-decorated artefacts are in the specific hoards but which are not related to the objects mentioned.

This second group, however, has an interesting connection to the central Lower Saxony region, namely to the NBA II burial from Heitbrack (Figure 4.029). The already-mentioned disc-headed pin has slightly smaller spirals, in both turns less than the one on Zealand. It can be assumed that these spirals were stamped due to their uniformity. In particular the centres of the spirals, the diameter of each groove, and the distance of the individual turns can all be compared with the spirals on the Danish artefacts.

Does this pin prove the contact between the two centres of metalcraft in NBA II? What kind of contact might that have been? The Lüneburg-type spiral-decorated disc-headed pin (Laux 1976: 42) should be considered as a northwest German form that is mostly spread in the Ilmenau area, with single finds in Mecklenburg, such as at Plau, in the Mecklenburg Lake district (Schubart 1972: 39). Consequently, it can be stated that the pin is not imported from Zealand. Furthermore, more parallels can be detected in the area adjacent to the specific pin. Here, three items seem to be crafted using spiral-stamps, the above-mentioned belt plate from Hohenbünstorf (LMN 24976) and the disc-headed pin from near Lüneburg (LMN 12041). These two items have identical spirals,

[5] Due to the preservation conditions of the collars from Vorup and Krasmose, a direct comparison is not possible. However, the centre, the central turns, and the turn width are all very similar.

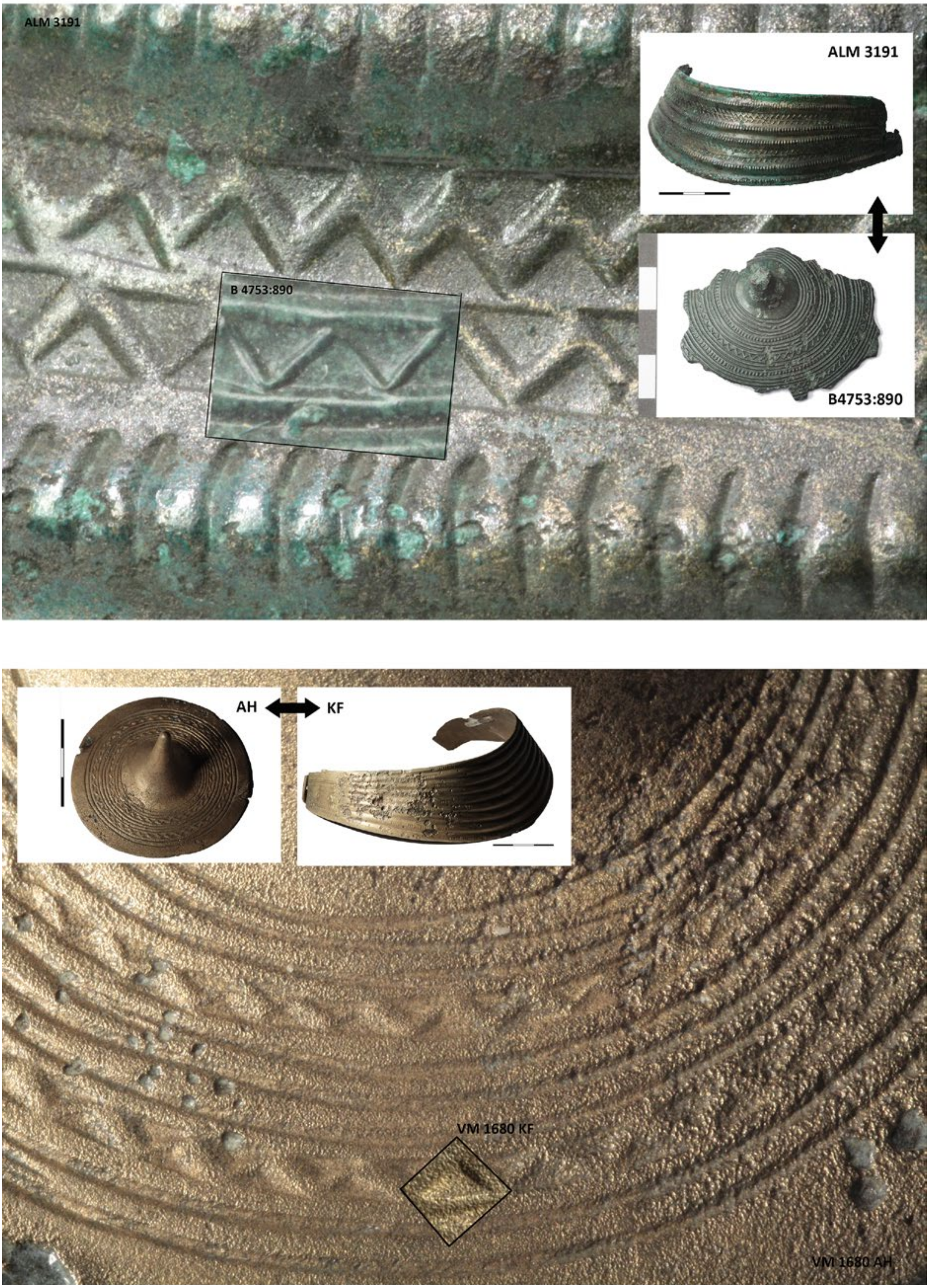


Figure 4.020: Triangle decoration of several artefacts was very likely made using the same tool, as seen on the belt disc from Vendsyssel (NM B4753:890) and the neck collar from Pisede (ALM 3191), and on the belt disc (VM1680 AH) and neck collar (1680KF) from Vognserup on Zealand.

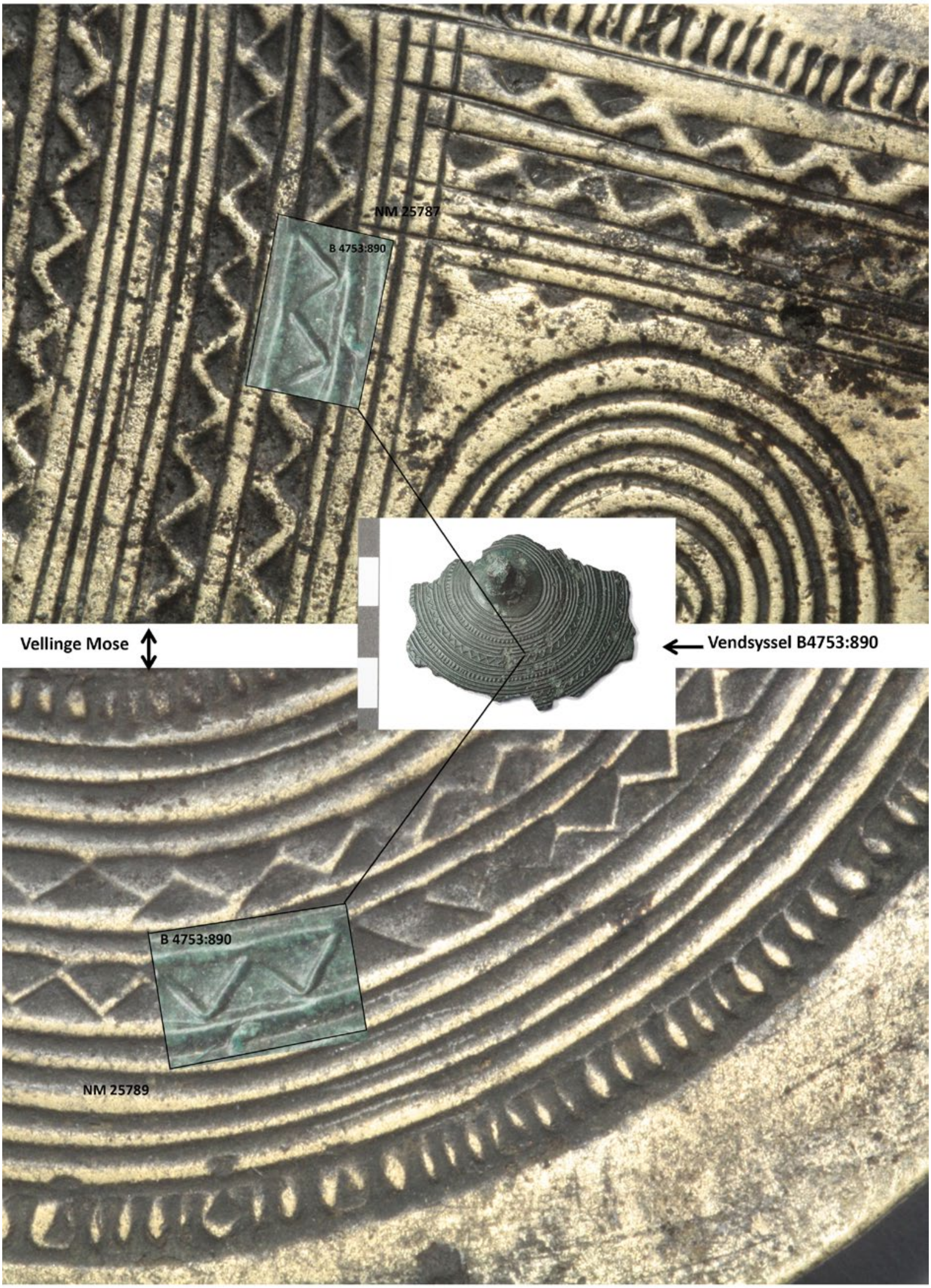


Figure 4.021: Triangle decoration of the small belt disc from Vendsyssel (B4753:890) is the same as on the neck collar from (NM 25787) and belt disc (NM 25789) from Vellinge on Fyn.

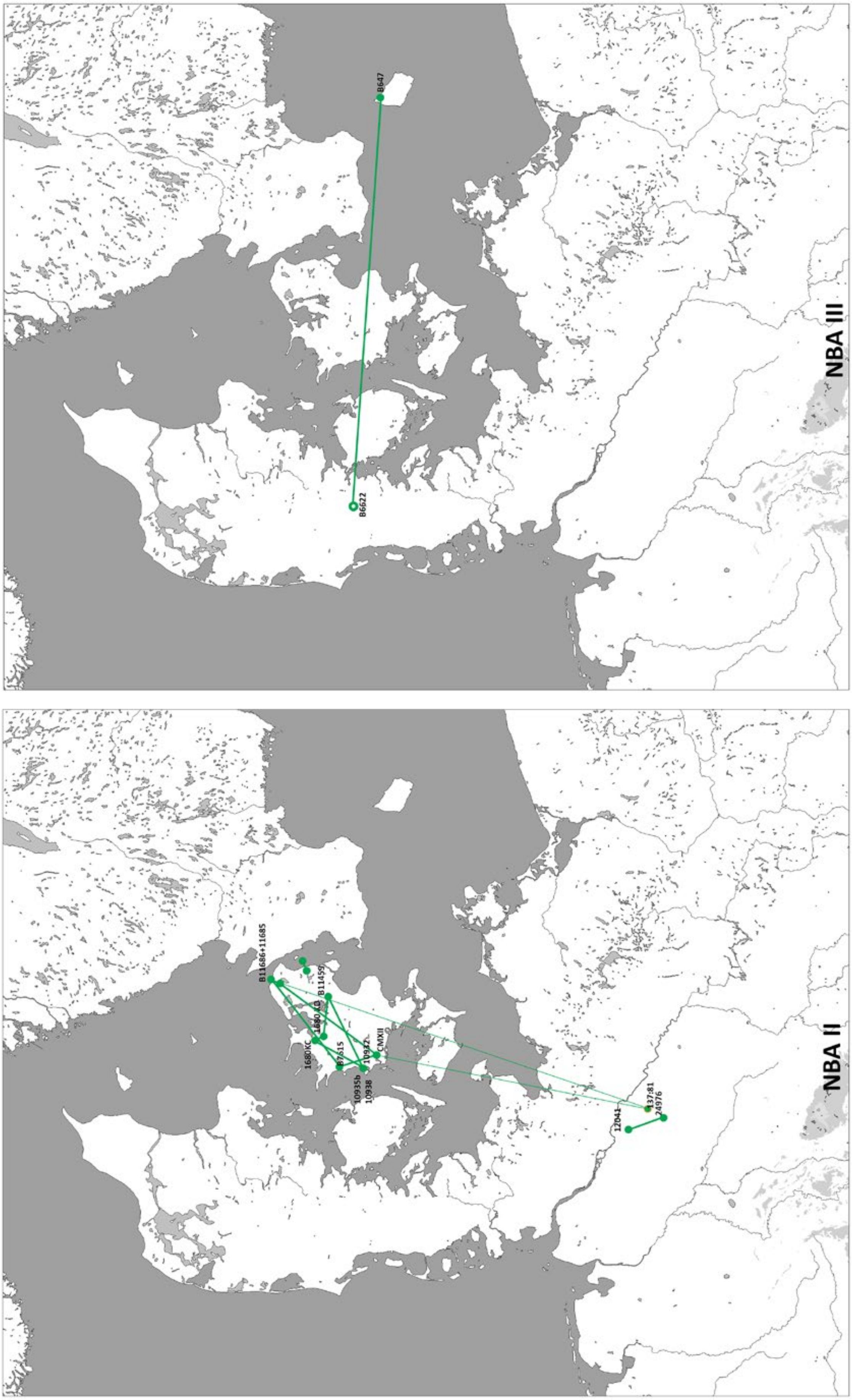


Figure 4.022: The occasional application of spirals, with the help of spiral-shaped stamps, resulted in groups of artefacts made with the same stamp in NBA II (left) and NBA III (right).

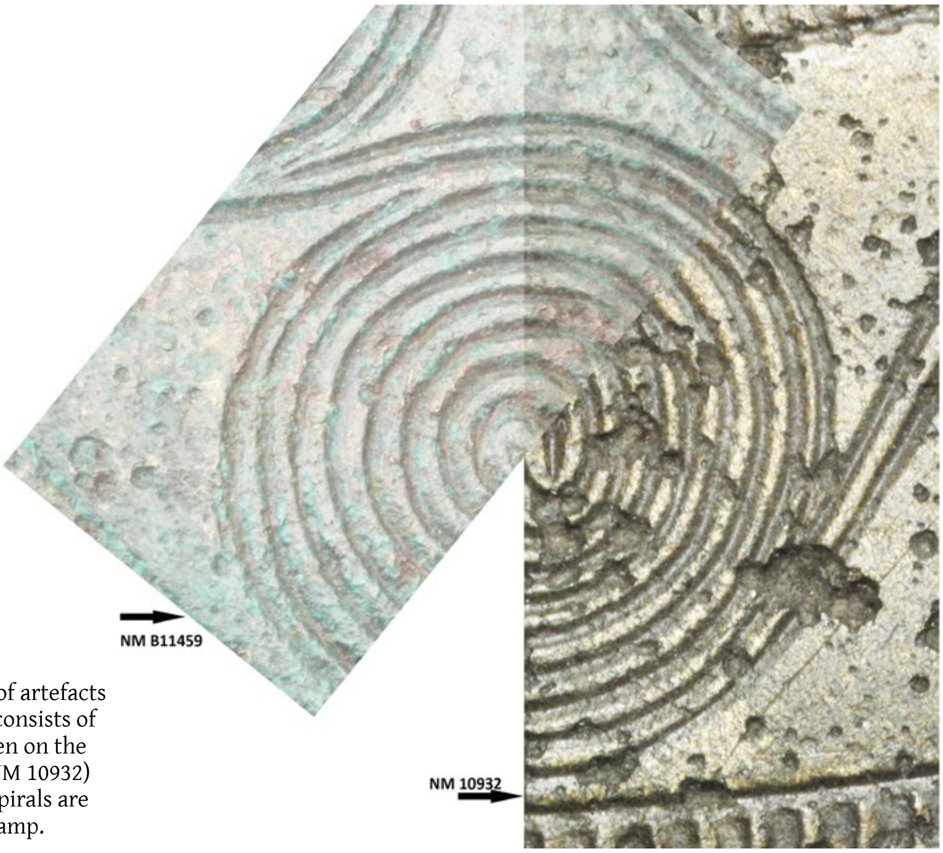


Figure 4.023: The first group of artefacts made with the same stamp consists of probably four pieces. As seen on the artefacts from Svenstrup (NM 10932) and Gerdrup (B11459) the spirals are made with the same stamp.

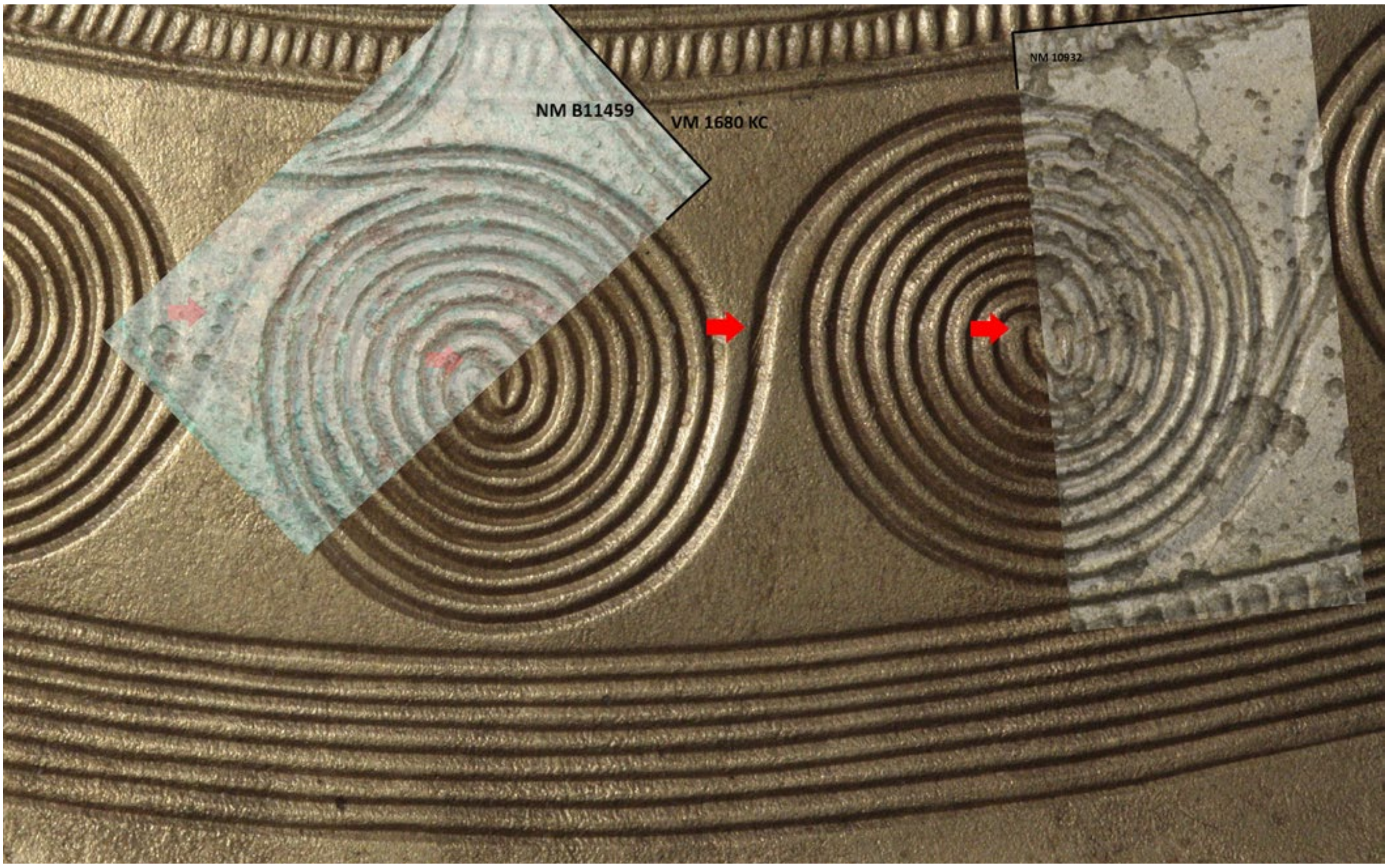


Figure 4.024: The artefacts from the very rich NBA II hoards, such as the Vognserup hoard (VM 1680 KC and KD) and, as already shown, the Svenstrup (NM 10932) hoard, also count amongst the first group of stamp-decorated artefacts. The spirals are a near perfect match.

Figure 4.025: The neck collars from Bringe (NM B3486) and Svenstrup (NM B10927) on Zealand not only match in the spiral decoration but also in the surrounding decorative ribbon.

Figure 4.026: A second group of artefacts made with the same stamp consists of probably four or five pieces. Here, the similarity between the spirals is very high, as seen on the neck collar (NM B11686) and belt plate (NM B11685) from Lavø on Zealand.

Figure 4.027: Same spirals were detected on the belt plate from Frankerup, Zealand (NM CMXII).

Figure 4.028: Same spirals were detected on the belt plate from Rye, Zealand (NM B7615).

which were probably applied with a spiral-stamp – the same that made the spiral impressions on the disc-headed pin from Heitbrack (Figure 4.030). The spirals of both pins are even nearly identical in size (0.84 cm – 1.02 cm in diameter). Thus it can be stated that the three items from south of the Elbe were probably crafted by the same hand, and that the above-mentioned four artefacts from Zealand are strongly related to each other (see also Nørgaard 2015b).

Furthermore, the belt plate from Eyendorf (H55) is, through characteristic traces of technical behaviour, also connected to the Lower Saxony items. Due to the regionally specific objects an import or exchange of artefacts is less likely; an exchange of craftspeople, however, would explain this pattern, as well as the exchange of specific tools, namely the stamp.

The dissemination of artefacts produced using the same spiral-stamp reveals further analytical workshops on Zealand (Figure 4.031). It is very likely that the collar and belt plate from Lavø were crafted in an analytical workshop in this region, as they display similarities in the further tool traces as well. The other items related to the Lavø artefacts appear in four of the six major hoards in this period.

The connection between the discs in central Lower Saxony is possibly an indication for mobility of craftspeople, as further artefacts were produced within the analytical workshop near Heitbrack.

Especially on Zealand during NBA II, connections are common between highly decorated artefacts, as seen in Jægersborg, where a neck collar and belt disc both display the use of the same spiral-stamp, or in Svenstrup where several pairs of belt plates appear (Figure 4.032).

However, also in NBA III, single items can be detected which were probably crafted by the same person, or, if not, at least by craftspeople strongly related to each other. Of interest are the Krasmose-type collars from Vorup (B6622) and Krasmose (B647): both have identical spiral stamps (Figure 4.032). Another NBA III collar from Bornholm (B2884) is interesting in this group, with the striking similarity to the pair on Jutland

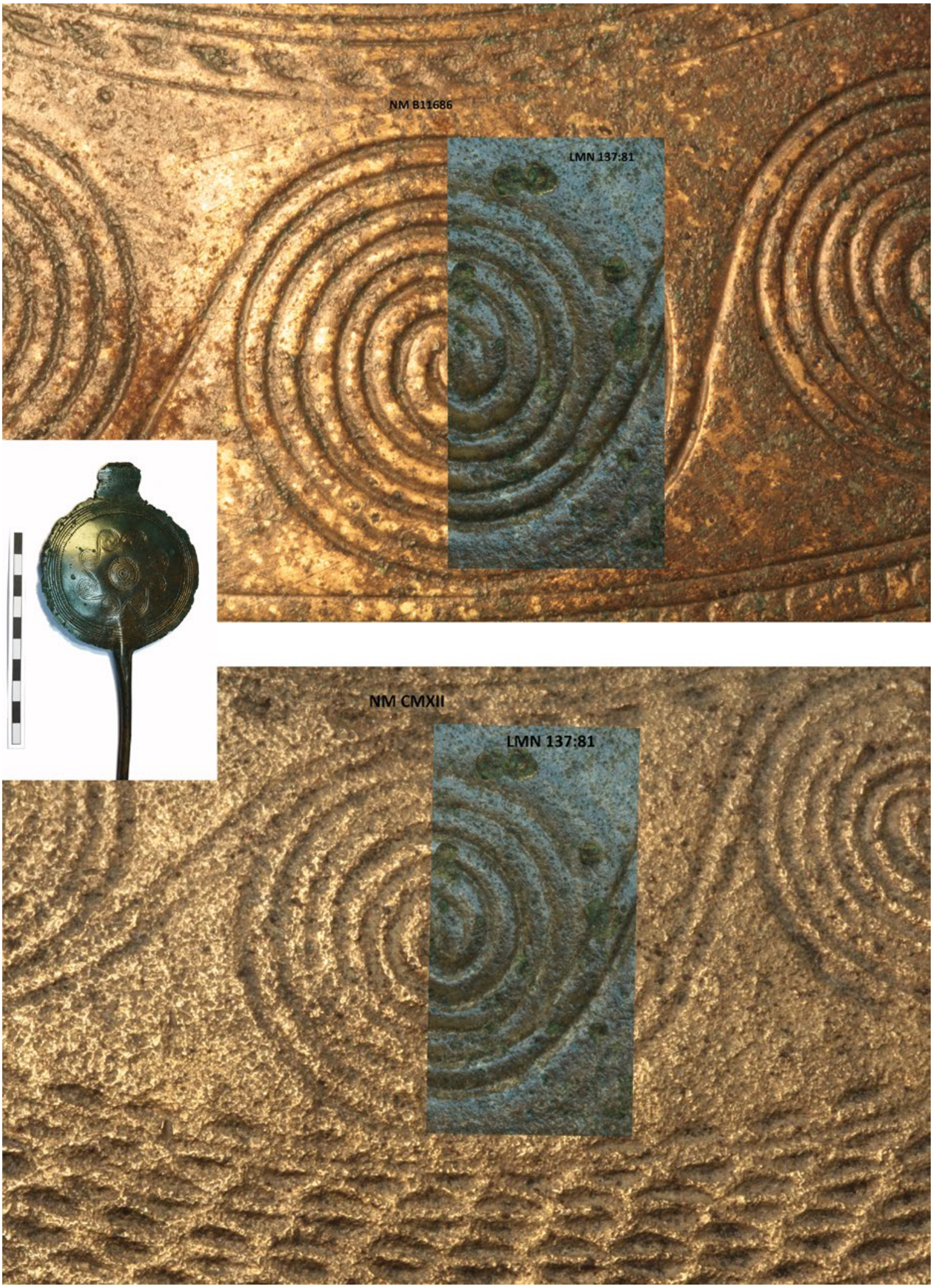


Figure 4.029: A very similar spiral (probably related to the second group) was also detected on the disc-head pin from Heitbrack (LMN 137:81) in central Lower Saxony.

Figure 4.030: Spirals from the disc-head pin from Heitbrack (LMN 137:81), furthermore, match the spirals from the disc-head pin from Lüneburg (LMN 12041), and thus are also related to the belt plate from Hohenbünstorf (LMN 24976).

in Gjedsted (B13259) and Sludstrup (B298), although the spirals here are twisted in the opposite direction. However, the artefacts on Jutland are from NBA II and the pieces on Bornholm date to NBA III. To what extent the chronological deviation is justified through long-distance travel, the passing on of status symbols, or perhaps chronological confusion concerning the material culture on Bornholm, the distance of around 450 km is still astonishing.

However, an artefact of this significance will have survived two generations (if used actively and not deposited)[6] and, therefore, the assumption that the two collars were crafted with the same tools (Krasmose-Vorup) is realistic and between the other some form of connection should be expected (Sludstrup-Bornholm).

During NBA III, spiral-decorated ornaments are concentrated within the northeast German region. However only occasionally were the spirals applied using a stamp, as seen at Friedrichsruhe (ALM 149.17). Only once was it possible to detect two artefacts stamped with the same tool: in Karow (Br. 178) and Weisin (ALM 2199), both found within the Mecklenburg Lake district. Nevertheless, on several Mecklenburg-type neck collars similarities in the spirals were detected that point towards similar tools and crafting habits, such as on the three collars from the Weitgendorf burial mound (Nørgaard 2011: 61; Bohm 1935: 63). These spirals are, in contrast to the Scandinavian spirals, constructed as single spirals and could be applied using a stamp-like tool. However, they might also have been applied by hand. Nevertheless they share specific characteristics, such as a distinct fan-structure in the centre (also within the single turns), a similar centre construction, several interruptions, a single superposition at the last turn, as well as their size (Figure 4.033). They should be considered as having been crafted by the same hand and probably another spiral-decorated collar from an unknown location (L IIQ,2) as well.

Additionally, within the investigated artefacts of NBA III only two more artefacts were designed using simple spirals, the collar from Friedrichsruhe (149.25) and the collar from Werder (II 6284). Here there might be

[6] The timespan of two generations, meaning around 40 years, can also be compared to the timespan in which the oak coffin burials occurred. They are dated nearly all in a range of 50 years, around 1391-1344 BC (Christensen 2006: 181; Christensen *et al.* 2007: 42). If social habits and ideologies are executed in a comparable span, then the use of specific symbols might also survive for 40-50 years. In this case the neck collars could have been crafted by the same hand.

Spiral stamp (short round centre - half-round impression)				**Spiral stamp** (long, thin, pointy centre – triangle/square impression)			
AW 7				AW 8			
Spiral size* per level	1st	2nd	3rd	Spiral size* per level	1st	2nd	3rd
CMXII (Frankerup)	**1,2**	**1,5**	**2,2**	**VM 1680KC (Vognserup)**	**1,1**	**1,4**	
NM 11686 (Lavø)	**1,2**			**VM 1680KD (Vognserup)**	**1,2**	**1,4**	
CMXIII (Frankerup)	**1,2**	**1,5**	**2,2**	**NM 10932 (Svenstrup)**	**1,0**	**1,4**	**1,4**
NM B7615 (Rye)		**1,5**		**NM B2307 (Langstrup)**	**1,1**	**1,4**	**1,8**
NM B6622 (Vorup)		**1,7**	**2,0**	**NM B11459 (Gerdrup)**	**1,2**		
NM B647 (Krasmose)		**1,5**	**1,7**	*NM B11458 (Gerdrup)*	1,0		
NM 11685 (Lavø)	1,2						
MDCCCXXI (Skagen)	1,1						
B6623 (Vorup)		1,5					
LMN 137:81 (Heitbrack)	0,8	1,0					
LMN 12041 (Lüneburg)	*0,8*	*1,0*					
LMN 24976 (Hohenbünstorf)	*1,2*						

Figure 4.031: Artefacts made using the same spiral stamp within AW 7 and 8. Each stamp seems to be characteristic for the specific workshop.

a connection between these items, as this technique is unique in the material. However, other artefacts show the use of similar tools in their rib-decoration, for instance the collar from Pisede and from Thürkow. These two artefacts display a high similarity in their overall style, and due to the nearly identical rib-notches they can be related to the same craftsperson.

When examining the spiral-decorated artefacts within this region several other pieces reveal similarities which can be related to the same way of doing (*habitus*). Here, four artefacts within a small area show a similar centre design which can, in contrast to further items, be viewed as distinctive for one workshop. Slight differences, however, may suggest the crafting by more than one hand or over a longer period of time.

In all, the specific techniques used (rib-waves and fingernail imprint), as well as the artefacts which show decoration applied with similar tools or a similar method, point towards several workshops within a small area. Each of these specific techniques was probably characteristic for one analytical workshop, and each of them being in close contact due to the social group they were part of.

It was demonstrated that several artefacts within the NBA could be related to each other with the help of crafting traces. The most distinctive traces found are the spirals applied with the help of a spiral-shaped stamp. The use of spiral-stamps was documented on 48 artefacts (see Figure 2.084-86). On Zealand at least three different stamps were used to craft multiple artefacts in NBA II (see Figure 4.031), and the artefacts from the Lüneburg Heath suggest another stamp, which was locally used. For NBA III it was only possible to detect one stamp on several artefacts.

Additionally, similar ways of constructing spirals could be detected and related to the craftsman´s *habitus* and consequently to the smallest interaction group of craftspeople or one individual. In this category identical repair marks and stylistic inventions are also seen, even if here parallel pictures occur due to the technical restrictions set by the material. The study was able to detect in NBA II the work of at least six different analytical individuals (who will be shown in the following to equate with the smallest interaction group of craftspeople) from south of the Elbe, and an additional three on Zealand (the identical spiral stamps are not included). Furthermore, the work of three different craftspeople or closely related craftsmen is distinguishable on Jutland. In NBA III in Mecklenburg at least five different interaction groups were determined. However, it should be noted that this calculation includes only those artefacts for which an affinity to other artefacts was found in regard to the respective crafting traces.

The above-presented relations between artefacts occur mostly between artefacts that are also temporally and spatially related to each other.

Figure 4.032: The use of the same spiral stamp can be detected on several artefacts, and occasionally two artefacts are decorated with the same stamp as the belt plates from Svenstrup (NM 10933 and 10931), or the neck collars from Krasmose (NM B647) on Bornholm and Vorup (NM B6622) in Jutland.

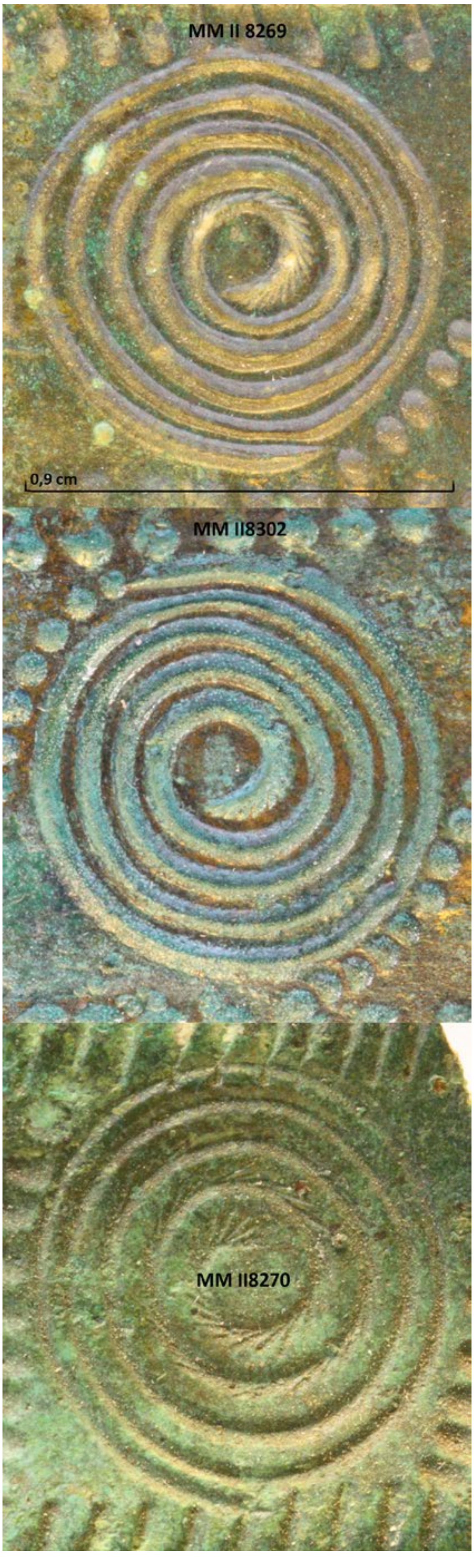


Figure 4.033: Spirals on the neck collars found in Weitgendorf (Brandenburg) have specific characteristics, such as a distinct fan-structure in the centre, several interruptions, and single superposition at the last turn, as well as their size.

Chapter 3

Traces of interaction groups of craftspeople – traces of the analytical workshop

Within this chapter, workshops are presented as defined through the material culture. These workshops should each be seen as 'analytical workshops' with fictitious locations calculated having the greatest density of regionally specific finds, such as graves, as the basis. As such, questions concerning the relation of artefacts to each other and the involvement of individual craftspeople in closed artefact assemblages are present themselves.

It is shown that, surprisingly, the items of one hoard are related rather to several other find locations than to the accompanying items. Furthermore, hoards on the Danish island apparently display another kind of structure behind the deposition of the bronzes than is found in Lower Saxony, where predominantly one analytical workshop is responsible for the crafting of the artefacts. In contrast, artefact assemblages in burials support the basic assumption that a costume set within a burial is crafted by connected craftspeople, however, with exceptions. Local costume-ornaments, as demonstrated by the Rehlingen burial, are crafted by one, probably local, craftsperson, while foreign, and thus extraordinary items in a burial, are mostly made in foreign workshops. Thus, given the social position of the buried, costume sets can be made by one or several craftspeople.

In central Lower Saxony, five analytical workshops are identified during the NBA II in close contact to each other, and occasionally with the same area of influence. Specific technical peculiarities, such as the stamped-spirals, can be named as one of many technological traces for the definition of these workshops. In Denmark several analytical workshops are defined. Four of were detected on Zealand, rich in magnificently decorated bronzes and with specific techniques. In NBA III several analytical workshops in central Lower Saxony, as well as on Zealand, continued to operate, whereas in Mecklenburg technical characteristics defined five different ones, while in NBA II there were no apparent analytical workshops. It is clearly shown that metalcraft in the NBA ranges from expert to novice work, and several workshops were in close contact during NBA II as well as NBA III.

4.3.0 A workshop's repertoire? An examination of hoard assemblages

While comparing the artefacts for similarities it becomes clear that, especially on Zealand, where the extremely rich depositions were found during NBA II, many artefacts were related to each other. However, surprisingly, the items of one hoard were related rather to several other find locations than to the accompanying items. However, how many craftspeople were involved in the crafting of artefacts deposited in such a hoard,[7] and will an investigation into this allow us to define the repertoire of a Bronze Age metalworker?[8]

One of the extraordinary finds on Zealand is the NBA II hoard from Svenstrup (Aner and Kersten 1976: 148-149), which was found in a bog. The hoard consists of 37 artefacts; a neck collar, four belt plates (of which the two biggest are examined), four smaller spiral-decorated belt plates, twelve line-decorated belt discs (of which three are examined), 11 ribbed tutuli (none of which is examined), two dome-shaped tutuli (one of which one examined) and spiral rings.

The most informative artefacts from this hoard have been examined for their crafting traces and an interesting picture arises (Figure 4.034). Earlier in this study it was shown that the neck collar was crafted using the same tool as was used for the collar from Bringe. The big belt plate (NM 10932) is related to several other items in regard to the spiral-stamp used. However, the belt plate NM10931 and the slightly smaller plate NM10933 show similar spirals, which might have been applied using the same tool. A third small belt disc (NM 10935c) might be related to this group due to its spiral shape; however, this artefact does not mirror the same technical *habitus*. Here perhaps the same workshop might be assumed but with the work of different individuals. Additionally, there are antler notches on three line-decorated belt discs, on one of the dome-shaped tutuli and on a small spiral-decorated belt disc; these notches were caused through a defect in an hourglass-shaped tool (see Figure 4.034). The same trace was found on a small belt disc from Vendsyssel. On the fourth spiral-decorated belt disc no tool traces or decorative elements could be detected that pointed towards a relationship to the other items in the hoard. Moreover, the disc (NM 10935a) is decorated with hourglass-shaped notches composed of two triangles, a technique unique within this hoard assemblage.

In summary, this hoard includes at least two sets of three and four related discs. Each set could be compared to burial equipment. Furthermore, within the examined

[7] This section does not aim to discuss the hoard phenomenon as such. For an intensive discussion concerning the interpretations of hoards and the various kinds of hoards, see Hansen (2013: 179).

[8] However, to get the fullest knowledge about the Bronze Age metal craftsman's repertoire, the weapons and tools should also be examined. This is a matter for further investigation and beyond the scope of this project.

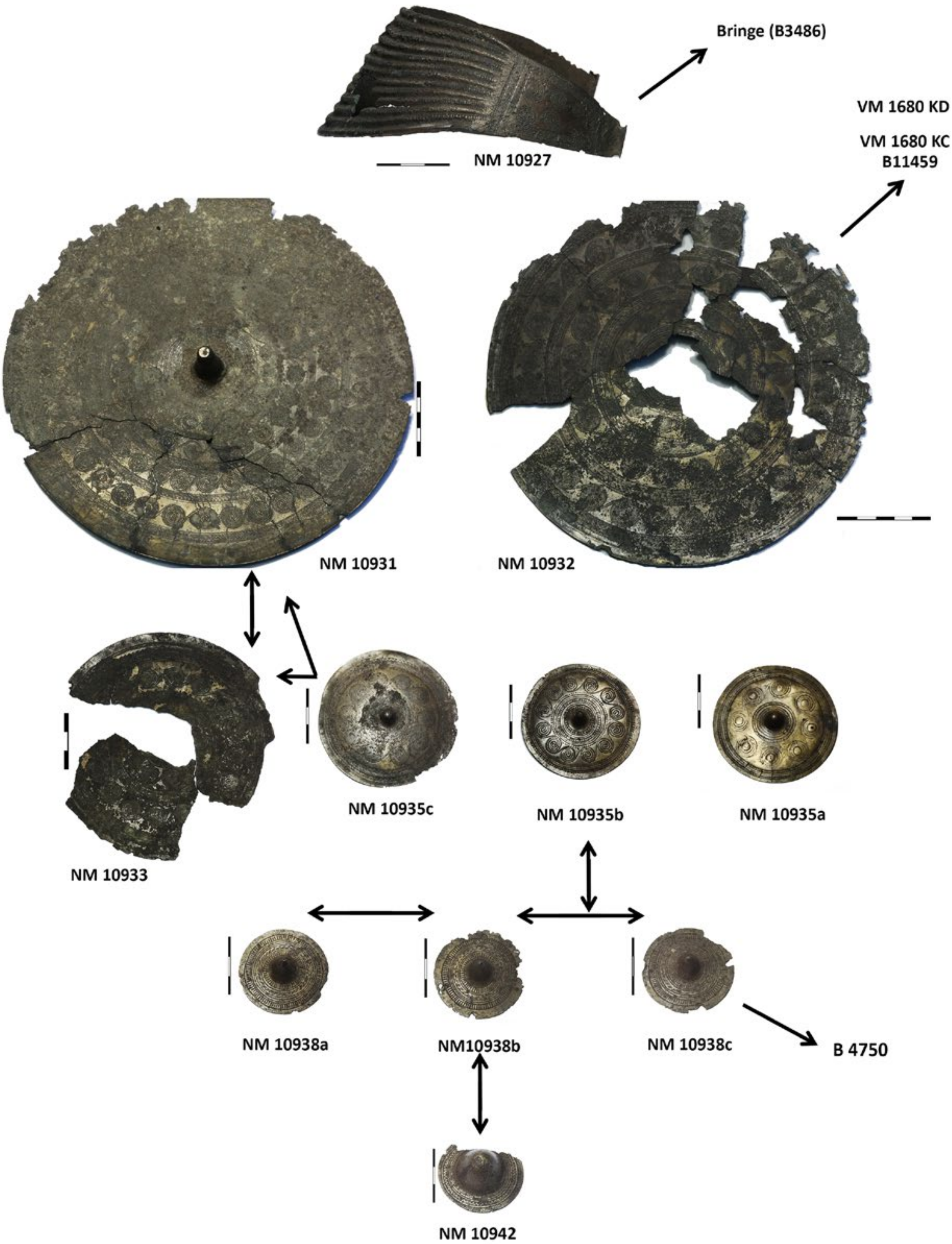


Figure 4.034: Within the NBA II hoard from Svenstrup the technical connections between the artefacts point towards the work of five different craftspeople and towards relationships to other artefacts.

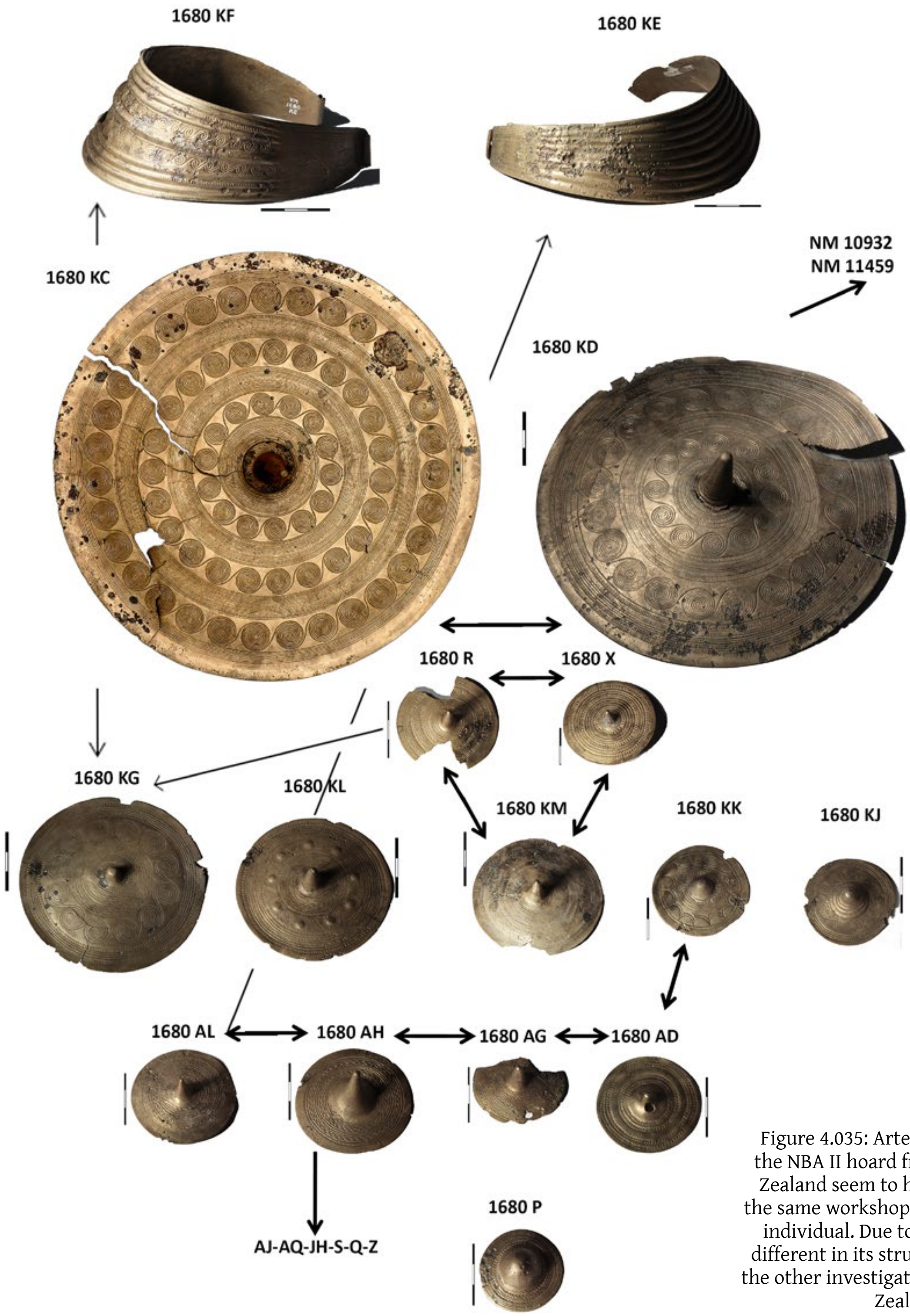


Figure 4.035: Artefacts deposited in the NBA II hoard from Vognserup on Zealand seem to have been made in the same workshop, but not by a single individual. Due to this the hoard is different in its structure compared to the other investigated NBA II hoards on Zealand.

material three artefacts – the neck collar, the big belt plate and the spiral-decorated belt plate – show no connections to the rest of the material. However, they are connected to items in other depositions and in a single case to an artefact deposited in a grave, all situated in northeast Zealand.

Another interesting find for this investigation is the Vognserup Enge hoard (Frost 2008), an NBA II bog find that has parallels to the Svenstrup hoard. Here, the two big belt plates were crafted using the same spiral-stamp as one of the plates in Svenstrup (Figure 4.035). The relationship between these two plates KC and KD is quite unusual within the other examined finds. However, there is no doubt that they were both crafted using the same spiral-stamp, which also exhibits a higher quality than all other spirals within this hoard. In addition, the notch decoration is very similar, with long hourglass-shaped notches. The high quality of both plates is striking. However, there are more parallels in the Vognserup hoard.

Of the 41 small belt discs and tutuli, six line-decorated discs and four spiral- or arch-decorated discs have been investigated in this study (see Figure 4.035). Remarkable parallels could be documented here that point towards crafting by one or two individuals who were in close contact to each other. Discs AL and AH have similar triangle imprints, as also found on the ribbed neck collar KF. The three discs AL, AG and AH have a comparable shape and similar tool traces. The construction of the eyelet is alike on discs AD, AG, AL and KK, but not on disc AH. Discs KK and AD were probably also decorated with the same tool which, however, was not used in decorating the other discs. Furthermore the very special way in which the eyelet of AH is constructed has parallels in the discs and tutuli AJ, AQ, JH, S, Q and Z (which have not been more closely examined). Within this group of objects many parallels suggest crafting by one hand. On the other hand some very distinctive differences are visible, which rather point towards two craftsmen in close contact, i.e. a 'workshop'. The neck collar KF and the belt plate KG are decorated with spirals which were not stamped but probably crafted by the same person, as distinctive characteristics of the craftsman's *habitus* reveal. A similar construction of the eyelet,[9] and very long hourglass-shaped notches, connect belt plate KG with the three smaller discs KM, R and X.

The Vognserup hoard contains artefacts which are closely related to each other, some were definitely crafted by the same hand, others mirror a 'close interaction and shared learning experience' resulting in 'great similarity along several axes of variation' (Redman 1977: 44). As these are decisive criteria for Redman to suggest crafting in a small interaction group similar to a family, the Vognserup hoard thus seems to be different than the other elaborated hoards on Zealand, as the assignment to one analytical workshop is obvious.

With the previously explained traces (see Chapter 2.6.2 and 2.6.5) there is no doubt that the artefacts deposited in the NBA II hoard from Molzen in Niedersachsen (Laux 1971: 259; Sprockhoff 1940: 30; Hachmann 1957: 200; Krüger 1925: 186-188) were made by three different individuals. Of the nine different belt discs, eight could be intensively investigated in this work. As a result, the spiral-decoration especially could be used to trace the connections between the items (Figure 4.036).

The two hanging discs are spiral-decorated, as are four of the belt discs; however, the overall picture differs. The central humps on the belt discs are even, round, and framed by spirals with a uniform line width, with the same distance between each turn and of regular depth, whereas the humps on the hanging discs are oval (multiple punches) and the spirals display several interruptions in each turn and are far from round. Here, two different craftspeople can be assumed due to differences in the technical *habitus*. The triangle-decorated discs were crafted by the same hand, a conclusion which is due to the way in which the decoration is constructed. Here, especially, the slightly oblique position of the lines is characteristic for the *habitus* of a craftsperson. However, the quality differs greatly. Another feature which could be observed on these discs might help to solve this problem. The eyelets of these six discs were constructed in the wax model using two different techniques, cotter of organic material and rod-like implements, an unlikely situation if they were crafted by one person. Thus, when referring to the difference in quality and similar technical habits, then two people might have been involved in creating these discs, of whom one was very likely still in training.

Consequently, the inventory of the Molzen hoard can be viewed as having been crafted by three people from possibly the same workshop (close interaction group of craftspeople). A master craftsperson was involved, and probably a less skilled person and an apprentice. The techniques used, the decoration applied and the technical details, point towards a close interaction between the craftspeople, even if the hanging discs might have been crafted elsewhere.

The hoard from Appel, within the same area, was examined to test a possible relationship between both finds (Figure 4.037). Even though the three belt discs are decorated with a star decoration no similarity to the previously described discs from Molzen could be found, although they are strongly related to each other (see Chapter 4.2.1). The fourth disc from this hoard differs in shape as well as technical style.

The results of the hoard investigation may lead to the assumption that the presumed costume-ornament sets might have been crafted by one craftsperson, and thus the hoard assemblage, which consists of several costume sets, was crafted by several craftspeople. Following this thought, then a costume set within a burial needs to be crafted by the same person. As a comparative, the female burial from the mounds within the 'Büchenberg' enclosure (near Rehlingen) was investigated. This burial was placed in a stone cist in the elongated mound V of, in all, five mounds (Laux 1971: 222).

[9] Conversely to the other examined artefacts this eyelet is designed with a protruding bar, probably using a slightly edged and rod-like tool.

Figure 4.036: The artefacts of the NBA II hoard from Molzen in central Lower Saxony were probably crafted by three people, possibly from the same workshop. In the crafting a master craftsperson was involved, as well as probably a less skilled person, and an apprentice.

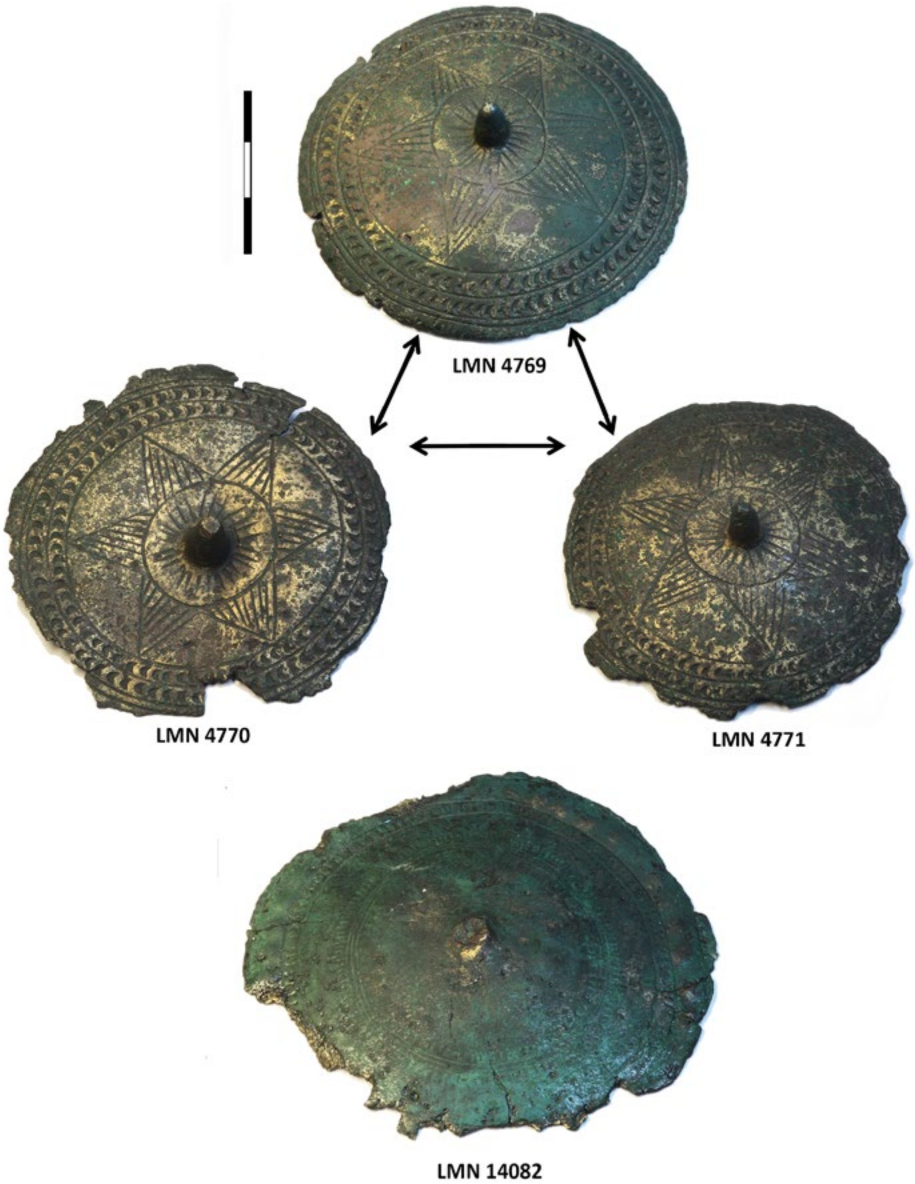


Figure 4.037: The NBA II hoard from Appel shows no connection to the hoard (and thus workshop) from Molzen. However, the artefacts from the hoard were probably crafted in one workshop by two different craftspeople.

This burial contained a neck collar, a spiral-decorated belt disc and a wheel-headed pin, all in good condition (Figure 4.038). A closer examination of the objects revealed that the wheel-headed pin and the neck collar were probably crafted by the same person, as the overall appearance is very alike. Both items have rounded rib-valleys with irregular grooves caused by subsequent processing (Figure 4.039). Furthermore, both pieces show severe surface damage due to hammering, a mistake which can be easily avoided if enough attention is paid. The third object in this costume set seems foreign. It displays unfamiliar characteristics compared to the former two objects and also the few tool marks that can be compared are dissimilar in kind. Were the belt plate and collar to have been made within a craft interaction group (or even by the same person), then it could be assumed that the rib-notches would be made with tools that were also used on the disc. But, even if the disc is decorated with incisions – a common method in rib decoration – the collar is decorated with rod-like impressions (Figure 4.040).

Furthermore, the overall picture of the disc gives an idea of a foreign piece. Thus, the local costume-ornaments of the Rehlingen burial are crafted by one, probably local, craftsman. The belt plate seems to be foreign and thus the whole set was made by several craftspeople.

Figure 4.038: The inventory of the NBA II burial from Rehlingen 'Büchenberg' was made by a local craftsman and probably contained an imported belt plate.

It seems that the hoards on the Danish island apparently display another kind of structure behind the deposition of the bronzes than in Lower Saxony. While the latter hoards can be predominantly related to one analytical workshop, the rich hoards on Zealand consist of artefacts crafted by several craftsman who were probably not part of the same closely related group of craftspeople (see Chapter 4.3.1), and the items occasionally travel hundreds of kilometres to form part of these depositions. After a close examination of

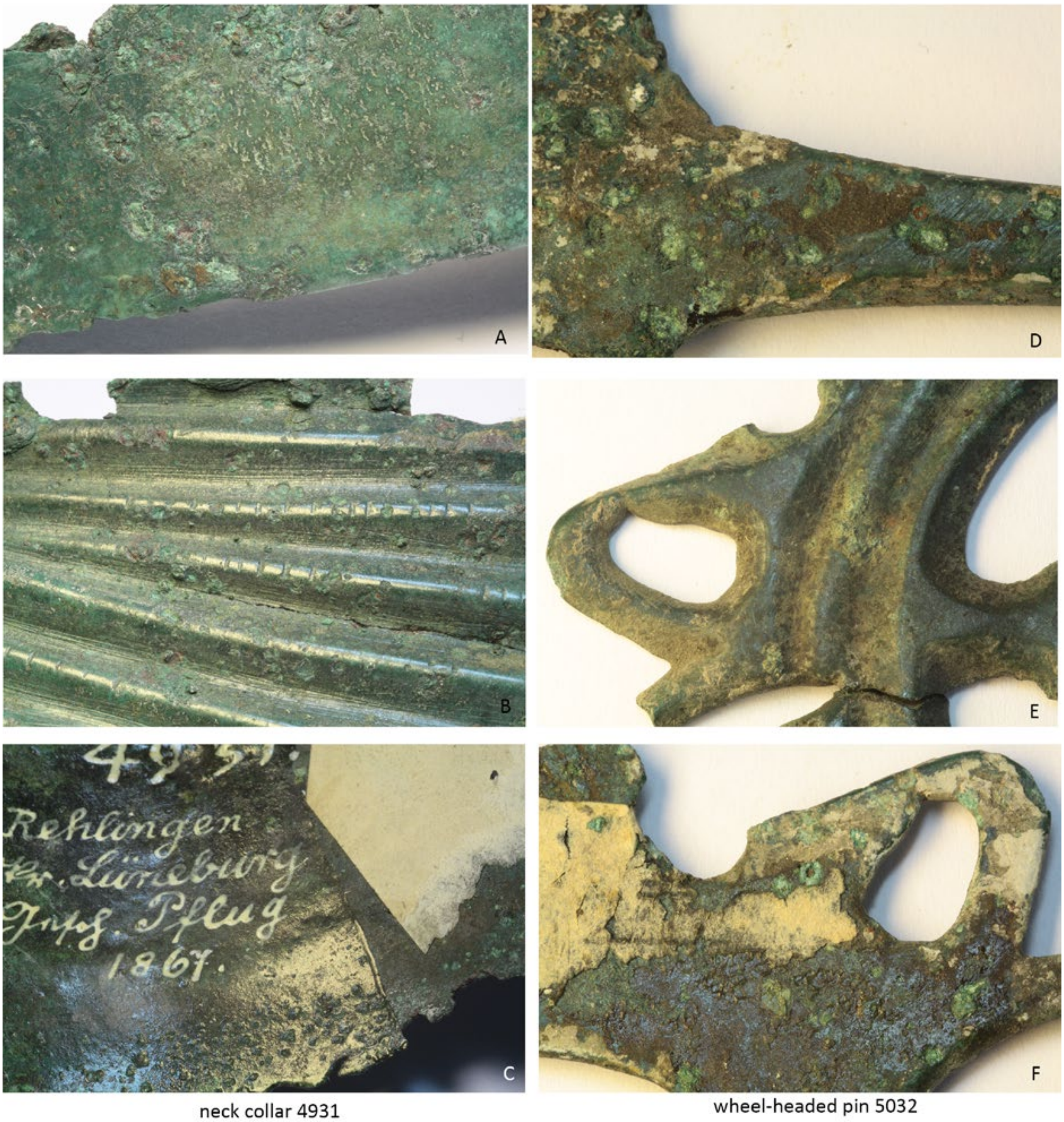


Figure 4.039: Wheel-headed pin (LMN 5032) and neck collar (LMN 4931) of the Rehlingen burial were probably crafted by the same person, as the overall appearance and technical features are alike.

a Lower Saxony burial it can be stated that the local elements were also made by one craftsperson (or the smallest interaction group), but, however, that the burial could also contain artefacts not crafted locally.

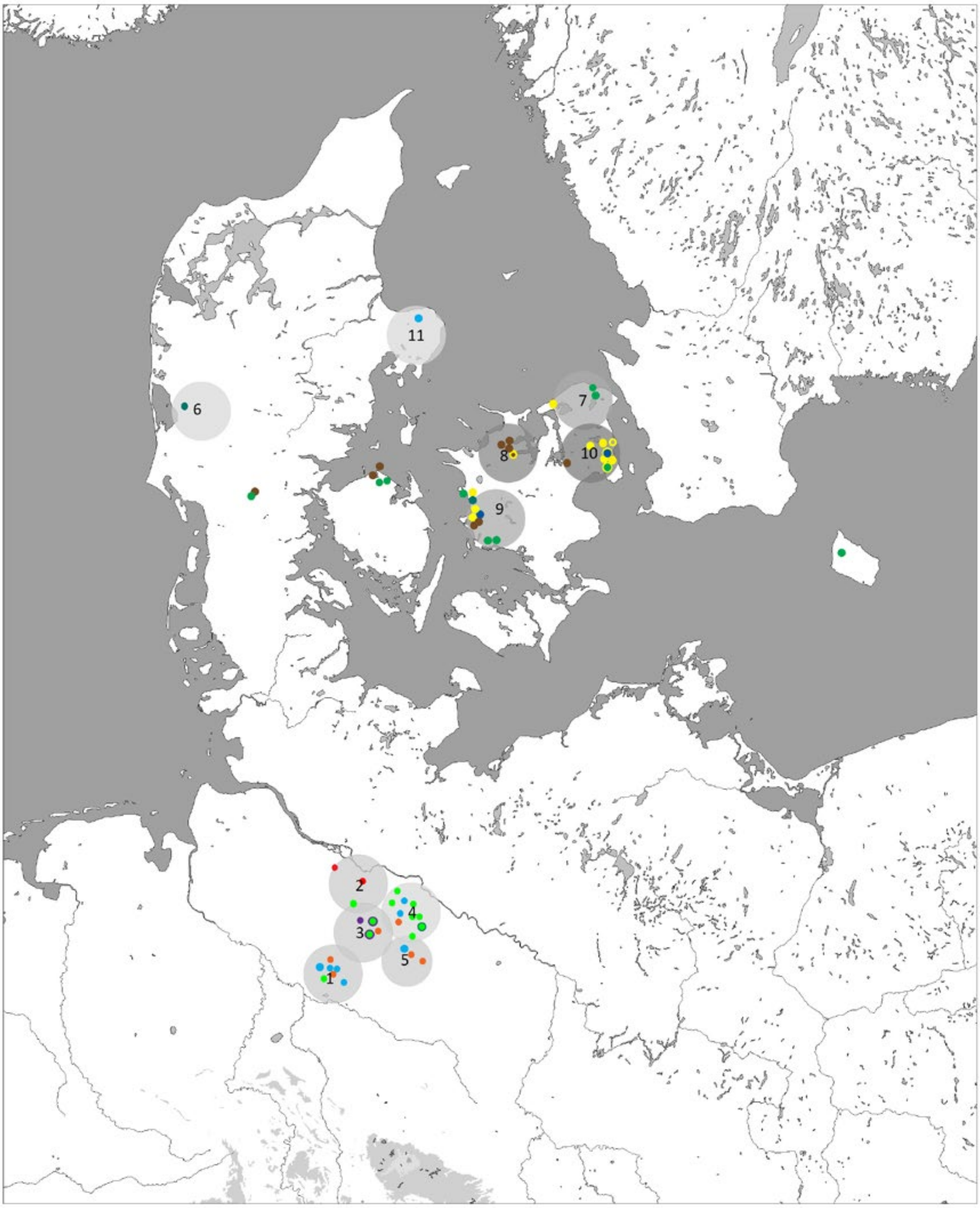
4.3.1 Workshops, craftspeople and their contacts

Workshop centres were, as already stated, a region where products were made that were crafted under the same technological conditions by craftsmen displaying a similar *habitus*. In other words a workshop circle may be said to mirror the technological tradition of a social group. Such social grouping may include several workshops, all united through the same technical repertoire and within the same workshop circle.

Thus a workshop should be defined not just as the physical location where metalcraft took place, but also through artefacts which display a similar motor habit and great stylistic similarities. A workshop, as defined

Figure 4.040: The belt plate (LMN 4755) of the Rehlingen burial is made by a different craftsperson with a different technical tradition and thus probably foreign.

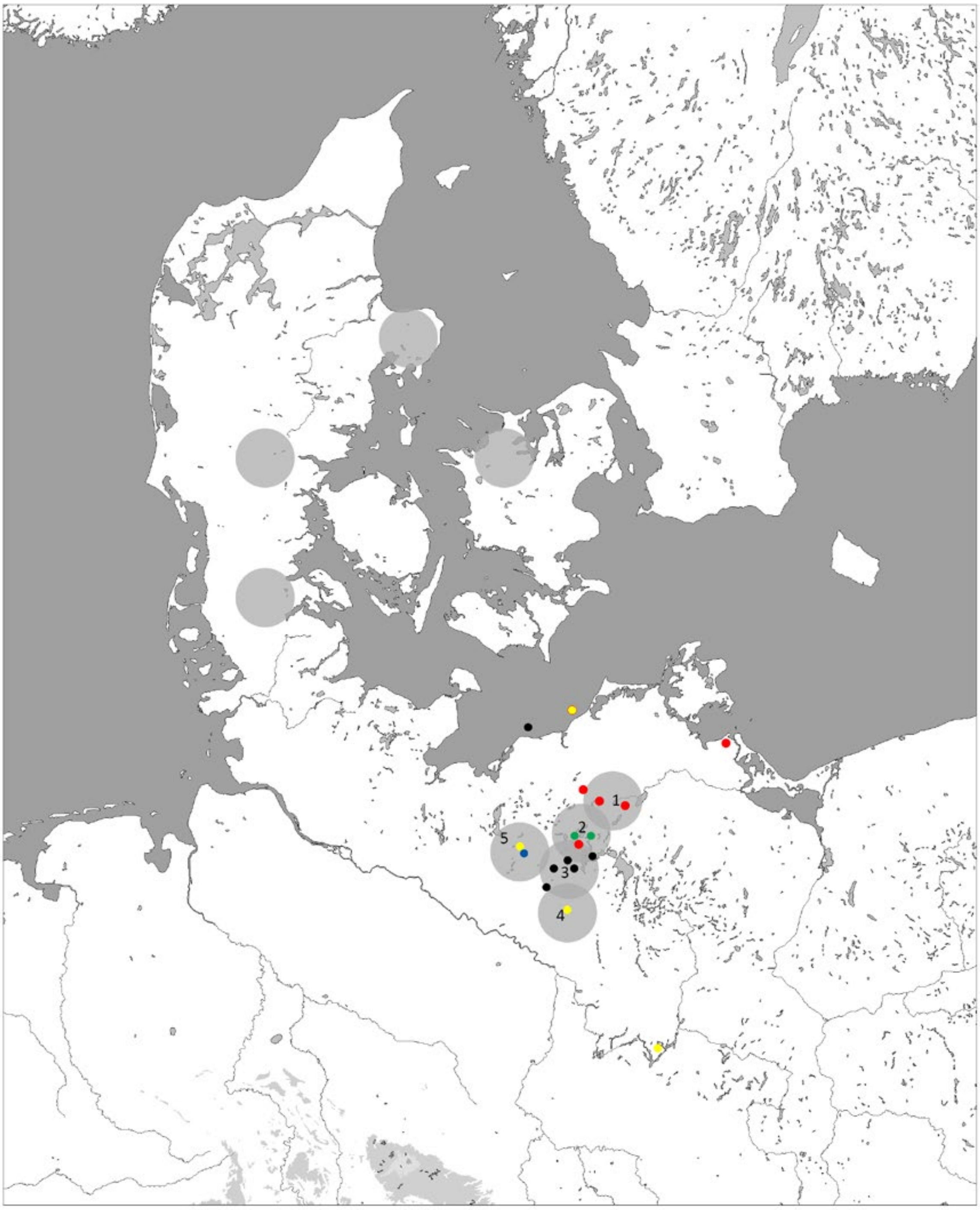
in this study, displays the smallest interaction group (after Redman 1977: 44) in metalcraft, based on the facts that craftspeople working in close interaction are able to share tacit knowledge and thus parts of their *habitus* will be similar. As only occasionally are physical workshops preserved, that which can be explained through the invisibility of the furnace structures and further stationary tools in settlements – the material



Map 37: The analytical workshops of NBA II, the artefacts that could be assigned to each AW are displayed in similar colours.

culture – is an important and reliable source to define these workshops. Thus, these workshops should each be seen as 'analytical workshops' (abbreviated as AW), as they are defined through the material culture. Their location is assumed, as described in the Introduction, and the places chosen for mapping are calculated by having the greatest density of regionally specific finds, such as graves, as a basis. Thus, the given location is assumed and should be considered 'possible' rather than assured.[10]

[10] However, having the density of the regionally specific finds as a basis, the assumed workshop locations might in future studies allow a closer investigation of the settlements in this region. It is very possible that the undefinied artefact categories within these settlements are residues of thesestationary workshops. The eastern part of Zealand is a very likely candidate for these.



Map 38: Analytical workshops of NBA III, the artefacts that could be assigned to each AW are displayed in similar colours. Analytical workshops that very likely still existed in NBA II are shown as grey circles.

Several of these above-mentioned analytical workshops could be named, and in MAPS 37 and 38 the investigated material was assigned to a specific workshop providing that the crafting traces made this possible.

Despite the large numbers of finds in NBA II, the best results were revealed from the material investigated from Zealand and central Lower Saxony, as here several separate analytical workshops could be determined. Already Laux assumed several workshops within the area of the Lüneburg group (Laux 1976: 33ff.).[11] However, in doing so, one should consider the contact range of such a workshop. As supposed by Jockenhövel

[11] One workshop is due to the dissemination of the spiral-decorated disc-headed pins around Uelzen (Laux 1976: 41), another probably from the upper Ilmenau (1976: 42), the Lüneburg-type disc-headed pins Laux assumes are produced in a workshop near Lüneburg (1976: 43). Concerning the workshop around Üelzen, Laux assumes a wide spectra of forms and the existence from the time period *Wardböhmen-Kolhagen* until *Deutsch-Evern* (1976: 45).

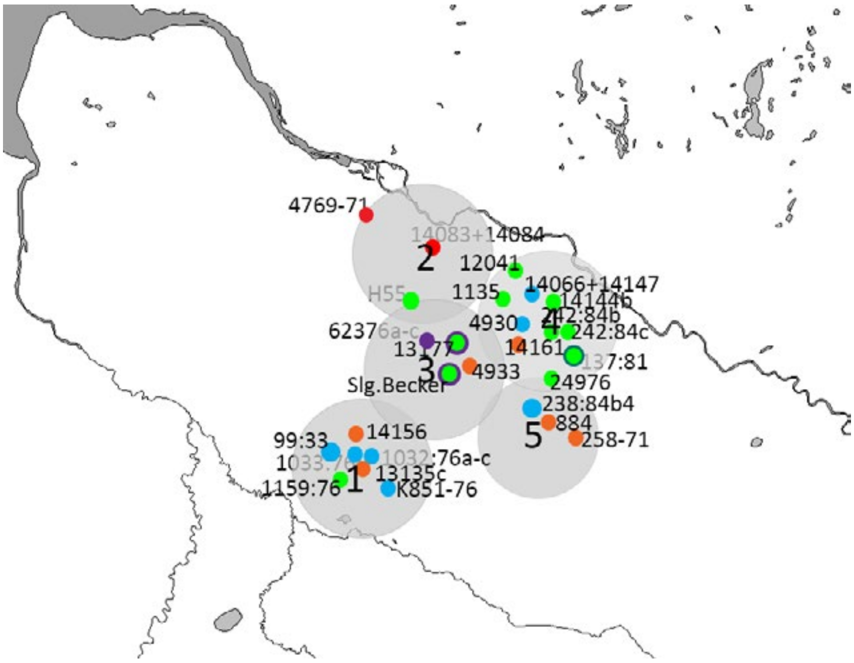


Figure 4.041: Analytical Workshop (AW)
AW 1: rod-like notches on triangle ribs in Bleckmar (K851-76), Westerweyhe (4930), Becklingen (1026:76); concentric ribbed discs in Becklingen (1032:76a-c); long deep rod-like notches in triangle ribs in Moorkate (99:33), Kolkhagen (ML238-84b4), Lüneburg (14066) and in Lüneburgischen (14147). AW 2: concentric ribbed discs in Raven (14083-14084); sloppy filled triangles in Appel (4769-4771). AW 3: arrow-like imprint in rib or ribbon in Amelinghausen (13177) and Ehlbeck (Slg. Becker); concentric ribbed discs in Toppenstedt (HH 62376a-c). AW 4: rib decoration with dot and triangle imprint in Amelinghausen (13177), Heitbrack (137:81), Hohenbünstorf (24976), Edendorf (14144b) and Wardböhmen (1159-76); spiral stamps in Hohenbünstorf (24976) and near Lüneburg (12041), as well as the same way of spiral construction in Heitbrack (137:81) and in Eyendorf (H55), the same tool used to apply the dotted lines in (Molzen ML 242:84b) and near Lüneburg (1135); precise filled triangles in Molzen (ML 242:84b-c). AW 5: rod-like rib notches in Becklingen (13135 a-c), Soltau (14156), Lutmissen (14161), Rehlingen (4933), Ripdorf (258-71) and Eitzen (884).

(1991: 60), a workshop might have produced goods for an area of 50 km in diameter, however, with the possibility to extend this area of influence of up to 250 km, similar to the range of mobility in intermarriage. However, since the latest strontium isotopic results, which could show the origin of the 'Egtved girl' in the German Alpine foothills (Frei 2015), our understanding of distances in Bronze Age is rewritten, and as such opens the possibility for much larger distribution areas than assumed. In contrast to the mobility of people, the region in which a specific workshop controls the dissemination of goods depends on the social structure. In an area where several groupings live in close contact to each other, the range of the associated workshop is less wide than in less populated areas. Additionally, the goods produced by attached specialists will be spread over wider distances than similar goods produced in local workshops, due to the embedded meaning of the artefacts – as for example links between elites of different regional groupings. Therefore artefacts that can be applied to one workshop as the 'smallest interaction group' might not only inform about their place of production but also about the social structure in the specific region due to their dissemination rate.

Thus, the investigation resulted in five identified analytical workshops in central Lower Saxony[12] that were in close contact to each other and occasionally had the same area of influence (MAP 37, 1-5). These were identified due to specific technical peculiarities, such as the stamped-spirals from Lüneburg (LMN 1204) and Hohenbünstorf (LMN 24976).

The analytical workshop to which the most artefacts can be assigned is placed in the Lüneburg region (AW 4) and contains artefacts of higher quality, displaying special techniques such as stamped-spirals (Figure 4.041). Here also the belt discs from Molzen were crafted, which are, in contrast to the discs from Appel, of much higher quality. Moreover, several artefacts made in this analytical workshop are decorated with hourglass-shaped notch decoration consisting of two dots, of which one is slightly more square (Figure 4.042). Due to the close geographical conditions, strong linkages are visible in the analytical workshops south of the Elbe. In this manner, artefacts assigned to an AW near Uelzen (AW 5) are spread over the presumable area of three others, and pieces crafted in an analytical workshop south of Soltau (AW 1) also appear in burials near the Elbe. Interestingly, artefacts from the AW 4 around Lüneburg are spread over nearly 130 km from the Elbe to the Aller. Moreover, the artefacts from this AW, found in the area of another analytical workshop which was probably located near Amelinghausen (AW 3), demonstrate the direct interaction between these workshops. Here, only a few pieces could be definitely assigned to AW 3, i.e. the ribbed discs from Toppenstedt (HH 62376a-c). The two above-mentioned neck collars from Amelinghausen (LMN 13177) and Ehlbeck (Slg. Becker), however, display, in addition to the hourglass notch decoration on the ribs (typical for AW 4), a

[12] Probably through further investigations the number of workshops will increase.

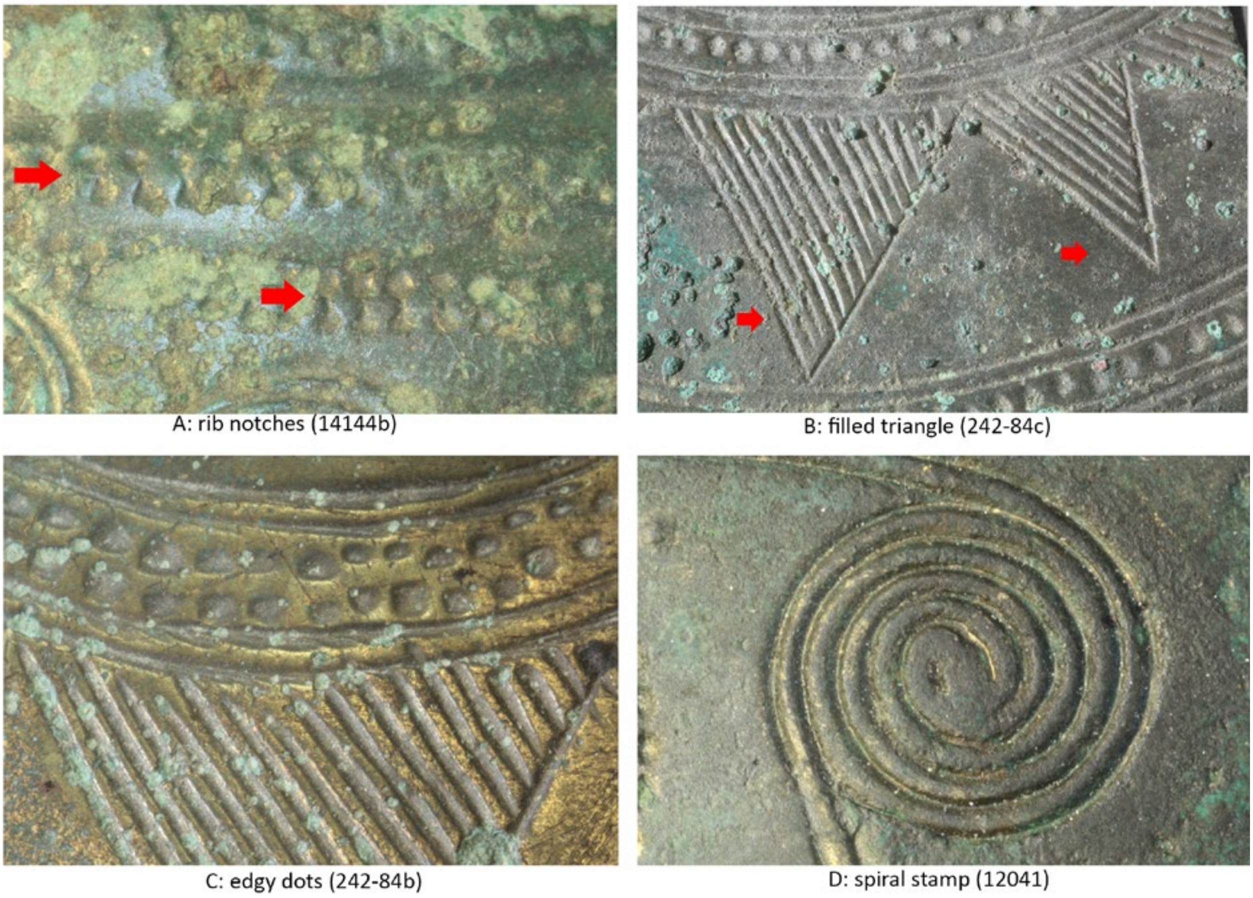


Figure 4.042: Characteristics of artefacts made within Analytical Workshop (AW) 4, situated south of the Elbe River in the Lüneburg region.

specific arrow-notch decoration, which only appears on three artefacts south of the Elbe, with the third item found in Molzen (ML 242:84e). It is likely that these two artefacts were crafted within AW 3 under the rules and style concepts applicable there, but, however, by a craftsperson related to AW 4.

In kinship-based social groupings, as they are expected to have been in the Bronze Age in this region (Laux 1997: 149; Jockenhövel 1991: 52ff.), a regular exchange of both goods and people is very likely (see Neipert 2006: 60; Sennett 2008: 53ff.). Thus, apprentices might have been sent out to widen their knowledge and work for a specific time in the neighbouring workshop.

In a similar way, these kinds of ornaments, knowledge, or tools might have travelled in the context of intermarriage.[13] The mobility of females within the Lüneburg Bronze Age (Jockenhövel 1991; Bergerbrant 2007: 79ff.) is the most probable explanation for the obvious mixing of the artefacts within this region.

Next to the area south of the Elbe, in Denmark several analytical workshops could also be detected (Figure 4.043). As the earlier examination in this study has shown, Zealand is especially rich in magnificently decorated bronzes and specific techniques (MAP 39). Perhaps due to its extraordinary artefacts, the situation on Zealand differs from south of the Elbe. It might be that here four analytical workshops are possible, of which most artefacts could be assigned to AW 10 on east Zealand and AW 8, near the Vognserup bog in north Zealand. The extraordinary hoard deposited there was probably crafted by one or two craftspeople in close contact, and the crafting traces suggest this to have been in a local workshop. A few more artefacts were made in the same analytical workshop, as seen on the identical spirals in Svenstrup (NM 10932) and Gerdrup (belt plate B11459). Moreover it is very likely, that the use of the U-shaped tool to rework or design the centres of the spirals on the artefacts in the Vognserup hoard, in Gerdrup (neck collar B11458), Svenstrup (NM 10933), Vellinge Mose (NM 25788 and B2654) and in Vorup (B6623b) was also a result of this analytical workshop (Figure 4.044) Also, in technical terms, this workshop was of special interest, as here eyelets of the dome-shaped tutuli were made of folded metal sheets (MAP 40).

[13] 'A far reaching network of kinship relations enables people to move easily to new areas because of the safety-net of kin' (Torbert 1988: 206).

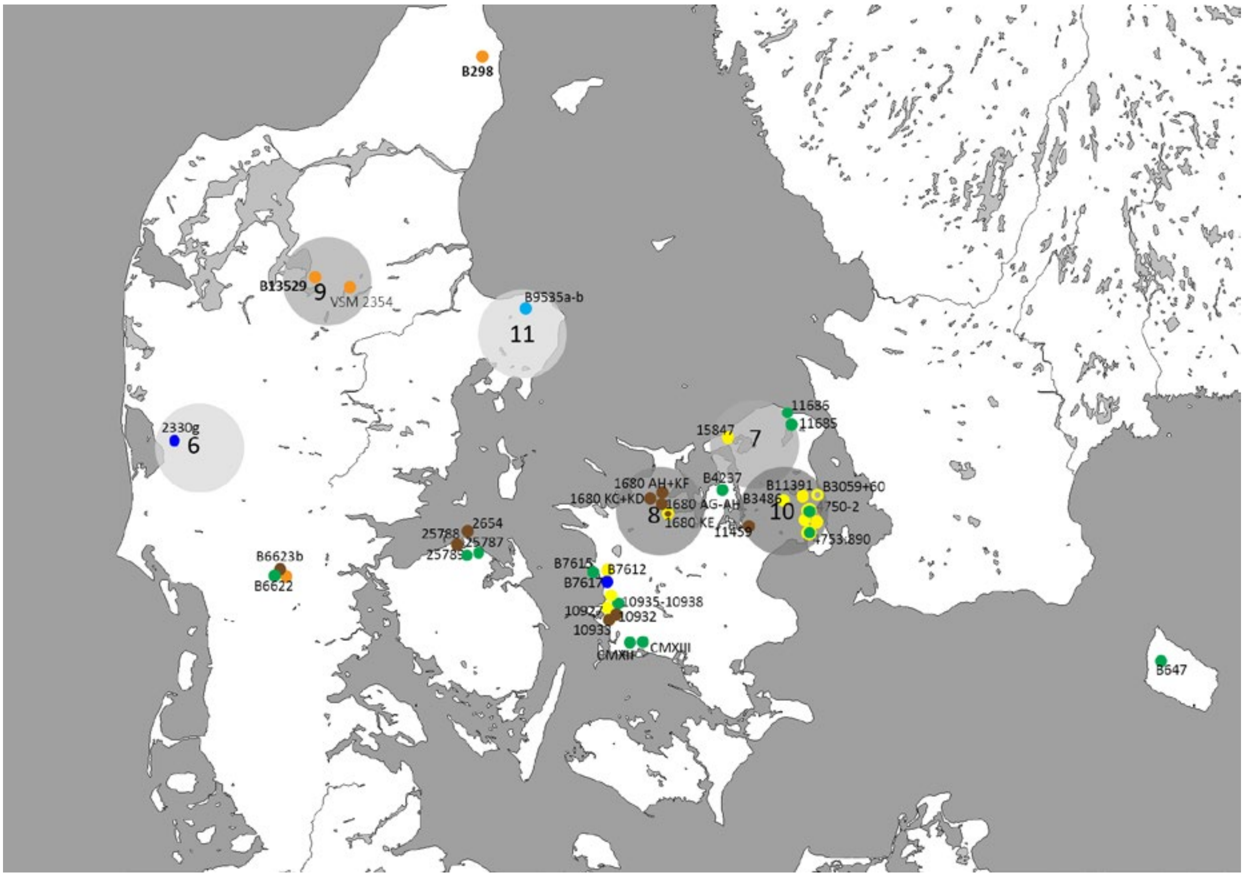
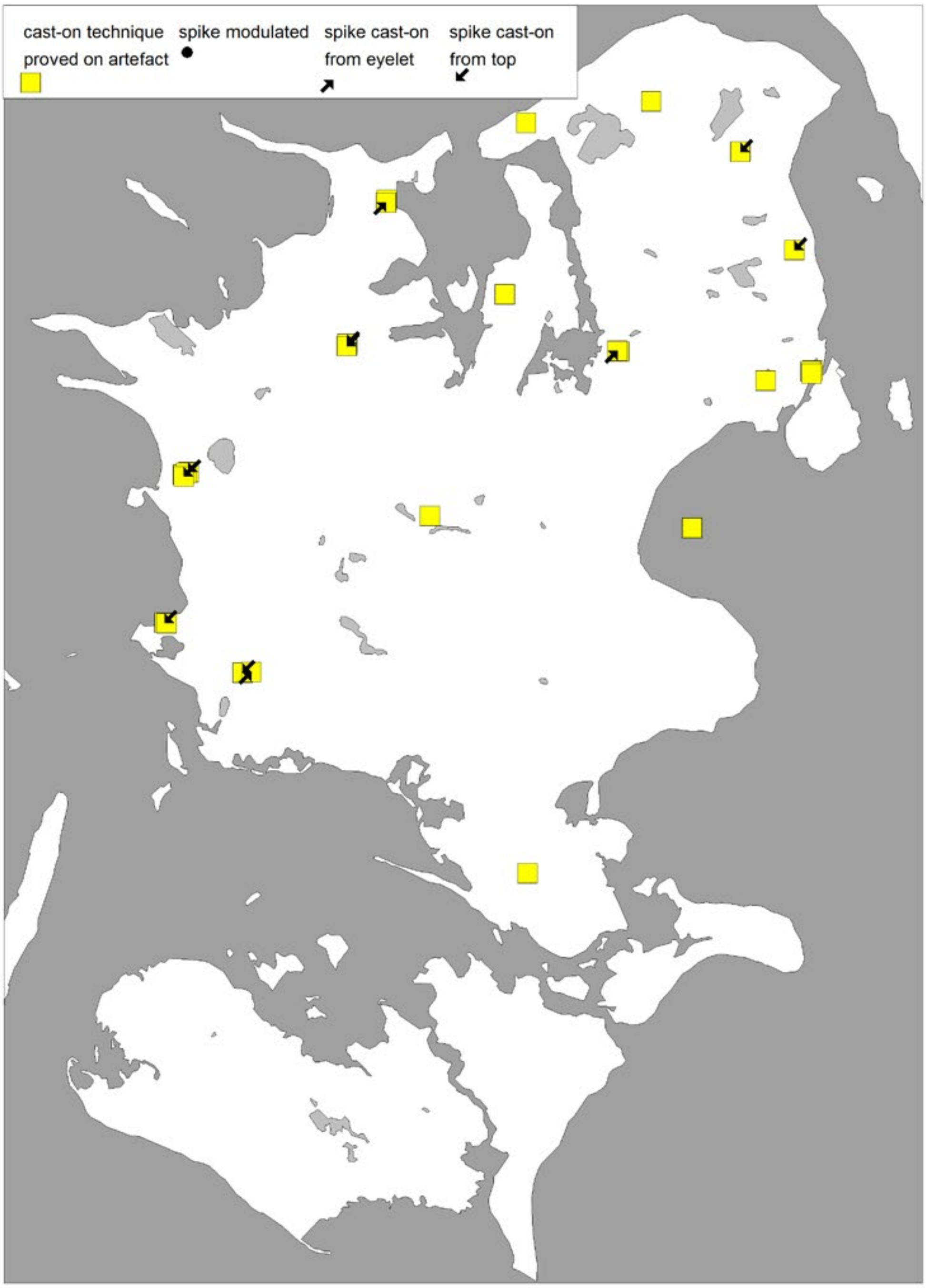


Figure 4.043: Analytical Workshop (AW)
AW 6: ox-hide shaped notches in Assing (2330g) and Rye (B7617). AW 7: the triangle imprints in Lavø (11686), Vellinge (25787+25789) and Vendsyssel (B4753:890); similar spiral stamps in Frankerup (CMXII), Rye (B7615), Annebjerg Skov (B997), Lavø (11685) and Lavø (11686); and bigger spiral stamps in Vorup (B6622), Krasmose (B647) and Frankerup (CMXIII); long slightly waisted notches (composed of triangles) on the collar from Vendsyssel (4750-2); Ferslev (B4237) and Vellinge (NM 25787); probably also the antler notches from Vendsyssel (B4750-2) and Sventrup (10935-10938). AW 8: similar triangle imprint on the belt discs from Vognserup (1680 KF+AH); same spiral stamp on Vognserup (1680 KC+KD), Svenstrup (10932) and in Gerdrup (11459); similar eyelet construction on the Vognserup discs (1680 AG, AH, AL); centre of spiral is made or reworked with U-shaped tool in Vognserup (1680KE), Gerdrup (B11458+11459), Svenstrup (10933), Vellinge Mose (25788 and B2654) and in Vorup (B6623b). AW 9: replication of at least three Krasmose-type neck collars, where the spiral decoration of the collar from Gjedsted (B13529), Sludstrup (B298) and Vammen (VSM 2354) is made with the same stamp. AW 10: rib-waves were found in Præstergårdsmark (15847), Bagsværd (B11391), Rye (B7612) and Vendsyssel (B4570-2, B4753:890), and slightly different waves in Vognserup (1680 KE); identical spirals were found in Svenstrup (10927) and Bringe (B3486); spiral pairs in Jægersborg (B3059, 3960). AW 11: shoe-shaped notches in Glæsborg (B9535).

Characteristic also of AW 10 in east Zealand are the rib-waves which occurred on several artefacts in this region and also, however, in the Rye and Vognserup hoards. Interestingly, rib-waves of another kind could also be detected on the neck collar (4570-2) and belt plate (B4573:890) from Vendsyssel, but these two items might have been crafted in another analytical workshop, as indicated by the distinct tool traces.

In such a closed society, due to the insular nature of Zealand, regular contact between the single communities is very likely and thus also an intensive mobility of artefacts. However, several artefacts reveal tool traces characteristic for a specific analytical workshop (the Vendsyssel collar and belt plate) with techniques typical of another. Here, additionally, the rib-waves on the collar from Vognserup (VM 1680 KF) need to be mentioned. This item was crafted together with a spiral-decorated plate and three smaller discs in the local analytical workshop, AW 8 (see Chapter 4.2.2). On the other hand, metal eyelets made of sheet metal were also used in east Zealand, in AW 10, however, on ribbed tutuli (Figure 4.043). In such a case, when characteristics of several workshops are mixed, the mobility of craftspeople within an exchange of knowledge can be expected, as the transmission of techniques is most effective in a face-to-face situation.

On Zealand is to be expected another large analytical workshop (AW 7); it is placed in northeast Zealand and



Map 39: Distribution of belt plates made using the cast-on technique. The direction in which the spike is cast-on is related to the detected analytical workshops on Zealand.

displays the widest distribution of artefacts (Figure 4.043). Here tool traces and the use of the same spiral-stamp suggest a distribution range from Vellinge on Fyn to the Frankerup hoard in southwest Zealand. Moreover, is it very likely also that the big spiral-decorated collars from Vorup and Krasmose were made in this analytical workshop. The high degree of similarity that can be traced between the spirals is striking (Figure 4.045). Moreover, the items decorated with the antler-like notches can be assigned to this AW. The above-mentioned collar and belt disc from Vendsyssel were decorated with a tool probably also used on a collar from Ferslev (B4237) and on the collar from Vellinge (NM 25787). Since here antler-notches occasionally occur, a direct connection to the Svenstrup hoard discs is also likely (Figure 4.043).

In Jutland the material only occasionally allowed the identification of analytical workshops, usually by the appearance of technical peculiarities on artefacts found

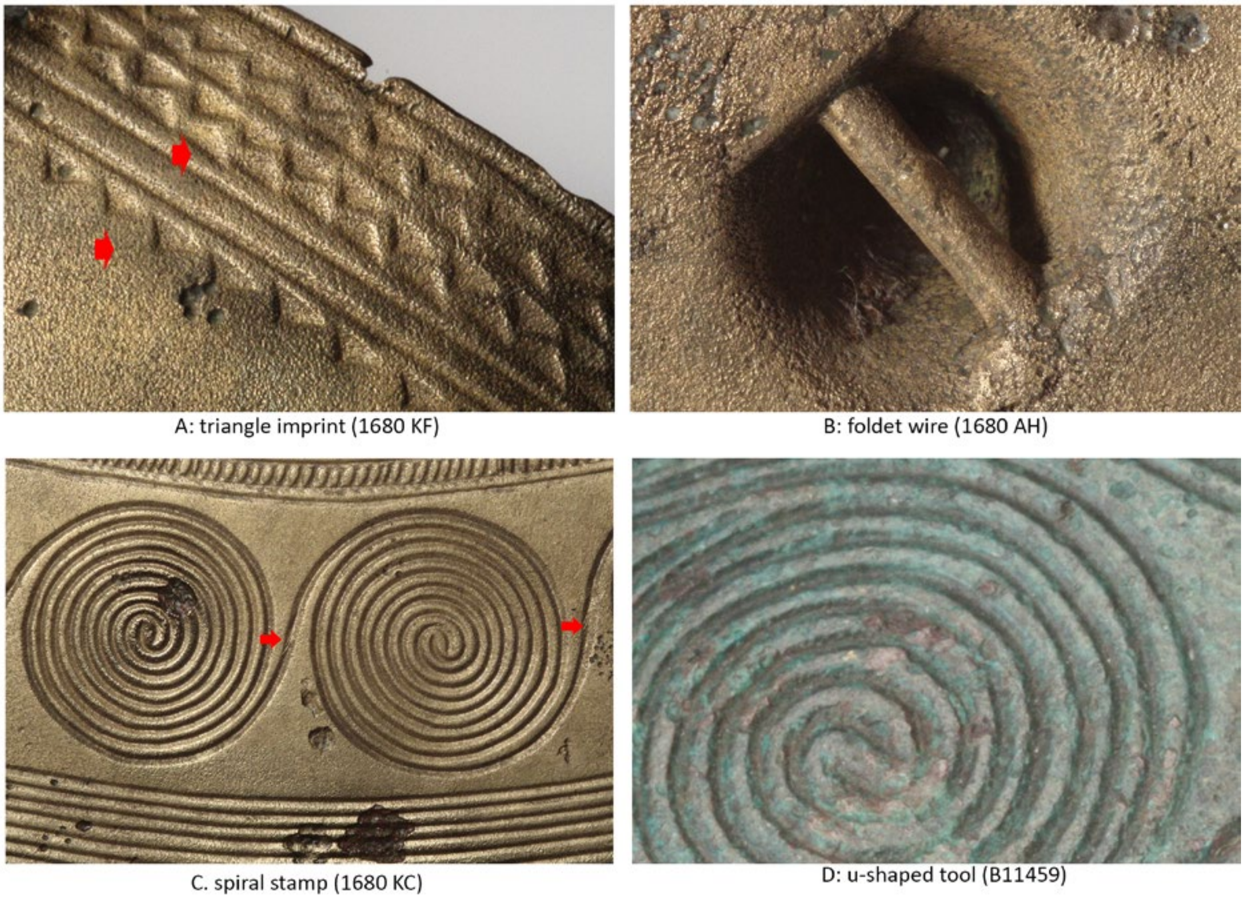


Figure 4.044: Characteristics of the artefacts allocated to Analytical Workshop (AW) 8, situated in north Zealand.

Map 40: The folding of sheet metal with the aim to use the wires as eyelets in tutuli can be traced to a single analytical workshops on Zealand.

Figure 4.045: Characteristics of the artefacts allocated to Analytical Workshop (AW) 7, probably situated in northeast Zealand.

in graves, as shown in Assing (FHM2330g). The ox-hide-shaped notches occur on one other item – the belt plate from the Rye hoard (B7617). Due to the hoard's mixed character it is very likely that a local analytical workshop (AW 6) existed near Assing producing goods highly influenced by the technological behaviour on Zealand. A similar situation can be suggested for the probable analytical workshop on Djursland (AW 11), where the shoe-shaped notch decoration of the Glæsborg discs was made. Even if in both places only one item can be assigned to the workshop, the uniqueness of this piece supports the theory of its local crafting. In northwest Jutland an analytical workshop (AW 9) is to be expected that was responsible for the crafting of at least three Krasmose-type straight spiral-decorated neck collars.

As shown in the previous chapter, the hoards (except Vognserup) display a collection of artefacts from a wide area. The assignment of the artefacts to the specific analytical workshops has shown that in three hoards (Svenstrup, Rye and Vendsyssel) artefacts appear from nearly all the located analytical workshops. In Vendsyssel some of the artefacts deposited show an interaction between these workshops. Moreover, pieces crafted on Jutland are also deposited in a hoard on the island.

In NBA III it can be expected that several analytical workshops in central Lower Saxony as well as on Zealand continued to operate. Within this study the volume of NBA III artefacts from Jutland and Zealand was not enough to point out whether the defined analytical workshop continued in existence (as might be expected for AW 8 in northwest Zealand) or if new centres occurred. Further studies should concentrate on this period. On Jutland, however, several results within this work also showed possible workshops in NBA III, such as on Djursland (east Jutland) and in central Jutland (see MAP 22).

In Mecklenburg several different analytical workshops stand out. In the area between Schwerin Lake and the Müritz five of them, with clearly defined technical characteristics were detected (MAP 38). Of these, AW 1 is probably situated between the Teterower, Kummerower and Malchiner Lake in northeast Mecklenburg. Here, the north German version of rib-waves originated (Figure 4.046). Another analytical workshop (AW 2) was probably around Krakower Lake in north Mecklenburg and was using one of the few spiral-stamps, as the neck collars from Weisin (ALM2199) and Karow (Br.178) show. West of Plau Lake a large number of artefacts could be identified to AW 3. Here, the artefacts decorated with fingernails

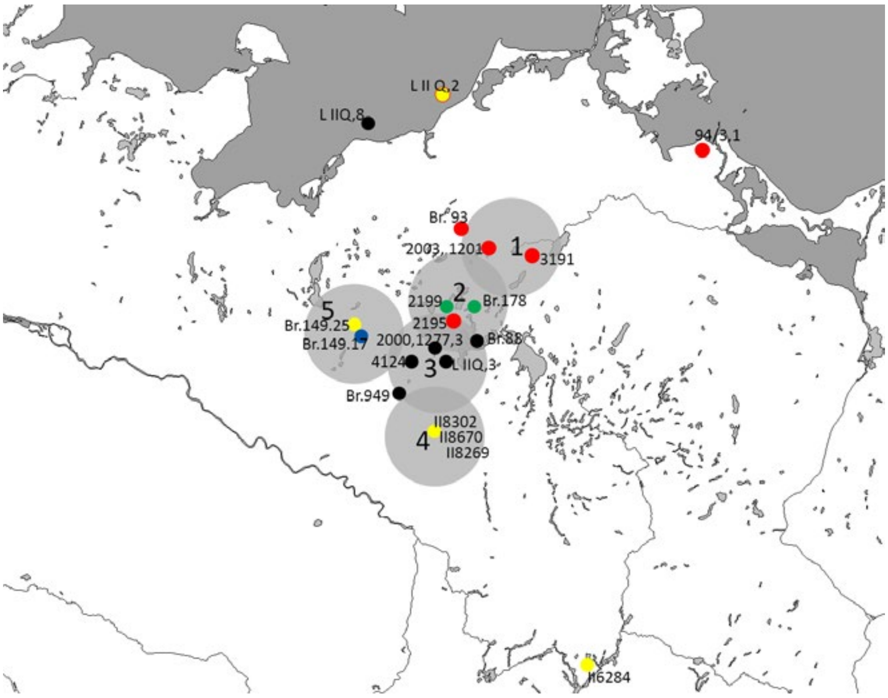


Figure 4.046: Analytical Workshop (AW)
AW 1: rib-waves as result of reparation in Lubmin (ALM 94/3, 1), Thürkow (ALM 2003,1201), Sarmstorf (ALM Br.93), Weisin (ALM 2195) and an unknown locality in Mecklenburg (ALM LIIQ, 2); long slightly tailored notches in Pisede (ALM 3191) and Thürkow (2003, 1201). AW 2: spiral stamp used in Weisin (ALM 2199) and Karow (Br.178). AW 3: spiral construction in Lübz (ALM 2000,1277,3), Karbow (ALM Br.88), Sparow (LIIQ,3), Wozinkel (ALM4124) and at an unknown locality (LIIQ,8); finger-nail imprint as arch ribbon in Lübz (ALM 200/1277, 3), Poltnitz (ALM Br. 949) and Sparow (ALM LIIZ1g1). AW 4: use of single spirals in Friedrichsruhe (ALM Br.149.25), Weitgendorf (MM II8269; 8670; 8302), in an unknown located grave (ALM LIIQ,2) and in Werder (MM II6284). AW 5: the use of a spiral stamp in Friedrichsruhe (ALM 149.17).

and several collars with a unique spiral construction (showing extensive fans in the centre) were crafted. South and west of this analytical workshop two smaller ones are very likely, as the collar from Friedrichruhe has no other expression (spiral-stamp) and might have been produced in a local analytical workshop (AW 5). A similar statement can be made for the single twisted spirals on the Weitgendorf collars (i.e. MM II 8302); the way in which they were made is only found on three other objects, spread over the entire lake district. It is very likely that all these pieces were made in one analytical workshop (AW 4), which was probably located near the Weitgendorf burial mounds. As two neck collars with unknown find locations can be assigned to AW 3 and AW 4, due to characteristic features, they might also have been found in the region. However, these five detected workshops might just be a small number of the actual analytical workshops in the area of the Mecklenburg group during NBA III.

When looking at the three areas where most analytical workshops could be defined – Zealand, the Lüneburg Heath and Mecklenburg – the mixing of artefacts is obvious. Mostly, this picture can be explained by the movement of persons or the exchange of goods. If, however, technical features of several workshops occur on an artefact, as already mentioned, then the mobility of the craftspeople should be considered. Such a type of mobility is limited to a specific area and usually takes place within the social network. Ethnography offers many parallels to such kinds of restricted mobility of craftspeople, as, for example, seen within the Toumra smith, a craft group where assignment to this group is fixed by birth. Here, marriage happens within this group, which is spread over a wide distance in the savannah in eastern Africa (Neipert 2006: 60-61; Haaland 1985). Thus an extensive exchange of ideas is secured through marriage and the possibility of sending the developing smith out to gain more knowledge within this craft group.

This thought leads to the question of who influences the production within a workshop. Regardless of the nature of the workshop (if family-ruled or attached craft) the influence on the craftsperson is similar (Figure 4.047). The society sets the technological and stylistic parameters which might already differ from workshop to workshop due to the social unit they are embedded in. In the present case, however, especially in central Lower Saxony, on Zealand and in Mecklenburg it could be shown that the defined analytical workshops were part of workshop circles which shared a specific technological repertoire (see Figure 4.007). Moreover, the customer also has an influence on the workshop that should not be underestimated (Roux *et al.* 1995: 66; Behura 1964: 123). As Bauer (2008: 91) states: 'Both sides, that of "producer" and "consumer", play a role in the interaction and thus in the development of the material culture operating within it... Market demand actively shapes the kind of material that is produced in the first place.'

However, the discussed influence requires a workshop structure, where craft is executed as a profession.

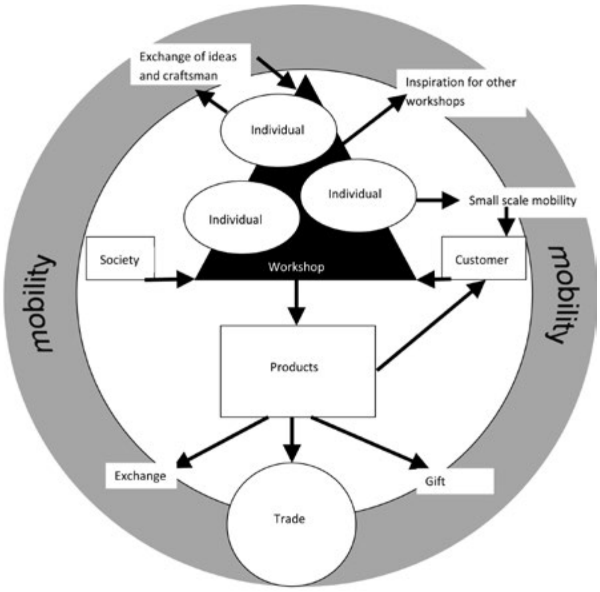


Figure 4.047: This general scheme shows different aspects of mobility in craftsmanship. The workshop was subject to various influences, such as those of the society, of other workshops and, particularly, of its customers. The goods produced can go directly to the customer, or they can be produced for the market, as gifts or as exchange objects. Craftspeople within the workshop have an influence on the products due to the habitus of the workshop as well as their use.

Such structure is highly assumable as around 65% of the investigated material is made by craftspeople with above average knowledge in terms of the processed material (see Chapter 4.2).

To satisfy the needs of the 'consumer', development is necessary (see Miller 1985: 186) and thus inspiration is needed. Such inspiration might come through an exchange of craftspeople in kin-based groups (Figure 4.047).[14]

Artefacts displaying characteristics of several workshops are the above-mentioned neck collars from Amelinghausen (LMN 1377) and Ehlbeck (Becker Collection) in Lower Saxony. They are decorated with the specific hourglass-shaped notches with a round and square impression known from AW 4, and the characteristic arrow-notches of AW 3. Furthermore the rib-waves on the Vendsyssel disc (B4750-2, B4753:890) and the Vognserup collar (VM1680 KE) are an element used in AW 10. However the artefacts originate, in terms of the spiral-decoration and the tool used to impress the notches, from AW 8 and AW 7.

Besides the regional contacts between craftspeople that are traceable in the material, contacts between the regions could also be traced that are not explainable by kinship. Such forms of knowledge exchange might have occurred between north Germany and Zealand, as supported by several artefacts. The belt disc from Vendsyssel (B4753-1) displays a distinct way in which the humps were applied in the wax model and reworked post-casting. A very similar pattern can be observed on the Hollenstedt collar from Lüneburg (ML 1135). Here it seems more likely that the large hump as well as the small one were added post-casting. However, the similarity is striking, especially when compared to the variety of possibilities in which humps can be applied to the ornaments (Figure 4.048). Additionally, the spiral of the disc-headed pin from Heitbrack is in such a way similar to the spirals made in the analytical workshop AW 7 on Zealand that it indicates that here too direct contact might have been possible.

Another case is that of the Krasmose-type collar crafted on northeast Zealand and spread from Jutland to Bornholm (see Nørgaard 2011: 80-83; Nørgaard 2014).[15] The main dissemination area of this collar type appears to be in Jutland. Seven collars were recovered from archaeological sites on the mainland in depositions and burials which were dated to NBA II (Aner and Kersten 1977) due to the objects which accompanied them. However, on Bornholm several further collars appear with a very similar design and the addition of local elements (Figure 4.049). Of special interest is the chronological context in which the Bornholm pieces were discovered, which was different from those in Jutland. In the Krasmose hoard, a metal vessel was found next to bracelets, fibulae and sickles dating from NBA III. With regards to this information and the questionable date of the burial at Jomfrugård (NBA II using undecorated spiral rings), the Bornholm neck collars are to be placed in the late NBA II to III. It was shown that at least two of the seven comparable collars were crafted in a workshop in northeast Zealand. Due to their extraordinary size and the elaborated decoration, these items were very likely used to display the owner's social status and/or connection to a specific group. Two other collars, the one in Sludstrup (B298) and the one in Gjedsted (B13259) on Jutland, were also made with probably the same stamp and technique (Figure 4.050) in a local workshop. Additionally, these collars show double-twisted spirals next to the common spiral. A third collar, the ornament from Vammen (VSM 2354), is to be expected to be part of this group.

[14] 'The introduction of new forms involves people who already are familiar with the new forms...' (Sofaer and Sørensen 2009: 2).

[15] Krasmose-type collars are classified as smooth neck collars. Their decoration is built out of a double spiral row framed by head- and triangle-ornaments. Between the two related spiral rows is an undecorated space. Like the spiral rows, it is framed by triangle-, line-, and head-ornaments. The endpoints of the open space frame point in the direction of the spirals. The final design of the spirals and the ornament combinations on the end-plates vary from piece to piece. A total of eleven collars of this type were collected, with distribution limited to Scandinavia during NBA II and III.

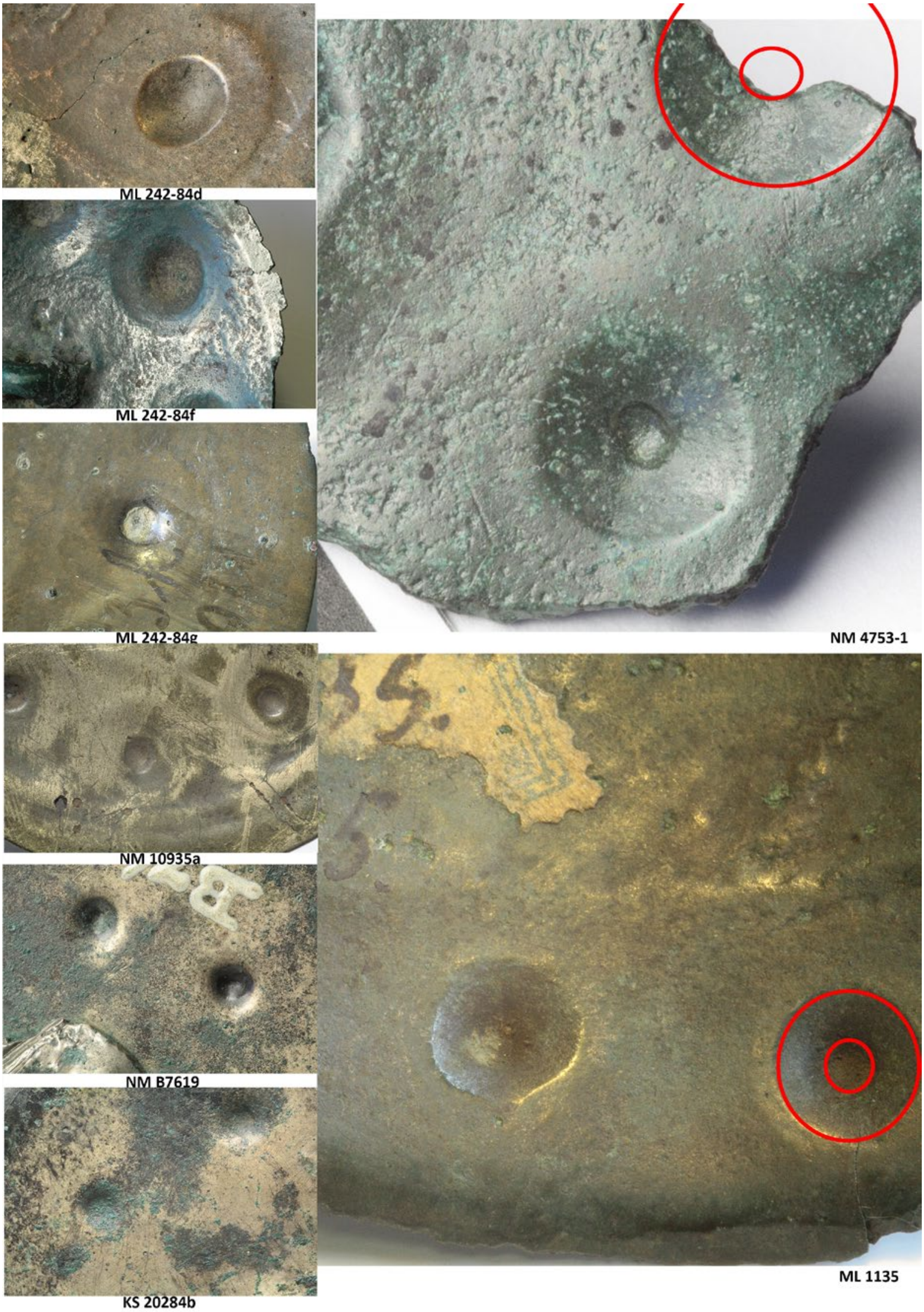


Figure 4.048: The similarity in the way the humps were applied between the belt disc from Vendsyssel (NM B4753-1) and the neck collar from Lüneburg (ML 1135) is obvious, especially compared to the various techniques observed.

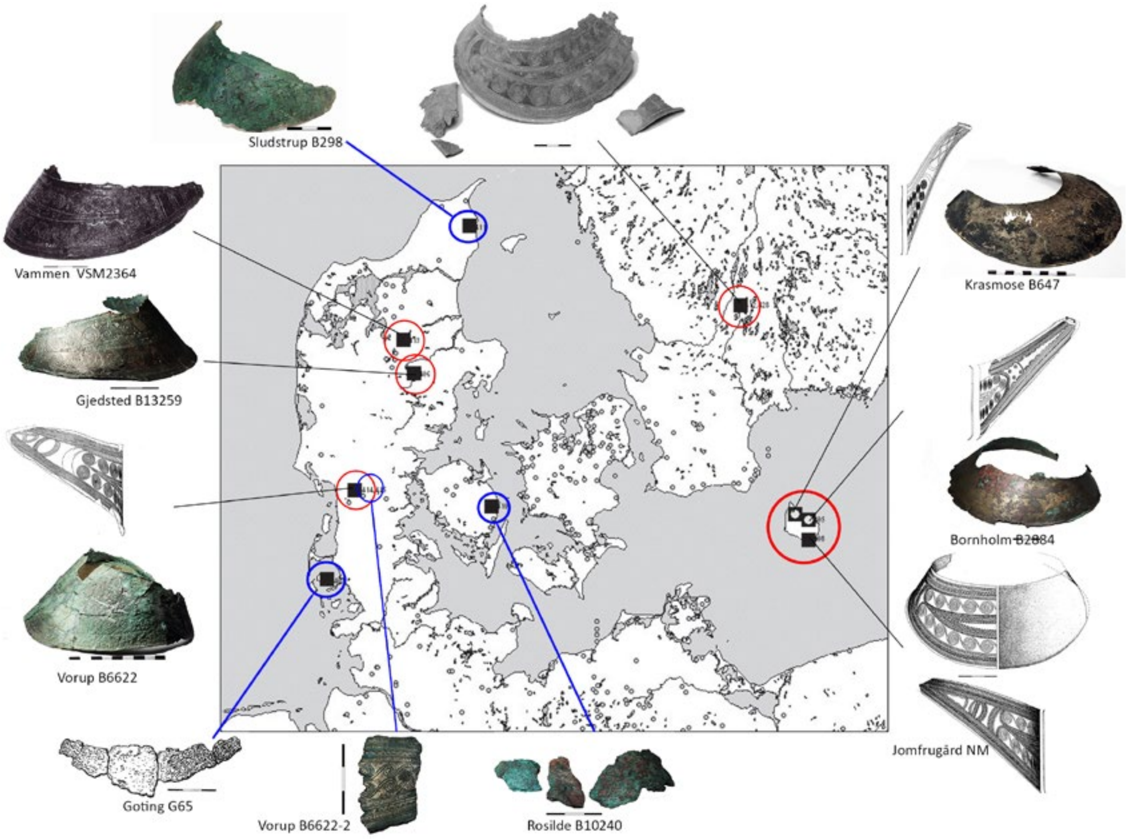


Figure 4.049: Distribution of Krasmose-type neck collar (after Nørgaard 2011). The collars related due to their crafting traces are highlighted (blue and red). Of interest is the extended distribution of the large collars (red), with several examples on Borholm.

Figure 4.050: Spirals on the collar from Sludstrup (B298) and Gjedsted (B13259) on Jutland, were probably made with the same stamp and technique.

Figure 4.051: Technical differences between collar from Vorup (NM B6622) and the collar from Gjedsted (NM B13259) are clearly visible. However they are of the same typological group.

Especially based on these two groups the importance of this artefact as a status symbol can be identified. One of the major motives for imitation is the 'social meaning of objects that reflects identify', and while imitating the 'form or raw material has been altered to make the object conform to new working or decorative contexts' (Choyke 2008: 12). Clearly the different amount of skill is visible, as well as the deviating techniques in the spiral production and the altered decoration between these two collar groups (Figure 4.051). However, without doubt they should be seen as part of one typological group.

However, why should a local workshop in north Jutland copy an artefact with status symbol associations crafted on the Danish islands?

The Vorup (B6622) collar originates on Zealand and can be regarded as an import. It was probably deposited on Jutland in the extension of the east-west contact axis between Zealand and the mainland.[16] The second collar found in this burial mound is of the same type, but very different in its appearance. This piece very likely aims to imitate the elaborated collar in its overall morphology and is crafted in a similar way as the Krasmose-type collars from the workshop in north Jutland. That this artefact might be the first imitation as a direct contact of the imported ornament is obvious. Therefore, it might be that in order to emphasise the connection to the collar wearer, other collars were made in the local workshops (see Figure 4.049) where the decorative elements of the local group were incorporated (Nørgaard 2014: 46).

Another collar, crafted in the workshop in northeast Zealand, should also be seen as an import. The collar found in the Krasmose hoard was probably a gift from Zealand added to the hoard, possibly as a sign of alliance. It seems, however, that in this case more than just the artefact was transferred, as two further neck collars of very similar design were also found on Bornholm. They should not be considered as imitations of the Krasmose collar, in the sense that the Jutland ornaments are considered imitations. The technical similarity is such that a direct transfer of knowledge should be inferred. The face-to-face interaction between the craftsman behind the Krasmose piece and the one making the collar from Bornholm (B2884) would explain the opposite turning direction of the spirals, as an unknown method (stamping spirals?) could have been taught and mirrored while imitating, and the result would be a mirrored spiral-decoration. Thus, the dissemination of the Krasmose-type neck collars might show the mobility of highly skilled craftspeople, which will be discussed in the final part of this chapter.

To distinguish between the inspirations to new techniques by imported goods, the imitation of such techniques, or the actual movement of the craftsperson, one should know the characteristics of every category.

An import of artefacts produced within the Nordic circle to another regional group is visible within the whole Nordic Bronze Age. Such can be seen in the Lüneburg costumes which were buried far from their places of origin, such as in Flintbeck in Schleswig-Holstein and in Smidstrup Hovgård, Praesto Amt (Bergerbrant 2007: 119). Here, the foreign artefacts travelled with the women as part of their costume.

Also, the investigated material revealed artefacts whose appearance and technical background can be defined as foreign, such as the neck collar from Bülkau near Hadeln in central Lower Saxony. Neither the shape of the collar (no hem), nor the technical design (cold-worked not cast), nor the alloy (only 5% tin) are common in this area. Thus, the collar from Bülkau should be named an import, as only the artefact itself was transferred to the Lüneburg Heath, and the technique with which it was crafted is obviously foreign in this region (see Biehl 2008: 107; Kristiansen and Larsson 2005: 18; Phillips 2005: 39). One important aspect of clearly imported goods is the communication system necessary for the exchange of goods and people (Biehl 2008: 106). Knowing through foreign artefacts that a contact between the large metal centres in NBA II (and apparently also in NBA III) existed, then there might be a possibility that direct contact also existed between the craftspeople.

A first proof of this intensive contact would be the imitation of the foreign artefacts or foreign techniques, as imitation is always the result of communication (see Biehl 2008: 108; Choyke 2008: 10ff.; Hodder 2006), or in other words: ‘An imitation speaks perhaps even more strongly than an import about the local significance of foreign prestige goods, and so does the application of foreign technological skills as they represent foreign knowledge’ (Kristiansen and Larsson 2005: 18).

Characteristic for imitations is, however, that only ‘part of the message is transferred’ (Choyke 2008: 6). In regard to technical aspects this will result in the copying of the morphological appearance of the artefact without using the original technique. Such behaviour could be documented several times within the material, as the repair of collars with the help of staples in the Lüneburg Heath demonstrates. On Zealand several neck collars and belt discs are repaired using horizontal staples (see MAP 23), in Lower Saxony a similar method is used but with vertical staples. The result is as effective as that on the island; however, the artefacts which are repaired with vertical staples were less skilfully made than, for example, the neck collar from Ferslev (B4237) on Zealand. These items are of interest as such a method is not used on the Danish mainland or in northeast Germany.

Another example is given with the way in which the hump decoration was applied to the ornaments. It is very likely that such a decorative element originates in the Únětician culture (Sprockhoff 1940: 29), and its application with metal toolsto the cast artefact seemed to have been the intended manner of crafting. This

[16] The find context of the Vorup artefacts is not secured as they were found while digging in a burial mound by two labourers. Aner and Kersten suggest a burial or hoard (Aner and Kersten 1986: Nr.3995) and the ornaments – two neck collars, two belt discs – make a hoard, as well as two separate burials, possible.

tradition was continued within the Lüneburg Bronze Age. The hump decoration on Scandinavian artefacts (only a few pieces are decorated with humps) is, however, applied in the wax model with tools of organic material. This major difference in crafting is explainable through the imitation of this foreign decorative element with local techniques, resulting in an innovative 'way of doing'. Interestingly, the same method was used on the Hollenstedt collar from Lüneburg (ML 1135), as mentioned above (see Figure 4.048). In contrast to the transfer of the decorative hump element to Zealand, where it was converted with local techniques into a local design, the crafting of the Lüneburg collar needed face-to-face transmission of the 'new' technique.

The material provides us with further examples where the morphology of artefacts was copied using different techniques, such as the different methods to create rib-valleys to achieve the ribbed shape of several collar-types, or the adoption of triangle rib-valleys as a major element in Mecklenburg during NBA II, without using the comb technique to make the ribs (no horizontal ridges in the valleys, MAP 17), and the variation of the cast-on technique in central Lower Saxony, where the spike was modulated on the cast disc, to name only a few.

Anderson (1999) wrote that: 'Craft is often implied to be a specialized activity assumed to take place at a workshop and performed by experts who mainly apply tacit knowledge to their work and who use a certain range of well-developed techniques and specific tools.' The previous chapter could show that this widespread opinion is only part of the truth. It was clearly shown that NBA metalcraft ranges from expert to novice work, and also artefacts exist that were made as a result of domestic skills. Several workshops were determined, and, especially on Zealand and in the Lüneburg Heath, several workshops were in close contact during NBA II as well as in NBA III in Mecklenburg. Detected differences between the defined analytical workshops suggest a divergent organisation, as the distribution range of artefacts, the labour input, and probably also their market demands vary from workshop to workshop. One might say that imported goods might have been the leading motive for developing the local metalwork. In many cases this happened through imitation, in other cases face-to-face contact was necessary.

Thus, the question must be asked: why these differences? Can we, with the knowledge we have, pinpoint the kind of workshop which occurred in the specific region? Does the type of workshop influence or restrict mobility of craftspeople? Is our knowledge of professional work, the kind of apprenticeship that took place, and the dissemination area of the single workshops enough information to really say something about the organisation of metalcraft in the Nordic Bronze Age?

Chapter 4

The organisation of craft in the Nordic Bronze Age

The overall combination of regional patterns, individual traces and theoretical models concerning the organisation of craftsmanship allow a concluding statement regarding how metalwork might have been organised during NBA II and III in Scandinavia and northern Germany.

Craft in prehistory was organised in various categories, which include domestic activities producing goods for internal use as well as for a more extended market, specialised craft, and attached craft. Furthermore, craft organisation is closely related to social complexity, and the appearance of workshops itself can be seen as an indication for specialised craft. Within this chapter, three possible forms of craft organisation are compared: the so-called communities of practice; family-based workshops and attached craft; these are then aligned with the results of this study. Signs of attached craft are an accumulation of high-quality craft with a high amount of labour input and a secured raw-material supply, under a governing institution, and are only occasionally detectable, such as in the analytical workshop in northeast Zealand. More often, workshops appear with all skill levels present and with clear signs of cross-craft activities, the so-called 'communities of practice'. They appear throughout the area of interest in every region, in between kinship-organised workshops. The latter are strongly connected to a small social unit and the individuals are very likely working only part-time as metalworkers.

In the small- to medium-sized chiefdoms of Bronze Age society in northern Europe, the importance of kinship within the established networks is visible in the material culture. At present there are but a few known instances in which itinerant smiths travel free of social bonds, despite the much-discussed theory proposed by Childe. On the contrary, ethnographic examples of metalworkers who move for their profession demonstrate tight social connections, including socio-economic duties towards the social unit to which they are connected. Knowing that extraordinary handicrafts had the power to strengthen alliances between social groups, due to the fact that they were exchanged as part of a gift exchange system, it is only a small step towards the idea that not just the artefacts but also the craftspeople themselves were exchanged. This chapter introduces the model of 'reciprocative craft mobility', in which specialists were exchanged for prestige objects.

4.4.0 About imports, imitation, mobility, and the organisation of craft

Through the research in this study, knowledge concerning the individual behind the bronze ornaments under investigation has developed further. Several distinct traces were found which made it possible to identify the individual craftsman. Even further, especially on Zealand, within the Lüneburg Heath and in Mecklenburg, several individual features were connected, and as a result eleven workshops could be determined in NBA II and five more workshops are highly probable within the Mecklenburg region during NBA III.

Thus, workshops, as well as their areas of influence, are known, and this leads to the question as to whether any of this information changes the perception of craft organisation during the Bronze Age. Several attempts to answer this have been made in past research, concerning specific forms of craft organisation – for example the characterisation of attached specialists or mobile craftspeople.

Based on the various approaches it can be summarised that craft in prehistory was organised in various categories, including domestic activities producing goods for internal use, as well as for a more extended market, specialised craft, and attached craft (i.e. Schlesier 1981: 13; Santley and Arnold 1986: 2-4; Olausson 1993: 1-3; 1997: 269; Zagal-Mach 2008: 190; Costin 1995). Concerning metalcraft in northern Europe, the distinction between highly skilled craft and 'average' craft, comparable with extended domestic activities, seems to be clear (i.e. Vandkilde 1996: 265; Gilman *et al.* 1981: 4; Willroth 1997: 140; Levy 1991: 70; Rønne 1993: 91). It is especially in this category of 'average' skilled crafts where occasionally the mobility of craftspeople has been emphasised (Pedersen 1987; Eriksen 2007; Vandkilde 1996: 265).

To discuss the organisation of metalcraft in regard to the results of the present study the social structure in which the craft was executed is of great importance, as craft organisation is closely related to social complexity (Olausson 1993: 3).

Bronze Age society in northern Europe is seen today as the accumulation of small- to medium-sized chiefdoms, in the sense of the term used by neo-evolutionists and structural Marxists, where inter-chiefdom alliances and the exchange of prestige goods played an important role (Jensen 1982: 169; 2002: 220; Kristiansen 1982; 1984; 1987; 1991; 1998a; Randsborg 1974: 60; Kristiansen and Larsson 2005; Artursson 2010). This model has had widespread acceptance, however, occasionally the importance of kinship within this network is also emphasised (Vandkilde 1996: 261; Rowlands 1980: 18). Nonetheless, criticism has also been expressed, particularly in view of the absence of central places and the lack of social differentiation within the Early Bronze Age burial mounds; these barrows might have been monuments constructed by several social groups (Johansen *et al.* 2004: 51-52; Thrane 1984: 152).

It is likely 'that a social order based on social inequality existed' (Vandkilde 1996: 260; see also Gronenborn 2010: 245), and the comparative analysis of the archaeological material across periods may help determine central places or centres of 'wealth' (Hansen 2013: 182ff.). Undoubted, however, is the importance of interaction between the small social units and the establishment of wide-ranging networks.

Some characteristics in material culture can be related to specific forms of craft organisation (Olausson 1997: 272); the very appearance of workshops can be seen as an indication for specialised craft (in terms of the skills involved) and production for larger regional markets. Furthermore, as Olausson (1993: 3) writes: 'Items produced at the household level should involve short manufacturing time, little skill, high error frequency but a low degree of standardization ... to identify attached craft specialization by its products: an item which is non-utilitarian, infrequently occurring, and showing skill of workmanship ... products of independent craft specialization should be: utilitarian, standardized, numerous, and not decorated or elaborate.'

An investigation of the material culture should thus be comparable to the assumed social structures, whilst on the other hand special patterns in the material culture that point towards a specialisation of craft on several levels, a form of attached craft and itinerancy, can be used to support an argument for social stratification in the Nordic Bronze Age (see Olausson 1993; Costin 1991; 1995; D´Azvedo 1973).

Therefore, a far more complex structure of metalcraft should be expected in the area of investigation, as has already been suggested by the use of ethnographic parallels (i.e. Costin 2000: 361).

4.4.1 Metalcraft: more complex than previously thought?

Throughout this study the differences between the individual regions have become clear. A question that remains is why these differences appeared, and if this might be related to the way in which metalcraft was organised within the different regions. The defined analytical workshops themselves suggest that a range of metalwork activities took place on a 'professional' level, next to those activities that can be seen as metalworking for personal or local supply. Artefacts such as those under investigation in this study are closely related to social elites, as they demonstrate a specific status, wealth and social power (see Chapter 1). Thus, they were less likely produced in the sphere of domestic activities, which might be inferred for the production of tools or more simple weapons and ornaments.

However, as a skill-related examination could show, also within these artefacts a classification from less skilled work up to highly skilled work, with labour inputs that in some cases pointed towards full-time craftsmen, were documented (see Chapter 4.2).

This leads to the inference that beyond 'professional' metalcraft a kind of highly specialised craft was performed commonly by highly skilled craftspeople. That such kinds of labour-intensive craft should be in a form of dependency ratio to a social elite seems logical: 'Professionalism...is achieved only by those who appeal to a wider area of demand than that of the local community, or by those who are supported as clients by wealthy patrons. Thus itinerancy and patronage are requirements of any full-time specialisation which does not carry the traditional credentials of local sponsorship' (D´Azvedo 1973: 135).

While investigating mistakes in crafting, a deviating picture concerning solely novice work and the participation of unskilled workers occurred, and pointed towards regionally specific behaviours. Here, also, mistakes clearly connected to professional labour were detected. These kinds of mistakes were related to a lack of concentration on the part of the highly skilled craftsperson during routine work and due to haste (see, e.g., Crown 2001: 452; Hagstrum 1985; Wendrich 1999: 391-393; Miller 2012: 228). In a similar way as the appearance of very skillfully crafted artefacts points towards professional work, the mistakes due to haste by skilled craftspeople suggest professional workshops where several people were involved in producing goods for an extended market.

Several researchers support the idea of such 'attached craft' in the NBA, as a direct link between social influence and high-quality craftsmanship seems to appear (Rowlands 1971; Kristiansen 1987; Kristiansen and Larsson 2005; Costin 1995: 621; Olausson 1997; Vandkilde 1996; 2007: 98).[17] Conversely, Costin (2000: 393) underlines 'that using attached–independent as a dichotomous variable is far too simplistic'. As she mentions, the ethnographic examples show elite involvement in craft activities in situations were no dependency ratio seems to exist (see Costin 1991; Neupert 2000).

However, the appearance of artefacts made with the active participation of novices is rather atypical for professional workshops with a secured raw-material

[17] However, the degree to which archaeological material – especially prestige weapons and ornaments – is connected to social elites is still a matter of debate (Primas 2008; Kienlin 2007: Levy 1991).

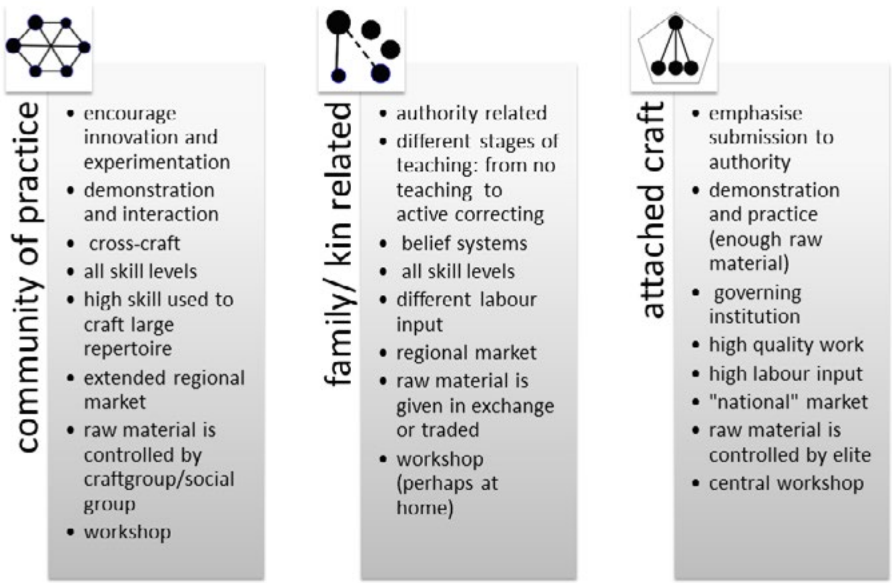


Figure 4.052: Comparison of the characteristics of three possible forms of craft organisation: the so-called communities of practice, family-based workshops, and attached craft.

supply, as is inferred in workshops attached to a governing institution. Under such conditions, novice work will be seldom kept and rather be destroyed. Such behaviour is expected in craft communities with a restricted raw material supply. In a strictly authority-regulated community (such as families), clearly novice work seldom occurs, as novices learn through participation within crafting (see Chapter 3.4).

Another interesting feature detected concerning the structure of the workshops is that the artefacts that could be assigned to a workshop clearly demonstrated interaction between workshops, and, especially on Zealand and in central Lower Saxony, the exchange of techniques.

All these features indicate a complex organisation of metalcraft already with the beginning of NBA II and the formation of the distinct style of the NBA. In Figure 4.052 the characteristics of three possible forms of craft organisation are compared: the so-called communities of practice; family-based workshops; and attached craft.

Characteristic for attached craft is an accumulation of high-quality craft with a high amount of labour input and a secured raw-material supply under a governing institution (see for example Brumfiel and Earle 1987: 5; Costin 1995: 621; Zaccagnini 1983). Such circumstances allow the production of elaborated artefacts, which, on the other hand, are used within an extended exchange network (see Rowlands 1971: 219) as a tool to display power, and probably as a political strategy for the legitimatisation of political authority (Earle 1987: 89; Peregrine 1991: 1-8). Thus, artefacts crafted by attached specialists should represent high levels of skill commonly combined with a high labour input (see, e.g., Costin 1995: 635) and scattered distribution over a wide area. Within the present study only the artefacts produced in analytical workshop AW7 on northeast Zealand showed such properties (see Figure 4.043). Additionally, this workshop showed fewer artefacts made by less skilled or unskilled people (apprentices), and the majority of the objects fall within the group of perfectly crafted artefacts (Figure 4.053). As a conclusion, in northeast Zealand (the location is defined through an accumulation of burials with workshop-related artefacts) there might have been a specialised workshop (Figure 4.054) for metalwork which was producing for elite patrons, probably as full-time artisans, or in Costin´s categories a so-called 'retainer workshop' (Costin 1995: 621). Supporting this conclusion is the far-reaching distribution area, with artefacts placed in the major hoards of NBA II and along the major trading routes (the east-west axis of Denmark-Sweden).

Analytical workshop AW8, with a similarly high frequency of artefacts which were elaborately-crafted objects (see Figure 4.053), is placed in northwest Zealand, however, several features point towards a differently organised structure. Several artefacts in this region show signs of haste in combination with artefacts clearly made by apprentices or with the help of individuals with lower levels of skill (see Chapter 3.4). Here all skill levels seem to be present and the time invested in making is also, at high skill levels, seldom as great as in the previously discussed workshop. Such features are characteristic for so-called 'communities of practice'. A community of practice may be composed of an ethnic group as well as several family-organised craftsmen groups executing their craft at a central place, often with several different crafts represented. Thus cross-craft interaction, knowledge exchange, and the involvement of apprentices is representative for a community of practice (Wendrich 2012: 5-11; Crown 2001: 451; Minar 2001: 392-393; Wenger 1998: 45; Cooney

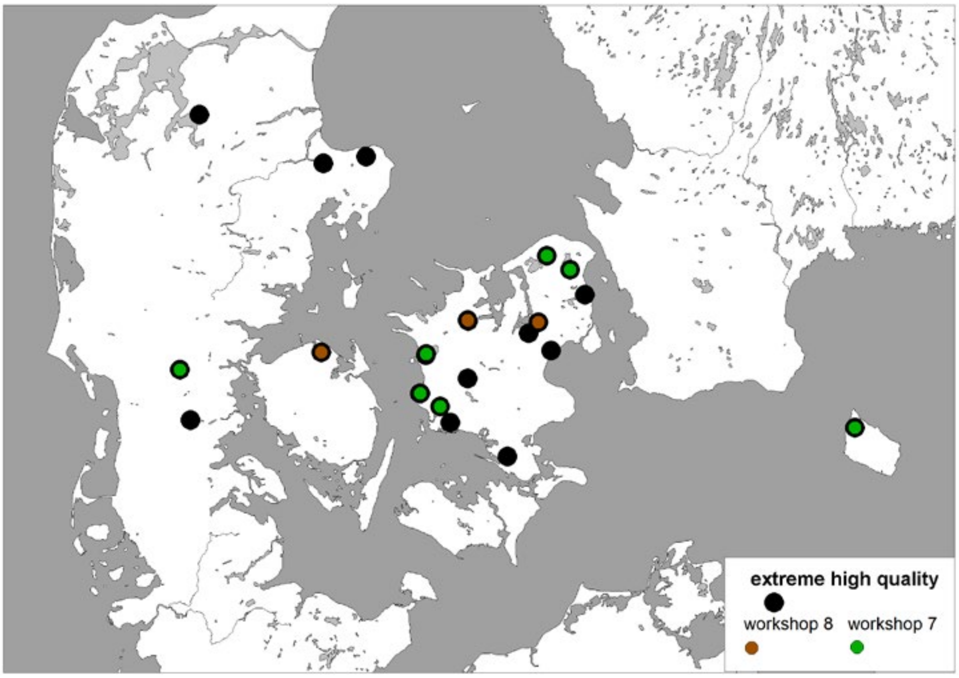


Figure 4.053: Distribution of artefacts considered to be of extremely good quality. The majority of these artefacts were made in the Analytical Workshops (AW) 7 (green) or 8 (brown).

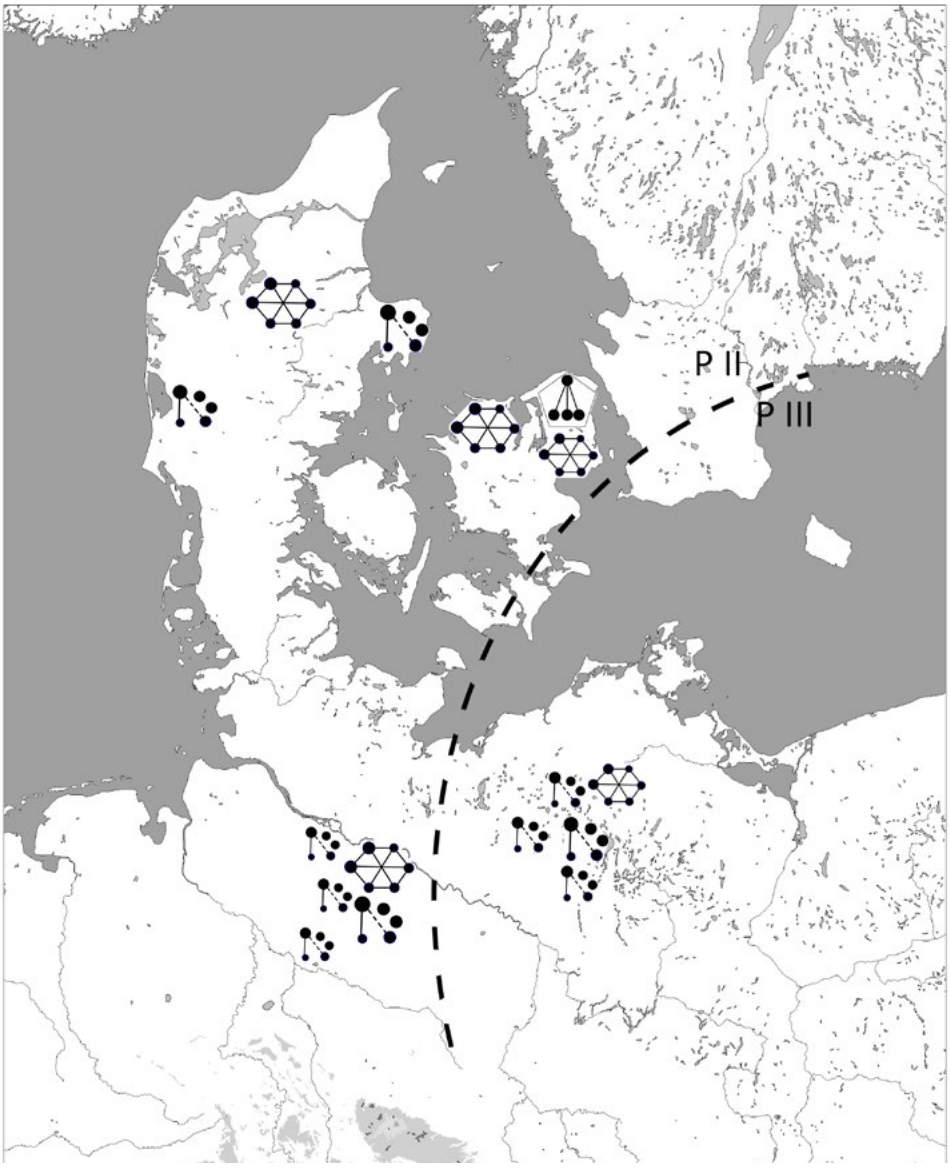


Figure 4.054: Assumed organisation of detected workshops in NBA II and III is visualised using the symbols from Figure 4.052.

2012: 146). As mentioned, AW8 in northwest Zealand strongly suggests such a form of craft organisation, even if here strong support by some type of governing institution is also to be inferred, as the artefacts are spread in a similar manner as those from AW7. Possibly, within this community several individuals were supported by the elite (i.e. the Vognserup founders).[18]

The third detected analytical workshop (AW10) on Zealand is probably also a community of practice, as here especially the effects of cross-craft knowledge exchange are striking. As these kinds of craft communities produced goods far beyond the needs of a single society the wide-ranging distribution supports this theory. In contrast to the lack of clear structures pointing towards attached craft, communities of practice seemed to have been a regular phenomenon (Figure 4.054). Several times the structures described above were visible, such as in north Jutland (AW9), south of the Elbe (AW4), and also in northeast Mecklenburg during NBA III (AW1).

As several detected analytical workshops show a restricted area of influence, another organisational form should be considered as very likely. These workshops may have been organised on a kinship-base, producing goods for the regional market. This kind of workshop is strongly connected to a small social unit and the individuals are very likely to be working only part-time as metalworkers. In contrast to communities of practice it can be expected that these smaller institutions controlled the resources they used and were paid in raw materials (see, e.g., Costin 1998). Due to the restricted distribution area the amount of artefacts needed was reduced and thus more possibilities for the expression of individual characteristics and social styles appeared. Especially in the Lüneburg Heath (Figure 4.054), several smaller kin-related workshops are to be assumed, as here the social units display unique decorative styles which can be expressed best through their own workshops. A similar situation should be assumed for the Mecklenburg Lake district in NBA III, as also here several smaller social units, probably each settlement consisting of such unit (see Johansen *et al.* 2004: 36; Rasmussen 1993: 182), were united within one technological tradition. An important characteristic of family/kin-based workshops is the authority-based training, which mostly results in a lack of novice work in the material culture (occasionally appearing as co-produced artefacts). Within these smaller workshops intensive knowledge exchange was detected, which was probably due to the intensive mobility of the metalworkers.

To conclude, concerning the organisation of metalcraft in the NBA the present study adds important information which resulted in the knowledge that metalcraft was organised in a far more complex way than was previously thought. Within this investigation only those artefacts which could be styled 'prestige goods' were included, as they required skilled craftsman, rare raw materials and a special group of customers. The basic decorative and technical styles of these artefacts were fixed within the technological tradition of the social group (see 'workshop circle', Chapter 4.1.3). However, Roberts has recently underscored the influence of consumer demand on the acceptance of new technologies and thus new styles (Roberts *et al.* 2009: 1019), which also might have differed between different kinds of workshops.

Within this object category of 'prestige goods' at least three different kinds of analytical workshops were determined. In northeast Zealand (AW7) it is very likely that the highly skilled craftspeople were attached to a governing institution and worked in a related workshop. Probably, single craftspeople of AW8 were also attached to a 'sponsor', but, however, worked in workshops belonging to a community of practice. Such craft communities could be also found in southeast Zealand, northern Jutland, central Lower Saxony, and in Mecklenburg. All these workshops seem to have been producing for an extended market. Additionally, especially in the Lüneburg Heath and Mecklenburg, several kinship-ruled workshops were detected, producing goods for the regional market.

Between these defined analytical workshops an intense exchange of knowledge took place that was somehow related to the market each workshop was dependent on. For example, is it more likely that attached craftspeople attempted to learn new techniques to satisfy the requirements of sponsors than workshops with a consolidated regional market. Here, the craft is determined more by traditions than by innovations.

However, also in regard to the kinship-based workshops, an exchange took place and would have involved a limited mobility of the craftsperson, which should not be seen as itinerancy, rather as a way of gaining more knowledge or within apprenticeship. Additionally, the movement of skilled craftspeople into a nearby community due to marriage, or lack of work, is credible and known from ethnographic studies (Rowlands 1971: 218). These different patterns of irregular mobility were principally caused by exogenous factors and were probably oriented along established social structures (Cameron 2000; also Eriksen 2007). In terms of mobility, most applicable to Bronze Age society is a 'regular craftworking movement' in which craftspeople have 'diverse seasonal dwellings' (Torbert 1988: 220). Such a model can be easily envisaged in sparsely populated areas where every village could not afford a metalworker, as for example in Jutland during NBA II. Such mobility is, as Megaw (1979: 52) postulates,

[18] Such groups of attached craftspeople are named in Costin (2001: 621) as 'dispersed or nucleated corvee'.

a prerequisite for full-time craftspeople without any governing institution. However, this might also appear under seasonal full-time labour (Rowlands 1971: 212; Marshall 1968: 143), as small-scale settlements often depended on outsiders for the supply of metal wares, as can be inferred from ethnographic studies (Neaher 1979: 357).

Another kind of mobility, not only with regard to the artefacts themselves, but also concerning craftspeople, might have happened in workshops where the influence of the elite is clearly visible in a wide technological repertoire, in foreign techniques and decorative elements, as well as in the raw-material available and labour input. Here, the produced material is used as manifestations of political expression and the crafted artefacts mirror, next to the technological tradition (manifested in the craftsman's *habitus*), also the wide ranging communication network of the governing elite.

4.4.2 The question of mobility: itinerant craftspeople in a new light

'But if they were detribalized they were ipso facto liberated from the bonds of local customs and enjoyed freedom to travel and settle where they could find markets for their products and skill' (Childe 1940: 163).

The idea of the socially independent itinerant craftsmen was the primary means of characterising the organisation of metalworking in prehistory (Childe 1952: 78), as mobility is a premise for creativity due to the fact that craftsmen spread knowledge and developed technical processes through various inputs. Childe's theory on the organisation of metalworking in prehistory (1930; 1952) is one of the most cited and most discussed theories in archaeology (i.e. Trigger 1980; Pigott 1965; Rowlands 1971).

However, at present there are but a few known instances in which itinerant smiths travel free of social bonds (Rowlands 1971: 214). Many ethnographic examples of metalworkers who move for their profession demonstrate tight social connections, including socio-economic duties between the smith and the social unit to which they are connected (Neipert 2006: 75-102). The reasons behind this rather cumbersome way of executing one's profession are manifold and some forms of craft mobility within a restricted area have been outlined above.

Nevertheless, is another form of itinerancy conceivable in the Bronze Age? That exchange between the single communities existed could be proved several times within this study.

What if not the *goods* but the *craftspeople* able to produce such high-quality work were exchanged? As shown, it is very likely that also in northern Europe attached specialisation existed and such extraordinary handicrafts had the power to strengthen alliances between social groups, due to the fact that they were exchanged as part of a gift exchange system (Mauss 1990) and united people through the visible presentation of similar symbols of power (Rowlands 1980; Earle 1987). In this case, might it not also be conceivable that the craftsmen themselves were involved in such exchanges?

The importance of specialised crafts as part of the exchange system between palace economies is known from around 1000 BC in the Near East. Written sources from the Mari archive describe highly skilled and specialised full-time craftsmen who worked the palace realm and were tightly bound to the administration which supplied them with food and materials (Zaccagnini 1983: 245). Here, the mobility of such craftsmen was documented in three different categories (Zaccagnini 1983: 247-254):

- Highly qualified craftsmen were sent out by their *owners* to fulfil work within the kingdom (redistributive mobility pattern).
- Within allied groups skilled craftspeople were exchanged according to the rules of gift-exchange ('reciprocative mobility pattern').
- Skilled craftspeople were deported in the course of war.[19]

That the exchange of people within such a network is nothing unusual is also confirmed by the existence of the so-called 'foreign women'. Between 1300-1100 BC, burials in the vicinity of the NBA (especially in the Lüneburg Heath and southern Scandinavia) included characteristic costumes which originated far from their places of deposition (Bergerbrant 2007; 2003: 119-123; Jockenhövel 1991; Wels-Weyrauch 1989). Furthermore, strontium isotopic studies were able to demonstrate that a much larger proportion of the traditional buried females than assumed were actually of foreign origin (Frei *et al.* 2015; 2017). These predominantly female burials are seen as evidence of a limited voluntary mobility of women to secure networks and alliances between neighbouring social groups.

Given Mauss's assumption that not individuals but collectives exchanged obligations and contracts (Mauss 1990: 5), alliances between neighbouring social units during the northern European Middle Bronze Age might have been of great importance. In the same way that marriage alliances created a connection between social groups, similar personal ornaments (with the

[19] 'In the Sumerian poem of Lugalbanda we are told of the siege of the city of Aratta by the king of Uruk; the city is besieged and the conquerers take away with them precious metals together with goldsmiths and precious stones together with jewelers, as well as the molds for casting metals' (Zaccagnini 1983: 257; Wilcke 1969).

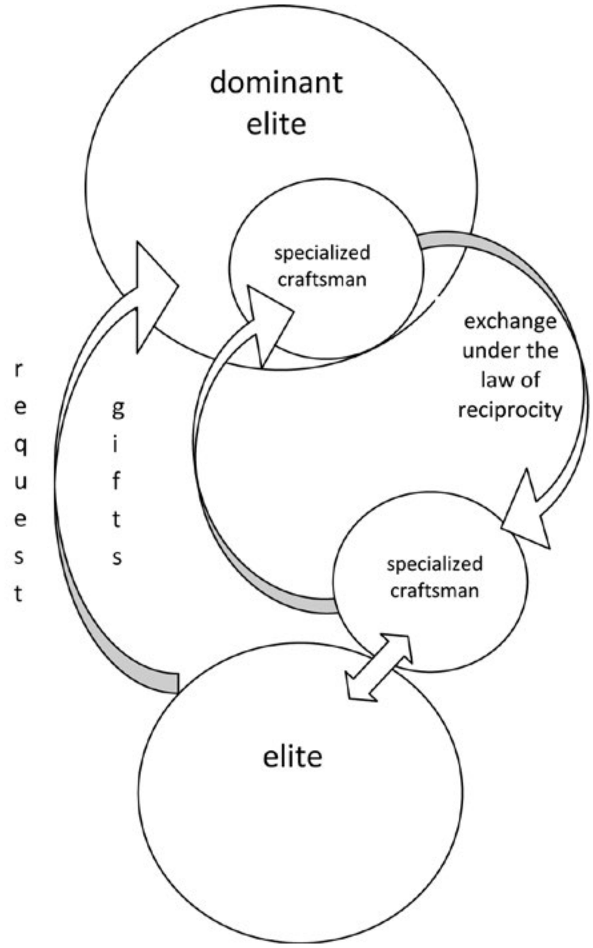


Figure 4.055: Visual representation of the 'reciprocative mobility pattern'
(based on Zaccagnini 1983).

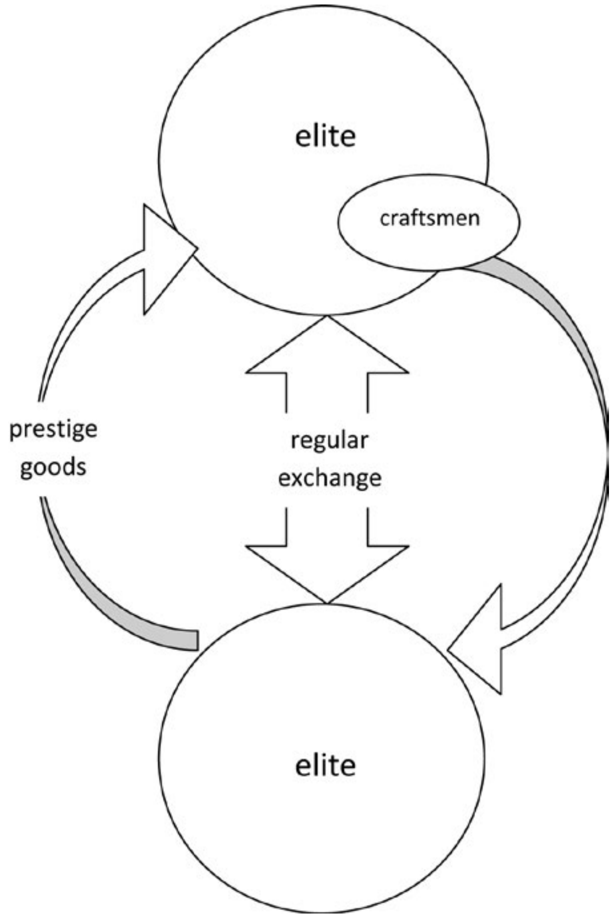


Figure 4.056: The 'unequal exchange model', in which specialised craftspeople are exchanged at a prestige goods level, in addition to regular exchange
(based on Zaccagnini 1983).

aim of distinguishing from the general public) might have been be a strong factor in connecting different social or hierarchical cadres. As mentioned by Brumfiel and Earle: 'to gather and hold a warrior force, a ruler had to offer suitable rewards... symbolized by similarly exalted items of wealth' (Brumfiel and Earle 1987: 8; see also Rowlands 1980).

The exchange of specialist craftsmen between evenly-allied partners could, therefore, be seen as an 'act of politeness' and might form a small part of a 'much more general and enduring contract' (Mauss 1990: 5) between social units at that time (Figure 4.055).

The 'exchange of qualified manpower between different palace organizations is patterned according to the rules of gift-exchanges' (Zaccagnini 1983: 250),[20] and, as such, it cannot be transferred directly to the NBA. It must be subjected to some changes due to significant deviations in the social and economic structures of the time.

In opposition to the highly structured society described in the documents from the Mari archives, we assume the NBA played host to several more or less equal social elites (i.e. Kristiansen and Larsson 2005; Vandkilde 1996). Accordingly, a model must be created based on exchange relationships between equal partners. There might also have been an exchange of these prestige items separately from regular exchanges. Finally, the possibility remains that there were two different types of 'reciprocative mobility pattern' for specialists within this area. An unequal exchange might have existed, in which specialists were exchanged for prestige objects with the expectation that the specialist remained at their new destination (Figure 4.056). By contrast, an equal exchange might have existed in which specialists of different kinds were exchanged in relation to the type of work that needed to be done (Figure 4.057). Both systems might have operated under the law of reciprocity (Mauss 1990: 13). Due to the fact that these specialists were seen as 'prestige goods' and were not, therefore, customary items sent with gifts or tributes,

[20] Zaccagnini´s 'reciprocative mobility pattern' (1983).

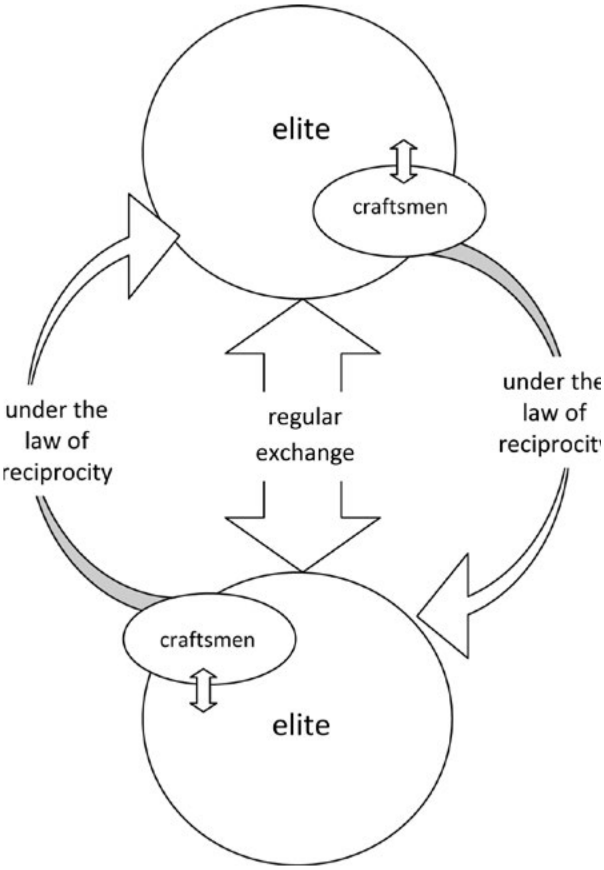


Figure 4.057: The 'equal exchange model' in which specialised craftspeople are exchanged for each other as a consequence of lack of work (based on Zaccagnini 1983).

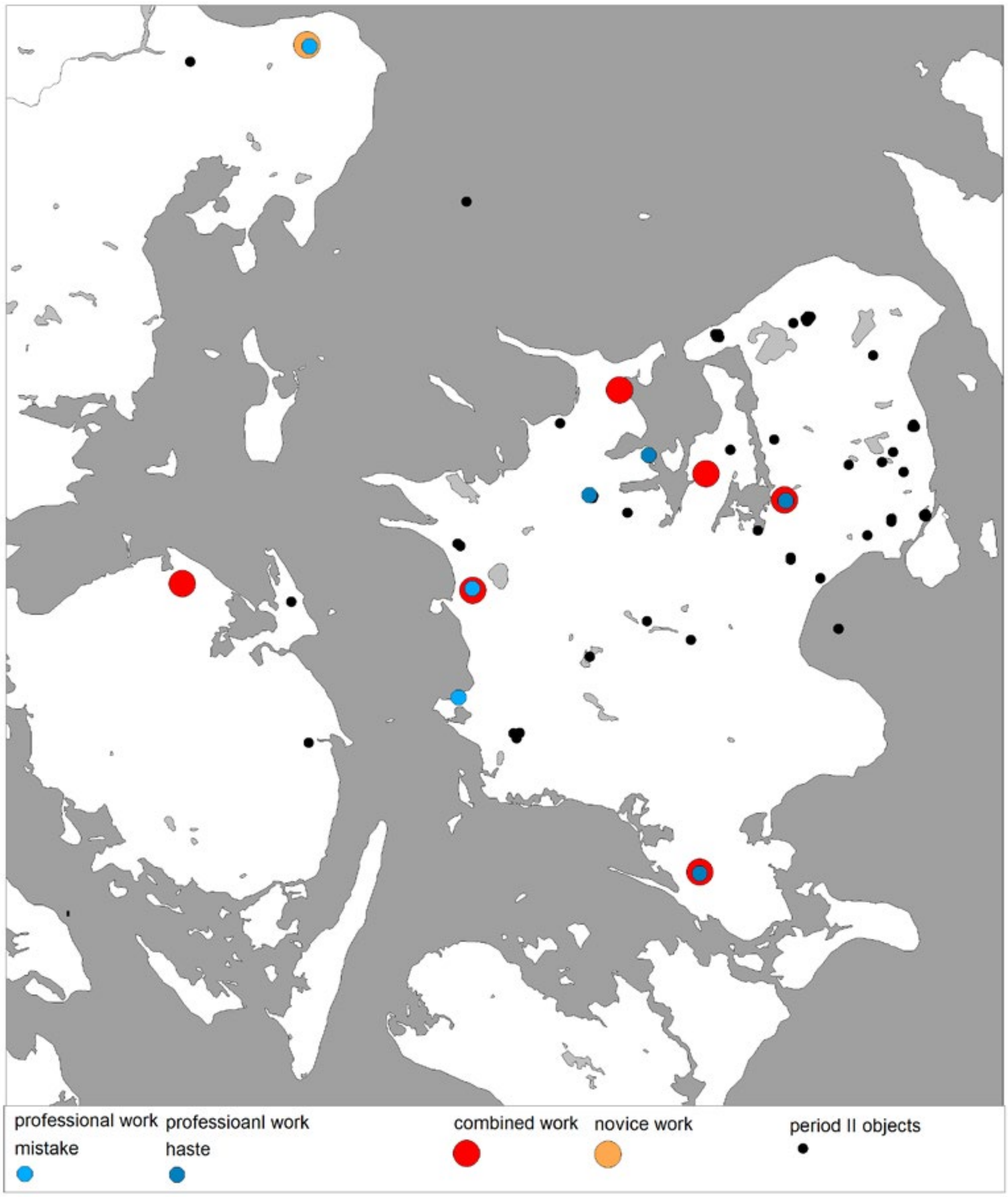
they could be requested and/or refused or dispatched like gifts (Zaccagnini 1983: 251).

The best way to trace craftsmen mobility is through the appearance of foreign techniques, as here the possibility that the tacit knowledge needed to fulfil this new technique was introduced by an actual person is very likely (see Sofaer and Sørensen 2009: 2). Such might have happened between Zealand and the Lüneburg Heath. Within the analytical workshop AW4 several features point towards a strong influence from Zealand, as here the application of spirals by spiral-stamps occurs and on one investigated artefact the technique used to apply humps is comparable to the one used in north Zealand (see Figure 4.048). As this particular workshop differs from the adjacent workshops by its structure, a more intense connection to the elite within this region is inferable. Attached craft can be assumed on Zealand, at least in the north, and so the above-discussed model might explain the mobility of craftspeople that very likely took place here. Whether the modulation of ribs with the use of a comb-like tool was invented south of the Elbe, and through craftsman exchange came to southeast Zealand, cannot be said with absolute certainty. However, several facts make the exchange of craftspeople from the Elbe region to the island possible, such as the fact that this technique was also documented on an NBA II neck collar from Mecklenburg.[21] Such early contact between Zealand and Meckleburg is rare, as shown in the distribution of decorative elements (see Chapter 4.1.1) more often the exchange of stylistic features took place between the Lüneburg Heath and west Mecklenburg. Additionally, the appearance of comb-modulated ribs in three of the determined workshops also supports the origin of this technique in central Lower Saxony. Under these conditions, the exchange of craftspeople between the mentioned regions happened on a basis of equal exchange, where specialised skilled craftsmen were exchanged one for another to strengthen the alliances between both these centres of metal technology during NBA II.

Furthermore, also within the object group of the Krasmose neck collar (see Figure 4.049), craft mobility took place in the form of an exchange of the craftsman responsible for the crafting of these collars. It could be proved that one of the three collars from Bornholm was crafted in analytical workshop AW7 in northeast Zealand. The other two collars were very likely crafted in close relation to the Krasmose craftsman, but, however, based on the additional incorporation of local styles in a workshop on Bornholm. Especially regarding this island, an intensive motivation to strengthen the connection to the elite on Zealand might be argued, and thus an exchange of highly skilled craftsmen (this time in a more unequal exchange) would bind the society on Bornholm visibly to Zealand.

Several further connections between the single workshops, as well as between the two centres of metalwork in NBA II, might also point towards craft mobility. Within the NBA III workshops in Mecklenburg an active mobility between the workshops and also an exchange between Zealand and Mecklenburg is very likely to have occurred. For example, the cast-on technique, as well as the construction of tutuli with metal-eyelets, potentially spread through the movement of craftspeople. Thus mobility remains a premise for the continued existence of metalcrafts, but, however, and in contrast to Childe (1940), it was mostly within and bound to social networks.

[21] The neck collar from Möllen, Kr. Güstrow ALM Br.438 (Nørgaard 2011: 32; Schubart 1972: 128ff.).



Map 41: Distribution of artefacts with signs of unskilled work, of a combination of professional work and novice works, and artefacts with signs of haste, in regard to the analytical workshops defined on Zealand

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Catalogue

Introduction to the Catalogue

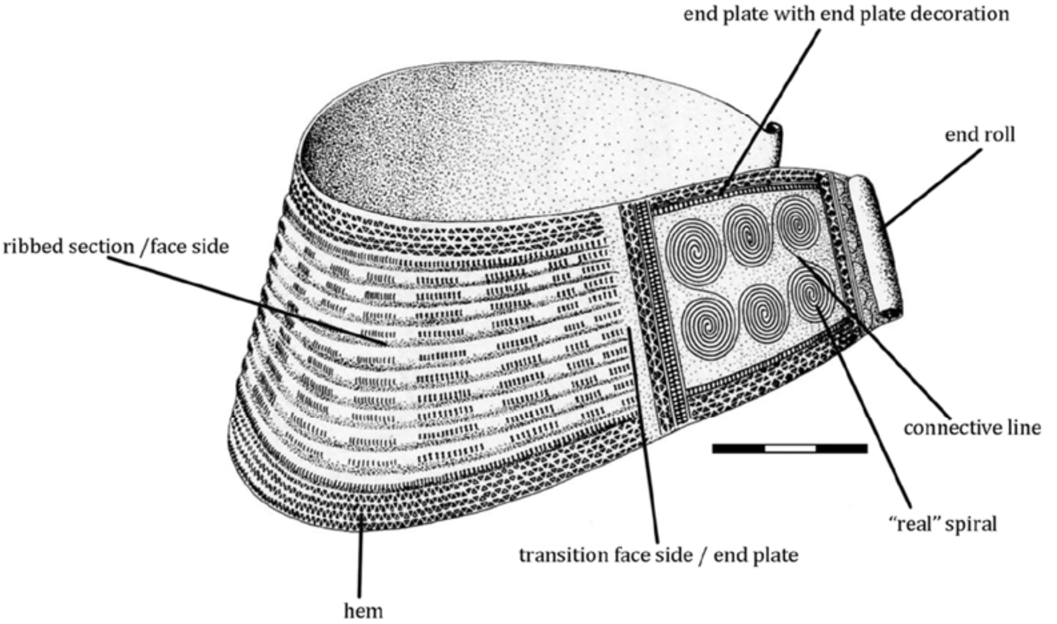
The Catalogue consists of a description of every artefact included in this study in alphabetical order based on the find location. General information on the find place as the chronological classification are given. For the Danish area the location names are based on the publication *Funde der älteren Bronzezeit des nordischen Kreises in Dänemark, Schleswig-Holstein und Niedersachsen*, here, the division in larger municipalities and the merging of parishes in modern days is disregarded due to the practical reasons of finding the specific places in the publication. In northern Germany, modern restructuring of several municipalities has resulted in different classification within the museum collections. As such, specifically for Mecklenburg, the locations are corrected to match the new definitions. In order to find the specific location within the respective publications the page number is given and older location names are set in parentheses. Every artefact is described in detail (including museum numbers) and respective figures are listed under the general information of the location. The information given in the catalogue is purely descriptive, and specific terms concerning the position of the artefact are illustrated on the next page. For further details concerning measurements or weights of the investigated artefacts Table 1 (sorted after museum numbers) should be consulted, in which all information is provided.

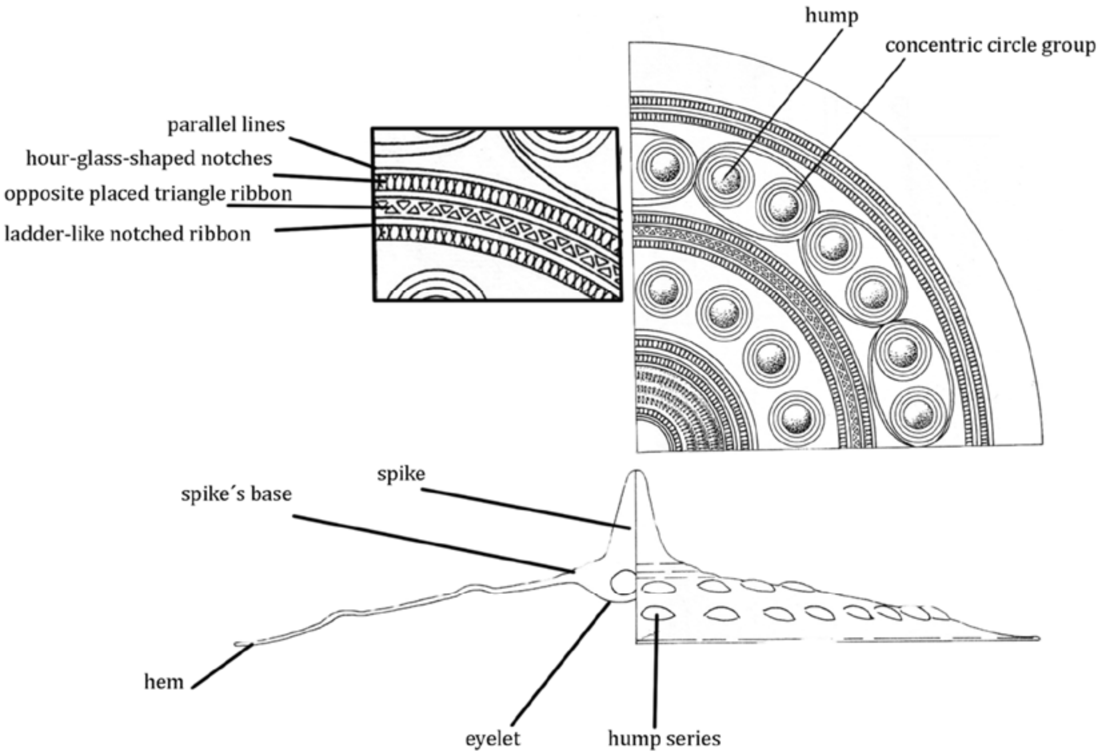
Additional investigation is listed, if it exits, such as metallographic analysis or the determination of the trace elemental composition. The latter is specified in Table 3 at the end of the Catalogue.

All pictures used in the catalogue are taken by the author with permission of the respective museums.

List of museums and abbrevations:

AA	Aarhus
ALM	Archäologisches Landesmuseum Mecklenburg-Vorpommern
FHM	Forhistorisk Museum Moesgaard (old signatures)
HH	Museum Hamburg Harburg
KS	Landesmuseum Kiel Schleswig
LMN	Landesmuseum Niedersachsen Hannover (Niedersächsisches Landesmuseum)
ML	Museum Lüneburg
MM	Staatliche Museen zu Berlin, Märkisches Museum
NM	Nationalmuseet København


end plate with end plate decoration
end roll
ribbed section /face side
connective line
"real" spiral
transition face side / end plate
hem


hump
concentric circle group
parallel lines
hour-glass-shaped notches
opposite placed triangle ribbon
ladder-like notched ribbon
spike
spike´s base
hem
eyelet
hump series

Alphabetical Catalogue

Alt Sammit, Rostock (LRO), Mecklenburg

ALM 2303
Schubart 1972: 75; Nørgaard 2011: 58-60
Burial Mound III, double cremation covered with stones
NBA III
Urn, two leg rings, sword and knife (tongue handle), organic remains of a scabbard, fibula, neck ring, neck collar
Plate 1

ALM 2303 – **Neck collar** with three groups of two notch-decorated ribs. Each of the free fields is decorated with a spiral series (above nine and below eight), connected with dotted lines. Towards the end plate the spiral series terminates in a stacked arrow ribbon framed in lines. The pairs of ribs are connected by four parallel half-arches. Following the arch, decoration frames the free field and terminates the arrow ribbon. Between the ribbed section and end plate is a vertical decorative ribbon of four parallel lines, two opposed arrow ribbons and four parallel lines. Accompanying the edge and framing the decoration of the end plate is an arrow ribbon framed in lines. The interior is filled with two parallel spiral series, each of three spirals, which are connected with dotted lines. The decorative frame terminates towards the well-preserved end rolls in a ribbon consisting of two parallel lines, two opposed arrow ribbons and four parallel lines.
Additional investigation: Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017: 2015a).
Crafting technique: Lost-wax cast with part of the decoration, partly post-casting decoration and reworking.

Amelinghausen, Lüneburg, Lower Saxony

LMN 13175-13179
Laux 1971: 210; Nørgaard 2011
Found in burial mound near the Lopau river
NBA II
Neck collar, stud-bracelet, leg ring, curved disc

LMN 13174 – Flat and slightly curved undecorated **belt disc** with reverse eyelet. The disc has a fringed edge where the material thickness decreases sharply and crafting defects are visible. Such cracks probably originate from an intensive hammering as deformed shrink-holes suggest. The surface of the disc is littered with shrink-holes and scratches The eyelet is a bit off centre and broken, probably a casting defect. This is additionally supported by a porous surface structure around the eyelet.
Crafting technique: cast and hammered into shape.

LMN 13176 – **Open bracelet** with straight ends and wide opening. The ends are of different thickness and rounded. The ring itself is predominantly round, however on the highest point (opposite the opening) severe wear marks and flattening can be documented. The surface of the ring is fine, only occasionally casting residues in form of slight deepenings are visible, no shrink-holes or pores can be detected. Especially at the ends some hammering and grinding marks can be detected at the sides.
Additional investigation: Metallography (Fig. 2.135; Nørgaard 2015b):
Sampled at the thin end. Microstructure near the artefact surface displays strain lines (several directions), annealing twins (moderate deformed), copper-sulfide inclusions. Microstructure towards the artefact´s centre displays larger grains, <delta>-phase, slightly deformed copper-sulfide, metallic copper (CuO) inclusions, round to angular lead inclusions (1.7µm). Trace elemental data is presented in Table 3.
Crafting technique: The fully recrystallised microstructure shows signs of repeated annealing and cold-work (annealing twins and strain lines). The differences in grain size are a result of unequal strength of previous cold-work, a high temperature during annealing and a temperature difference while cooling (probably in air). The strain lines indicate final cold-work. Presumably the bracelet is cold-worked from a bronze ingot.

LMN 13178 – **Stud-bracelet** with nine sharp defined ribs, varying in distance from each other, of which the central rib is wider and higher than the others. The rib-valleys are half round, tapering towards the ends. The edge accompanying outermost ribs are irregular rounded and occasionally hammering traces are visible. The surface is covered with shrink-holes and horizontal grooves are visible in the rib-valleys.
Additional investigation: Metallography (Fig. 2.126; Nørgaard 2015b):
Sampled at the widest point, near the edge. Microstructure towards the centre shows Cu-rich-dendrites, <delta>-phase, copper-sulfide (at grain boundaries), shrink-holes. Microstructure near the surface displays cuprite, copper-sulfide, tin-oxide, occasional strain lines. Trace elemental data is presented in Table 3.
Crafting technique: Slowly cooled cast object (as-cast microstructure with dendrites) showing signs of final cold-work at the rib slopes and the edges.

LMN 13177 (13179) – **Neck collar** in several pieces with six sharp, notched ribs. The rib ornament is always continuous on the first, third, fourth and sixth ribs from above and arranged in groups on the other ribs. Below the bottom rib is a smooth, protruding hem. The hem is decorated with a decorative band consisting of two bordering horizontal lines, an arrow band, four parallel lines, another arrow band and a final line. The lower part of the decorative band passes into the end plate and reaches to the end roll. Here, the decorative ribbon is completed by two superimposed semi-arches. The top arrow band, merges into the rib-decoration. Between the bottom rib and the decorative band there is an undecorated field that tapers towards the rib end. The ribs, always three in a group, are gathered together by arches and separated from the end plate. There are four tapered simple spirals on the end plate. The end plate ends in a final roll. The back of the collar shows a fine surface apart from a spot where burrs and irregularities in the structure can be seen.
Additional investigation: Metallography (Fig. 2.127, 2.134; Nørgaard 2015b):
Sampled (13177) at lower rib near hem (1), close to the end plate (2) and (13179) at upper rib. Microstructure in the ribbed section towards the centre displays larger grains, partly Cu-rich-dendrites, <delta>-phase, slightly deformed copper-sulfide, metallic copper (CuO) inclusions. Microstructure near the hem shows strain lines (several directions), annealing twins (several generations), moderate deformed and aligned copper-sulfide and <delta>-phase inclusions. Trace elemental data is presented in Table 3.
Crafting technique: The ribbed section is cast, supported by the as-cast microstructure with irregularly formed casting grains and interdendritic patterning in sample 2. At the lower hem a fully recrystallised microstructure with signs of repeated annealing and cold-work. The annealing temperature and

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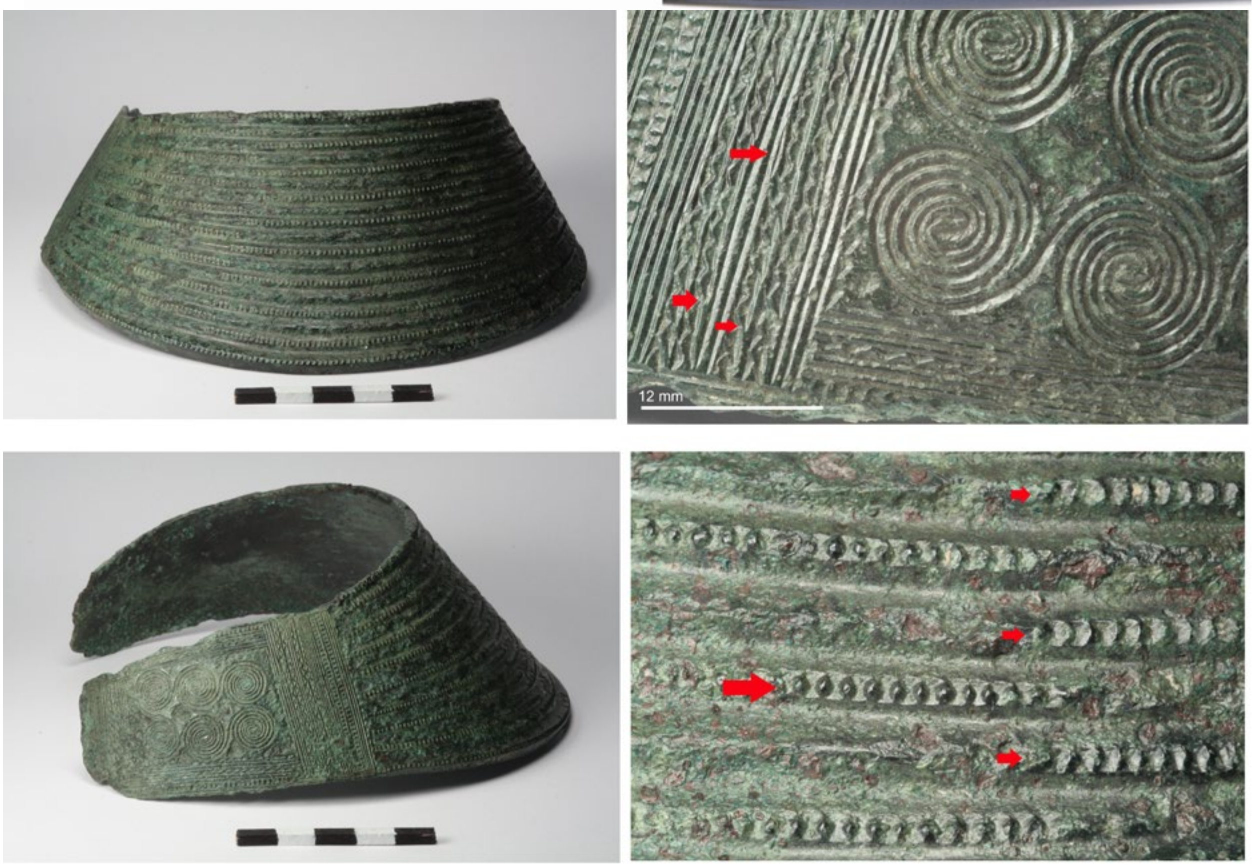

Plate 1:
1) Alt Sammit, Rostock (LRO), Mecklenburg – neck collar ALM 2303; 2) Annebjerg Skov, Højby, Holbæk – neck collar NM B995.

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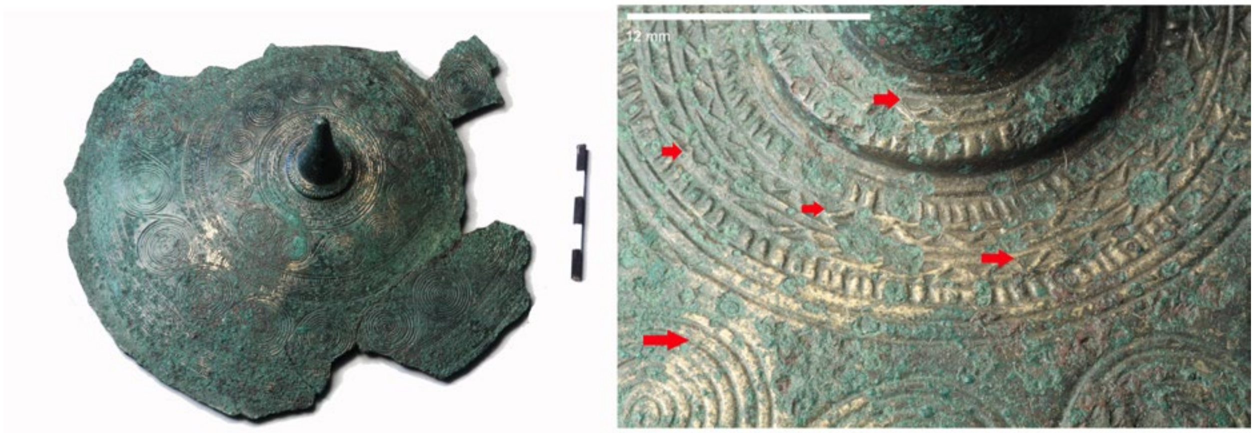

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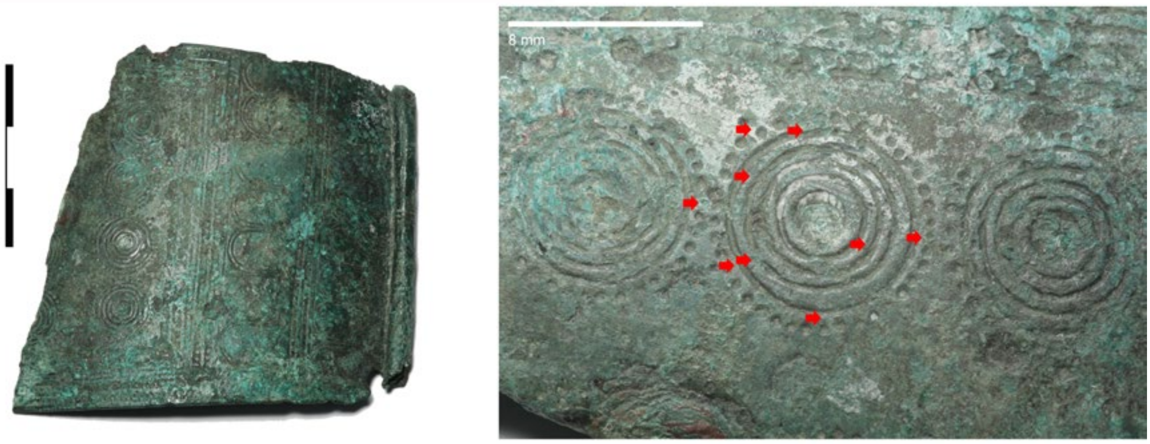

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Plate 2:
1) Annebjerg Skov, Højby, Holbæk – neck collar NM B996; 2) Annebjerg Skov, Højby, Holbæk – belt plate NM B997; 3) Annisse, Holbo, Frederiksborg – neck collar NM Z672; 4) Assing, Hammerum, Ringkøping – belt plate NM 2330g; 5) Assing, Hammerum, Ringkøping – neck collar NM 2330h.

time varied (size of recrystallised grains), at a high level of final cold-work. On all specimen samples, stain lines indicate final cold-work. The rib-decoration as well as the edges shows signs of final cold-work.

Annebjerg Skov, Højby herred, Holbæk Amt

NM B995-B1004
Aner and Kersten 1976: 57; Nørgaard 2011: 39-40
Hoard next to a bog
NBA II
Neck collar, smooth neck collar, belt plate, arm ring, spiral arm ring, tutulus, two sickles, palstave, three awls
Figures: 2.098; Plate 1 and 2.

NM B995 – **Neck collar** with 18 ribs and notch decoration. The wide notch decoration is continuous on the top and bottom rib and alternating in groups on the ribs in between. The notch-groups which are close to the transition to the end plate are significantly longer. As a separation of the frontal area and the end plate a broad, vertically arranged decorative ribbon is attached. It consists of four parallel lines, two ladder-like notched ribbons separated only by a line, six parallel lines, two adjacent opposing triangle ribbons separated by a line, another triangle ribbon separated from the first by an extra vertical line and four parallel lines. The decoration of the end plates is framed with edge accompanying line decoration consisting of (from the edge to the inside) a ladder-like notched ribbon, two parallel lines, a band of opposing triangles and two parallel lines. These horizontal parts of the decorative frame are attached onto the vertical part, which separates the frontal area from the end, and runs to the broken end roll. Towards the end, the frame is completed by a vertical decoration consisting of three parallel lines, two opposing triangle ribbons, parallel lines, a ladder-like notched ribbon, and two parallel lines. The interior is decorated with two rows, each of three connected spirals, the middle of which is a little bigger than the others. Pointing to the spirals and based on the innermost line of the decorative frame is a row of triangles.
Crafting technique: Rough lost-wax cast, post-casting decoration.

NM B996 – Fragment of a smooth **neck collar** with spiral-decoration. The fragment shows the transition from the front to the end plate. The front decoration is made of two spiral rows. On each row, two spirals connected by double lines are preserved. The spiral rows are separated from each other by a ladder-like notched ribbon formed by slightly triangular punch marks and associated lines. These ribbons continue as an arch-like frame at the end of the spiral row and are also part of the edge-accompanying decoration. Between the slightly curved outward hem and the ladder-like notched ribbon are three parallel lines. The edge-accompanying decoration continues into the end plates. The decoration of the end plates has not been preserved. It can be assumed that it is similar to the decoration that separates the ends from the frontal region. Here a vertical ribbon of a ladder-like notched ribbon, three parallel lines and two ladder-like notched ribbons framed in lines are used.
Crafting technique: Rough cast, sheet-metal, post-casting decoration.

NM B997 – The relatively strong patinated **belt disc** is composed of several fragments and mounted on a glass plate. The back is barely visible through a thick layer of blooming patina. The plate is decorated with a pattern of two spiral rows that are connected with dual lines. The spirals of the different rows vary in size. In the centre of the disc is a slightly higher pedestal on which a long conical, undecorated spike is attached. Around the spike is a decorative band of opposing triangle lines, ladder-like notched ribbons, and parallel lines. The decoration begins on the podium and continues onto the disc. The ensuing spiral series consists of twelve small spirals, connected by double lines. This spiral series is separated from the next by a lined pattern. The relatively wide decorative ribbon consists of a single line, a ladder-like notched ribbon (the notches are hourglass shaped), two parallel ribbons of opposing triangle lines and another hourglass ribbon. The spiral line is only partially preserved and consists of 11 of, presumably, 18 spirals. The spirals are significantly larger than the previous spirals and are connected with double lines. The spiral series is separated from the upwardly curved hem by a decorative ribbon consisting of: a framed in lines ladder-like hourglass punch ribbon, four parallel rows of opposing triangle lines and another ladder-like notched ribbon.
Crafting technique: Lost-wax cast with rough decoration, post-casting reworking of decoration, cast-on spike.

NM B1000 – Very well-preserved **tutulus**, with dome-like spike and narrow decorated hem. The hem is completely decorated with (from the outside onwards) two parallel lines, a ladder-like notched ribbon with hourglass punch marks, a row of opposing triangles, a broad band framed in lines and filled in with four parallel diamond notch series, a ladder-like notched ribbon similar to the first, and two parallel lines. The transition from the hem to the dome is initiated by three parallel lines. Based on these lines there are at four points decorative strips each consisting of three ladder-like notched ribbons (notches are hourglass shaped) and intervening parallel lines. These run vertically up to the dome's centre. The rest of the dome is smooth and undecorated. On the inside of the hollow dome two intersecting ridges are attached, slightly below the transition to the disc.
Crafting technique: Lost-wax cast, reworking of decoration.

Annisse, Holbo sogn, Frederiksborg Amt

NM Z672
Aner and Kersten 1973: 5; Nørgaard 2011: 46-47
Cremation in the 'Smedebjerg' burial mound, Sb Nr.46
NBA II
Burned bones, neck collar
Plate 2

NM Z672 – Fragment of an **end plate of a large ribbed colla**r. The piece is very well maintained and the decoration easily recognisable. The main area of the end plate is framed by a decorative ribbon consisting of two parallel ladder-like notched ribbons, one horizontal and two vertical parallel lines, an opposed triangle series, and a ladder-like notched ribbon. This decorative band is in the horizontal close to the rounded edge and in the vertical presumably separates the ribbed section from the end part. The decorative frame stops at a significant distance before the end roll. In between the frame and the end roll a ribbon of stacked adjacent U-shaped arches, which ends in arrow-like triangles, is parallel to the vertical decoration. The arch series is placed on a single vertical line. Another vertical decorative band of two ladder-like notched ribbons and a parallel line form the base of another series of stacked U-shaped arches, but without triangle ends. The narrow end rolls are preserved in the entire length. They follow directly on the decoration and are decorated with several groups each of three lines. Inside the decorative frame two vertical rows (formerly of four to six rows) with four concentric circle

groups are still preserved. These are surrounded by punctured circles. Each circle group consists of a centre groove and four concentric rings around it.
Crafting technique: Lost-wax cast with parts of the ornament, post-casting ornamentation (lines and arches).

Appel, Harburg, Niedersachsen

LMN 4769-4771, 14082
Laux 1971: 191; Sprockhoff 1940: 32f; Hachmann 1957: 199
Hoard find
NBA II (ZG II after Laux)
Figures: 2.033; 2.034; 2.069-70; 4.016-17; 4.037
LMN 14082 – Heavily damaged **belt disc** with a small spike, which is broken off at the base. Around the spike is a wide open field, which is completed by a decorative band, consisting of weakly recognizable hourglass notches, three parallel lines and a further series of adjacent hourglass notches. Within the described field 14 humps are placed, which are barely visible on the face side, however, on the back they are clearly present as depressions. Between the described field and the next decorative band (consisting of a framed in lines hourglass notched ribbon) is a narrow empty space. The decorative ribbon is followed by a hump line (25 are visible) which is weakly visible on the front, however, the humps are clearly recognisable as negative shapes on the back. The edge-accompanying decorative band might have been planned as a framed hourglass notched ribbon, however, it is preserved as an incised line. On the back, opposite the spike, a protruding triangular eyelet is situated. The eyelet is attached to the point of greatest curvature of the disc and formed out of an irregular-shaped bar. The hole is pierced and recognisable as a depression in the surface.
Crafting technique: Lost-wax cast with post-casting reworking.
LMN 4769 – **Small belt disc** with a short, slightly conical shaped spike with a rounded top. Around the spike is a decoration consisting of lines arranged in seven groups of three, pointing away from the spike and bounded by a line running around the spike. On this line six large standing triangles are placed that are filled with lines, gently sloping towards the tip. The decoration is terminated by a further line centred around the spike. This line also forms the beginning of a band consisting of two framed and parallel running semi-circles or arrow bands. Two parallel lines complete this decorative ribbon before a smooth narrow hem completes the disc. On the back, opposite the spike, a triangular protruding eyelet with perforated hole is situated. The majority of the decoration can be seen as negative.
Crafting technique: Lost-wax cast with post-casting decoration, the eyelet is formed with a core.
LMN 4770 – **Small belt disc** with a short, slightly conical shaped spike with a rounded top. Around the spike is a decoration consisting of lines that are arranged radially, pointing away from the spike and bounded by a line running around the spike. On this line six large standing triangles are placed that are filled with lines, gently sloping towards the tip. The decoration is terminated by a further line centred around the spike. This line also forms the beginning of a band consisting of two framed and parallel running semi-circles or arrow bands. Two parallel lines complete this decorative ribbon before a smooth narrow hem completes the disc. On the back, opposite the spike, a triangular protruding eyelet with perforated hole is situated. The perforation has multiple signs of intrusion. The majority of the decoration can be seen as negative.
Crafting technique: Lost-wax cast with post-casting decoration, the eyelet is formed with a core.
LMN 4771 – **Small belt disc** with a short, slightly conical shaped spike with a rounded top. Around the spike is a decoration consisting of lines that are arranged in seven groups of three pointing away from the spike and bounded by a line running around the spike. On this line six large standing triangles are placed that are filled with lines, gently sloping towards the tip. The decoration is terminated by a further line centred around the spike. This line also forms the beginning of a band consisting of two framed and parallel running semi-circles or arrow bands. Two parallel lines complete this decorative ribbon before a smooth narrow hem completes the disc. The hem is heavily damaged and broken. On the back the eyelet is clearly off-centre, and consists of triangular protruding bar with double perforation on one side. The majority of the decoration can be seen as negative.
Crafting technique: Lost-wax cast with post-casting decoration, the eyelet is formed with a core.

Assing (sn), Hammerum herred, Ringkøping Amt

FHM 2330
Aner and Kersten 1995: 36; Nørgaard 2011: 86-87
Inhumation in burial mound
NBA II
Belt disc, four arm rings, three tutuli, neck collar, fibula, knife and saw (perhaps not related)
Plate 2
FHM 2330h – Very poorly preserved smooth **neck collar** which is heavily damaged through the blooming patina. On the smooth surface of the frontal area of the collar, the remains of a two-row spiral-decoration are recognisable. The spiral series is framed by an edge-accompanying decorative ribbon consisting of five parallel lines and a series of dots. The spirals are not horizontally but vertically connected with double lines. The collar has a slightly outwardly curved hem and continues towards the ends to a rounded triangle. Another end (a probable lock) is not preserved.
Crafting technique: probably lost-wax cast, heavily reworked.
FHM 2330g – Fragmented **belt disc** with a short conical spike and spiral-decoration. The disc is applied to a glass plate and reconstructed; therefore, the reverse is not examinable. Around the short conical undecorated spike is a decorative ribbon, starting at the foot of the spike with two parallel lines. The decorative ribbon which follows consists of a ladder-like notched ribbon (hourglass-shaped notches), two parallel lines, another similar ladder-like notched ribbon, a line, a series of opposed triangles, two parallel lines and, finally, a ladder-like notched ribbon. Placed in the broad field is a spiral series, connected with double lines. Accompanying the edge and only separated by a short undecorated hem, another decorative band is placed. Similarly, this consists of a ladder-like notched ribbon (hourglass-shaped notches), two parallel lines and a ladder-like notched ribbon. The hem tapers towards the edge and is lightly curved outwards.
Crafting technique: Lost-wax cast probably with decoration (spiral stamp), reworking of decoration.

Bagsværd, Gladsakse sogn, København Amt

NM B11391-92
Aner and Kersten 1973: 131-132; Nørgaard 2011: 51
Found in 1850 in burial mound, probably inhumation
NBA II
Neck collar, belt plate

Figures: 2.104
B11391 – **Neck collar** with nine tapered ribs. The ornamental decoration on the ribs consists of slightly waisted, long rectangular impressions. They are alternately arranged on the ribs with a slight overlap. Over the top and under the bottom rib is a decorated hem. The decoration consists of five parallel grooves. The edges of the collar are heavily corroded. On the heavily damaged end plate only remnants of the decoration can be seen. The ribs are separated from the end plate by a vertical decorative ribbon of triangular notches, framed by lines. This is followed by four parallel lines and another triangle ribbon framed by lines.
Crafting technique: Lost-wax cast, partly post-casting decoration.

Ballemose, Balle sogn, Viborg Amt

FHM 5171
Nørgaard 2011: 160-161
Probably from bog deposit
NBA II
Neck collar, three open arm rings
Figures: 3.003

FHM 5171 — Neck collar with seven different broad ribs that converge towards the end plate. Above and below the ribbed section is a slightly flared undecorated hem. The fourth rib from the top and the third rib from the bottom are noticeably shorter than the other ribs and conjoin at the junction of the stomach and end plate. Following this a lenticular space is formed in the centre of the collar. Furthermore, the second and third rib from the top are each combined with the second rib from the bottom forming a similar lenticular decoration. The joints are shaped like an arrow and continue as stacked arrows towards the end. Only the left end plate is preserved and tapers towards the end. No end rolls are visible; instead two holes are probably used as a lock.
Crafting technique: Lost-wax cast.

Becklingen, Celle, Lower Saxony

LMN 1026:76, 1032:76, 1033:76
Piesker 1958: 25; Laux 1971: 15a; Nørgaard 2011: 54-58
Inhumation in burial mound 44, 'Gertrudenhof', Grave 1
NBA II
Neck collar, wheel-headed pin, three spiked discs
Plate 3
LMN 1032:76a – **Spiked disc** with five ribs placed in concentric circles around the spike. The ribs stand out clearly from the disc and start directly after a rib-valley placed around the spike. In between the ribs and the smooth and unadorned wide hem is another deep rib-valley. The irregularly-shaped spike is located centrally in the disc and terminates in a rounded, slightly widened tip. The spiked disc has an irregular shape because of the different widths of its hem. The flat back of the disc is entirely restored and covered by a backing material.
Crafting technique: Open mould with post-casting reworking.
LMN 1032:76b – **Spiked disc** with five ribs placed in concentric circles around the spike. The ribs stand out clearly from the disc and start directly after a rib-valley placed around the spike. In between the ribs and the smooth and unadorned wide hem is another deep rib-valley. The irregularly-shaped spike is located centrally in the disc and terminates in a rounded, slightly widened tip. More than three quarters of the spiked disc are reconstructed. The flat back of the disc is entirely covered by a backing material.
Crafting technique: Open mould with post-casting reworking.
LMN 1033:76 – **Spiked disc** with five ribs placed in concentric circles around the spike. The ribs stand out clearly from the disc and start directly after a rib-valley placed around the spike. In between the ribs and the smooth and unadorned wide hem is another deep rib-valley. The irregularly-shaped spike is located centrally in the disc and terminates in a rounded, slightly widened tip. The flat back of the disc is entirely covered by a backing material.
Crafting technique: Open mould with post-casting reworking.
LMN 1026:76 – Well-preserved **neck collar** with ten well-marked ribs. The top rib accompanies the edge and the middle of the front part is much wider. The following ribs follow the curving shape of the collar. Due to this the rib-valley between these ribs is wider in the middle and towards the end has only a narrow groove. Directly attached to the bottom rib is a smooth wide trim, decorated with a continuous series of small humps. This series of humps, which is parallel to the closest rib, ends at the height of the transition from the front to the side. In the middle of the front part of the collar at the widest point of the seam an additional series of small humps can be assumed. The ribs terminate at the transition to the end plate at different heights. The lower three ribs are longer on both sides than the upper rib. The valleys are all pointed outwards. At the transition from the front to the side a vertical decorative band is placed, consisting of four parallel lines, a broad band within which vertical adjacent triangles are placed on lines, four additional parallel lines (wherein the last is the base for a decoration of three superposed half arches), four parallel lines and a mirror-like one with decoration of semi-circular arches. The collar is badly damaged at the edges and the end plates are reconstructed.
Crafting technique: Lost-wax with post-casting reworking (ribs and bulges).

Becklingen, Celle, Lower Saxony

LMN 13135
Bergmann 1970: 91; Laux 1971: Nr. 15B; Nørgaard 2011: 54-58
Single find near burial mound, 'Gertrudenhof'
NBA II
Plate 4
LMN 13135a – **Neck collar** with eight sharply defined and trapezoidal ribs. The rib-valleys are deep and distinct. The top rib is rounded and runs concomitantly to the edge. Below the lowest rib is a groove from which the wide, smooth and unadorned hem emerges. The ribs move with the shape of the collar, and are therefore slightly wavy. At the transition from centre to the end plate the ribs terminate at one height.
Additional investigation: Metallography (Fig. 2.131, 2.133; Nørgaard 2015b):
Sampled at the transition front part to end near hole (1) and at the transition front part to end near lower hem (2). Microstructure towards the artefact´s centre displays partly Cu-rich-dendrites, large recrystallized grains, copper-sulfide, lead inclusions (0.5 µm) within the <delta>-phase. Microstructure near the surface shows strain-lines, annealing twins, deformed copper-sulfide inclusions, cuprite, <delta>-phase. Trace elemental data is presented in Table 3.
Crafting technique: The two samples indicate a varying degree of cold-work of the item. The ribbed section is cast (a nearly pure as-cast microstructure) and near the hole deformed grains indicate a high amount of cold-work. At the transition to the end the microstructure changes from partly to fully

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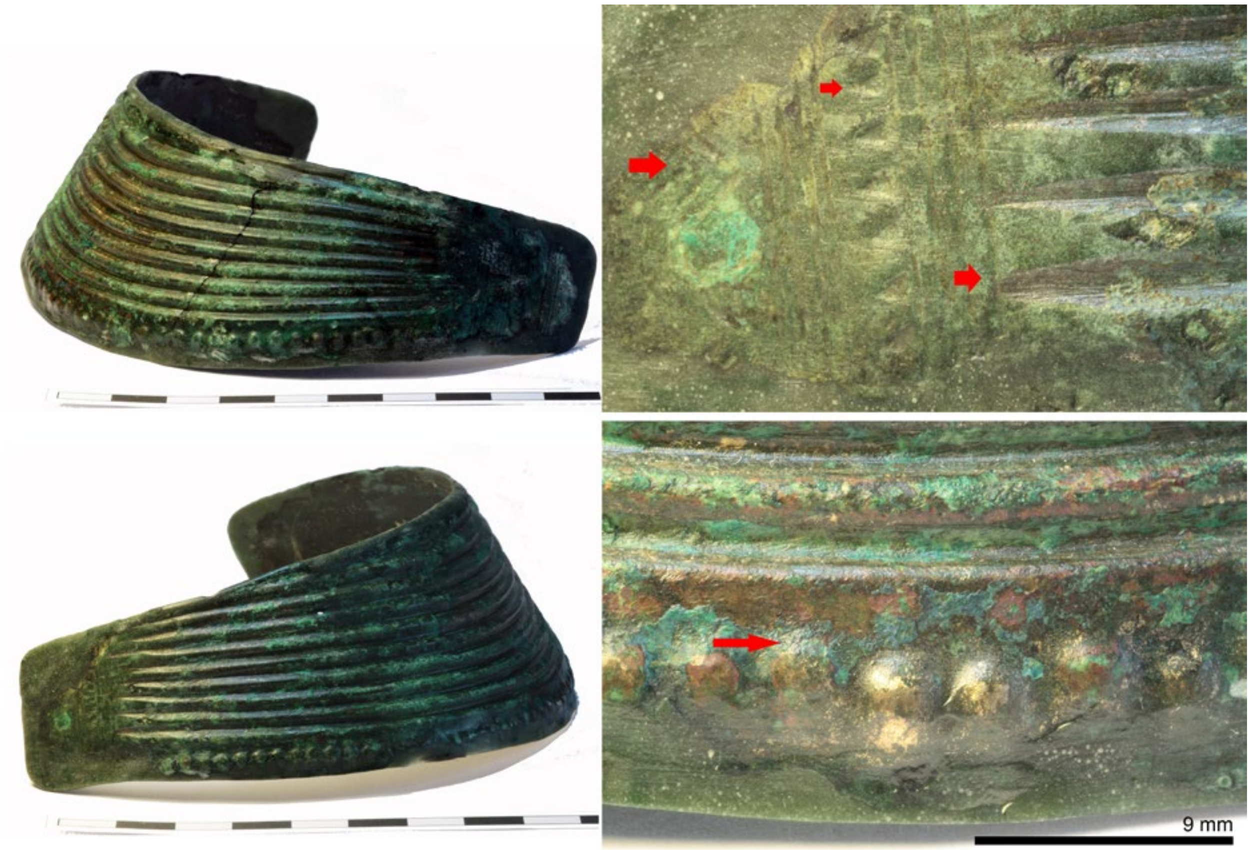

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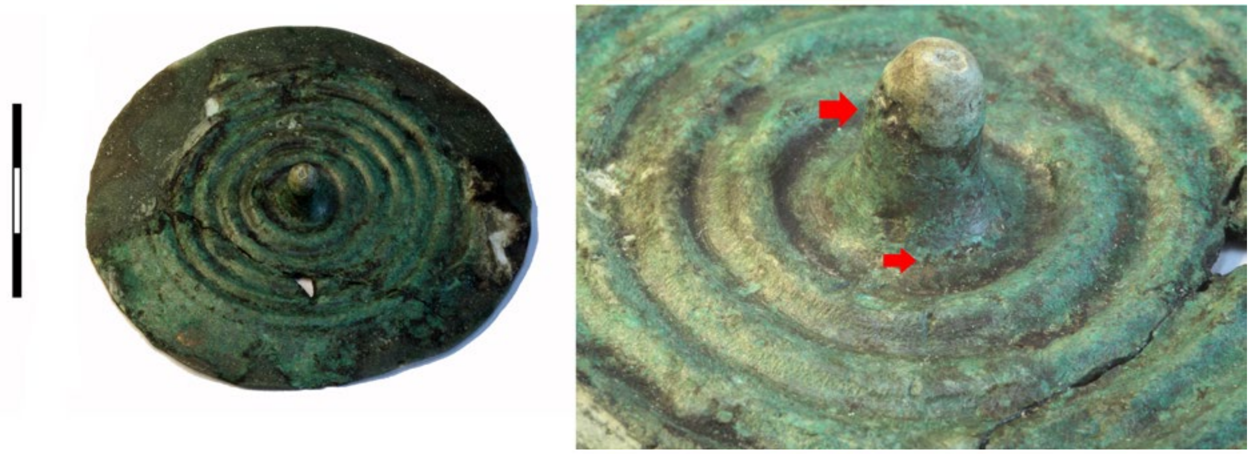

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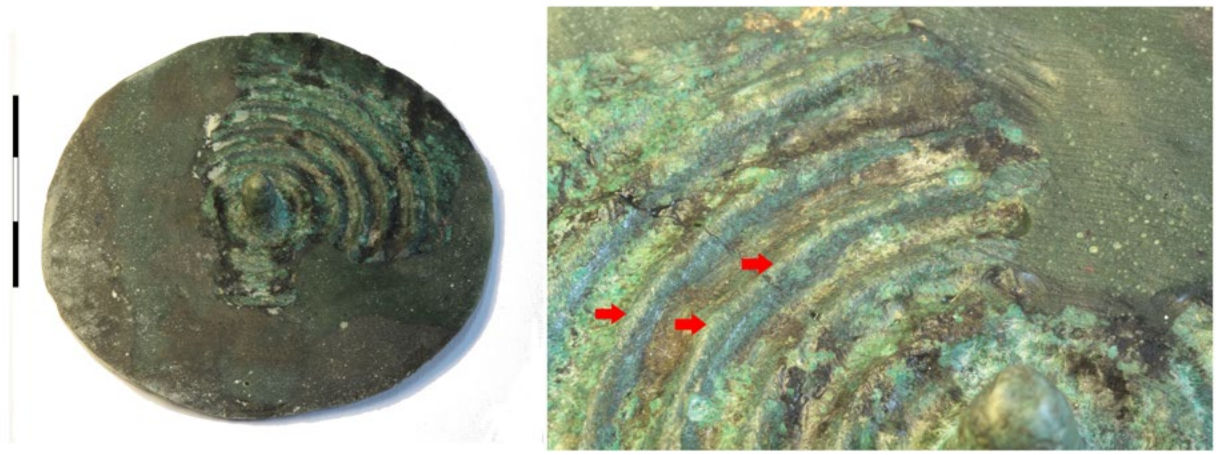

Plate 3:
1) Becklingen, Celle, Lower Saxony – neck collar LMN 1026:76; 2) Becklingen, Celle, Lower Saxony – spike disc LMN 1032:76a; 3) Becklingen, Celle, Lower Saxony – spike disc LMN 1032:76b.

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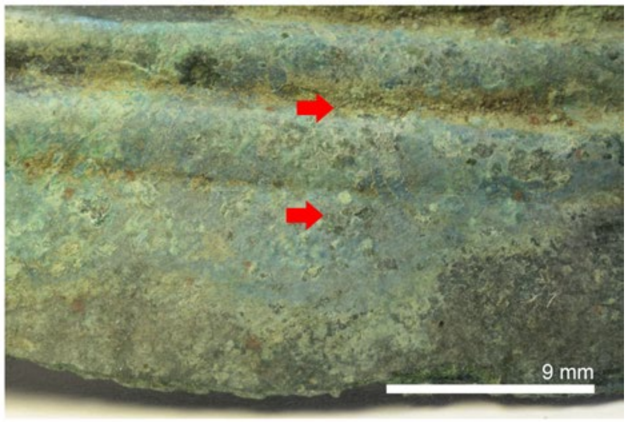

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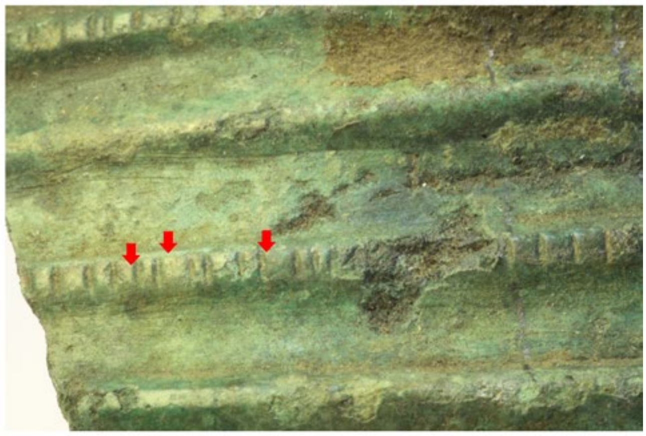

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Plate 4:
1) Becklingen, Celle, Lower Saxony – neck collar LMN 13135a; 2) Becklingen, Celle, Lower Saxony – neck collar LMN 13135b; 3) Becklingen, Celle, Lower Saxony – neck collar LMN 13135c.

recrystallised. The final cold-work was intensive, indicated by strain lines and deformed grains.

LMN 13135b – Fragment of a **neck collar** with six narrow, sharply defined ribs. The ribs are far away from each other and are decorated with wide slots that cover the entire back ribs. The top rib and following every second rib are undecorated. At the bottom a seventh rib can be assumed to form the collar's edge. The rib-valleys are shallow. The end plate, obtained as a fragment, is narrow, undecorated and ends in vertical end rolls.

Additional investigation: Metallography (Fig. 2.126; Nørgaard 2015b):

Sampled at the upper edge in the front (ribbed) section and at the end, near lower edge. Microstructure towards the centre displays small Cu-rich-dendrites, <delta>-phase, copper-sulfide, shrink-holes, cuprite (in corrosion). Microstructure near the surface shows a recrystallised grain structure, cuprite and copper-sulfide inclusions. Trace elemental data is presented in Table 3.

Crafting technique: As-cast microstructure indicating a cast artefact. The cast is of bad quality as many shrink-holes in the sample show. The small dendrites indicate a fast cooling. Occasional, the microstructure is partly recrystallised mostly near the edges and at the transition to the end.

LMN 13135c – Fragment of a **neck collar** with eight ribs, of which the fourth rib from the top adorns only the frontal area and conjoins towards the side with the third rib. There is also an extended notch decoration that covers the junction at this point. Below the eighth rib is a clearly pronounced smooth hem that starts below the rib. At the transition to the end plate the top three ribs are parallel to each other, as are the lowest three ribs. They follow the shape of the collar and are slightly bent. The valleys between the fourth and fifth ribs are significantly smaller, resulting in an arrow-like structure. Centrally in the collar there is a slightly oval hole.

Additional investigation: Metallography (Fig. 2.132; Nørgaard 2015b):

Sampled at the end, near ribs at the hem. Microstructure towards the centre displays cloudy large grains, <delta>-phase, copper-sulfide and shrink-holes (very small and speckled). Microstructure near the surface shows recrystallised grain structure, regular small grains, cuprite, copper-sulfide inclusions. Trace elemental data is presented in Table 3.

Crafting technique: The microstructure of the sample indicates a different treatment of the item from the ribbed section towards the hem. Strain lines and grain deformations indicate final cold-work and the fully recrystallised microstructure at the hem indicates multiple annealing phases. Here, residual heat influences the nearby as-cast microstructure which is partially recrystallised.

Bidstrup (Sankt Jørgensberg), Jørgens sogn, København Amt

NM B1568-69
Aner and Kersten 1973: 177-178; Nørgaard 2011: 36-38
Inhumation in sand
NBA II
Neck collar, bracelet with spiral ends, spiral finger ring
Plate 5

B1568 – Heavily patinated **neck collar** with nine distinctly designed ribs and stroked ornate end plates. The top and bottom ribs are wider than the other ribs, and are triangular in cross section. The ribs are decorated with alternately arranged decorative notch groups that sit on every second rib exactly at the same position. All the ribs terminate on the same level at the transition to the end plate and are cut by a vertical line decoration. The vertical decoration ribbon consists of a ladder-like notched ribbon, two parallel lines and a further ladder-like notched ribbon. Next to this decorative ribbon a number of standing triangles are mounted, built up from two overlapping rows of triangles. On the end plate, the vertical decorative ribbon is repeated three times (a detailed description is not possible due to the preservation) and divides the end plate into four fields. The area just before the small end rolls is undecorated. On the back and around the ends of the collar traces of organic materials are visible in the patina.

Crafting technique: Lost-wax with partly forged decoration.

Bleckmar, Celle, Lower Saxony

LMN 953:76
Laux 1971: Nr. 19A; Piesker 1958: Nr. 12; Nørgaard 2011: 56-58
Within burial mound, 'Kahlberg 3', with stone circle and wooden coffin
NBA II
Neck collar, 200 cone-shaped tutuli, bronze rolls, spiral rolls, four hair spirals, fibula (Haarknotenfibel), wheel-headed pin, two arm spiral rings, leg ring
Plate 5

LMN 953:76 – The heavily reconstructed **neck collar** is covered with a thick layer of varnish. The few original parts preserved show a collar consisting of eight rounded ribs of which the uppermost rib is edge-accompanying and, therefore, bent. The other ribs are nearly horizontal and are, therefore, of different lengths. Between the edge-accompanying rib and the second very short rib, within the lenticular rib-valley, there is a slightly pronounced rib with an irregular width. The lower hem is reconstructed for the most part. It probably ran parallel to the lowest rib and decreased in its width towards the end. The undecorated end plate is quite long and appears to have a consistent width. At the end, parts of the end rolls are preserved.

Crafting technique: Rough lost-wax cast (ribbed section), post-casting decoration, cold-working (hem) and reworking.

Bleckmar, Celle, Lower Saxony

LMN K851:76
Laux 1971: Nr. 21B; Piesker 1958: Nr. 25; Nørgaard 2011: 56-58
East of the 'Kahlberg' on the 'Wittenberg', Mound 4, Grave V, female inhumation.
NBA II
Neck collar, twisted gold ring, gold spiral, three hair spirals, spiral finger ring, spiral rolls, belt disc, wheel-headed pin, two arm spirals, leg ring
Plate 5

LMN K851:76 – A **neck collar**,very fragmented and consisting of six ribs, which are clearly pronounced. They are decorated on their flat back with a chessboard-pattern arrangement of oblique, wide notches. The bottom rib is very flat and runs directly into a wide undecorated hem which is very thin at the ends. At the transition to the end plate, the rib-valleys terminate in peaks and the ribs flatten into the smooth end plate. Most fragments of the collar are preserved only as patina; only within the frontal area is a metal core still preserved.

Additional investigation: Metallography (Fig. 2.127; Nørgaard 2015b):

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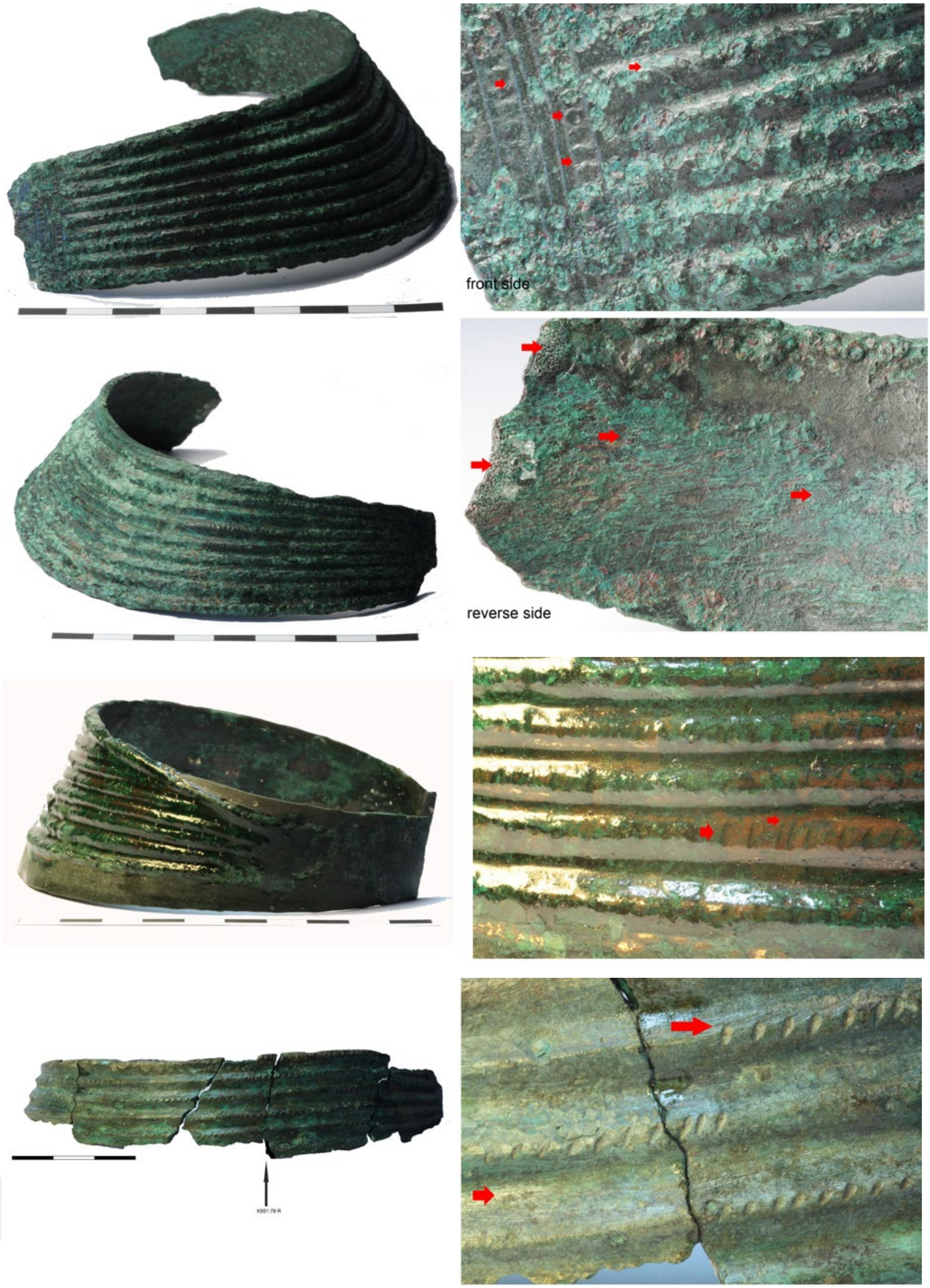

Plate 5:
1) Bidstrup (Sankt Jørgensberg), Jørgens, København – neck collar NM B1568; 2) Bleckmar, Celle, Lower Saxony – neck collar LMN 953:76; 3) Bleckmar, Celle, Lower Saxony – neck collar LMN 851:76.

Sampled at front section, at the lower hem. Microstructure towards the centre displays cloudy large grains, <delta>-phase, copper-sulfide inclusions, shrink-holes, cuprite (corrosion accompanying dendritic structures). Microstructure near the hem and surface shows recrystallised grain structure, strain lines, cuprite, deformed copper-sulfide inclusions. Trace elemental data is presented in Table 3.
Crafting technique: Partly recrystallised as-cast microstructure, it seems as if the lost-wax cast item was annealed at low temperature (Homogenisierungsglühen). The hem was cold-worked and annealed. Strain lines on the rib back indicate final cold-work.

Boldebuck, Rostock (LRO), Mecklenburg
ALM Br.271-292
Schubart 1972: 82ff; Nørgaard 2011: 58-62
'Trielberge' burial mounds, Mound 1, stone setting with female cremation.
NBA III
Neck collar, neck ring, seven different decorated open arm rings, seven tutuli, two leg rings, bronze pin of Weitgendorf-type, sword (tongue handle), spiral rolls
ALM Br.271 – **Neck collar** with three groups of two ribs and intervening smooth areas. The neck collar is covered with a thick patina, which makes it almost impossible to recognise any decoration. A spiral-decoration is partly visible between the rib groups and on the end plates. The spiral rows within the smooth fields are completed by four superimposed semi-circles at height of the transition between ribbed section and end plate. However, an arrow band seems to be missing. The spirals of the end plates are framed by ladder-like notched ribbons. The ends are rolled into narrowing end rolls.
Crafting technique: Lost-wax cast probably with decoration.
ALM Br.281 – Medium-sized **tutulus** with long spike, which concludes with a thickening (ball) at the top. The largest part of the area (except for a seam at the edge) and half of the spike are decorated with parallel grooves, forming a step-like ribbing. The surface is heavily damaged by a blooming patina. On the back, opposite the spike, is a thin round bar that forms the eyelet. The dome-like ribbed section (the foot of the spike) is partly hollow until the base of the massive spike. This tutulus is one of five large identical tutuli, all with ball tip.
Crafting technique: Cast in lost-wax with clay core.

ALM Br.284 – Small **tutulus** with broken spike. The largest part of the area (except for a seam at the edge) and half of the spike are decorated with parallel grooves, forming a step-like ribbing. The surface is heavily damaged by a blooming patina and the tutulus is heavily deformed due to heating. On the back, opposite the spike, is a thin round bar that forms the eyelet.
Crafting technique: Cast in lost-wax with clay core.
ALM Br.285 – Small **tutulus** with long spike, which concludes with a thickening (ball) at the top. The largest part of the area (except for a seam at the edge) and half of the spike are decorated with parallel grooves, forming a step-like ribbing. The surface is heavily damaged by a blooming patina and the tutulus is heavily deformed due to heating. On the back, opposite the spike, is a thin round bar that forms the eyelet. The dome-like ribbed section (the foot of the spike) is partly hollow until the base of the massive spike.
Crafting technique: Cast in lost-wax with clay core.

Bornholm (unknown location), Denmark
NM B2884-B2885
Aner and Kersten 1977: 56; Nørgaard 2011: 80-83
Probably related, from burial mound
NBA III
Neck collar, fibula Bornholm-type
Figures: 3.015; Plate 6
B2884 – Smooth and high **neck collar** with double spiral-decoration on the face side. The two spiral lines (11 spirals at the bottom and seven spirals at the top) are connected by an additional spiral on every side. in between they are connected by single lines. A horizontal decorative ribbon consisting of parallel lines and accompanying, inwardly directed, triangle ribbons separates the spiral rows from one another. The decorative strip is lens-shaped, with an open space in the middle. Above and below the spiral series runs, accompanying another decorative ribbon of five parallel lines that frame a series of opposing triangle ribbons. At the bottom hem (a slightly outwards curved hem) an additional decoration is faintly discernible, consisting of a ladder-like notched ribbon. The same can be found at the top hem. Both decorative ribbons continue until the end rolls, where they form the frame of the end plate decoration. They end in a centrally-aligned triangle of three parallel stacked lines, the tip points towards the collar's centre. The decoration of the end plate is separated by a curved decorative ribbon that is attached to the edge-accompanying decoration at the transition from frontal region to end plate. It consists of parallel lines and triangle strips. A similar curved decorative ribbon is within the centre of the end plate and consists of two parallel lines and a triangle strip. This divides the decoration into two fields. The first field (towards the spiral-decoration) is decorated by four concentric circle groups (three rings) and an edge-accompanying stacked arch series. The smaller, slightly triangular, box towards the end has edge decoration accompanying in each case a series of six arch groups (each consisting of three stacked increasing arches). The end rolls are preserved as small outwards bent rolls.
Crafting technique: Lost-wax cast with decoration (probably spiral-stamp), heavy reworking of decoration.
B2885 – **Bornholm-type fibula** with a pointed oval large plate. The needle is preserved only in fragments and the decorative plate, as well as the attached spiral, is heavily fragmented. The plate is decorated with a wide edge-accompanying decorative ribbon. The ribbon consists of an edge-parallel line, a ladder-like notched ribbon, three parallel lines, another ladder-like notched ribbon, a line, ladder-like notched ribbon, three parallel lines and another ladder-like notched ribbon. Towards the oval inner field, the ribbon is completed through a series of standing triangles. The otherwise empty box is decorated with a series of seven spirals connected with simple lines and slightly increasing in size towards the centre. At the ends of the decorative plate the cast-on needle is visible.
Crafting technique: Lost-wax cast, cast-on spiral and holder, (probably) post-casting decoration.

Bornhöved, Segeberg, Schleswig-Holstein
KS 8021
Splieth 1900: 54; Nørgaard 2011: 54-56
Within stone mound with burned bones
NBA II

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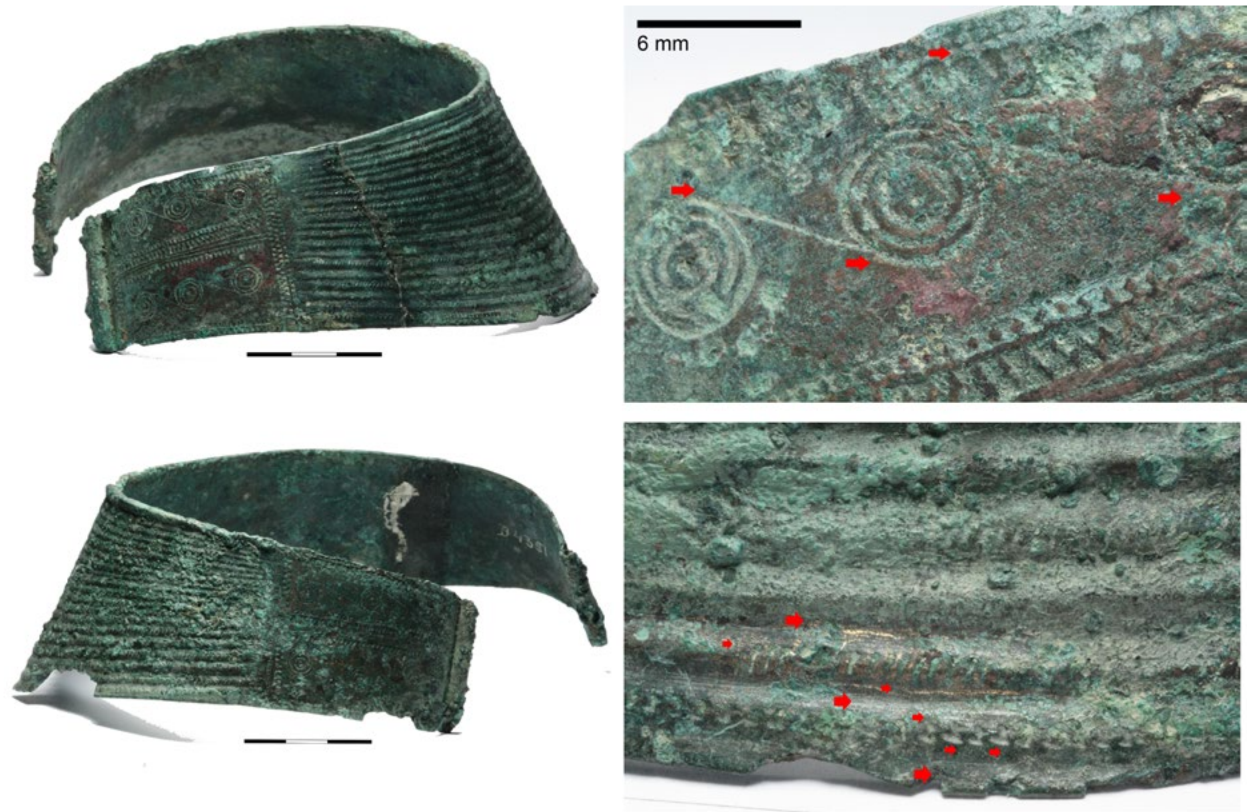

Plate 6:
1) Bornholm, unknown location, Denmark – neck collar NM B2884; 2) Bragergården, Ørslev sogn, Præsto Amt – neck collar NM B4351.

Neck collar, three neck rings, fibula (Kreuzbalken), two awls, six arm rings, four arm rings with stud-ends, bracelet, three tutuli, knife, belt hooks, ceramics, two golden spirals
KS8021b – Fragmentary preserved and reconstructed **neck collar** with three rib groups. The uppermost and the lowest group are each constructed of two ribs. In the middle is, however, only one rib. The intervening smooth areas are decorated with hanging and standing triangles, which are directly applied onto the field-accompanying rib. The ribs terminate at the same position at the transition to the end plate. The decoration of the end plate is introduced with a wide vertical decorative ribbon consisting of two opposing oblique-notch ribbons forming an arrow ribbon, framed in lines. Another vertical oblique-notch ribbon is located just before the (not preserved) end rolls. Both decorative ribbons are interconnected by diagonally running oblique-notch ribbons. These cross each other at the centre of the end plate. The collar has the approaches of end rolls.
Crafting technique: Lost-wax cast with part of the decoration, partly post-casting decoration (triangle).

Bragergården, Ørslev sogn, Præsto Amt
NM B4351-61
Aner and Kersten 1976: 178-179; Nørgaard 2011: 39-40
From burial mound, Sb Nr. 7, inhumation in stone packing
NBA IIIa
Neck collar, two spiral arm rings, three arm rings, spiral finger ring, four double-buttons in pairs, 12 tutuli on leather band, three fragmented fibula, belt hooks, awl, sickle
Plate 6
B4351 – Relatively well-preserved **neck collar** with 20 decorated ribs in a chessboard pattern. The uppermost rib is wider than the others and rounded. A small, smooth hem runs parallel below the lowest rib. The ribs are narrower toward the edge and terminate all on one level on the transition to the end plate. The bottom rib is continuously decorated with a series of very square hourglass-shaped notches, consisting of two triangular punch marks with the tops aligned to each other. The end plate is separated from the frontal area by a vertical decorative band consisting of an hourglass-notched ribbon (similar to the one described) and a series of opposed triangles. A similar decorative ribbon accompanies the top and bottom edge of the end plate. Another decorative ribbon consisting of a notched and a triangle band, two parallel lines and a series of changing triangles divides the end plate in the middle. The resulting two fields, are each filled with three concentric circular groups (each consisting of a groove and three rings), connected with simple lines. The broad end plates end in long, narrow end rolls.
Crafting technique: probably Lost-wax rough cast, post-casting decoration and cold-working.
B4357 – Well-preserved **belt disc** (tutulus) with long extended spike (round in cross section). The spike has a small hemispherical head plate. At the foot of the spike stepped ornamental ribs are wound spirally around the spike and form a conical hump. The stairs decorate the tutulus and are decorated with oblique notches on every second rib-like step. The disc is undecorated and very wide. On the back underneath the steps is a deep groove that ends at the base of the round massive spike. In this groove, a round bar is inserted. On the surface of the back the remains of a leather strap can be detected and within the groove the remains of a probable clay core are preserved.
Crafting technique: Lost-wax cast with clay core, post-casting reworking.

Bredenbeck (Kronsburg), Rendsburg, Schleswig-Holstein
KS 12149
Aner and Kersten 2005: 30; Nørgaard 2011: 54-56
Probably from female burial near Kronsburg
NBA II
KS 12149 – Partially preserved ribbed **neck collar** with undecorated hem below the lowest rib. The nine ribs of the collar are narrow and clearly separated. From the tenth rib the hem emerges. The approximately three-ribs-wide hem is smooth and heavily damaged at the edges due to heavy patination. On the ribs a weak alternating applied notch-trim is recognisable. The ribs terminate at the same position at the transition to the end plates. The end plate is initiated with a vertical decorative ribbon consisting of a vertical arch series and two parallel lines. The remains of a vertical ladder-like notched ribbon are also partly visible. Another decoration is not preserved but possible. On the back of the collar are several layers of organic material visible under the strong patina, as well as patinated grass imprints.
Crafting technique: Lost-wax cast with part of the decoration, partly post-casting decoration.

Bredentin, Rostock (LRO), Mecklenburg
ALM Br.733, Br.738, Br.741
Schubart 1972: 84ff; Beltz 1910: 175; Nørgaard 2011: 58-60
From burial mound with several graves, Grave 3, stone cist and coffin with inhumation
NBA III
Neck collar, neck ring, three different decorated open arm rings, two golden spiral rings, two leg rings, 300 spiral rolls, pin of Weitgendorf type, knife.
Br.733 – **Neck collar**, damaged beyond recognition by patina and heat. The information that this collar is a type Mecklenburg neck collar is taken from Schubart.
Crafting technique: Unknown.
Br.741 – **Weitgendorf-type pin** with disc-shaped head. The pin is heavily damaged through patina and additional heating. There is no metal preserved within the needle (as visible at the broken parts).
Crafting technique: Unknown.
Br.738 – **Spiral leg ring** damaged through patina and heat. The two spirals and the ring are preserved in parts. Under the patina, the line decoration of the spirals and the bar is visible. The diameter of the wire of the spirals increases evenly in width from the inside to the outside. Each spiral consists of nine turns and the connecting bar is oval in cross section.
Crafting technique: Probably forged from an ingot, decorated with chisel-like tools and heavily reworked.

Bringe, Værlose sogn, København Amt
NM B3486
Aner and Kersten 1973: 123; Nørgaard 2011: 45-46
Bog find
NBA II
Figures: 2.085; 2.139; 4.025
B3486 – **Collar** with 18 chessboard-like notch-decorated ribs. The uppermost and lowermost rib are significantly wider, undecorated and slightly protruding. The ribs terminate all on one level on the transition to the end plate and are completed by a vertical zig-zag band. Following this ribbon,

a wide decorative band is placed. This decoration consists of a single line, a ladder-like notched ribbon, two parallel lines and two parallel rows of opposed triangles, two parallel lines, a ladder-like notched ribbon and a single line. This decorative ribbon runs concomitantly as a frame around the end plate. Within this frame are 12 spirals, connected to each other horizontally and vertically, in three rows of four spirals. Towards the end rolls the decoration concludes with a number of lying triangles, placed on the last vertical line, with extended tips. The wide but tightly wound end rolls are fully preserved.
Crafting technique: Lost-wax cast, slight reworking of decoration.

Brøndbyvester (sogn), København Amt

NM B138887-93
Aner and Kersten 1973: 100-102; Nørgaard 2011: 40
Within burial in mound, inhumation in coffin
NBA II
Neck collar, two spiral arm rings, tutulus, belt plate, four small tutuli, teeth
Plate 7
B13888 – **Neck collar** with nine narrow, rounded ribs. The rib-valleys are wide and shallow, with a half-round cross-section. The ribs are decorated with wide cuts (slightly hourglass shaped notches) which leave rectangular bars in between them. The transition to the end plate is initiated with a notched bar. A frame of a notched bar encloses a field of three times three connected spirals. In direction to the (not preserved) end roll a ladder-like notched ribbon (again hourglass-shaped notches) with a series of side-to-side arches is placed. The end plate is preserved but fragmented. The whole collar is covered with a flowering patina, together with the fragmentary preservation of the collar this means an investigation is nearly impossible.
Crafting technique: Probably lost-wax cast with partial reworking of the decoration.

Bülkau, Cuxhaven (form. Hadeln), Lower Saxony

LMN 5552
Bergmann 1970: 145; Nørgaard 2011: 34-35
Bog find
NBA II
Plate 7
LMN 5552 – **Neck collar** with 17 well-profiled ribs. The top rib is decorated throughout with a wide notch decoration. In the following ribs the decoration occurs in a rhythm of two undecorated ribs and a continuous notched rib. The lowest five ribs are alternately notch-decorated with the edge-accompanying rib fully notched. The collar has a consistent width within its frontal part and tapers first towards the end plates within a very short length. The ribs are parallel to the shape of the collar and end at the same position at the transition to the end plate. The short and very narrow end plates are undecorated and end in end rolls. The collar has a nice brown bog patina.
Additional investigation: Metallography (Fig. 2.134; Nørgaard 2015b):
Sampled at upper edge, parallel to the ribs. Microstructure towards the centre shows large grains, <delta>-phase and deformed copper-sulfide inclusions as oblong shrink-holes. Microstructure near the hem and surface displays annealing twins (multiple generations), multiple strain lines, cuprite, oblong deformed copper-sulfide inclusions. Trace elemental data is presented in Table 3.
Crafting technique: Fully recrystallised microstructure with slightly deformed grains and signs of multiple annealing (annealing twins). The difference in grain size is due to an unequal strength of previous cold-work and a varying cooling temperature. Final cold-work is assumable (strain lines). Of importance is also the exceptional high copper amount measured in the sample, an alloy untypical for the Lower Saxony region.

Bustrup, Ramsing sogn, Viborg Amt

NM B11250- B11252
Broholm 1943: Nr.743; Kersten 1936; Nørgaard 2011: 64-66
Burial mound, cremation grave in stone cist
NBA III
Neck collar, neck ring, two ribbed bracelets, tutulus
Figures: 3.003; Plate 7
B11250 – Very poorly preserved **neck collar** with three groups of ribs. The top rib group is only visible at the ends, the rest has disappeared under a highly developed patina. The rib group in the middle consists of two well-rounded ribs with different widths and a semi-circular rib-valley. At the bottom is only one broad, rounded rib which is accompanied by a broad smooth hem. The two smooth fields between the ribs groups are decorated with rib-accompanying hanging and standing triangle ribbons. The end plates are either not preserved or very short. On the left side of the collar two irregular holes are inserted into the short end plate. The fragmentary remains of probably old broken end rolls are present at the end plate.
Crafting technique: Lost-wax cast, post-casting triangle decoration.
B11252 – Large **tutulus** with long pointed spike. The foot of the spike is decorated with stepped ribs up to the middle of the disc. These steps form a dome-like foot from which the long, round in cross section spike rises. The tip of the spike was presumably broken in prehistory. The steps are slightly rounded and undecorated. The rest of the disc, up to the rounded edge, is smooth and undecorated. On the reverse of the spike there is a groove (as deep as the step-like decoration). The bar of the loop is attached to the slope of the groove but does not protrude over the surface.
Crafting technique: Cast in lost-wax, probably with clay core.

Bütow, Mecklenburgische Seenplatte (MSE), Mecklenburg

ALM Br.1204
Schubart 1972: 86; Nørgaard 2011: 33-35
Single find in burial mound
NBA II
Plate 8
Br.1204 – **Neck collar** with nine trapezoidal ribs broken into two parts. The end rolls are only fragmentarily preserved and partially restored. The second, fourth, sixth and eighth ribs are decorated with small notches centrally of the collar. The other ribs have the same decoration toward the end plates. The rib grooves run out into shallow grooves at the transmission to the end plate. The end plates are short, broad and unadorned.
Additional investigation: Trace elemental analysis, data shown in Table 3 (based on Junghans *et al.* 1974).
Crafting technique: Lost-wax cast with a few reworkings (mostly edges).

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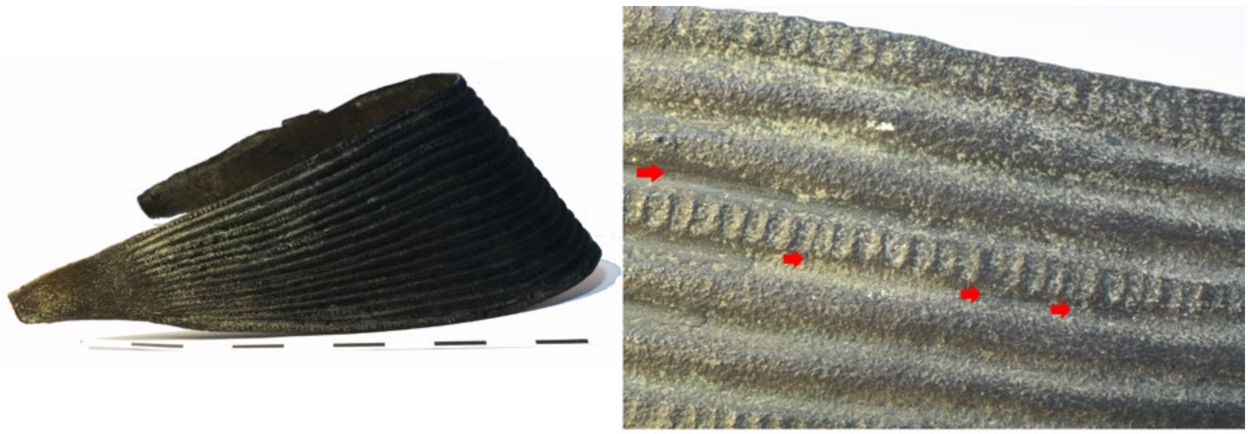

Plate 7:
1) Brøndbyvester (sogn), København – neck collar NM B13888; 2) Bustrup, Ramsing, Viborg – NM B11250; 3) Bustrup, Ramsing, Viborg – NM B11252; 4) Bülkau, Cuxhaven (form. Hadeln), Lower Saxony – LMN 5552.

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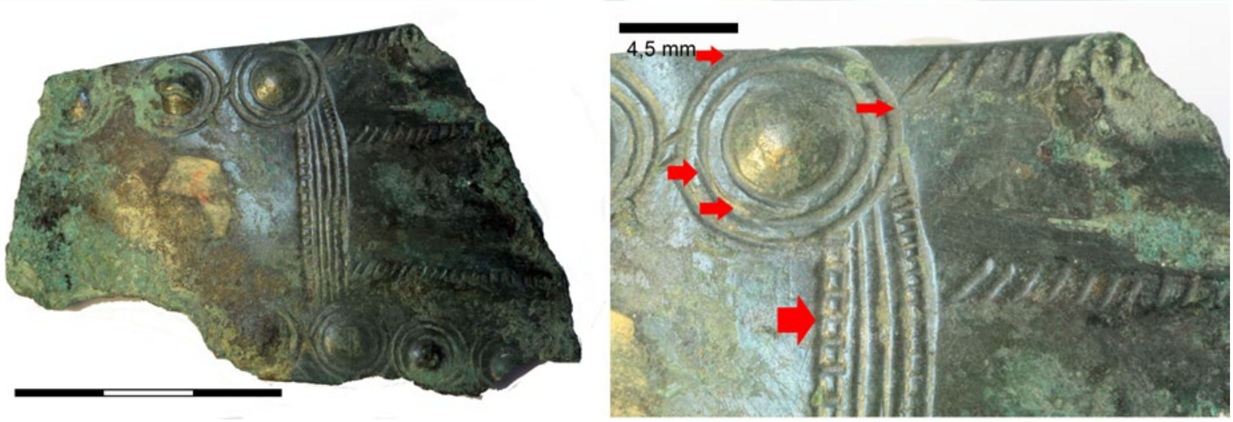

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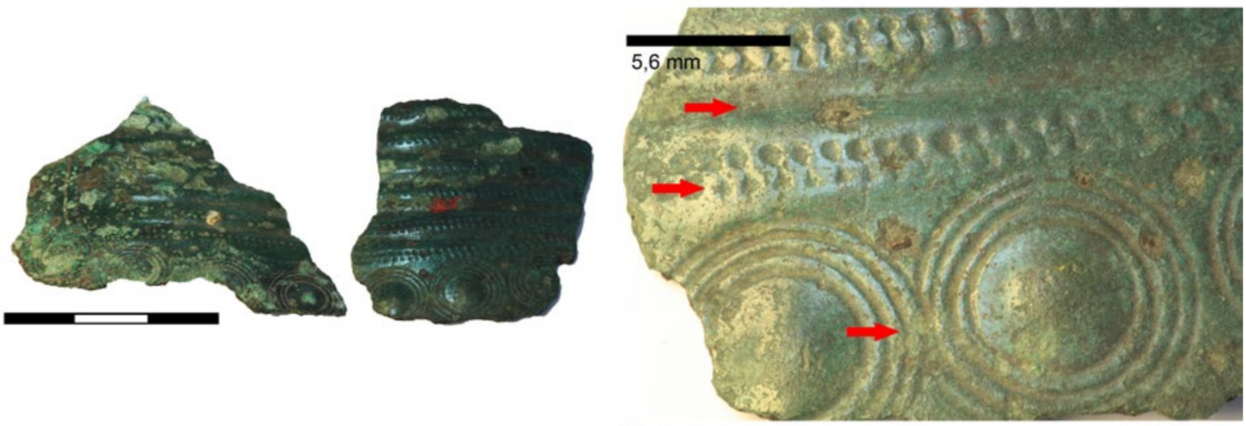

Plate 8:
1) Bütow, Mecklenburgische Seenplatte (MSE), Mecklenburg – neck collar ALM Br.1204; 2) Edendorf, Uelzen, Lower-Saxony – wheel-headed pin LMN 5027; 3) Edendorf, Uelzen, Lower-Saxony – neck collar LMN 14144a; 4) Edendorf, Uelzen, Lower-Saxony – neck collar LMN 14144b.

Dabel, **Ludwigslust-Parchim (LUP), Mecklenburg**
ALM Br.239
Schubart 1972: 88f; Nørgaard 2011: 58-62
Within burial mound, probably mound V, with several graves
NBA III
Neck collar, belt plate, leg ring
Figures: 2.096; 2.113
Br.239 – Heavily damaged **small belt disc** with short rounded spike. The spike is irregularly conical in shape and the foot of the spike rises slightly over the disc. Around the spike is an undecorated area which is framed by a decorative ribbon. The ribbon consists of four parallel lines, a dotted line (round notches), a line and a further dotted line framed in lines. Towards the edge on the outermost line 13 dash-filled triangles are attached. The triangles have a vertical line filling that partly adopts the triangle shape. The tips of the triangles touch a further decorative ribbon consisting of two framed dotted lines. Attached to this decorative ribbon are 17 triangles, with the tip pointing towards the edge. These triangles are larger than the previous examples, filled with vertical line filling and some of the tips are touching the final decorative ribbon. The outermost decorative ribbon consists of a framed dotted line. Towards the rounded and slightly curved upward rim is a wider undecorated hem.
Additional investigation: Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017; 2015a).
Crafting technique: Lost-wax cast, post-casting decoration.

Damerow, **Uecker-Randow, Mecklenburg**
MM IIa 507a
Schubart 1972: 89. Nørgaard 2011: 56-58
Unknown context
NBA III
MM IIa 507a – Six fragments of a **neck collar** with three groups of two notch-decorated ribs. In the fields between each of the rib groups is a spiral series connected with dotted lines. Towards the end plate the spiral series ends in a decorative ribbon consisting of stacked arches framed in lines, which become narrower towards the end plate. The rib groups are connected by multiple curved parallel lines. The end plate is separated from the frontal section by a decorative band of three parallel lines, one framed-in-lines stacked arch ribbon and three other lines. The end plate is framed by ladder-like notched ribbon. In the field thus formed are probably two rows, each of three spirals, connected by dotted lines. The collar is heavily damaged by past deposition and heating (fire at the museum).
Crafting technique: Probably lost-wax cast with reworking.

Drage, **Steinburg; Schleswig-Holstein**
KS 6976c-6976g
Aner and Kersten 1993: 23-24; Nørgaard 2011: 56
Row of burial mound, within mound 4, coffin grave A, with inhumation
NBA II
Neck collar, two spiral rings, bronze sheet, fibula, two arm rings, two tutuli, dagger, amber bead, leg ring.
KS 6976c – Well-preserved **neck collar** with six rounded ribs and an unadorned hemline above the uppermost rib and below the lowest rib. The ribs vary slightly in width and run together towards the short triangular end plate. Accordingly, the ribs are of different lengths. The fourth rib from the top is only visible in the frontal region and ends in a slanted tip. This tip is placed in between the third rib from the top and the second rib from the bottom, which run together at the side of the collar and form a lenticular space between them. Both ribs merge into each other and form an arrow-like end. The closest ribs run parallel to these. The bottom rib is greatly shortened and runs obliquely. Due to the lenticular arrangement of the middle section the width of the ribs at the side is much less than in the middle. The undecorated hem forms a frame around the ribs. The short end plates are undecorated.

Crafting technique: Lost-wax cast, post-casting cold-working and decoration
KS 6976g – Fully but poorly preserved **tutulus** with dome-shaped spike. On the spike weak line decoration is visible, similar to the decoration on the disc surrounding the spike. This decoration probably consists of circumferential ribbons of parallel lines and a ladder-like notched ribbon (hourglass notches). The spike is not entirely of hemispherical shape but has a slightly more domed tip and gently sloping sides. The disc is entirely decorated with a line decoration consisting of two parallel rows of opposed triangle ribbons, directly attached to the foot of the dome, and following two juxtaposed framed in lines hourglass-notched ribbons. A further line decoration is probably parallel to the triangle ribbon and applied close to the spike. On the reverse a round bar is inserted into the hollow spike which is slightly under the height of the surface of the disc.
Crafting technique: Lost-wax cast with cast-on eyelet, pre-cast decoration and reworking.
KS 6976gg – Fully but poorly preserved tutulus with dome-shaped spike. On the spike weak line decoration is visible, similar to the decoration on the disc surrounding the spike . This decoration probably consists of circumferential ribbons of parallel lines and a ladder-like notched ribbon (hourglass notches). The spike is not entirely of hemispherical shape but has a slightly more domed tip and gently sloping sides. The disc is entirely decorated with a line decoration consisting of two parallel rows of opposed triangle ribbon, directly attached to the foot of the dome, and following two juxtaposed framed in lines hourglass notched ribbons. A further line decoration is probably parallel to the triangle ribbon and applied close to the spike. On the reverse a round bar is inserted into the hollow spike which is slightly under the height of the surface of the disc.
Crafting technique: Lost-wax cast with cast-on eyelet, pre-cast decoration and reworking.

Edendorf, **Uelzen, Lower Saxony**
LMN 14144-14145, 5027
Laux 1971: 246; Nørgaard 2011: 56-58
Several artefacts all found in burial mound near Edendorf, stored in the Esstorf Collection
NBA II
Figures: 2.056; Plates 8 and 9
LMN 14144(1) – Fragment of a ribbed **neck collar** which is decorated on the lower flat and wide hem with hump and concentric circle decoration. The six partly very weak ribs are decorated on every second rib throughout with slightly oblique incisions. The top rib is edge-accompanying and notch-decorated. The lower hem has four still preserved humps, which lie in the centre of three concentric circles. The hump-decoration of the seam extends on to the end plate. The end plate is separated from the ribbed section by a vertical band consisting of a ladder-like notched ribbon, three

parallel lines and a ladder-like notched ribbon. At the top of the end plate another similar series of concentric circles, with a hump in the centre of each circle, runs parallel to the lower hump series. The centre part of the end plate is undecorated.
Additional investigation: Metallography (Fig. 2.132; Nørgaard 2015b):
Sampled at font section near the lower hem. Fully recrystallised microstructure with deformed grains. Towards the centre a variable grain size, <delta>-phase (oriented at grain boundaries), deformed copper-sulfide inclusions, lead inclusions (0.5 µm). Microstructure near the surface shows annealing twins and strain lines (several generations), cuprite, copper-sulfide, <delta>-phase. Trace elemental data is presented in Table 3.
Crafting technique: Lost-wax cast artefact with post-casting decoration. The fully recrystallised microstructure with a difference in the grain size and annealing twins indicates an unequal strength of previous cold-work (bulges) and several annealing phases. Especially the hem is heavily cold-worked. The still existing delta-eutectoid inclusions are an indication of a lower annealing temperature that also results in different grain sizes. Strain lines and deformed grains indicate final cold-work.
LMN 14144(2) – Fragments of a ribbed **neck collar** decorated on the lower flat and wide hem with hump and concentric circle decoration. The seven, slightly weak, pronounced ribs are continuously decorated with hourglass-shaped notches, consisting of two separate triangles. The top ribbed section is not preserved. The lower hem has seven humps still preserved, which lie in the centre of four concentric circles. The hump-decoration of the seam extends on to the end plate. The end plate is separated from the ribbed section by a vertical, slightly curved, line which is accompanied to the ribs by a dotted line. The centre part of the end plate is undecorated. On the back patinated fabric residues are visible.
Additional investigation: Metallography (Fig. 2.134; Nørgaard 2015b):
Sampled at upper hem including top rib. Microstructure towards the centre displays cloudy and large grains, partly Cu-rich-dendrites, <delta>-phase and copper-sulfide at the grain boundaries. Microstructure near the surface shows strain lines, annealing twins, cuprite, deformed copper-sulfide inclusions, tin-oxide in <delta>-phase. Trace elemental data is presented in Table 3.
Crafting technique: Lost-wax cast with post-casting decoration. The microstructure reveals a different strength of cold-work within the sample. On height of the rib back, a fully recrystallized microstructure with deformed annealing twins and grains is visible (sign of heavy cold-work and annealing). The grain deformation and multiple strain lines indicate final cold-work.
LMN 14145 – Fragment of a **neck collar** with 11 ribs. The heavily abraded and corroded fragment shows the transition area from the central part to the neck of the collar. The upper hem is strong and rounded, the top three ribs are shorter than the rest. The top rib is edge-accompanying and conjoins early with the shallow seam, towards the end plate. The second rib from above terminates at the side of the central area, forming a lens-shaped groove. The third rib runs a little further towards the end plate, but also stops much earlier than the other, and forms a lens-shaped groove in between the ribs. The other ribs are parallel to the slightly curved edge and are slightly pronounced. The bottom rib is separated from the rest by a particularly wide and deep rib-valley. The collar is unusually thick and strong.
Additional investigation: Metallography (Nørgaard 2015b):
Sampled at transition front section to end. Microstructure towards the centre displays Cu-rich-dendrites, occasionally <delta>-phase, copper-sulfide, lead inclusions (0.5 µm), cuprite within corrosion at the grain boundaries. Microstructure near the surface shows cuprite, copper-sulfide, <delta>-phase. Trace elemental data is presented in Table 3.
Crafting technique: Lost-wax cast. The as-cast microstructure is supported by the cuprite inclusions that accompany the dendritic grain boundaries. Strain lines at the sample edge indicate final cold-work.
LMN 5027 – **Wheel-headed pin** with double wheel decoration. The pin head is placed on top of a round shaft, slightly flattened towards the needle. The head consists of two interlocking rings, associated with two intersecting struts. Following, the inner ring is parted by a cross of a horizontal and a vertical strut. The area between the inner ring and the outer ring, in addition to the four vertical and horizontal struts, is also parted with an additional strut. On top of the needle head, following the line composed by shaft and vertical strut, an eyelet is attached.
Crafting technique: Two-part mould, forged shaft.

Ehlbeck, Lüneburg, Lower Saxony
Collection Becker
Laux 1971: 214; Nørgaard 2011: 54-56
Found in burial mounds at 'Buschberg', in one mound a female inhumation
NBA II (ZG II)
Neck collar, neck ring, spiral rolls, wheel-headed pin, two stud-bracelets, three arm rings, two spiral arm rings, two leg rings
Figures: 2.094; Plate 9
Collection Becker (1) – **Neck collar** preserved in fragments, with eight sharp narrow ribs, broad rib-valleys and a smooth spiral-decorated hem below the lowest rib. The narrow ribs on the back are decorated alternately with an interlocking arrow-like notch ornament. The top and second ribs are decorated throughout, followed by every other rib. The spiral trim on the hem fills it completely. It consists of probably nine spirals, of which seven are preserved. The spirals have a more or less pronounced hump at its centre and are connected with double lines. At the transition to the non-preserved end plate the upper three ribs terminate slightly before the further ribs. The rib-decoration continues on the end plate and connects with the arch-like rib-decoration lying beneath. The following three arches consist of arrow-like notched ribbons integrating with the end plates. A rudimentary two-row spiral-decoration is probably on the end.
Crafting technique: Lost-wax cast, reworking of decoration.
Collection Becker (2) – Good and completely preserved **disc-headed pin** with a curved shaft. The small solid disc head is decorated with six connected spirals (double line connection) around a centrally placed circle ornament. The centrally positioned circle group consists of two rings. The third outer ring is formed by an hourglass-shaped notched ribbon. The ensuing spiral series is applied closely to the central decoration. Towards the edge a decorative band is placed parallel to the edge consisting of an hourglass-shaped notched ribbon, two parallel lines, another an hourglass-shaped notched ribbon and two parallel lines. There is an undecorated area between the rounded slightly frayed edge

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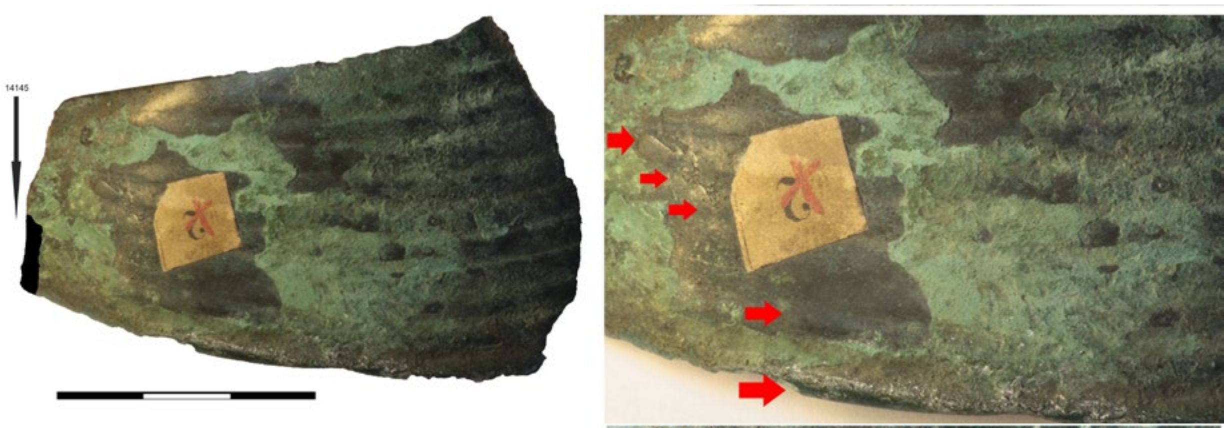

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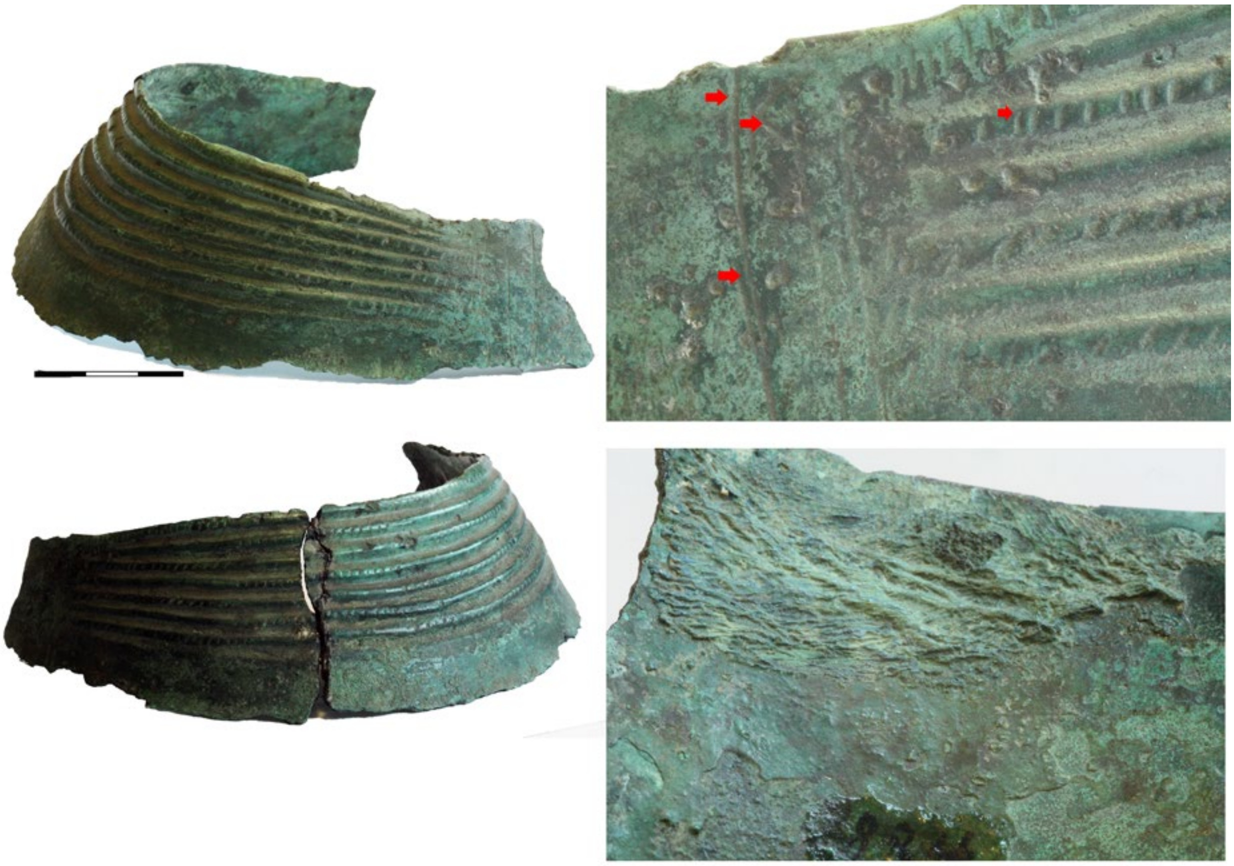

Plate 9:
1) Edendorf, Uelzen, Lower-Saxony – neck collar LMN 14145; 2) Ehlbeck, Lüneburg, Lower-Saxony – neck collar, collection Becker; 3) Eitzen, Uelzen, Lower-Saxony – neck collar ML 884.

and this decorative ribbon. The shaft of the needle is mounted centrally on the back (eventually cast-on) of the head and is bent in a right angle. The massive shaft ends in a significantly tapered tip.
Crafting technique: Lost-wax cast probably with decoration, eventually cast-on shaft.

Eitzen, Uelzen, Lower Saxony
ML 884
Laux 1971: 246; Nørgaard 2011: 54-56
Bought as closed find, unknown circumstances
NBA II (ZG II)
Neck collar, cone-shaped tutuli, spiral arm ring, leg ring
Plate 9
ML 884 – Quite well-preserved **neck collar** with seven ribs and a wide undecorated hem below the lowest rib. The ribs are clearly separated and decorated with a chessboard-pattern notch decoration. The top rib is notch-decorated throughout. The hem develops out of the back of the seventh rib and runs into the end plate were they conjoin. All ribs terminate at the same position at the transition to the end plate. The wide end plates are old, broken and display an irregularly vertical line decoration. In between, the remains of a series of triangles are present. On the reverse of the collar are scattered patinated organic remains.
Crafting technique: Lost-wax cast, probably post-casting cold-working and decoration of the end plates.

Estrup, Ringsted herred, Sorø Amt
NM B11969, B11964
Aner and Kersten 1976: 128-129; Nørgaard 2011: 40
From burial mound with multiple burials, artefacts from stone packing, Grave D.
NBA III
Tutulus, four arm rings, knife, wood and wool, neck collar
Figures: 2.068; 2.078
B11969 – Large **neck collar** with 20 small and closely-spaced, mostly rounded, ribs. The ribs are decorated with irregularly alternating hatching (top with two groups, single group in centre, two groups at bottom). At the transition to the end plate the rib-valleys terminate on different heights. The end plate is framed by a slightly trapezoidal frame of different notch bands and shows large-scale differences depending on the side. The frame consists of two parallel hourglass-shaped notch bands, framed in lines. Inside the frame are nine concentric circle groups, each with four rings and a slightly square indentation in the centre. Towards the end roll the frame is completed with a row of lying triangles, point to the end. These triangles are composed of U-shaped lines (arches) in the form of a running line which is directed towards the end. The end rolls are very tightly curled and are preserved on both sides in large parts.
Crafting technique: Lost-wax cast with parts of the decoration, post-casting decoration.
B11964 – Large **belt disc** with long funnel spike, which shows a stepped foot. These step-like ribs are continued partly on the decorative plate which is rudimentarily preserved. Accompanying the edge the decorative plate consists of a broad undecorated hem. The only decoration is the mentioned stepped conical foot of the spike, which covers a third of the plate. These ribs are decorated with notch groups (they differ in shape from axe-shaped to partly hourglass-shaped). The notches are arranged alternately with intermediate undecorated areas. The rest of the spike is slightly tapered, and undecorated; the end (presumably a small plate) is broken off.
Crafting technique: Lost-wax cast with clay core.

Estrup, Ringsted herred, Sorø Amt
NM B11957
Aner and Kersten 1976: 128-129; Nørgaard 2011: 30-32
From burial mound with multiple burials, artefacts from stone packing, Grave A.
NBA II
Plate 10
B11957 – Six fragments of a **neck collar** with approximately eight ribs. The ribs are evenly rounded and the rib-valleys are characterised as sharp semi-circular to triangular indentations. The ribs are decorated with an alternating chessboard-pattern notch pattern. The end plate of the collar and hem are not preserved.
Crafting technique: Lost-wax cast with reworking.

Eyendorf, Harburg, Lower Saxony
ML H.55
Laux 1971: 195
Stored in the Heintzel Collection, found in burial mound in stone packing
NBA II
Figures: 4.018
H.55 – Half of a well-preserved **belt disc** with a small, slightly conical spike. The short spike is surrounded by an unadorned field that is framed by a decorative ribbon consisting of a dotted line and four parallel lines. In between the latter decorative ribbon and a further decorative ribbon of four parallel lines is a spiral series. This spiral row consists of approximately twelve spirals, connected by double lines. A second spiral series, slightly larger and predominantly one turn wider, is located in between two decorative ribbons of which the outerwards one is edge-accompanying. The decorative ribbon consists of a dotted line and four parallel lines. The spiral series consists of approximately 16 spirals, connected with double lines. Towards the slightly rounded edge is a free undecorated hem. Below the spike a protruding loop is situated on the reverse of the disc.
Crafting technique: Lost-wax cast, post-casting decoration, eyelet with organic core.

Ferslev sogn 'Dansehøj', Frederiksborg Amt
NM B4237-B4238
Aner and Kersten 1973: 36; Nørgaard 2011: 39-40
Found in the 'Dansehøj' burial mound, inhumation in stone packing
NBA IIb
Neck collar, tutulus, fibula ('weidenblattförmiger Bügel')
Figures: 3.003; Plate 10
B4237 – Well-preserved **neck collar** with 14 rounded and partially decorated ribs. The rather large collar has on the rounded ribs (at the edge clearly and centrally less rounded) a decoration of slightly cleaver-like alternating notch groups. However, due to the advanced patina, the decoration is apparent only at a few places. The ribs terminate at the same position at the transition to the wide end plate. The end plate is decorated with a frame decoration, which consists vertically of two parallel lines, five parallel ribbons of opposed triangles and two parallel lines. The horizontal ribbons consist of two series of opposed triangles, each framed in lines. These ribbons run parallel to the edge until

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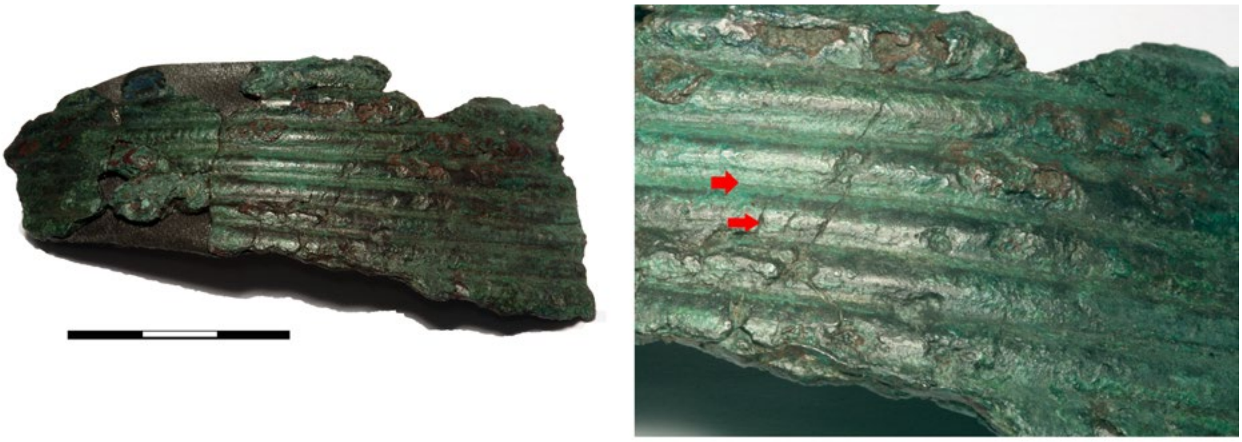

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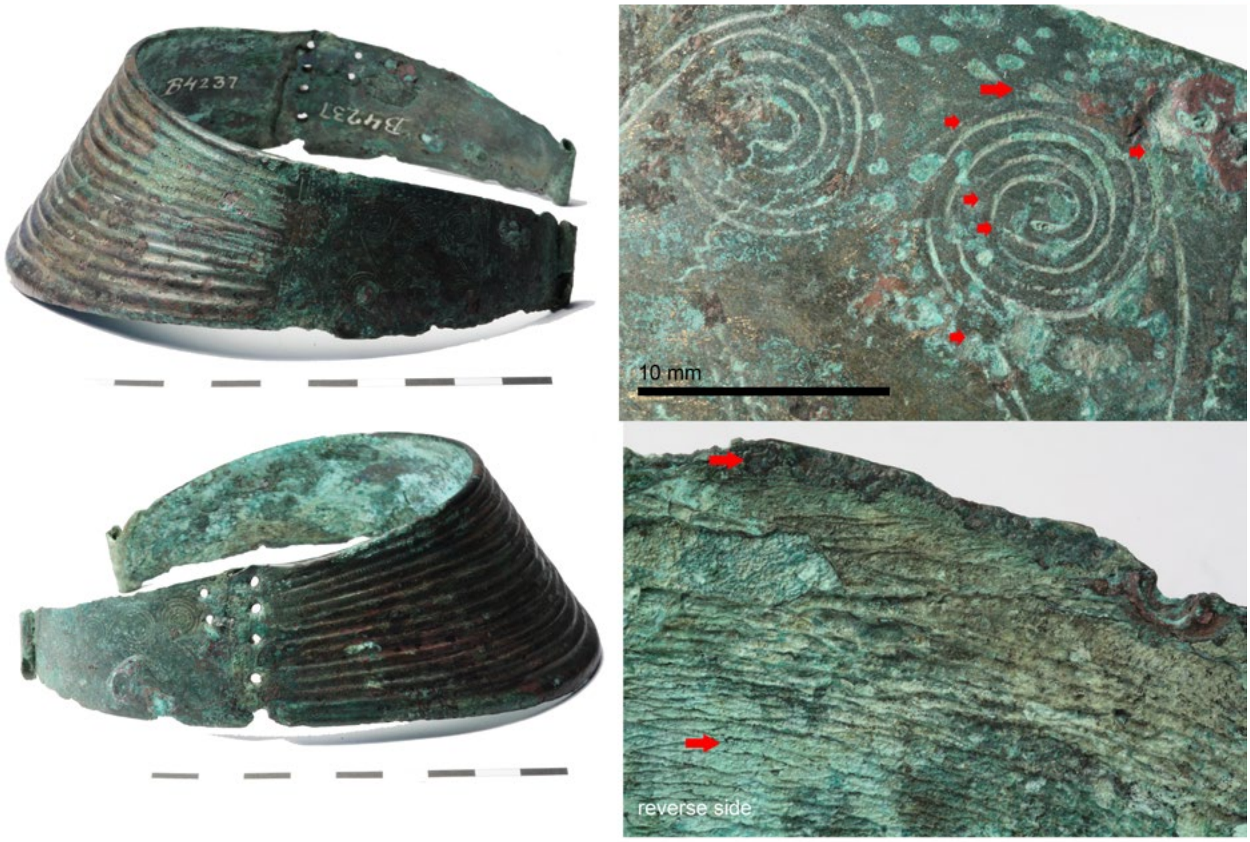

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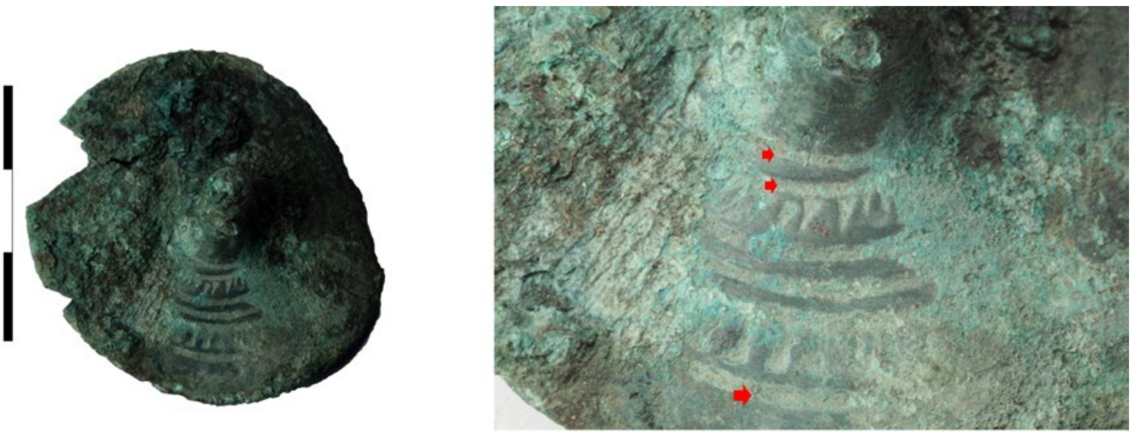

Plate 10:
1) Estrup, Ringsted herred, Sorø Amt – neck collar NM B11957; 2) Ferslev 'Dansehøj', Frederiksborg – neck collar NM B4237; 3) Ferslev 'Dansehøj', Frederiksborg – tutulus NM B4238.

shortly before the end where they are terminated by a vertical ribbon. This consists of one or two parallel lines, two groups each of three opposed triangle series, a wide ladder-like notched ribbon with hourglass-shaped notches and a parallel line. Within this decorative frame another frame is placed formed by a single line (not preserved on all four sides) which is accompanied in the vertical by a series of standing triangles. Inside the described frame are six spirals which are horizontally and vertically connected with double lines and are probably framed on both sides by an arc. The end rolls are rolled outwards and are as wide as the end. On the back of the collar fabric structures are present under a strong blooming patina.

Additional investigation: Photographic documentation of fabric residues under the patina.

Crafting technique: Lost-wax cast (possibly with decoration), intense reworking and repair of decoration and shape.

B4238 – Small, flat **tutulus** heavily covered by a blooming patina despite a small area. Also, the conical spike with rounded tip is severely damaged by the patina. Around the bottom of the spike runs a decorative strip formed by a single line, a ladder-like notched ribbon (the notches are long plated triangles placed on the inner line), two parallel lines and a band of adjacent hourglass-shaped notches and finally a sunken line. The hem is flat and undecorated. The tutulus is perfectly flat on the reverse and the eyelet is mounted below the spike. It consists of a wide bar, oval to round in cross section, through which a hole is pierced. Under the patina residues of leather and fabric structures residues are visible.

Crafting technique: Lost-wax cast with core, presumably decorated model.

Frankerup, Eggeslevmagle sogn, Sorø Amt

NM CMXII-CMXIXA

Aner and Kersten 1976: 156; Nørgaard 2011: 49-51

Bog deposit

NBA II

Two large belt plates, neck collar, two large spiral arm rings, two spiral rings, sickle, bracelet with spiral end.

Figures: 2.050; 2.075; 2.082; 3.002; 4.027

NM CMXIV – **Neck collar** with 11 chessboard-pattern notched ribs. Attached to the top and below the bottom rib is a narrow plain hem. The ribs terminate at the same position at the transition to the end plate. The wide end plate is decorated with four connected spirals. The spirals are framed by a curved decorative band. On the side facing towards the ribs the decorative ribbon is composed of a ladder-like notched ribbon, a row of opposed triangles and another notched ribbon. The decoration of the right end plate differs from that of the left side (here are two rows of opposed triangles). Towards the end rolls the decorative ribbon consists of two parallel lines, a ladder-like notched ribbon, and two further parallel lines. Attached to this curved bar are five lying triangles, filled with an alternating hatch pattern. The triangles have long tapered ends. The completely preserved end roll on the right is slightly shorter than the one on the left side.

Crafting technique: Lost-wax cast (probably stamped spiral), slight reworking of decoration, cold-working of ends.

NM CMXII – **Large belt plate** with long undecorated spike. The conical spike is placed on a rounded end plate and is initiated by three step-like grooves. On the back, below the spike, is a round plate attached with rivets which has a protuberant bar with flattened ends forming the eyelet. Around the spike is a decorative band consisting of two parallel opposed triangle ribbons, ladder-like notched ribbon, and a single line to which a series of hanging triangles is attached. The first spiral series consists of 13 spirals, each with six turns. The end of each spiral touches the next spiral and thus forms a double connecting line. The decorative ribbon parting this series from the next consists of a series of standing triangles placed on a line, three parallel rows of opposed triangles and another line to which hanging triangles are attached. This spiral series consists of 17 spirals of eight coils which are connected in the same way as the former series. The following decorative strip is composed of two parallel lines on which a series of standing triangles is placed, a ladder-like notched ribbon, four interlocking diamond notch ribbons and again a ladder-like notched ribbon and two parallel lines with attached hanging triangles. The outermost spiral row consists of 22 spirals each of ten turns and a double connection line. This series is separated from the seam by a decorative ribbon consisting of standing triangles placed on two parallel lines, a ladder-like notched ribbon, six interlocking diamond notch ribbons, a ladder-like notched ribbon, and two parallel lines. The smooth hem shows a few cracks.

Crafting technique: Lost-wax cast (stamped spirals), slight reworking of decoration, cast-on spike, reparation.

NM CMXIII – **Large belt plate** with a long conical spike, which is decorated with 13 grooves up to the half-length of the spike. The top part of the spike is smooth and ends in a flat area with rounded edges. The spike is old, broken and re-attached to the plate with several rivets. On the reverse below the spike a groove is visible within the spike, and above is a round bar with flattened ends attached. Around the spike a spiral-like line, with a small distance in between the lines, is placed, which devolves into a decorative strip consisting of a ladder-like notched ribbon, seven parallel lines, and a further ladder-like notched ribbon. The first spiral series consists of 12 spirals, connected with a double lines. Each spiral consists predominantly of six turns (occasionally also five turns). The decorative ribbon that separates this spiral series from the next is comprised of a ladder-like notched ribbon, six parallel lines and another ladder-like notched ribbon. The second spiral series consists of 18 double-linked spirals, each with six to seven turns. The decorative band which separates them from the last row is similar to the previously built up ladder-like notched ribbons and parallel lines. The last row has 20 spirals, connected with double lines. The number of turns of the spiral varies from eight to nine turns. Between this spiral series and the undecorated broad hem is a decorative ribbon consisting of a ladder-like notched ribbon, six parallel lines and another ladder-like notched ribbon.

Crafting technique: Lost-wax cast (probably stamped spirals), reworking of decoration in model and cast, reparation.

Friedrichsruhe, Ludwigslust-Parchim (LUP), Mecklenburg;

ALM Br.149.17-24

Schubart 1972: 94ff.; Nørgaard 2011: 58-62

From the 'Kannensberg' burial mound , stone hill at the southern part of the hills, cremation

NBA III

Neck collar, two neck rings, spiral ring, gold wire, 21 blue glass beads, 101 amber beads

Figures: 2.085

Br.149.17 – Spiral-decorated **neck collar** with three groups of two notch-decorated ribs. The regular notches extend

over the entire, slightly triangular rib and have slightly broadened ends (presumably the notches consist of slope-accompanying dots connected with notches). In each smooth field is a spiral series (connected with dotted lines) that increase in size slightly towards the centre. The top row consists of 13, the lower row of 15 spirals. Towards the ends the spiral rows are framed by four superimposed curved lines. The vertical decorative ribbon that separates the end plate from the ribbed section is not preserved. However, the end plate decoration consists of two superposed rows each of three spirals which are horizontally connected by dotted lines. Towards the preserved end rolls a vertical decorative ribbon of four parallel lines, a ladder-like notched ribbon and parallel lines is visible.
Additional investigation: Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017; 2015a).
Crafting technique: Lost-wax cast with decoration (spiral stamp), reworking of decoration.

Friedrichsruhe, Ludwigslust-Parchim (LUP), Mecklenburg
ALM Br.149.25-38
Schubart 1972: 94ff.; Nørgaard 2011: 64-66
From the 'Kannensberg' burial mound , stone hill at the southern part of the hills, cremation towards the east
NBA III
Neck collar, bronze pin, pin of Weitgendorf type, three neck rings, five arm rings, ring, probably leg ring (spiral plates), dagger, gold wire, 73 amber beads
Plate 11
Br.149.25 – **Neck collar** with three groups of two ribs and intervening smooth fields. The ribs are decorated with a narrow notch decoration, which increases in its length towards the end. The spaces between the ribs are flat and partly very wide. Within the grooves runs a series of dots parallel to the ribs. The smooth fields between the rib groups are decorated with three rib-accompanying lines, two opposed triangle ribbons and a dotted line in the centre. The field decoration terminates towards the end plates in three parallel curved lines, which are accompanied inwardly by two dotted lines and outwardly only by one dotted line. A vertical decorative ribbon consisting of three times four parallel lines and an opposed triangle ribbon separates the decoration of the end plate from the one on the ribbed part. The end decoration, however, is only sporadically visible. A similar vertical decorative strip probably separates the main field from the end rolls. In between there are probably four connected spirals.
Additional investigation: Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017: 2015a).
Crafting technique: Lost-wax cast with parts of the decoration, partly post-casting decoration or reworking.

Gerdrup, Kirkerup sogn, København Amt
NM B11452-63
Aner and Kersten 1973: 173; Nørgaard 2011: 87-88
Burial mound row, within one mound a stone cist with multiple inhumations (six skulls)
NBA II
Bone awl, animal teeth, two amber beads, neck collar, belt plate, large belt plate
Figures: 2.049; 2.084; 4.023
B11458 – Fragmentary preserved **neck collar** fixed on a glass plate and decorated with a spiral and hump ornament. The thin collar is decorated along the edge with a wide decorative ribbon consisting of a ladder-like notched ribbon, two parallel lines and another ladder-like notched ribbon. Towards the rounded end is a small free hem. This decorative ribbon frames the face side of the collar. Towards the end plate the ribbon is parted and a smaller ribbon consisting of a ladder-like notched ribbon and a parallel line which is continuous into the end plate. Another part of the ribbon separates in a curve the end plate from the face side of the collar. This ribbon consists of a ladder-like notched ribbon. The field in between the decorative frame is filled with a spiral series (top) of ten spirals which are connected with simple lines. At the bottom is a series of ten humps embedded in two concentric circles. Spirals and circle groups decrease in their size towards the end. The end plate is completely filled with a line decoration consisting of hatched ribbon, a ladder-like notched ribbon, a hatched ribbon, and two ladder-like notched ribbons in repetition. This line decoration follows the curved form of the ribbon between the face side and end plate until the end. The edge-accompanying frame unites just before the end of the triangular end plate in a nice round form. The end plate has a pointed round conclusion in which a hole is inserted.
Crafting technique: Lost-wax cast with parts of the decoration, partly post-casting decoration.
B11459 – Central fragment of a large belt plate. The long slightly conical spike ends in a rounded tip and is decorated with several line groups. The lowest group contains eight lines and the group at half the height of the spike contains six lines. The tip is undecorated. The undecorated foot of the spike is framed by a decorative ribbon of three parallel ladder-like notched ribbons whose boundary lines are inserted very deeply. The notches of the ladder-like notched ribbon consist of two opposed pointed triangles. The three ladder-like notched ribbons are accompanied towards the spiral-decoration by a single line. The first of the probably two or three spiral series contains ten spirals, connected with double lines. This series follows a decorative ribbon consisting of a single line, three ladder-like notched ribbons and a line. The further decoration of the disc is unknown. On the reverse an eyelet is placed on the slope of the hollow spike.
Crafting technique: Lost-wax cast with decoration (spiral-stamp), ceramic core, reworking.
B11459,2 – **Central fragment of a large belt plate**. The long slightly conical spike ends in a rounded tip and is decorated with line groups. The line group at the bottom contains five lines. The tip and the rest of the spike are undecorated. Around the foot of the spike is a small undecorated area which is framed by a decorative ribbon consisting of a line, four parallel ladder-like notched ribbons whose boundary lines are inserted very deeply and separated from each other by an extra line. The notches of the ladder-like notched ribbons consist of hourglass-shaped notches. The first of the probably two or three spiral series contains approximately 15 spirals, which are connected with double lines (only five spirals are preserved). It can be assumed that the spirals have approximately six turns. The eyelet applied to the back is located just opposite the spike and is placed on the disc using cast-on technique. The roughly shaped loop consists of a wide bar and plate combination with a coarse line decoration.
Crafting technique: Lost-wax cast with decoration (spiral-stamp), cast-on spike and eyelet, reworking.

Gielow, Mecklenburgische Seenplatte (MSE), Mecklenburg

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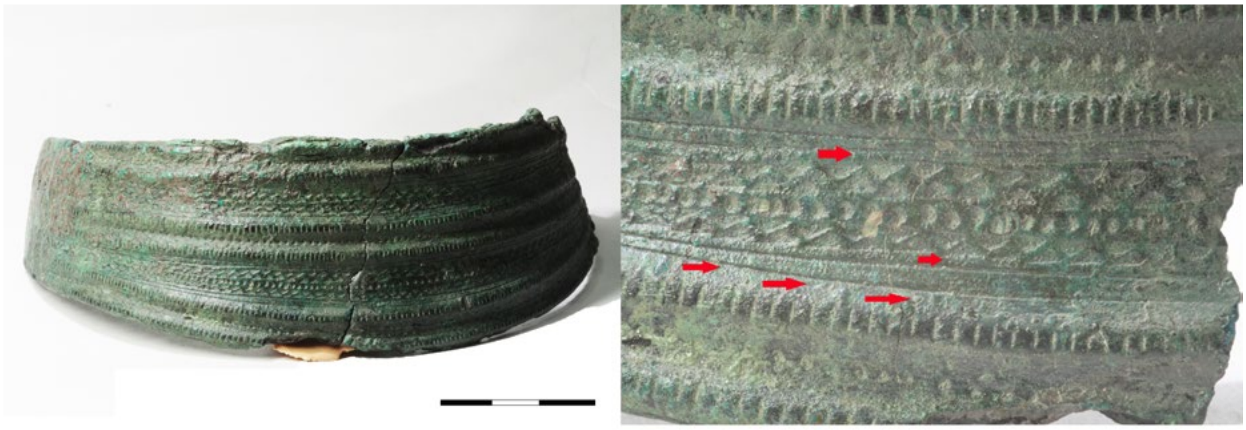

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Plate 11:
1) Friedrichsruhe, Ludwigslust-Parchim (LUP), Mecklenburg – neck collar ALM 149.25; 2) Gielow, Mecklenburgische Seenplatte (MSE), Mecklenburg – neck collar WA IV/64/561b; 3) Gielow, Mecklenburgische Seenplatte (MSE), Mecklenburg – arm ring WA IV/64/561c and d.

Staatliche Museen zu Berlin WA IV/64/561
Schoknecht 1965: 109; Nørgaard 2011: 62-64
Found in urn burial with stone protection near gravel pit
NBA III
Urn, neck collar, two arm rings, bronze button, bronze sheet, burned bones
Plate 11

WA IV/64/561b – Fully preserved **neck collar** with three groups of two triangular ribs. Between the rib groups in the smooth fields is a decoration consisting of two opposed triangle ribbons. These are rib-accompanying and leave a small lenticular gap in the middle of the field. At the transition to the end plate, each rib is concluded by a lying cross (following six superimposed crosses). A vertical decoration consisting of four parallel lines, two opposed oblique notched ribbons and three parallel lines forms the separation between the section of the collar and the end plate. The decoration of the end plate is attached to this vertical ribbon. It consists of two horizontal decorative ribbons, each designed of three parallel lines, an opposing triangle ribbon (towards the edge) and a line of triangles (towards the other ribbon). The resulting open field in the centre of the end plate is undecorated. This horizontal decoration ends similarly to the first in a vertical ribbon just before the end rolls.
Additional investigation: Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017; 2015a)
Crafting technique: Lost-wax cast with decoration (triangles), partly post-casting decoration.

WA IV/64/561c – Probably line-decorated **open arm ring**. The arm ring is heavily damaged by corrosion. It has a sharp lenticular cross section and the edges are only slightly rounded. The arm ring is of interest due to its partly polished (modern) surface.
Additional investigation: Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017; 2015a).
Crafting technique: Probably forged from an ingot.

WA IV/64/561d – Probably line-decorated **open arm ring** (broken into two parts). The arm ring is heavily damaged by corrosion. It has a sharp lenticular cross section and the edges are only slightly rounded. The arm ring is of interest due to its partly polished (modern) surface.
Additional investigation: Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017; 2015a).
Crafting technique: Probably forged from an ingot.

Gjedsted 'Hverrehus', Viborg Amt

NM B13259-B13260
Broholm 1943: Nr. 728; Broholm 1940: 117; Nørgaard 2011: 80-83
Found in burial mound near bank, inhumation in wooden coffin
NBA II
Neck collar, belt plate, 14 tutuli, dagger, bronze comb, four bracelets with middle rib and spiral ends, bronze rolls
Figures: 2.076; 2.086; 4.050-51

B13259 – **Smooth neck collar** with outwardly bent edges and triangular converging end plates. The face side of the collar is decorated with an edge-accompanying wide decorative ribbon consisting of a notched ribbon framed in lines (hourglass-shaped notched composition of opposed triangular imprints), three parallel lines and another notched ribbon framed in lines. In the centre of the face side there are two ladder-like notched ribbons (consisting of hourglass notches). The bands are separated in the middle by an undecorated space and run towards the ends together. From this decoration a line rises which surrounds the spiral trim above and below in a semi-circle. The undecorated field in between the ladder-like notched ribbon is lenticular. Over and under the decorative band there is a spiral series consisting of different kinds of spirals. The top row is made of 12 spirals connected with double lines. The bottom row consists of 13 double spirals, which are connected with double lines (the extra point upwards and downwards). A vertical decorative ribbon is at the transition to the end plate, consisting of three parallel lines and an opposed triangle ribbon. The end plate is decorated by repetitive vertical decorative bands consisting of parallel lines, opposed triangle ribbons and notched ribbons with intermediate undecorated fields (all three undecorated boxes). On the back of the collar a large area is covered by patinated fabrics.
Additional investigation: Photographic documentation of fabric residues under the patina.
Crafting technique: Lost-wax cast with decoration, post-casting reworking and cold-working of the ends.

B13260 – Very well-preserved **large belt disc**, with a long cone-shaped spike which is decorated with grooves at the bottom and in the middle. The spike ends in a rounded tip and is decorated with two groups of five grooves. At the bottom of the spike are the first five parallel grooves, the others are half way to the top. Around the spike is an undecorated area framed by a decorative ribbon consisting of a ladder-like notched ribbon, three parallel lines, an opposed triangle ribbon, three parallel lines and a ladder-like notched ribbon. This line decoration is followed by a spiral series, consisting of 12 smaller spirals which are framed in pair in an oval line frame. The connection between the spirals within the frame has a single line and the connection line from oval to oval is a double line. The spiral series is separated from the next one by a decorative ribbon, which consists of a single line, an opposed triangle ribbon, two parallel lines, an opposed triangle ribbon, two parallel lines and an opposed triangle ribbon. The second spiral series is larger and is composed of 24 spirals, all connected with single lines and grouped in twelve pairs framed in an oval line frame. The following line decoration is identical to the previous one. The ensuing spiral series is made of 30 spirals, again framed in pairs in oval line frames. The connection between the spirals within the frame has a single line and the connection line from oval to oval is a double line. The last spiral series is separated from the edge by a ladder-like notched ribbon, three parallel lines, an opposed triangle ribbon, three parallel lines and a ladder-like notched ribbon. Following are three incised edge-accompanying grooves. On the back is a protruding loop over a flat groove under the spike.
Crafting technique: Lost-wax cast with decoration (spiral-stamp),reworking or partly post-casting decoration.

Glæsborg, Nørre herred, Randers Amt

NM B9530- B9542
Kersten 1936: 121; Nørgaard 2011: 49-51
Hoard
NBA II
Neck collar, two spiral arm rings, spiral finger ring, two small belt discs, spike disc, 19 small tutuli, sword blade, three sickles, socketed axe, socketed chisel, four spear heads, saw, fragments of sickles.
Figures: 2.073; 2.085; 2.087; 2.111; 2.140

B9531 – **Neck collar** broken into several parts. A large piece with remains of the end plate decoration is present, and a large piece of the frontal ribbed section. The collar has nine well-profiled chessboard-pattern decorated ribs. At the corners of the chessboard-pattern decoration the exchange takes place with slight overlap. The rib-decoration consists of hourglass-shaped impressions which presumably consist of two composite triangular impressions. The second rib from the bottom is decorated throughout. The ribs terminate at the same position at the transition to the end plate and the rib-decoration runs a little beyond this. On the end plate is an ornament of four real spirals, framed in a preserved arched line. In the horizontal the spirals are connected to each other.
Crafting technique: rough Lost-wax cast, post-casting decoration.
B9532 – Poorly preserved **neck collar** broken into several parts. Preserved are a large piece of the frontal ribbed section and another larger fragment of the end plate. The collar has nine well-profiled ribs on which the remains of a chessboard-pattern decoration consisting of rod-like impressions is visible. The end plate has the remains of an ornament that probably consisted of four spirals framed by arched lines. Horizontally, the spirals are connected to each other. The superposed spirals show no connection line, however, they are very close together.
Crafting technique: Rough lost-wax cast, post-casting decoration.
B9530 – Highly fragmented **large belt plate** with a long unadorned spike. The disc is decorated with three spiral rows, framed by decorative bands. The final decorative ribbon, which separates the wide and slightly curved upwards hem from the spiral-decoration, consists of a ladder-like notched ribbon, three parallel lines and another ladder-like notched ribbon, which is set in lines. The outermost spiral series consists of an unknown number of spirals, connected with double lines. The separation to the next spiral row is formed by a decorative band of three superimposed rows of opposed triangles framed in a line. The middle spiral series differs only in size from the outermost one. The following decorative ribbon is constructed in accordance with the previous one. The innermost and third spiral row consists of 12 spirals connected with double lines. At the foot of the spike are two deep parallel lines that initiate the circumferential decorative band. The wide band separates the spike from the smallest spiral row and consists of a ladder-like notched ribbon (built of hourglass-shaped notches), another notched band, four parallel lines, a further ladder-like notched ribbon and finally two parallel lines.
Crafting technique: Lost-wax cast, post-casting decoration.
B9534 – **Small belt disc** with a short, funnel-shaped and wide spike. The disc is damaged at the edge. Around the spike, a decorative band is placed consisting of two parallel lines, a ladder-like notched ribbon and two parallel lines. The spike itself is undecorated and rounded at the tip. Between the decorative ribbon which surrounds the spike and the edge-accompanying decorative ribbon, consisting of two parallel lines and a ladder-like notched ribbon, there is a series of interconnected spirals. The eight spirals are of different size and shape and connected with double lines. On the back of the disc under the partly hollow spike is a small flat bar which forms the eyelet.
Crafting technique: Lost-wax cast with clay core, post-casting spiral-decoration.

B9535a – **Small belt disc (or tutulus)** with a decoration of two parallel lines right on the foot of the spike. This is followed by a series of rectangular to oval-shaped impressions (which can be compared with shoe prints), three parallel lines, another similar notched ribbon with shoe-like imprints, three parallel lines and another notched ribbon. The decorative ribbon is ended by an incised line. Between the decorative ribbon and the rounded edge is placed a smooth, approximately 5 mm wide, undecorated hem. The funnel-shaped spike is undecorated and has an irregular, rounded tip. On the back, at the height of the spike, a slightly tailored bar is placed above a groove within the spike. The bar does not protrude from the disc surface.
Crafting technique: Lost-wax cast, reworking of decoration.
B9535b – **Small belt disc (or tutulus)** with a decoration of four parallel lines on the foot of the spike. This is followed by a series of rectangular to oval-shaped impressions (which can be compared with shoe prints), five parallel lines, another similar notched ribbon with shoe-like imprints, four parallel lines and a further much wider notched ribbon. The decorative ribbon is ended by two parallel incised lines. Between the decorative ribbon and the rounded edge is placed a smooth and undecorated hem. The funnel-shaped spike is undecorated and has an irregular, rounded tip. On the back, at the height of the spike, a slightly tailored bar is placed above a groove within the spike. The bar arches over the shallow groove.
Crafting technique: Lost-wax cast, reworking of decoration.
B9542 – **Small belt disc** with a short, wide and nicely rounded spike. On the back of the disc below the spike is placed over a shallow groove a curved bar which forms a small eyelet. The plate is decorated with interconnected, concentric circle groups. This series of six groups, each of four rings with a slightly triangular groove in the middle, is connected by double lines. Each circle group differs from the other in distance and depth of the circles. Between the smooth and undecorated hem and the circle decoration is a decorative ribbon. This ribbon consists of five parallel lines, which are accompanied by a band of triangles. The tips of the triangles point to the line group. They lie on a sixth line, which is apparent in the gaps and might be a construction line.
Crafting technique: Lost-wax cast, heavy reworking of decoration.

Gollern, Uelzen, Lower Saxony

LMN 4753
Laux 1971: 248
Probably related to the ‘Osterberg’ burial mounds.
NBA II
Figures: 2.047
LMN 4753 – **Small belt disc** with two spiral rows connected with double lines. The spirals are quite regular in size and shape, however, the distance between them varies slightly. In the centre of the disc is a broad conical spike, which terminates in a rounded tip. Around the spike is an undecorated area that is framed by a decorative ribbon of four parallel lines and a notched ribbon (hourglass-shaped notches). Another similar decorative ribbon of hourglass-shaped notches and five parallel lines separates a narrow undecorated field of the first spiral series. This consists of fourteen spirals. The small spirals are connected with double lines and are separated from the next spiral series of 20 of similar size by a further decorative ribbon. This consists of an hourglass-shaped notched ribbon and six parallel lines.

An edge-accompanying decorative ribbon of seven parallel lines separates the spiral series from an undecorated smooth hem and the rounded edge of the disc. On the back of the disc opposite the spike is a protruding loop, composed of a round in cross-section arched bar.
Crafting technique: Probably lost-wax cast and partly post-casting decoration, cast-on spike.

Grabow (municipality), Ludwigslust-Parchim (LUP), Mecklenburg
ALM LIIQ,8
Kersten 1936: 121; Nørgaard 2011: 49-51
Unknown
NBA III
Plate 12
ALM LIIQ,8 – Well-preserved **neck collar** broken into four parts. The individual parts are damaged to some extent. The collar has a beautiful, partly yellowish patina. The frontal section is decorated by three groups of two notched ribs. In between the pairs of ribs are two smooth fields decorated each with one row of seven dots and connected spirals. The valleys between the ribs are exceptionally wide and deep. The spiral series is completed towards the sides by a framed-in-lines arch ribbon, which is terminated by several curved lines which reach from rib to rib, framing the smooth field. The end plate is framed by a decorative ribbon consisting of oblique notches and separated vertically from the ribbed section by notched ribbon and additional parallel lines. The six spirals in between the frame on the end plate are horizontally interconnected by dotted lines. Vertically the spirals overlap almost, so that it seems as if there are two connected spirals. Towards the end the badly damaged remains of another vertical decorative ribbon of three parallel lines, a curved ladder-like notched ribbon, three lines and ladder-like notched ribbon can be assumed. Additionally a decoration of parallel placed arch-like lines is visible close to the end rolls.
Additional investigation: Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017: 2015a).
Crafting technique: Lost-wax cast with decoration, heavy post-casting reworking of decoration.

Grabow (municipality), Ludwigslust-Parchim (LUP), Mecklenburg
ALM LI H16
Schubart 1972: 104
Probably related to burial mounds near Grabow
NBA II/III
Figures: 2.041-42; 2.075; 3.002
ALM LI H16 – Fragment of a slightly curved **belt plate** with spiral-decoration. Within its centre is a tall, conical spike with a rounded tip. The spike is placed on a round podium decorated with two parallel lines, a ladder-like notched ribbon and three parallel lines. Spike and plate were added post-casting and are connected to the eyelet on the back. The decoration on the podium continues on the disc, consisting of three parallel lines, a ladder-like notched ribbon (hourglass-shaped notches) and three parallel lines. The following spiral series consists of probably 11 spirals connected by double lines. Another decorative ribbon follows this series. It consists of three parallel lines, a ladder-like notched ribbon (hourglass-shaped notches), three parallel lines, ladder-like notched ribbon (hourglass-shaped notches) and three parallel lines. The next spiral series probably consists of 20 connected spirals. A final decorative ribbon, similar to the one in the middle separates the outermost spirals from the slightly convex edge.
Additional investigation: Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017: 2015a).
Crafting technique: Lost-wax cast with decoration (spiral-stamp), reworking of decoration.

Handewitt, Flensburg, Schleswig Holstein
KS B145-1
Aner and Kersten 1978: 36; Nørgaard 2011: 66-69
Burial mound with several graves, in Grave A a wooden coffin with cremation of two individuals
NBA III
Neck collar, tutulus, arm ring, neck ring, fibula
KS B145-1a – Very well-preserved **neck collar** with three groups of two ribs. The ribs are decorated on the upward facing slope of every rib with deep and long notches. However, the upper rib pair deviates from this rule. Here the decoration of the top rib is placed on the inside slope so that the two notched rows abut within the rib-valley. The decoration captures the light very well and achieves a strong effect. The smooth fields in between the rib groups are undecorated. The ribs terminate all at the same position at the transition to the end plate. The end plates are probably undecorated and end in small broken end rolls. One of the ends has been subject to historic repair. Here a hole is inserted instead of the broken end roll.
Crafting technique: Lost-wax cast with post-casting decoration.
KS B145-1b – Very well-preserved **tutulus** with stepped rib-decoration and long spike with top plate. The round flat disc on the spike's tip is decorated with a star-shaped decoration around a circle-shaped centre. The stepped ribs on the foot of the slightly conical spike are alternately decorated with oblique notches. The stepped ribs reach into the flat disc. The disc is decorated with a line and dot decoration that consists of eight triangles. Each triangle is constructed of four or five superimposed triangles which are divided in the middle by a line drawn from the steps up to the edge ('pine tree pattern'). The line is longer than the triangle. These decorative elements divide the disc into eight fields. Towards the interior these fields are framed in dotted lines. Also, the star on the top is framed by a dotted line. On the back the spike is hollow and on the slope of the stepped ribbed foot a round bar is attached. The same forms the eyelet.
Crafting technique: Cast in lost-wax with clay core, post-casting decoration (besides the star in the top plate).

Harburg-Wilhelmsburg, Harburg, Lower Saxony
HH 62886
Laux 1971: 189; Nørgaard 2011: 52-54
Burial mound 'Brunnenthal', unknown circumstances
NBA II
HH62886 – The small fragment belongs to a longitudinally **ribbed neck collar**, whether it is a Rehlingen type (Nørgaard 2011), cannot be determined on the basis of this piece. The piece has six weak pronounced and rounded ribs. It is covered by a patina layer which covers most of the decoration. Towards the end, the ribs flatten out. The end plate, hem and edges are not preserved. On the back clearly patinated organic structures are visible.
Crafting technique: Lost-wax cast.

Heidekreis (orig. Soltau-Fallingbostel), Lower Saxony;
ML 46

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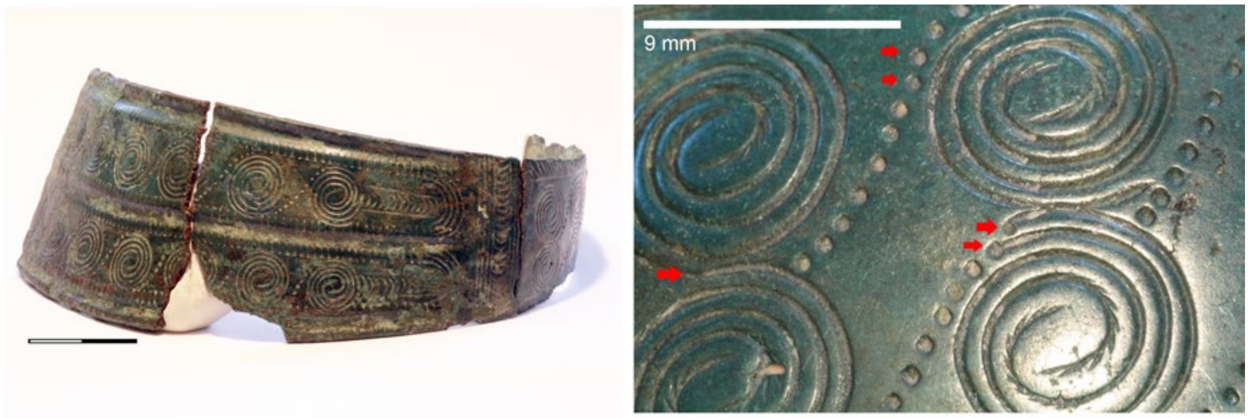

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3


4


Plate 12:
1) Grabow (municipality), Ludwigslust-Parchim (LUP), Mecklenburg – neck collar ALM LIIQ,8; 2) Heidekreis (orig. Soltau-Fallingbostel), Lower-Saxony – neck collar ML 46; 3) Heidenau, Harburg, Lower-Saxony – neck collar HH 63928; 4) Heidenau, Harburg, Lower-Saxony – wheel-headed pin HH 63931.

Laux 1971: 225; Nørgaard 2011: 69
Single find from the Ehlers Collection, probably found near Behringen
NBA II (ZG II)
Plate 12
ML 46 – **Neck collar** with seven notch-decorated ribs and a smooth, slightly curved outwards hem at the bottom. There is a free undecorated field between the second and third rib which is slightly lens-shaped and converges towards the ends. The upper two ribs are parallel to the top edge and the ribs below the smooth field are parallel to the curved hem. All ribs terminate at the same position at the transition to the end plate. The short end plate is undecorated and the ends are broken. On the back (near the hem) small residues of corroded organic fabrics are visible. From a typological point of view this piece shows the features of the type Ebertshausen (area of Thuringia) mixed with the typical characteristics of the Lüneburg area – the wide bottom hem (Nørgaard 2011: 70).
Additional investigation: Photographic documentation of fabric residues under the patina.
Crafting technique: Lost-wax cast, post-casting decoration and cold-working.

Heidenau, Harburg, Lower Saxony
HH 63928, 63931
Laux 1971: Nr. 148 G; Nørgaard 2011: 54-56
Row of 21 burial mounds, Mound 7, with several stone packings
NBA II
Neck collar, wheel-headed pin, two belt discs, two twisted neck rings, arm spiral, cone-shaped tutulus, spiral rolls, ceramic.
Plate 12
HH 63928 – Heavily restored and reconstructed **neck collar**. The original piece consists of two large fragments of the ribbed section and remains of the end plates, the missing parts are reconstructed with the help of a yellowish silicone mass. The mass covers the entire end as well as the whole of the reverse. The collar consists of seven ribs and a wide smooth hem, which is applied below the lowest rib. On the hem the rest of a rudimentary arch decoration is visible. The lowest five ribs terminate all at the same position at the transition to the end plate. The upper two ribs are shorter and have arrow-like ends. The end plates are, as far as recognisable, undecorated.
Crafting technique: Probably lost-wax cast with post-casting cold-working and decoration.
HH 63931 – Very poorly preserved **wheel-headed pin**. The pin is applied to a support material, and the shaft is completely reconstructed. Details of the pin are covered by a thick layer of varnish and the heavily patinated surface. The pin head consists of a ring of three curved ribs/grooves and within its centre is attached a simple cross. At the highest point of the needle three triangles are attached, similar in height and constructed of round wire. The lateral triangles have extended outer edges due to the rounding of the pin head. The shaft is similarly round in cross-section over all its length.
Crafting technique: Cast in one-side mould or open mould.

Heinrichswalde, Ludwigslust-Parchim (LUP), Mecklenburg
ALM 7236
Kersten 1936: 121; Nørgaard 2011: 49-51
Hoard in bog next to bones
NBA II
Neck collar, disc-headed pin, two spiral arm rings, spear head, two bronze pendants, fragments of spiral arm rings.
Figures: 2.090; 2.154
ALM 7236a – Longitudinal **ribbed neck collar** with nine well-defined rounded ribs. The rib-valley is semi-circular in cross-section and varying in width and depth. On every second rib can be found an oblique notch decoration near the end plate and on each other rib the decoration is centred. The notches vary in position and length. Within the second rib-valley from the top there is a slightly oval hole with rounded edges measuring 4 mm at the face side. The end plates of the collar are undecorated and have a slightly rough and porous surface. The collar ends in end rolls with frayed ends.
Crafting technique: Lost-wax cast, post-casting rib-decoration and reworking.
ALM 7236b – Large **disc-headed pin** with a central hump and edge-accompanying hump rows of different sizes. A small narrow and unadorned hem lies between the first two, closely spaced, hump series and the frayed edge. The small humps are spaced a short distance from one another and are inserted from the back. Towards the centre, the small hump series is accompanied by a series of twelve large humps, also inserted from behind. The humps are applied at irregular intervals and at different depths. The transition to the shaft is flattened, triangular in shape and has slightly rounded edges. The needle shaft is relatively long and towards the disc head 'rounded-rectangular' in cross section. Towards the end of the shaft the cross-section becomes round.
Crafting technique: Lost-wax rough cast, cold-working disc and shaft and post-casting decoration.

Heitbrack, Uelzen, Lower Saxony
LMN 148:81, 151:81, 137-139:81
Schirnig 1985: 154-157
Closed hoard next to a stone
NBA II
Two fibula ('Haarknotenfibel'), two wheel-headed pins, disc-headed pin, two arm rings, four spiral rings, three spiral finger rings, two twisted neck rings, neck collar, four belt discs, socketed axe, pincette, 12 cone-shaped tutuli, spiral rolls
Figures: 1.038; 2.066; 2.086; 3.011; 4.018; 4.029-30
LMN 148:81 – Well-preserved **neck collar** with nine distinctly pronounced ribs, trapezoidal in cross-section. Starting from the rib-slope at the bottom rib a broad smooth seam which is partly damaged is located. On the hem a series of true spirals is applied, connected with double lines. The spirals are mostly set close to the edge and cut off sporadically. The second to fourth ribs are slightly shorter than the other ribs, thus at the transition to the end plate an optical stepped effect is formed. The smooth and narrow tapered end plate is decorated with six spirals in two rows. Due to the poor preservation of the decoration it cannot be determined with certainty whether the spiral line of the hem is continued in the end plate decoration. The spirals of the end plate are connected with double horizontal lines. The collar terminates in broken and slightly small end rolls.
Additional investigation: Trace elemental analysis, data shown in Table 3.
Crafting technique: Rough lost-wax cast, additional cold-working and post-casting decoration.

LMN 151:81 – Very well-preserved **small belt disc** with simple decorative spiral ornament. The spike of the plate, the eyelet, and a quarter of the belt disc are reconstructed. Around the short rounded spike is an undecorated area, which is closed by a decorative band. The decorative band consists of one line of small superposed arches (arrow band) and three parallel lines. The decorative strip is followed by a number of simple spirals connected with double lines. The centre around which the spirals are placed is formed by a large hump. There is another decorative band between the spiral band and the slightly curved upwards smooth hem. This band consists of an arrow line and five parallel lines. Opposite the reconstructed spike, on the back, there is a wide, raised and perforated eyelet.
Crafting technique: Rough lost-wax cast probably around organic core, post-casting decoration.
LMN 137:81 – A **disc-headed pin** consisting of a round disc-shaped head, with a flat head plate placed on top of the disc with its end rolled up into a roll. The head sits on a shaft with varying diameter, from flat oval to round. The shaft is forged strongly at the base so that at the connection to the needle head a tab is formed at the back. The plate is decorated with a small centrally positioned punch mark, around the groove a decorative band of five concentric circles is attached. This decorative element terminates in a ladder-like notched ribbon consisting of square notches introduced opposite one another. The wide surface in between this band and the decorative edge-accompanying band, consisting of a similar ladder-line notched ribbon and five parallel lines, is decorated with a running spiral ornament. These eight spirals vary in size and are connected with double lines. The top head plate is decorated with two superimposed decorative tapes, as also used on the disc. The wide decorative ribbon is composed of six parallel lines, a ladder-like notched ribbon, another four parallel lines and another ladder-like notched ribbon. On the back of the disc the negatives of the decoration are clearly visible.
Crafting technique: Rough lost-wax cast, post-casting decoration and cold-working.
LMN 138:81 – A well-preserved **arm ring** with blunt ends with a continuous line decoration. The ends abut one another and show distinct traces of strong cold-working as well as the interior sides of the ring. This results in an irregular lenticular cross-section. The line decoration starts at each of the ring ends and consists of a regular repeating pattern of seven parallel lines, two bands of opposing, slightly diagonal, lines with the line crossing the centre of the so arranged arrow (herringbone pattern) with a dividing line in between, six parallel lines and another herringbone pattern, and again seven parallel lines followed by two slightly curved, adjacent diagonal line-filled ribbons. Between these decorative ribbons a lenticular clearance is formed on the back of the ring. The pattern is repeated continuously.
Additional investigation: Trace elemental analysis, data shown in Table 3.
Crafting technique: forged presumably from a bar (multiple annealing) and forged decoration.
LMN 139:81 – Well-preserved **open arm ring** with straight ends. The ring is semi-circular in cross-section with a uniform straight bottom. The tapered ends are decorated with ten parallel lines mostly visible on the domed side of the ring. This band is followed by a poorly preserved herringbone pattern. After about a five lines-wide open space, which was probably filled with oblique lines as might be expected from the edges, follows a region which is decorated with five parallel lines and thereafter a repetition of this pattern. At the highest point of the ring a revolving decoration of five parallel lines is visible. The rest of the ring is undecorated.
Additional investigation: Trace elemental analysis, data shown in Table 3.
Crafting technique: Forged presumably from a bar (multiple annealing) and forged decoration.

Hohenbünstorf, Uelzen, Lower Saxony

LMN 24968-24977
Laux 1971: 252
Burial mounds at 'Ahn-Berg', in Mound A, female and male burial.
NBA III (ZG III)
Fibula (Haarknotenfibel Ostgruppe), twisted neck ring, Disc-headed pin, hanging disc, six leg rings
Figures: 2.086; 2.108; 4.030
LMN 24976 – Very poorly preserved **belt disc** with small conical spike and spiral-decoration. Around the short spike is a wide undecorated field, which rises slightly towards the spike´s foot. The field is framed by a decorative ribbon consisting of a dotted line, seven parallel lines and a further dotted line. This ribbon is followed by a further ribbon, which is separated from the former by the spiral-decoration. The decorative ribbon consists of a dotted line, and five parallel lines. Between these decorative bands are a series of probably 14 spirals. The uniformly structured spirals are connected with double lines. On the reverse opposite the spike is a wide oval protruding bar with perforated eyelet.
Crafting technique: Lost-wax cast with decoration (spiral-stamp), reworking of decoration.
LMN 24977 – Heavily damaged and reconstructed **disc-headed pin** with spiral and hump-decoration. The broken shaft is significantly broadened and flattened at the base to the head. On the visible side, the shaft is decorated with a line decoration that is set into a frame, which is formed parallel to the shape of the shaft piece. The filling of the frame consists of parallel lines and arrows and bands of superimposed arches. The round disc head is decorated with an edge-accompanying frame of a framed-in-lines arrow band (arches), three lines and another framed arrow band. The decoration strip is, towards the edge, accompanied by a series of point-shaped grooves which also continue on the shaft. In the centre of the disc was probably a hump surrounded by at least four concentric circles or a spiral. Around the hump is a spiral series of five spirals, connected with double lines. In the centre of each spiral is a large hump. On the reverse of the disc, the negative forms of the humps are visible.
Crafting technique: Lost-wax cast with decoration (also humps), reworking of humps and decoration.

Hornslet Ø, Lisbjerg herred, Randers Amt

AM 6333
Unpublished
Single find on field
NBA III
Plate 13
AM 6333 – Fragmented **tutulus** with a long spike and presumably a head plate. The upper parts of the spike (including the head plate) are missing. Around the foot of the spike is a stepped rib-decoration which is spirally wound around the conical foot. This stepped decoration reaches halfway into the decorative plate. The ribs are notch-

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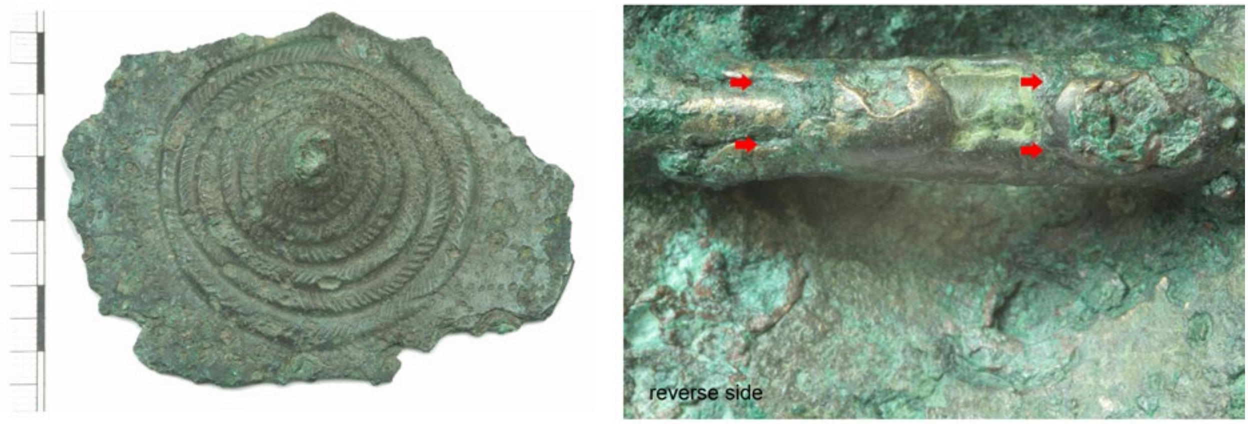

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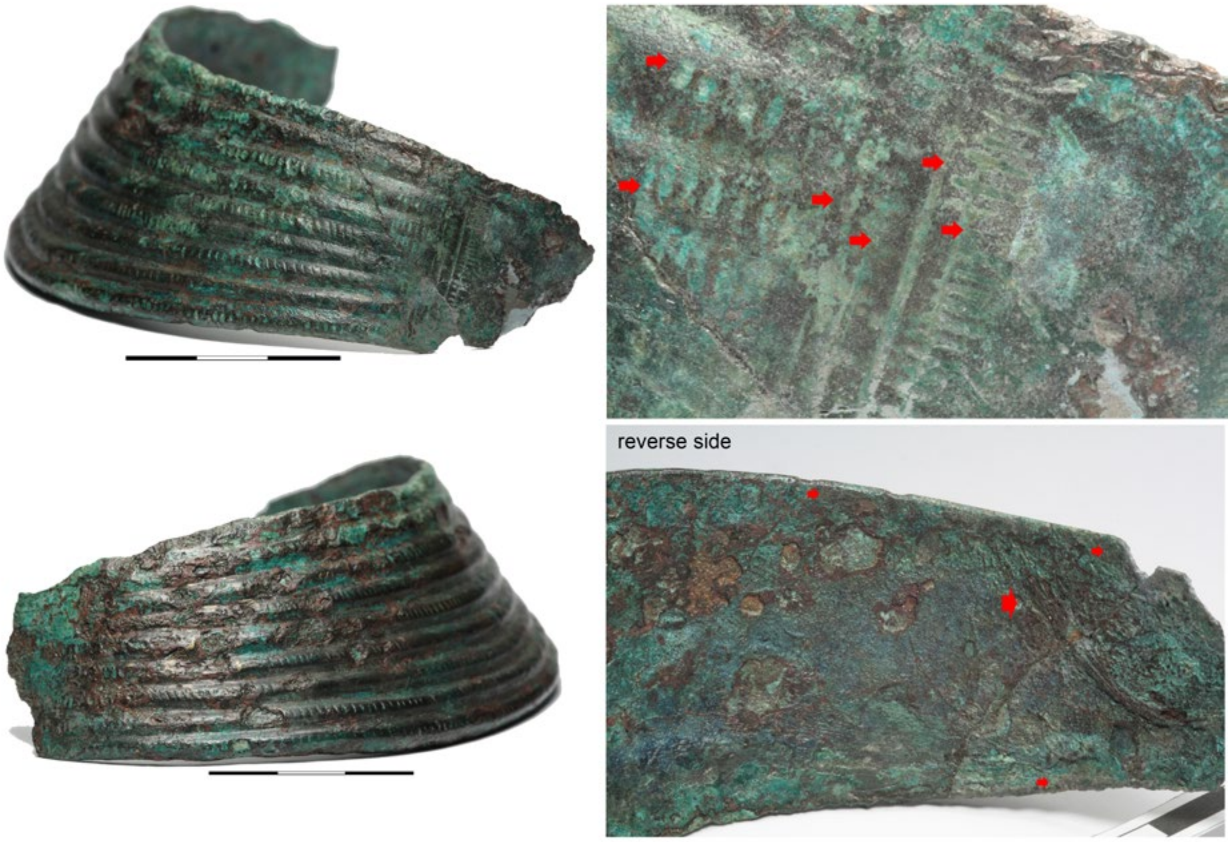

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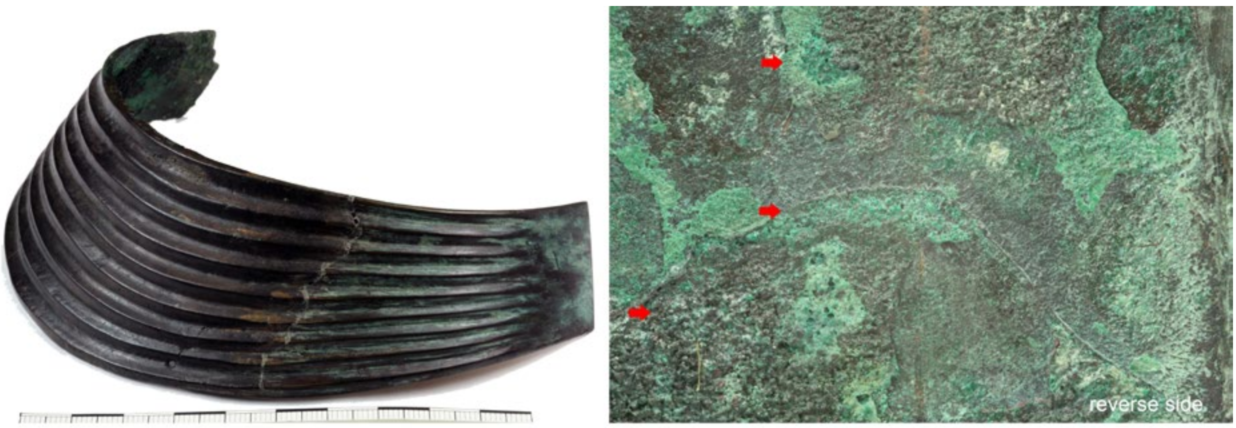

Plate 13:
1) Hornslet Ø, Lisbjerg, Randers – tutulus AM 6333; 2) Høve 'Esterhøj', Ods, Holbæk – neck collar NM B12931; 3) Jutland, unknown location, Denmark – neck collar FHM/ AM 548.

decorated throughout. The grooves are arranged in groups that change in orientation. The orientation of the oblique notches changes on each turn (step). The decorative plate of the tutulus displays the remains of a decoration consisting of puncture bands in triangle form. Towards the ribs, directly attached to the bottom rib, is a series of small, standing triangles. On the back of the disc, within the groove of the spike, a rectangular bar is attached. The bar is placed at the edge of the slope and the ends are partly enclosed by an additional layer of material (probably cast-on).
Crafting technique: Cast in lost-wax with cast-on eyelet, post-casting decoration.

Høve 'Esterhøj', Ods herred, Holbæk Amt
NM B12931-33a
Aner and Kersten 1976: 38; Nørgaard 2011: 35-38
Inhumation in the 'Esterhøj' burial mound, Burial B
NBA II
Neck collar, belt plate, 11 small tutuli, bracelet with spiral ends
Plate 13
NM B12931 – Well-preserved **neck collar** with nine distinctive ribs which have a triangular cross section and a changing oblique notch-decoration. The top and bottom ribs are wider than the rest of all the ribs, and terminate at the same height at the transition to the end plate. At the end, all the ribs are decorated with a longer notch decoration. A vertical ribbon of opposing triangles framed in lines, a notched ribbon and parallel lines initiates the end plate. On the short preserved part of the end plate no other decoration is recognisable. On the back of the collar, patinated organic material is preserved.
Additional investigation: Photographic documentation of fabric residues under the patina.
Crafting technique: Lost-wax cast with post-casting reworking.

Jægersborg Hegn 'Rundforbi', Søllerød, København Amt
NM B3059-65
Aner and Kersten 1972: 151-152; Kersten 1936; Nørgaard 2011: 49-50
Found in burial mound with stone cist
NBA II
Neck collar, belt plate, twisted neck ring, fibula, knife, spiral ring
Figures: 2.085; Plate 14
B3059 – **Neck collar** with 11 chessboard-pattern notched ribs. Over the top and below the bottom rib is a smooth hem. The wide end plate is damaged at the end (no preserved end rolls). The main field on the end plate is decorated with four connected spirals. In between the ribbed frontal area and the spiral-decoration on the end plate a vertical decorative band is placed. It consists of a ladder-like notched ribbon (notched bar), two parallel lines, two parallel series of opposed triangles separated by a line, two parallel lines and a notched bar with subsequent parallel line. Near the end rolls, the pattern is only rudimentary. It seems wider and ends in oblique dashed triangles.
Crafting technique: Lost-wax cast (with decoration), stamped-spirals, reworking of decoration.
B3060 – Very poorly preserved **large belt plate** with three spiral rows. In the middle of the disc a long, square tapered spike with decorative grooves is attached. The spike decoration consists of ten deep grooves at the bottom, at regular intervals. The spike is on a pedestal, a hatched arched ring, and was broken in the past. From this platform the surrounding decorative ribbon starts, consisting of two rows of ladder-like notched ribbons framed in lines. The innermost spiral series consists probably of 12 spirals, which are connected with a single line. The separation to the next spiral series is formed by a decorative ribbon of an opposed triangle series framed in lines, three parallel lines and another opposed triangle series. The middle spiral series consists of probably 17 larger spirals, connected with simple lines. Another decorative ribbon, similar to the previous one, forms the separation from the third and largest spiral series. This spiral series probably contains 25 spirals all connected with a single line. The final edge decoration is hardly recognisable due to the heavy corrosion. It might be constructed of an opposed triangle series framed in lines, two parallel lines and another triangle series. The wide hem is decorated by three parallel grooves.
Crafting technique: Lost-wax cast (with decoration), stamped-spirals, reworking of decoration.
B3061 – Small **tutulus** with large dome shaped spike. The surface of the spike is heavily corroded and therefore the nearly continuous ornament is hardly recognisable. At the transition from dome to disc a decorative ribbon of parallel lines is placed. Towards the point of highest curvature the dome is horizontally decorated with a series of opposed triangles. The top of the dome is smooth and undecorated. At the transition to the disc a ladder-like notched ribbon is placed. The disc itself is decorated with four bands of opposed triangles. It concludes with two parallel lines at the edge of the disc.
Crafting technique: Lost-wax cast presumably with decoration, reworking of lines.

Jylland (unknown location), Denmark
FHM (AM) 548
Unpublished
Unknown circumstances, reconstructed for auction
NBA II
Plate 13
AM 548 – The simple **ribbed neck collar** is three-quarters preserved. The rest of the collar has been reconstructed in modern times (in order to achieve a greater price at auction). The collar has nine sharply defined, triangular in cross-section ribs and wide undecorated end plates. The ribs terminate at the same position at the transition to the end plate. The reconstructed side adapts very well to the original. The back of the original piece shows traces of corroded organic remains or fabrics.
Additional investigation: Photographic documentation of fabric residues under the patina.
Crafting technique: Lost-wax cast, reworking and cold-working.

Karbow, Ludwigslust-Parchim (LUP), Mecklenburg
ALM Br. 88-Br. 92
Schubart 1972: 113; Nørgaard 2011: 58-62
Found in burial mound
NBA III
Neck collar, two neck rings, two open arm rings, ten tutuli, pin of Weitgendorf type
Plate 14
Br.88 – **Neck collar** in three large fragments. The decoration consists of three groups of two ribs, decorated with oblique notches. Within the smooth fields between the groups of ribs a

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Plate 14:
1) Jægersborg Hegn 'Rundforbi', Søllerød, København – neck collar NM B3059; 2) Jægersborg Hegn 'Rundforbi', Søllerød, København – tutulus NM B3061; 3) Karbow, Ludwigslust-Parchim (LUP), Mecklenburg – disc-headed pin Weitgendorf type ALM Br.92.

spiral series of similar size connected with dotted lines is placed. Towards the end plate the spiral series ends in an arch ribbon that is concluded by four parallel curved lines. These four curved parallel lines connect the pairs of ribs with each other. The end plate is separated from the frontal ribbed section by a decorative ribbon of three parallel lines and an arch ribbon framed in lines. An edge-accompanying arch ribbon framed in lines creates a frame around the end plate. Within its centre two rows, each of three spirals connected with dotted lines, are placed. The end rolls are broken. The reverse of the collar displays different organic remains (fabrics) under the strong patina.
Additional investigation: Photographic documentation of fabric residues under the patina and trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017; 2015a).
Crafting technique: Lost-wax cast probably with decoration, heavy reworking of decoration.
Br.92 – Well-preserved **Weitgendorf-type needle** (at least 20 cm preserved). The decoration concentrates on the first 9.14 cm. Below the flat disc head, the shaft is attached by a slight funnel-shaped thickening. Further down the shaft are periodic ring-like attachments in groups of different numbers. The first two ring groups consist of three rings, then seven rings, then three rings, then a wide ring with notch pattern and following three more rings. The rest of the shaft is undecorated until its broken tip.
Additional investigation: Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017; 2015a).
Crafting technique: Lost-wax cast or two part mould with hard model.

Karlslunde, Karlslunde sogn, København Amt

NM 4184-87
Aner and Kersten 1972: 181-182; Nørgaard 2011: 45-46
Found in burial mound, Grave A with stone cist
NBA II
Bones, wood, golden spiral finger ring, neck collar, bronze rolls (corded skirt)
Plate 15
NM4185 – Very heavily corroded **large neck collar** with 31 notch-decorated ribs, which are very close together and flat. The rib-valleys are very thin and vary in their width. The corrosion has progressed so far that it is not possible to see the exact shape of the rib-decoration. The end plates are very wide and long. They are edge-accompanying and framed by a decoration consisting of probable notched ribbons, parallel lines, a network of several lines of lying diamonds, two triangular bands and probably a notched bar. The vertical part of this decorative frame separates the end plate from the ribs. Therefore, the ribs terminate at the same position. Inside the frame there are the remains of four rows, each of (presumably) four or five connected spirals. Nine of the approximately 16 spirals are preserved; the rest is hidden under a blooming patina. At the bottom of the collar wool-like fabric structures can be detected in several places. Due to modern restoration methods, the back of the collar is not available for investigation.
Additional investigation: Photographic documentation of fabric residues under the patina.
Crafting technique: Lost-wax cast, probably pre-cast decoration.

Karow, Kr. Lübz, Mecklenburg

ALM Br. 178-Br. 182
Schubart 1972: 114; Nørgaard 2011: 58-62
Found in the 'Blockenberg' burial mounds, Mound 2, secondary Grave 2.
NBA III
Neck collar, open arm ring, knife, golden spiral finger ring, ceramics, iron knife
Figures: 2.010; 2.112
Br. 178 – Heavily corroded **neck collar** with three groups of two ribs. The ribs are partly rounded and partly pointed. They are decorated with oblique notches and often an arrow-like decoration can be assumed. The rib groove is triangular in cross-section. In the smooth fields between the ribs are series of spirals, connected with dotted lines. The spirals increase in diameter towards the centre. There are approximately eight spirals in the top and nine spirals in the bottom row. Towards the end plate the spiral series devolve into an arch ribbon that is concluded by two parallel curved lines. A vertical decorative band of three parallel lines and a framed-in-lines arch ribbon separates the ribbed section from the end plate. The end plate is decorated with two rows, each of three spirals, connected with dotted lines. The spirals are faintly discernible. The ends are not present. On the back of the collar are significant remains of corroded fabrics or organic material.
Additional investigation: Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017; 2015a).
Crafting technique: Lost-wax cast with probably parts of the decoration, post-casting decoration and reworking.
Br. 179 – Poorly preserved **open arm ring** with strongly profiled oval cross section. The patina makes it difficult to investigate the decoration of the arm ring. The open ends terminate in a sharp edge and join to form a closed arm ring. The arm ring is decorated on the top side by a changing line decoration. This includes at least nine parallel lines and three parallel cross-hatched bands that are framed in lines. The material thickness of the arm ring varies slightly from the ends towards the centre. The inside is undecorated and has, centrally, a flattened surface. The incline from the decorated top side to the inside is sharp.
Crafting technique: Lost-wax cast (eventually two part mould), post-casting decoration and cold-working.

Kolbedal, Tørrild herred, Vejle Amt

FHM (AM) 5106
Aner and Kersten 1990: 92
Found in burial mound, within stone packing
NBA III
Figures: 2.065; 2.149
AM 5106 – Large **tutulus** with long, thin spike which terminates in a flat arched disc. The top plate is decorated with a star formed of four deeply incised lines. The spike´s foot devolves into a stepped, ribbed, flat conical section. The ribs are ornamented with alternating oblique notches (each second rib). The disc is decorated with rib-accompanying elongated cleaver-shaped notches, followed by a series of small standing triangles, the tip points towards the edge. The largest area of the disc is undecorated. Edge-accompanying, but separated from the rounded edge by a small undecorated hem, is a faint line on which a dotted line is placed. The dotted line is accompanied on both sides by a series of triangles. The triangle row inside is placed so that the tip of every triangle points towards the spike, the outer series points with the tip towards the edge. On the back a round bar is laid over the hollow spike, which is probably cast-on.
Crafting technique: Lost-wax cast, cast-on eyelet, post-casting decoration.

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Plate 15:
1) Karbow, Ludwigslust-Parchim (LUP), Mecklenburg – neck collar ALM Br.88; 2) Karlslunde, Karlslunde, København – neck collar NM 4185.

Kolkhagen, Lüneburg, Lower Saxony
ML 238:84,b
Laux 1971: 217; Nørgaard 2011: 54-56
Found in the 'Dewelsheide' burial mounds, Mound 7, Grave 2 with wooden coffin
NBA II (ZG II)
Neck collar, cone-shaped tutuli, disc-headed pin, belt disc, arm spiral, small spiral finger ring, spiral rolls, leg ring
Plates 16 and 17

ML 238:84, b4 – **Neck collar** with nine irregular, rounded ribs and wide hem below the ninth rib. The ribs are of different length, the upper six ribs run parallel to the upper edge and end at the same height at the transition to the end. The seventh rib is parallel to them but runs out before the others. The lowest two ridges are parallel to the seam and conjoin towards the end. The curved hem is heavily damaged and, parallel to the lower edge, is decorated with a series of small humps which terminate in the end plate. The end plates are smooth and undecorated. On the back of the collar organic remains can be detected under a strong blooming patina.
Crafting technique: Cast through lost-wax, additional reworking and cold-working of the humps.

ML 238:84, b11 – Heavily patinated **belt disc** preserved only in fragments. Around the short, slightly conical spike with a rounded tip is a free field, which is bounded by a decorative band of parallel lines and accompanying hourglass ribbons. The subsequent field is filled by a spiral series. The spirals are only occasionally recognisable and are connected with dual lines. Parallel to the final edge a decorative band of a series of hourglass punch marks and six parallel lines is placed. The front and back of the disc have the remains of a grass or other organic wrapping. Underneath the spike on the back of the plate a thick loop with perforated hole is placed.
Crafting technique: Probably lost-wax cast with part of the decoration, reworking.

Kolsbæk 'Bavnehøj', Blistrup sogn, Frederiksborg Amt
NM B7030-32
Aner and Kersten 1973: 8; Broholm 1943: 1215; Nørgaard 2011: 45-46
Found in the 'Bavnehøj' burial mound in stone packing
NBA III
Neck collar, tutulus, leather string, wood
Plate 16

B7030 – Very **large collar** with 19 clearly pronounced and narrow ribs, which are decorated with slightly diagonal cuts. The ribs follow the shape of the collar, and therefore are narrower at the sides. The ribs terminate at the transition to the end plate at the same height. A decoration consisting of an arch series (adjacent U-bends on a line) completes the ribbed section. The U-shaped arches are arranged in such a way that the back of each rib is concluded by one arch. Following this a decorative ribbon comprises of a ladder-like notched ribbon, a line and a ladder-like notched ribbon forming a frame around the end plate. In the thus created field within the frame are four superimposed rows, each of five spirals (which are horizontally and vertically connected). The ends are broken on both sides. However, it can be assumed that the collar had long narrow end rolls. The back of the collar is covered with a support material and therefore not used for the investigation.
Crafting technique: Lost-wax cast, heavy reworking of decoration.

Krasmose, Klemensker sogn, Bornholm Amt
NM B647-652
Aner and Kersten 1977: 10; Broholm 1952: Nr. 313. (listed as Klemensker); Nørgaard 2011: 80-83
Hoard within the 'Krasmose' bog
NBA III
Neck collar, three sickles, spiral arm ring, eight tutuli, two bronze bars, fibula of Bornholm type, bronze vessel
Figures: 4.032; Plate 17

NM B647 – Large, smooth **neck collar** with two spiral series on the face side. The collar has an exceptionally large diameter at the bottom and is very flat. The 23 evenly crafted and very large spirals are applied in two rows. The bottom row displays twelve spirals and the top row nine spirals. The outermost spirals of the lower ribbon are, with the help of a spiral that is placed within the peak of the face side, connected with the upper spiral series. The spirals themselves are connected with double lines. The lenticular-shaped decorative ribbon in between the spiral rows follows the shape of the collar. It consists of three parallel lines, a series of opposed triangle rows and three parallel lines. A row of standing triangles, pointing into the undecorated space in the middle of this ribbon, is applied on the innermost line. Accompanying the edge is another decorative ribbon that also frames the spiral-decoration. This ribbon is placed on the slightly outwardly curved hem and is separated from the edge by a small undecorated area. It consists of a ladder-like notched ribbon, five parallel lines, a series of opposed triangle rows, another five parallel lines and a concluding ladder-like notched ribbon. This decorative ribbon continues into the end plates where it ends slightly cut off. The decoration of the end plate is connected to this edge-accompanying ribbon. The spiral-decorated face side and the end plates are separated by a decorative ribbon consisting of two oppositely directed curved line groups (six parallel lines). Framed by the second arch group, the field towards the end roll is decorated with a series of edge-accompanying stacked arch groups in decreasing number. The last space towards the end rolls is undecorated.
Crafting technique: Lost-wax cast with decoration (probably spiral stamp), reworking.

Kremmin, Ludwigslust-Parchim (LUP), Mecklenburg
ALM L II Q,4, L II A 2 b a, 7, L II U 2 a, L II D2 2, 7, L II Z 1 a
Schubart 1972: 119; Nørgaard 2011: 58-62
Probably secondary burial in mound
NBA III
Golden arm ring (main burial), sword (main burial), neck collar, knife, two open arm rings, button, bronze pin.
Plate 17

L II Q,4 – Poorly preserved fragment of a **Mecklenburg-type neck collar**. The frontal part of the collar shows three groups of two ribs, which are probably notch-decorated. However, the decoration is barely recognisable. Two spiral series are faintly visible (top three and the bottom four) which are connected through dotted lines. The distance between the ribs in the rib pair is relatively small and the ribs themselves are weak. The further decoration of the collar is so weakly applied that a decorative ribbon at the end of the spiral series is not visible.
Additional investigation: Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017; 2015a).
Crafting technique: Lost-wax cast, probably post-casting decoration.

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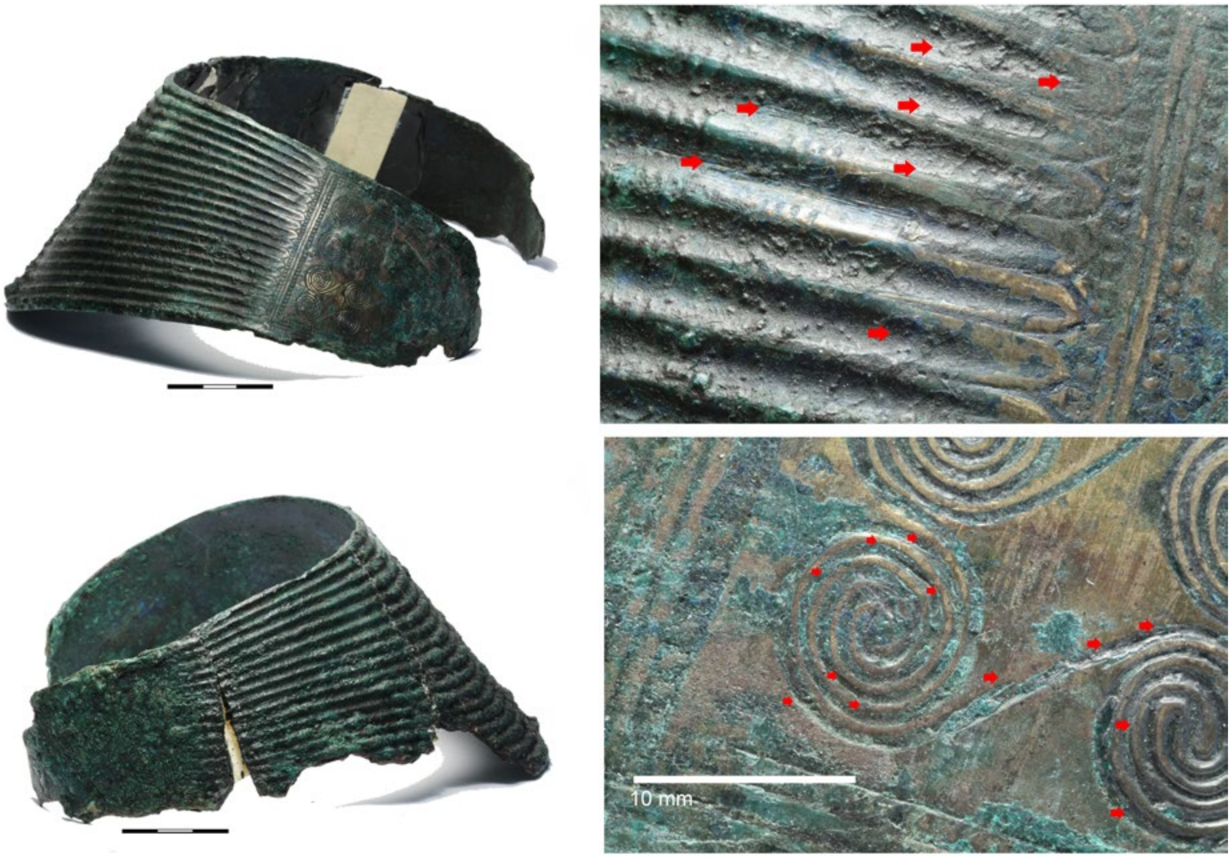

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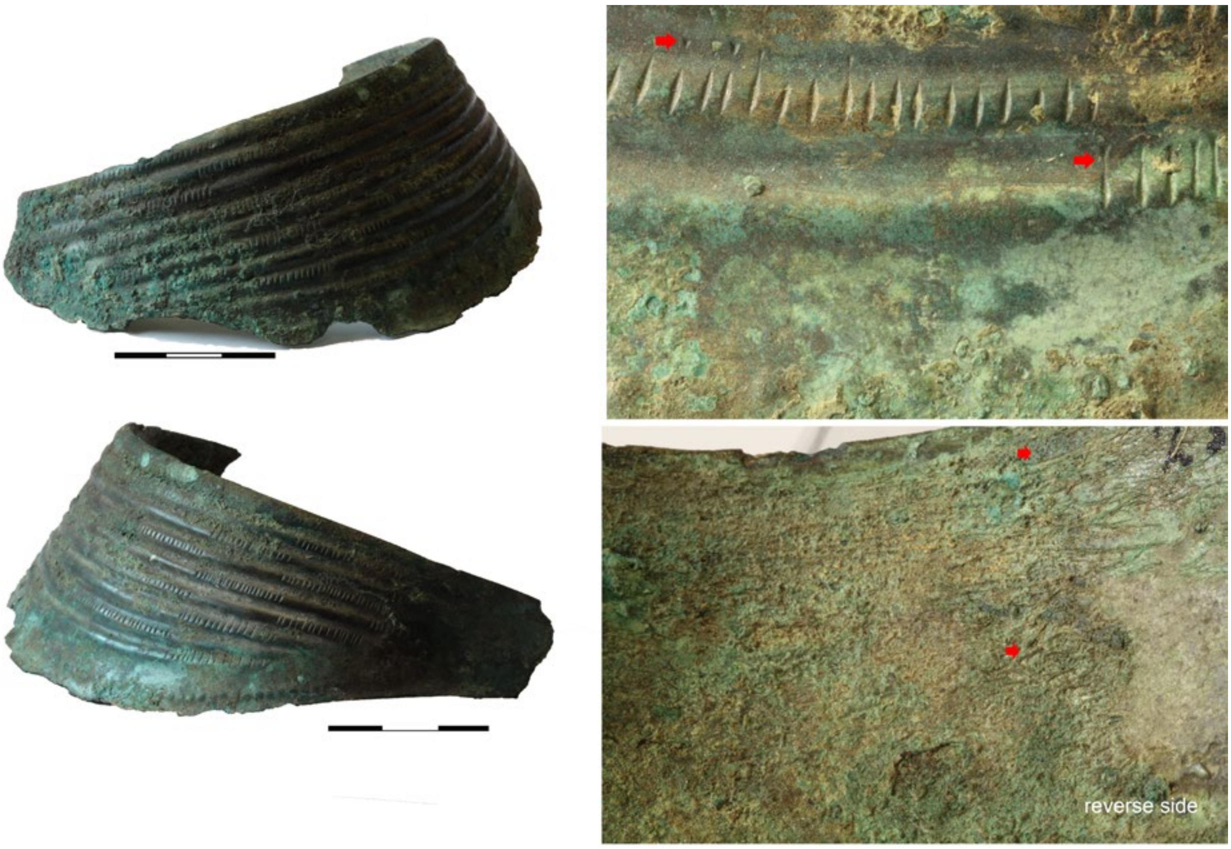

Plate 16:
1) Kolkhagen, Lüneburg, Lower-Saxony – neck collar ML 238:84, b4; 2) Kolsbæk 'Bavnehøj', Blistrup, Frederiksborg – neck collar NM B7030.

Kværkeby (sogn), Sorø Amt
NM B3348-49
Aner and Kersten 1976: 131-135; Nørgaard 2011: 40
Found in the 'Klokkerhøj' burial mound, with the inhumations of several individuals
NBA II
Neck collar, tooth enamel, bronze rolls
Figures: 1.025

B3348 – Neck collar with nine chessboard-pattern ornamented ribs. The entire collar is covered with a strong blooming patina and not particularly suitable for investigation. The transition to the end plate is introduced with a decorative band consisting of a notched ribbon, parallel lines and another notched ribbon. On the heavily damaged end plate the remains of three spiral rows or half sheet rows are visible. The back of the collar has the residues of organic layers (probably from fur) preserved through the patina.
Additional investigation: Photographic documentation of fabric residues under the patina.
Crafting technique: Lost-wax cast, reworking of probably cast decoration.

Langstrup, Asminderød sogn, Frederiksborg Amt
NM B2307-09
Aner and Kersten 1973: 58
Hoard found in bog, artefacts bought in auction
NBA II (III)
Belt plate, two spiral arm rings, knife
Figures: 2.046; 2.051; 2.079; 2.083

B2307 – Well-preserved **large belt plate**, with a long conical spike decorated with parallel grooves. The spike ends in a broken (or not finished) tip. The grooves are arranged in five groups of seven grooves, between which is a free area. The conical spike is placed on a platform decorated with parallel lines (around the spike), a notched ribbon (hourglass-shaped notches), five parallel lines, another notched ribbon and an oblique hatched ribbon at the stepped break. The spike and platform are crafted as a unit and attached onto the disc. Around the spike and platform there is on the disc a decorative ribbon consisting of a ladder-like notched ribbon (hourglass-shaped notches), four parallel lines and a ladder-like notched ribbon. This is followed by a spiral series with 15 small spirals, connected with simple lines. The spiral series is separated from the next by a decorative ribbon, which consists of a ladder-like notched ribbon, four parallel lines, and a ladder-like notched ribbon. This spiral belt consists of 22 spirals, which are slightly taller (one to two turns) and are all connected with simple lines. The decorative ribbon separating the following spiral series from that mentioned is identical to the previous ribbon. The third spiral series consists of 26 spirals (again around a turn bigger) which are connected with simple lines. The decorative ribbon separating the fourth spiral series from the third is identical to the previous two. The fourth spiral series consists of 32 closely juxtaposed spirals (one or two turns bigger). All spirals are connected with simple lines. Towards the edge is a decorative ribbon similar to the previous ones, with additional six parallel lines or wide grooves. Accompanying the edge is a narrow hem. On the reverse of the disc a protruding cross-sectional oval rectangular loop with widening ends (almost X-shaped) is opposite the spike. The eyelet is mounted on an irregular platform. The spike and eyelet form a unit that is independent of the disc and connected to the disc through being cast-on.
Additional investigation: Previous crafting analysis (Rønne 1989; 1991).
Crafting technique: Lost-wax cast with decoration (spiral-stamp), cast-on spike, slight reworking.

Lavø, Helsinge sogn, Frederiksborg Amt
NM B11684-B11691
Aner and Kersten 1973: 14; Nørgaard 2011: 49-50
Hoard next to a river
NBA II
Belt plate, two smaller belt discs, neck collar, one tutuli, knife, two saws
Figures: 2.084; 4.026

B11686 – Neck collar with 13 chessboard-pattern notch-decorated ribs (the decoration is hardly preserved). Over the top and under the bottom rib is a wide hem, decorated with three rows of opposed triangle series. This decorative ribbon frames the ribs and separates the frontal area of the end plate. Between the vertical triangle ribbon and the ribs a series of semi-circular arcs which close the ribs is applied. Towards the end plate the vertical belt is reinforced by a ladder-like notched ribbon. This decorative ribbon is connected halfway up to the curved decoration that frames the end plate. The frame is composed of two curved bands, of which each is composed of a ladder-like notched ribbon, three rows of opposed triangle series, four parallel lines and a ladder-like notched ribbon (the rear frame has no triangle strips). The wider decorative band is placed on the side towards the ribbed area, the narrower between spiral and end roll. The inside of the end plate is decorated with four connected spirals that are additionally connected diagonally with a line. Placed on the inside of the decorative frame in between the spirals are three superimposed semi-circular arches.

B11684 – Belt disc with a short spike which is initiated by concentric step-like grooves. Around the spike is a band of parallel lines, notched ribbon (ladder-like notched ribbon) and parallel lines. The first decorative series consists of 16 concentric circle groups, each composed of three circles and a central hump. Many of the humps are perforated at the highest point. The following decorative band is made of a ladder-like notched ribbon, parallel lines, a series of opposed triangles, two parallel lines, and a ladder-like notched ribbon. The following row consists of a total of 29 concentric circle groups, each with four rings and a central hump. Two hump-circle-groups are continuously framed with a double line. The ovals thus formed touch each other and form a closed band. Due to the uneven number a hump-circle group is individually framed in a fifth ring. The separation of the decoration towards the broad, slightly upwardly curved smooth hem forms a ribbon consisting of a ladder-like notched ribbon, parallel lines, a ladder-like notched ribbon and parallel lines.
Crafting technique: Probably lost-wax cast, humps forged from the reverse.

B11685 – Large belt disc with a broken central spike or hump (probably cast-on spike). Around the probable spike a decorative ribbon is placed consisting of at least three rows of hanging and standing triangles, two parallel lines, a ladder-like notched ribbon and a line. The first series of 14 spirals has the smallest diameter. These single spirals are connected with single lines and the spaces in between the spirals are filled with two semi-circular ladder-like notched ribbons. Between this and the next spiral series, there is a band of parallel lines, a ladder-like notched ribbon, parallel lines and a ladder-like notched ribbon. The next row consists of 20 double-spirals

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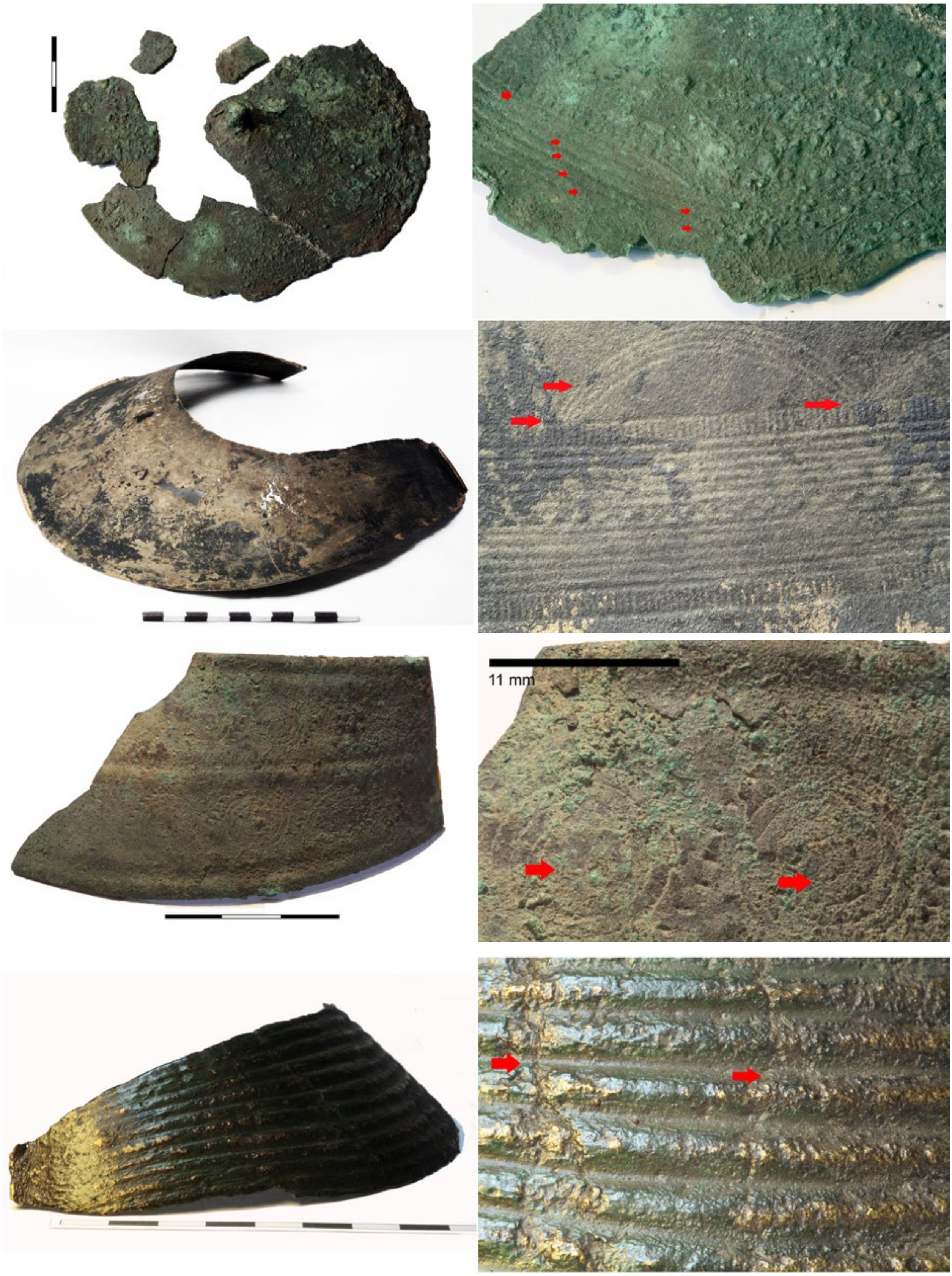


Plate 17:
1) Kolkhagen, Lüneburg, Lower-Saxony – belt plate ML 238:84, b11; 2) Krasmose, Klemensker sogn, Bornholm Amt – neck collar NM B647; 3) Kremmin, Ludwigslust-Parchim (LUP), Mecklenburg – neck collar ALM LIIQ,4; 4) Lower Saxony (unknown location) – neck collar LMN 195:78.

that are connected with a single line. The remaining lines run into the decorative ribbon above and below it. The decorative strip towards the next spiral series consists of a ladder-like notched ribbon, three rows of hanging and standing triangles and again a ladder-like notched ribbon. This spiral row is formed of 24 large single-spirals, connected through single lines. Towards the edge-accompanying decorative ribbon a row of standing triangles is placed within the spiral-decorated field. This is followed by a band of hanging and standing triangles and a bundle of parallel lines. A smooth hem lies between this decoration and the rounded edge.

Crafting technique: Lost-wax cast (with stamped-spirals), reworking of decoration, cast-on spike.

B11687 – **Small belt disc** with short, undecorated spike with a round tip. The spike lies on a slightly increased small step. The decorative ribbon around the spike begins at the end of this podium. The decorative ribbon consists of two ladder-like notched ribbons separated by a line. Accompanying the edge runs a decorative band consisting of two parallel lines and a ladder-like notched ribbon. In the open field between the decorative bands are 11 triple superposed semi-circular arches, which are open to the outside. The top of the arches touches sporadically the inner decorative ribbon and the converging peaks touch sporadically the outer decorative ribbon. The surface of the disc is severely damaged by corrosion and paint residue (from the restoration process).

Crafting technique: Probably lost-wax cast with decoration.

B11688 – **Tutulus** with a hollow spike. The spike is long with rounded tip. The bottom of the spike consists of trapped ribs. The bottom rib is notched, otherwise the spike is undecorated. Attached on the ribbed pedestal is a decorative band of five rows of opposed triangles and a row of hanging triangles. Towards the edge is a broad smooth hem. On the back a round bar is placed into the hollow spike, forming the eyelet.

Crafting technique: Lost-wax cast with parts of the decoration, clay core, post-casting decoration (triangles).

Lockstedter Lager, Steinburg, Schleswig-Holstein

KS 18214a

Aner and Kersten 1993: 34; Nørgaard 2011: 33 (here Hohenlockstedt)

Found in burial mound, Burial B

NBA II

KS 18214a – Well-preserved **ribbed neck collar** with undecorated end plates. The nine trapezoidal ribs of the collar are decorated with alternating notches. The top and bottom ribs are continuously provided with long oblique notches and the other ribs show bundles of notches on each rib with intermediate undecorated areas. All the ribs terminate at the same position at the transition to the end plate. The transition is indicated by two parallel vertical lines. The rest of the end plate is undecorated and consistent in its width until it ends in an end roll. On the right side of the collar the end plate was broken a long time ago and severely shortened, an end roll was bent from the remains.

Crafting technique: Lost-wax cast, post-casting reworking and additional decoration.

Lower Saxony (unknown location)

LMN 195:78

Unpublished

Unknown

NBA II

Plate 17

LMN 195:78 – **Neck collar** with 11 notch-decorated ribs. It is not clear whether the notch trim is continuous or has interruptions, due to the surface preservation. The relatively uniform ribs go along with the shape of the collar and are, therefore, slightly wavy. The ribs end at the same point at the transition to the end plate. Here the height of the collar is considerably narrower than the frontal region. The end plates are short, undecorated and end in partially preserved end rolls. The left end plate is not preserved.

Additional investigation: Metallography (Fig. 2.127; Nørgaard 2015b):

Sampled at the transition to end. Microstructure towards the sample centre displays large irregular grains (underlying dendritic structure), <delta>-phase (equally spread in the sample) and speckled copper-sulfide inclusions. Microstructure near the surface shows occasionally strain lines, irregular grains, cuprite which is accentuating the dendritic structure and copper-sulfide inclusions. Trace elemental data is presented in Table 3.

Crafting technique: The as-cast microstructure indicates that the piece was cast via the lost-wax method and post-casting only slightly reworked (supported by several strain lines).

Løserup, Udby sogn, Holbæk Amt

NM B10522-30

Aner and Kersten 1976: 122; Nørgaard 2011: 27-29

Burial mound with stone setting, covered in seaweed, inhumation

NBA II

Dagger, belt plate, neck collar, three tutuli, spiral arm ring, spiral finger ring, fibula

Plates 19 and 20

B10524 – The **neck collar** is preserved only in fragments and is heavily corroded. The individual ribs (14 ribs in total) vary in height due to the greenish- to reddish-brown patina. More significant, however, are the wider rim-accompanying ribs and the triangular in cross-section rib-valleys. The end plate is apparent only as a small fragment. It seems the edge-accompanying rib is partly extended into the end plate. The probably undecorated end plate shows strong changes in the surface structure due to the advanced corrosion.

Additional investigation: Photographic documentation of fabric residues under the patina.

Crafting technique: Lost-wax cast, probably reworking.

B10523 – Well-preserved **belt plate** with long conical spike which ends in a rounded tip. The belt plate is heavily damaged by a reddish corrosion. Around the slightly sloping foot of the spike is an undecorated area that is framed by a decorative ribbon. This consists of an oblique notched ribbon, two parallel lines, an oblique notched ribbon, two parallel lines and an oblique notched ribbon. The oblique notched ribbons of the innermost decorative ribbon point all in one direction. A series of 13 spirals connected by single lines lies between this band and the next identical decorative ribbon. The only difference between these two decorative ribbons is the change within the direction of the oblique notches. The next spiral series consists of 18 larger spirals, connected through double lines. Parallel to the edge is a single ladder-like notched ribbon. The smooth hem is undecorated and decreases radically in thickness towards the edge. On the back opposite to the spike there is a loop. It consists of a broad bar through which a hole is pierced.

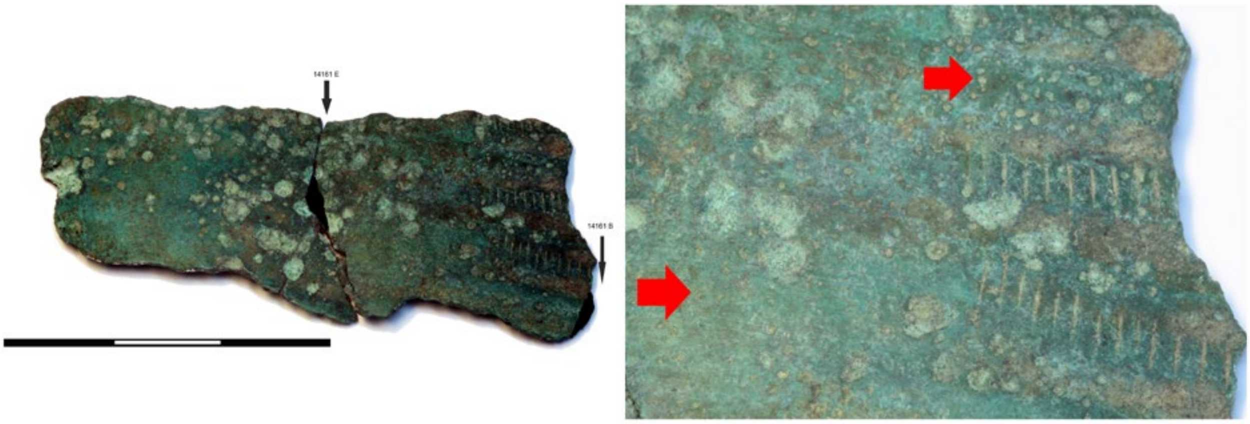
Crafting technique: Lost-wax cast with parts of the decoration (probably spiral-stamp), partly post-casting decoration and reworking.

Lubmin, Vorpommern-Greifswald (VP), Mecklenburg
ALM 1994/3/1
Schmidt 1994: 55-72; Nørgaard 2011: 64-66
Found in early BA burial field, cremation with stone packing in OW
NBA III
Neck collar, two open arm rings with different decoration, double-button, two fibulae
Figures: 2.102
ALM 1994/3/1 – **Neck collar** with three groups of two ribs. The triangular in cross-section ribs are decorated with gently sloping, very deep incisions. The rib-valley is decorated at its deepest point with a series of dots. The smooth field between the rib groups is divided horizontally with a line. Above and below the line standing triangle series are applied, which have their counterpart in another rib-accompanying equilateral triangle series. The arrangement of the triangle ribbon results in free space between the opposed triangle series. The ribs and the intervening smooth fields are concluded towards the end plate with simple curved lines. A vertical decorative ribbon consisting of a broad cross-hatched band initiates the decoration of the end plates. The same consists of three hatched ribbons which divide the end plate vertically in thirds. Horizontally, in between the hatched bands, there are in each field four ribbons consisting of four or five parallel lines; the exterior lines are edge-accompanying. Parallel to these lines and pointing towards the free space are standing triangle series. The end rolls are fragmentarily preserved.
Additional investigation: Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017; 2015a).
Crafting technique: Lost-wax cast with decoration, heavy reworking of decoration.

Lübz, Ludwigslust-Parchim (LUP), Mecklenburg
ALM 2000/1277,3-2000/1277, 10
Schubart 1972: 123f.; Nørgaard 2011: 58-62
Found in grave, 0.7 m deep, inhumation with wooden coffin
NBA III
Ceramics, neck collar, two neck rings, cone-shaped tutuli, fibula, tutulus, four open arm rings with different decoration, two leg rings, spiral finger ring, two spiral leg rings
Plate 18 and 19
ALM 2000/1277,3 – Well-preserved **neck collar** with three groups of two ribs. The ribs are accompanied by incisions. These are connected with slightly offset notches, forming a rib-decoration with flared ends. The grooves between the pairs of ribs are broad and flat. In the two smooth intermediate fields there is a series of connected spirals that are completed with an arrow band (composed of superimposed arches). The arrow band terminates at the height of four superimposed semi-circles. The arrow band is longer on the right side than on the left side. The mentioned semi-circles each connect the inner ribs from the upper, middle and lower pair. The rib-decoration is partly visible within the arch decoration. The frontal decoration is separated from the decoration of the end plates by a vertical decorative ribbon. This ribbon consists of two parallel lines and in the centre a ribbon of opposed arches, each arch series applied to a line. The end plate is divided in the middle by a similar decorative ribbon and framed with additional arrow bands (composed of half-arches). In each of the two resulting fields is placed a series of six connected spirals, which decrease slightly in size. Shortly before the preserved end roll is a vertical decorative ribbon consisting of two parallel lines, an arrow band, and two parallel lines. Placed on the final line a series of dash-filled triangles conclude the end decoration.
Crafting technique: Lost-wax cast, reworking of spirals (lying triangles are post-casting decoration).
ALM 2000/1277,10 – Very poorly preserved **small tutulus** with a pointed spike. The tutulus is covered with a thick blooming patina, therefore the decoration is only partially visible. The continuously rising surface (from the edge to the tip) is centrally decorated with a ring of small humps. The narrow spike is smooth, with finished edges, and undecorated. On the back a thick bar is visible, which is placed in the groove under the spike. Within the spike´s groove a rough surface with presumably core residues is preserved.
Crafting technique: Lost-wax cast with clay core.

Lüneburg, Lüneburg, Niedersachsen
LMN 14066, 4754 and 12041
Laux 1971: 218; Nørgaard 2011: 33-35
Unknown context, found together
NBA II
Neck collar, disc-headed pin, belt disc, arm spiral
Figures: 2.065; 2.086; 2.108; 4.030
LMN 14066 – The **neck collar** is covered largely with a nice smooth patina. On the ventral side, a smaller area is covered with a blooming patina. The collar fragment has eight ribs with a different spacing between the ribs. Especially between the lowest three ribs, the distance varies considerably. The uppermost rib is significantly broader and is tapered to the top edge. The ribs are decorated in a notched chessboard-pattern, each rib having a notch decoration at its beginning, except the second rib from the bottom. The ribs terminate all at the same height at the transition to the end plate. The end plate is unadorned and relatively short. It probably ends in end rolls which were broken in prehistory.
Additional investigation: Trace elemental analysis, data shown in Table 3.
Crafting technique: Lost-wax with post-casting decoration and reworking.
LMN 4754 – Poorly preserved **small belt plate** with a small round spike and three decorative spiral rows. The innermost spiral series is no longer visible and can only be determined on the basis of patina patterns. Around the slightly rising spike is a free undecorated field followed by a decorative band consisting of a row of standing triangles, five parallel lines and hanging triangles. Between this decorative ribbon and the next, similarly constructed, ribbon a number of small, connected spirals can be assumed. Only the second spiral line is clearly visible, it consists of about 15 (the bad condition of the discs makes it difficult to determine an exact number), connected by double lines. This series is separated from the outermost series by a decoration consisting of six parallel lines. The outermost spiral series consists of 22 large spirals, connected with double lines. The conclusion to the edge is formed by a decorative band of six parallel lines placed before the disc ends in a slightly curved upwards undecorated narrow rim. On the back of the disc an eyelet is attached below the spike.
Crafting technique: Lost-wax, post-casting reworking and cast-on spike.

1

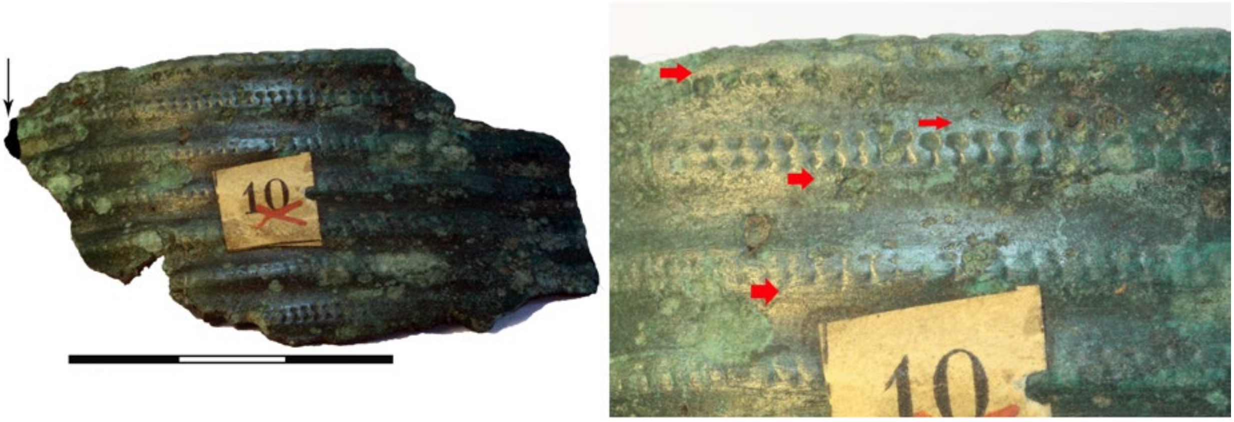


2

3

Plate 18:
1) Luttmissen, Uelzen, Lower Saxony – neck collar LMN 14161; 2) Luttmissen, Uelzen, Lower Saxony – stud-bracelet LMN 14161S; 3) Lübz, Ludwigslust-Parchim (LUP), Mecklenburg – neck collar ALM 2000/1277,3.

1


2


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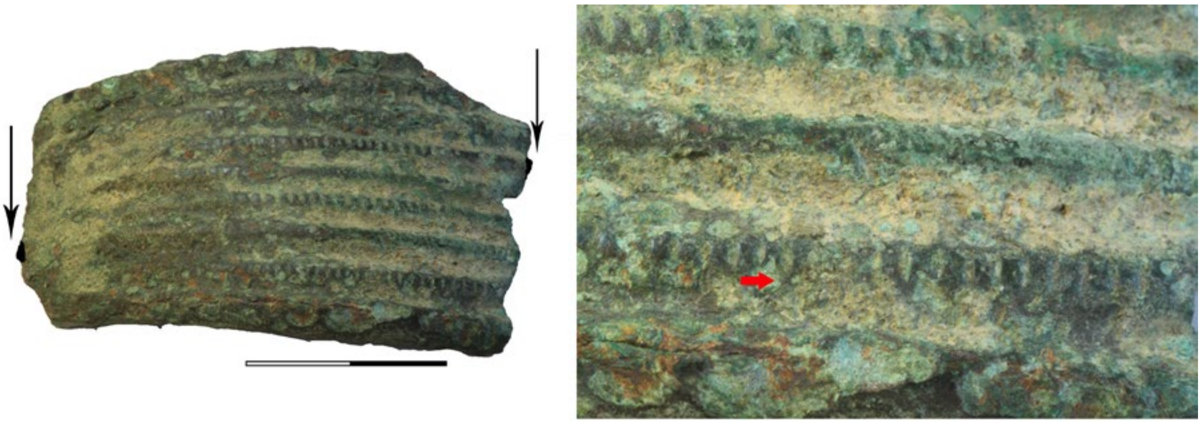

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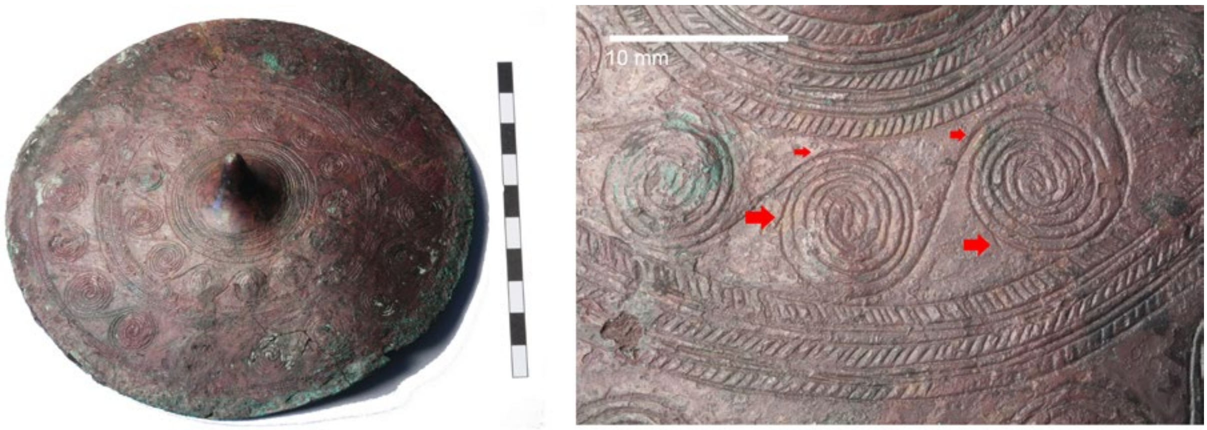


Plate 19:
1) Lübz, Ludwigslust-Parchim (LUP), Mecklenburg – tutulus ALM 2000/1277,10; 2) Lüneburgisches, Lüneburg, Lower Saxony – neck collar LMN 14146; 3) Lüneburgisches, Lüneburg, Lower Saxony – neck collar LMN 14147; 4) Løserup, Udby sogn, Holbæk Amt – belt plate NM B10523.

LMN 12041 – From the **spiral-decorated disc-headed pin** about half was preserved and the other half was reconstructed with the help of a yellowish material, so the difference is clearly visible and can be easily distinguished between original and contemporary pieces. The uniformly thick slightly oval disc-head is decorated with a parallel line decoration consisting of five lines in the centre of the disc. Whether the centre formed a hump or a groove cannot be said because of the condition of the disc. A decorative ribbon consisting of five parallel lines, which are accompanied to the inside by a dot line, runs parallel to the rounded edge of the disc and is separated from the latter by a finger-wide unadorned hem. The area lying in between the decorative ribbons is filled with a series of connected spirals with double lines (five of seven spirals are original). The transition point of the shaft and disc head has a flat rectangular cross-section and tapers towards the middle of the shaft with a round cross-section.
Crafting technique: Probably cast in rough forms with cold-working of the plate and shaft, additional post-casting decoration and reworking.

Lüneburgisches, Lüneburg, Lower Saxony

LMN 14146-14148
Laux 1971
Single finds
NBA II
Plate 19
LMN 14146 – Fragment of a **neck collar** with seven clearly separated ribs. The ribs are alternately decorated with hourglass-shaped notches. The piece is frayed at the edges, chipped, and the surface is covered with a blooming patina. The ribs are wide apart, and the rib-valleys are triangular in cross section.
Additional investigation: Metallography (Fig. 2.130; Nørgaard 2015b):
Sampled at frontal section, near top ribs. Microstructure in the sample centre displays large irregular grains, <delta>-phase, copper-sulfide, cuprite (corrosion). Microstructure towards the surface shows smaller and regular grains, strain lines (several generations), cuprite, copper-sulfide, <delta>-phase. Trace elemental data is presented in Table 3.
Crafting technique: The as-cast microstructure of the lost-wax cast with superficial traces of cold-work indicates a slightly cold-worked artefact post-casting. The rib-decoration is probably introduced post-casting (strain-lines) and the edges reworked. A pre-work annealing at a low temperature is possible. The cold-work indicated by strain lines was final.
LMN 14147 – Fragment of a **neck collar** decorated with nine alternating notched ribs. The top and bottom ribs are wider and stronger than the remaining ribs. Excepting the second rib from the top, all ribs terminate at the transition to the end plate. The second rib is slightly shortened and the rib-valleys at this point are tapered. The end plate was previously broken and was not preserved. On the back of the collar patinated fabric remains are visible.
Additional investigation: Metallography (Fig. 2.123, 2.127, 2.128; Nørgaard 2015b):
Sampled at front section, fourth rib from top (1) and at the transition front to end (bottom). Microstructure towards the centre displays Cu-rich-dendrites, <delta>-phase, copper-sulfide, lead inclusions (0.5 µm), cuprite (corrosion at dendritic structure). Microstructure near the surface shows strain lines, annealing twins (single generation), cuprite, copper-sulfide, <delta>-phase, copper-linseed oil layer (covering the artefact). Trace elemental data is presented in Table 3.
Documentation of fabric residues under the patina.
Crafting technique: As-cast microstructure with strain lines indicates cast via lost-wax technique. Towards the end is a partly recrystallised microstructure indicating a post-cast finishing of the item. Between the body of the item and the ends the microstructure changes distinctive. The body shows no sign of recrystallisation. Towards the end the deformation rate increases and the microstructure is recrystallised. Here, several annealing phases are possible. Strain lines indicate final cold-work.
LMN 14148 – Fragment of a **stud-bracelet** with nine parallel ribs. The central rib is wider and slightly higher than the parallel running ribs.
Additional investigation: Metallography (Fig. 2.130; Nørgaard 2015b):
Sampled at centre part, including middle rib. Microstructure towards the atefact´s centre displays large irregular grains, <delta>-phase, copper-sulfide. Microstructure near the surface shows partly regular formed grains, strain lines, annealing twins (one generation), cuprite (accentuating the dendritic boundaries), copper-sulfide, tin-oxide in <delta>-phase. Trace elemental data is presented in Table 3.
Crafting technique: As-cast microstructure with traces of slight deformation near the surface indicates a reworked cast artefact. Partly recrystallised microstructure may be due to deformation and probably low temperature annealing. The small grains as well as the annealing twins within the rib-valleys indicate a high strength of deformation. Strain lines indicate final cold-work. On the reverse side are reworked cast errors (shrink-holes) visible.

Lüneburgisch, Lüneburg, Lower Saxony

ML 1133-1135
Laux 1971
Unknown context
NBA II
Figures: 2.091; 2.093; 4.048
ML 1133 – Quite well-preserved, broken **neck collar** with six ribs and a wide smooth hem at the bottom. The upper rib is concomitant to the edge and follows its shape. The second rib is parallel to the lower ribs, all of which run parallel to the lower edge. This creates a broad lens-shaped open area between the top and the second rib. The second rib is reduced and conjoins with the first rib shortly before the transition to the end plate. The ribs are alternately decorated with long, deep cuts. The transition to the end plate forms a vertical decorative ribbon consisting of a dot band, five parallel lines and a further dot band. The hem at the bottom of the collar is decorated with a total of ten or 11 bosses (the exact number can only be assumed because of the state of preservation); these bosses are enclosed in circles. The end plate is provided with a similar boss decoration placed between vertical decorative ribbons. The end plate is probably divided into three fields, in each of which are placed two bosses, framed in a line. The vertical ribbons are composed of a dotted line, and in the first ribbon five, in the second ribbon four, and finally three lines, and probably another dot line. The ends are not preserved.
Crafting technique: Lost-wax, additional post-casting decoration (bulges) and reworking.

ML 1135 – Head of a **disc pin** with remains of the shaft. The slightly oval disc is decorated by an edge-accompanying decorative ribbon consisting of sunken line, an hourglass punch line, three parallel lines and another hourglass punch line. Towards the edge is a narrow undecorated space that is wider at the base of the shaft. The inside surface of the head plate has a decorative circle of circle groups arranged in spiral manner, which are placed around a hump. The number of turns varies greatly (from three to six turns) as does the depth of the bosses. The six groups are centred around a decoration of a boss surrounded with a star-like hourglass punch line and five concentric circles. The remains of the shaft of the disc pin are visible on the back. The bumps can be seen in negative form.
Crafting technique: Probably cast in rough forms with cold-working of the plate and shaft, additional post-casting decoration and reworking.

Luttmissen, Uelzen, Lower Saxony

LMN 14161, 14161S, 115/23/7
Laux 1971: 250; Nørgaard 2011: 56-58; described as Haarstorf, Uelzen
From burial, unknown context
NBA III
Neck collar, bracelet with stud-ends, arm spiral
Plate 18
LMN 14161 – End-piece of a **neck collar**, on which the start of the five remaining ribs can be seen. The piece is relatively flat and has only slightly pronounced ribs. Every second rib is decorated with elongated, blade-like and very deep scores. At the bottom of the collar there is a smooth seam that continues into the end plate. The long, narrow end plate is undecorated and broken at the end. An end-roll is not visible. The hem shows small depressions, especially on the back, which are possibly from humps.
Additional investigation: Metallography (Fig. 2.132, 2.134; Nørgaard 2015b):
Sampled at front section, near lower hem (1) and at the transition to end (2). Microstructure towards the artefact´s centre shows large irregular grains, occasionally <delta>-phase, copper-sulfide, angular bismuth inclusions and cuprite as a corrosion underline dendritic structure. Microstructure near the surface at the end displays strain lines, annealing twins, deformed annealing twins (towards the end), cuprite (corrosion at grain boundaries), copper-sulfide. Trace elemental data is presented in Table 3.
Crafting technique: Lost-wax cast, reworking of the hem and end plate. The different recrystallised microstructures between the samples indicate a different level of post-casting cold-work. At the hem and towards the end the microstructure is fully recrystallised. Towards the middle the as-cast microstructure is only partly recrystallised. Annealing twins indicate several annealing phases at the end and strain lines indicate final cold-work especially at the hem.
LMN 14161S – The two fragments of a strong **stud-bracelet** consist of seven and four ribs. The wider piece probably originates from the widest part of the bracelet, which, therefore, had seven ribs. On the narrower part the termination point of the ribs is visible. A decoration of the uniformly arranged and pronounced ribs cannot be seen due to the massive corrosion.
Additional investigation: Metallography (Fig. 2.126; Nørgaard 2015b):
Sampled at the stud end. Microstructure in the sample centre displays Cu-rich-dendrites, occasionally <delta>-phase, copper-sulfide, angular bismuth inclusions, cuprite that is accentuating the underlying dendritic structure. Microstructure near the surface shows strain lines, dendrites (Cu and Sn phases), cuprite, copper-sulfide, occasionally tin-oxide in <delta>-phase. Trace elemental data is presented in Table 3.
Crafting technique: As-cast microstructure of the lost-wax cast shows dendritic patterning. Strain lines indicate final cold-work near the ribs with moderate strength. It can be assumed that the cast artefact has been reworked, however, not annealed. Thus, the bracelet is cast as a ring.

Martofte, Stubberup sogn, Odense Amt

NM B1027
Aner and Kersten 1977: 103; Nørgaard 2011: 35-38
Found in the 'Brydeshøje' burial mound, female inhumation in stone chamber
NBA II
Neck collar, dagger blade, spiral finger ring, bones
Plate 20
B1027 – Poorly preserved **neck collar**, covered with a strong blooming patina. The collar has 17 rounded and narrow ribs of which the top five are parallel to the upper edge and the bottom ribs follow along the curved shape of the collar. The fourth and fifth ribs from the top conjoin at the side of the collar into a single rib which terminates at the same height as the others. A similar pattern is formed by the sixth and seventh rib and the ninth and tenth, the latter converging significantly closer to the rib end. The rib-valleys lying between these ribs are thus shortened and slightly lenticular. At the transition to the end plate only 15 ribs are left. The ribs are decorated with a wide notched trim, which is continuous on the top and bottom rib and occurs on the remaining ribs in a chessboard-pattern. The frontal area is separated from the end by a vertical line decoration. This decoration is attached as a frame around the end plate and runs out towards the ends in a triangular shape. It consists of bands of cross-hatched and parallel lines (due to the heavy patina an accurate statement cannot be made).
Crafting technique: Lost-wax cast, slight reworking.

Mecklenburg (unknown location)

Several artefacts from unknown locations
Schubart 1972: 182; Nørgaard 35-38
Circumstances unknown
NBA II
Plate 21
ALM S6 – **Neck collar** with nine ribs, triangular to flat triangular in cross-section. The ribs are decorated with groups of notches arranged in a chessboard-pattern. The ribs terminate at the vertical decorative band that separates the frontal area from the end plate. This ribbon consists of two parallel lines, a ribbon of superimposed crescent-shaped notches and a further line. Attached to this ribbon, and parallel to the edge of the end plate, a horizontal ribbon is placed, consisting of three decorative strips each designed from two opposed arch ribbons. This decoration causes two undecorated fields which form part of the pattern and stop just like the ribbons shortly before the end rolls.
Additional investigation: Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017; 2015a)
Crafting technique: Lost-wax cast, post-casting decoration.

1

2

3

Plate 20:
1) Løserup, Udby sogn, Holbæk Amt – neck collar NM B10524; 2) Martofte, Stubberup, Odense – neck collar NM B1027; 3) Mecklenburg (unknown location) – neck collar ALM LIIQ,2.

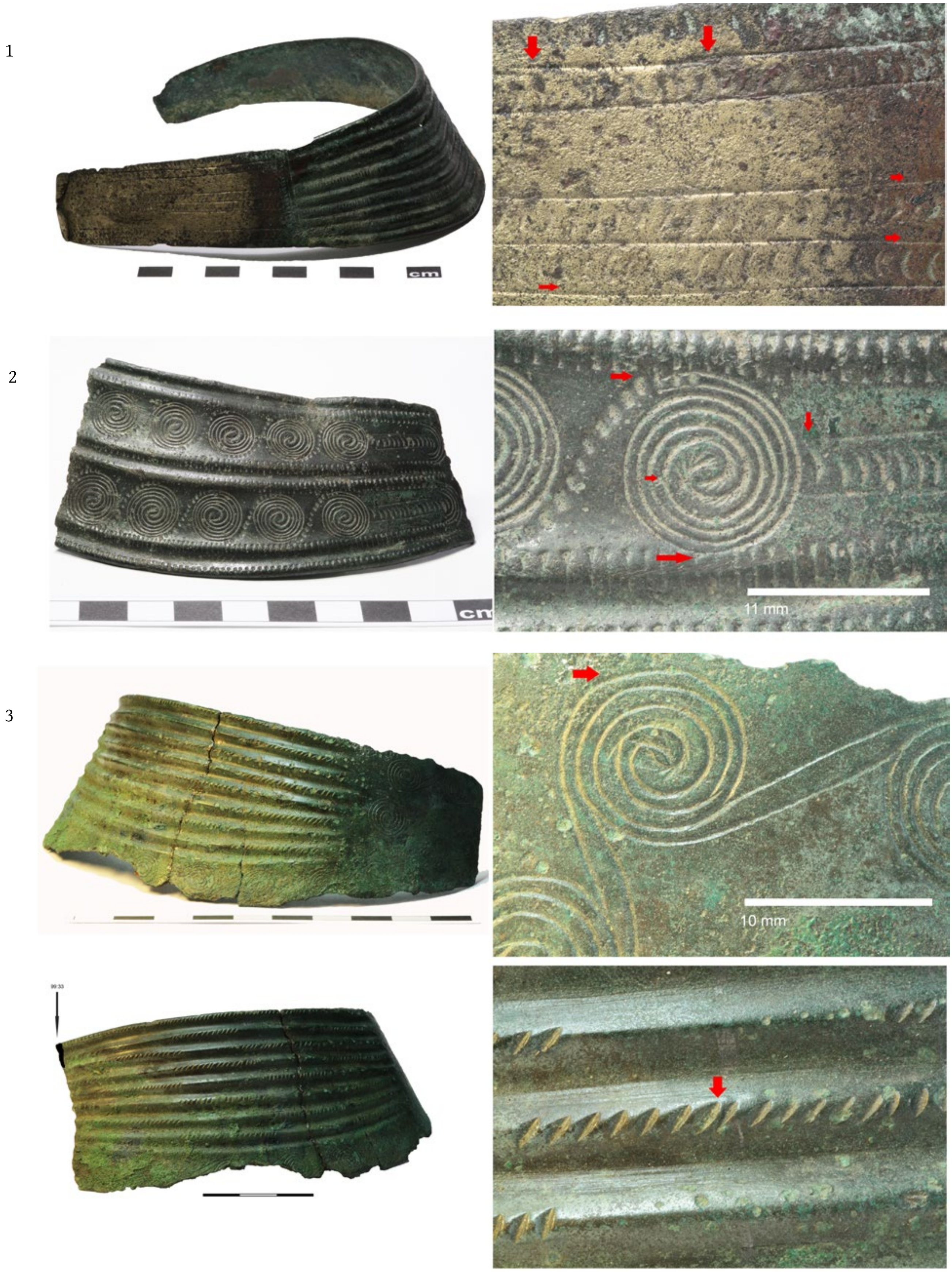


Plate 21:
1) Mecklenburg (unknown location) – neck collar ALM S6; 2) Mecklenburg (unknown location) – neck collar ALM26; 3) Moorkate, Heidekreis (form. Soltau-Fallingbostel), Lower-Saxony – neck collar LMN 99:33.

Mecklenburg (unknown location)
Several artefacts from unknown locations
Schubart 1972: 182-183; Nørgaard 58-62
Circumstances unknown
NBA III
Figures: 3.012 (ALM 94-1032/4); Plates 20 and 21
ALM LIIQ,2 – Almost completely preserved **neck collar** in three large fragments. The spiral-decoration of the frontal part consists of seven spirals in the upper and seven spirals in the lower part. The spirals slightly decrease in size towards the edge. They are connected with a weak visible band of sunken imprints and the termination of the spiral line is initiated by a framed half-sheet ribbon, which itself is closed by four stacked, increasing arcs. The still-preserved end plate displays two superimposed rows of two interconnected spirals. As on the whole collar, strong corrosion is visible. The irregular spirals are connected with the help of the same pointed band, which is also evident in the frontal part of the collar, but it does not connect directly to the spiral. Towards the end residues of a decorative tape consisting of ladder-like notched ribbons and parallel lines can be seen.
Additional investigation: Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017; 2015a); photographic documentation of fabric residues under the patina.
Crafting technique: Lost-wax cast, partial post-casting reworking.
ALM LIIQ,7(1) – One fragment of a **neck collar** (to which the Museum gives the same number as two other fragments). All three pieces are badly damaged and the decoration is very difficult to detect. The piece shows a part of the spiral-decoration of the end plate, consisting of four connected spirals in two horizontal rows. The connection between the spirals is in the vertical given by the overlap of a pair of spirals. At the edge fragments of the ladder-like notched ribbon framing the end plate are visible.
Additional investigation: Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017; 2015a)
Crafting technique: Rough lost-wax cast, additional post-casting decoration.
ALM LIIQ,7(2) – One fragment of a **neck collar** (to which the Museum gives the same number as two other fragments). All three pieces are badly damaged and the decoration is very difficult to detect. The fragment of the end plate of this collar is very fragile and shows a slightly indented spiral. The smallest fragment shows a rounded rib-pair with parts of the rim and an irregular spiral. The rib-decoration is made of arrow-like notches in the rib-valley.
Additional investigation: Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017; 2015a).
Crafting technique: Lost-wax cast, partial post-casting decoration (spiral).
ALM 26 – Frontal **fragment of a neck collar** with three groups of two ribs and intervening smooth areas. The free fields are decorated with a number spirals, which are connected by pointed lines. Accompanying the edge of the ribs, light triangular notches which are connected via incisions are used as rib-decoration. The rib-decoration terminates in the superposed semi-arches, which are placed at the end of each spiral series. These four arcs are initiated by a band of framed, arched notches. The decoration of the end plates is unknown.
Additional investigation: Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017; 2015a).
Crafting technique: Lost-wax cast, post-casting reworking of parts of the decoration.
ALM 94/1032/4 – Fragments of an **end plate** with parts of the frontal area and remains of the rolled ends of a **neck collar**. A small piece still shows the three groups, each of two ribs in the frontal area of the collar which are connected by three superposed arcs. One ribbon of diagonally hatched incisions is placed between the arcs and the first half of the spirals in every open field. The decoration of the end plate consists of two rows of three spirals, which are connected with dotted lines. Framing the spirals a decoration of diagonally dashed lines accompanied by parallel lines is placed in an edge-accompanying manner. The end rolls are separated from the spirals by eight parallel lines.
Additional investigation: Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017; 2015a).
Crafting technique: Lost-wax cast, probably modern reworking.

Möllen, Rostock (LRO), Mecklenburg
ALM Br. 438
Schubart 1972: 128-129; Nørgaard 2011: 30-32
Found in hoard near lake
NBA II
Neck collar, open arm ring
Plate 22
ALM Br. 438 – **Neck collar** with nine slightly tapering ribs. The ribs are alternately decorated with lens-shaped notches, the centre of which is preserved. The nine rib-valleys are of triangular cross-section and flatten slightly towards the end plates. The ribs terminate all at the same height at the transition to the end plate. They are closer together towards the end than in the middle of the collar. The undecorated end plates end in rolls that are slightly narrower than the height of the plate.
Additional investigation: Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017; 2015a).
Crafting technique: Lost-wax cast with decoration.

Molzen, Uelzen, Lower Saxony
ML 242:84
Laux 1971: 259; Krüger 1925: 185f.
Probably from a hoard found on a field
NBA II
Three belt discs with star motif, four belt discs with humps, bronze button, two hanging discs
Figures: 2.032; 2.035; 2.069; 2.092; 4.017; 4.036
ML 242:84b – Well-preserved **belt disc** with a short, conical spike with a round pointed tip. Around the spike is a wide undecorated field that is terminated by an irregular decorative band of two parallel lines, two adjacent point or puncture rows and two parallel lines. On this ribbon, seven standing, dash-filled triangles are applied. The slanted line fill is arranged parallel to the left side (top view) in each triangle. The triangle tip abuts the edge-accompanying decorative band. This decorative ribbon consists of three parallel lines, two adjacent point or puncture rows and two parallel lines. In between the ribbon and the slightly rounded edge is a free hem. On the back of the disc is a slight groove over which a weakly protruding loop is placed. The loop consists of an oval bar that is wider towards the end, like a fan.
ML 242:84c – Well-preserved **belt disc** with a short, conical spike with a round pointed tip. Around the spike is a wide undecorated field that is terminated by a decorative ribbon consisting of a point or puncture row, two parallel lines, another point or puncture row and three parallel lines. On this ribbon, twelve standing, dash-filled triangles are

applied. The slanted line-fill is arranged parallel to the left side (top view) in each triangle. The triangle tip abuts the edge-accompanying decorative band. This decorative ribbon consists of two parallel lines, a point or puncture row and three parallel lines. In between the ribbon and the slightly rounded edge is a free hem. On the back of the disc there is in a distinct groove (which is pronounced through the negative imprints of the decorative ribbon) a weakly protruding loop. The loop consists of an oval bar that is wider towards the end, like a fan.
Crafting technique: Rough lost-wax cast with core, post-casting decoration and cold-working.
ML 242:84d – Well-preserved **small belt disc** with short conical spike. The spike of the disc merges into the surface and is bounded by a decorative ribbon of three parallel lines which are framed by a row of standing triangles. On the decorative ribbon follows a series of spirals with a large hump in its centre. The spirals are connected with double lines. The beginning of the spiral is cut into the foot of the hump. Edge-accompanying and separated only by a small undecorated hem is a decorative ribbon consisting of a row of standing triangles and five parallel lines. On the back of the disc, the negative forms of the humps are visible as significant indentations. Slightly offset towards the centre there is, however, a protruding loop below the spike.
Crafting technique: Lost-wax cast probably with humps and core (eyelet), post-casting decoration.
ML 242:84e – Well-preserved **small belt disc** with short conical spike. The spike of the disc merges into the area and is framed by a decorative ribbon, which consists of two adjacent arrow bands (stacked arches) framed in lines. On the decorative ribbon follows a series of spirals with a large hump in its centre. The spirals are connected with double lines. The beginning of the spiral is cut into the foot of the hump. Accompanying the edge and separated only by a small hem is another decorative ribbon. The ribbon consists of a series of stacked arches framed in lines, a parallel line, and another series of stacked arches framed in lines. On the back of the disc, the negative forms of the humps are visible as weak indentations. Slightly offset towards the centre there is, however, a protruding loop below the spike. In addition to the probable core the spike is perforated.
Crafting technique: Lost-wax cast probably with humps and core (eyelet), partial post-casting decoration.
ML 242:84f – Well-preserved **small belt disc** with short conical spike. The spike of the disc merges into the area and is framed by a decorative ribbon, which consists of three parallel lines accompanied by a framed in lines arrow ribbon (superimposed arches). On the decorative ribbon follows a series of spirals with a large hump in its centre. The spirals are connected with double lines. The spirals are doubled. The beginning of the spiral is cut into the foot of the hump. Accompanying the edge at a small distance to the rounded edge a decorative ribbon is placed. It consists of a framed in lines arrow ribbon (superimposed arches), two parallel lines and a further framed in lines arrow ribbon. On the back of the disc, the negative forms of the hump are visible as significant indentations. Slightly offset towards the centre there is, however, a protruding loop below the spike.
Crafting technique: Lost-wax cast probably with humps and core (eyelet), post-casting decoration and reworking of humps.
ML 242:84g – Well-preserved **belt disc** with a spiral- and hump-decoration and slightly conical spike with flat rounded tip. Around the spike is a wide undecorated field that is framed by a decorative ribbon. It consists of a notched ribbon framed in lines (slightly oblique Z-shaped notches) and two parallel lines. On the decorative ribbon follows a series of spirals with a large hump (with one exception) in its centre. The spirals are connected with double lines. Accompanying the edge at a small distance to the rounded edge, a decorative ribbon is placed. This decorative ribbon consists of two parallel lines, a notched ribbon framed in lines and two parallel lines. On the back of the small disc, the negative imprints of the hump in several steps are clearly visible. Opposite the spike there is a wide protruding eyelet.
Crafting technique: Lost-wax cast probably with humps, core (eyelet) and line decoration, post-casting notches and reworking of humps.
ML 242:84h – Very well-preserved **hanging disc** with broad back-bent eyelet. The eyelet is separated from the disc by a decorative ribbon of an arrow-like ribbon (stacked lying arches) framed in lines, four parallel lines and another framed in lines arch ribbon. Attached to the top line of this decoration ribbon are three groups each of three superimposed arches. The slightly non-circular decorative plate has a centred and long, slightly tapered spike with rounded tip. Around the spike runs a decorative ribbon consisting of two parallel lines and a framed in lines arch ribbon. Following this are four spirals whose centre forms a hump, placed in a row and connected with double lines. Edge-accompanying and separated only by a narrow unadorned hem, is a decorative ribbon of two parallel lines and a framed in lines arch ribbon. On the back of the disc the negative forms of the decoration and the humps are easily recognisable. The flap of the eyelet is notched.
Crafting technique: Rough lost-wax cast or two-part mould, post-casting decoration.
ML 242:84i – Partly preserved **hanging disc** with broad back-bent eyelet. The eyelet is separated from the disc by a decorative ribbon of an arrow-like ribbon (stacked lying arches) framed in lines, four parallel lines and another framed in lines arch ribbon. Attached to the top line of this decoration ribbon are three groups each of three superimposed arches. The slightly non-circular decorative plate has a centred and long, slightly tapered spike with rounded tip. Around the spike runs a decorative ribbon consisting of four parallel lines and a framed in lines arch ribbon. Following this are four spirals whose centre forms a hump placed in a row, connected with double lines. Of those four spirals only one is completely preserved. Edge-accompanying, and separated only by a narrow unadorned hem, is a decorative ribbon of two parallel lines and a framed in lines arch ribbon. On the back of the disc the negative forms of the decoration and the humps are easily recognisable. The flap of the eyelet is notched.
Crafting technique: Rough lost-wax cast or two-part mould, post-casting decoration.

Moorkate, Heidekreis (form. Soltau-Fallingbostel), Lower Saxony
LMN 99:33
Nørgaard 2011: 56-58
Probably related to burial mounds
NBA II
Neck collar, bronze pendant (Segelohrring)
Plate 21
LMN 99:33 – The **neck collar** has nine well-defined ribs (triangular in cross-section), of which the uppermost is notch-

decorated throughout and the other ribs are a chessboard-pattern decorated with notches. The bottom rib goes directly into a broad smooth seam which is decorated with a spiral series, connected with double lines. The ribs terminate all at the same place at the transition to the end plate. The spiral series of the hem continues into the end plate and forms the bottom row of the decorative frame on the end plate. At the transition between the ribbed section (vertical) and end, and along the upper edge of the end plate, extends a further series of connected spirals. However, the spiral line of the hem and the spirals on the end plates are not interconnected. There are no end rolls preserved. The surface of the collar is variably well preserved, partly covered by a thick patina and the original surface partly clearly visible.
Additional investigation: Metallography (Nørgaard 2015b):
Sampled at the transition front to end near upper edge. Microstructure towards the sample centre displays large irregular grains and regular recrystallised grains, occasionally <delta>-phase, copper-sulfide, shrink-holes. Microstructure near the surface shows strain lines, annealing twins (single phase), different sized grains, cuprite, copper-sulfide (slightly deformed), occasionally <delta>-phase. Trace elemental data is presented in Table 3.
Crafting technique: As-cast microstructure with traces of cold-work indicating a cast item with the lost-wax method, post-casting reworked. The strain lines indicate final cold-work at the rib back and at the edges and rib-slopes. A partly recrystallised microstructure towards the end indicates a high deformation rate with one possible annealing. The different sized grains are probably due to a different strength of previous cold-work.

Norre Snede, Vrads herred, Skanderborg Amt

AM 5337
Aner and Kersten 2014: 208
Found in in burial mound, probably in stone cist
NBA II
Belt plate, arm ring, two arm rings with stud ends, twisted neck ring, spiral finger ring, fibula
Figures: 3.013
AM 5337 – Heavily corroded and partly fragmented **belt plate** with short broad spike and a spiral-decoration. The spike is undecorated, broad and conical with a rounded tip. Around the foot of the spike is a narrow undecorated area, which is framed by a decorative ribbon consisting of a ladder-like notched ribbon, two parallel lines and a ladder-like notched ribbon. On this decoration follows a spiral series of eleven spirals, connected with single lines. The slightly varying in size spirals are separated from the next spiral series by a wide decorative ribbon. This consists of a ladder-like notched ribbon, two parallel rows of opposed triangles, two parallel lines and a ladder-like notched ribbon. The following spiral series consists of 18 very large spirals, connected with single lines. A final decorative ribbon separates the spiral-decoration of the slightly rounded edge. This decorative ribbon consists of a ladder-like notched ribbon, two parallel lines, a row of opposed triangles, two parallel lines and a row of opposed triangles. An undecorated hem follows this decorative ribbon. The back of the wafer cannot be seen because it is mounted on a glass plate.
Crafting technique: Lost-wax cast with post-casting decoration and probably cast-on spike.

Oldendorf a.d. Luhe, Lüneburg, Lower Saxony

ML 1007-1009
Laux 1971; Nørgaard 2011: 35
Female burial in mound
NBA II
Neck collar, bronze rolls, two wheel-headed pins, two arm spirals
Figures: 2.053; 2.056
ML 1009 – Found in fragments and reconstructed **wheel-headed pin** with single wheel cross and eyelet on the inner ring and an additional elongated loop at the top of the head. The long shaft of the pin is at the base of the head slightly square and tapers slightly towards the end. The wheel-head consists of a ring, formed of three ribs. On the ring, in extension of the shaft, an eyelet is mounted. In the ring, there is a simple cross, which terminates at an inner ring. The back of the needle shows no structure, just a smooth casting surface.
Crafting technique: Open mould (?).
ML 1008 – Simple **wheel-headed pin**, the bar has a thin slightly oval cross-section. The long thin shaft is square and very uneven. The shaft tapers sharply shortly below the head. The head consists of a non-circular simple ring with a lens-form cross-section and an inner cross. As an extension of the shaft a loop is placed on top of the wheel-head.
Crafting technique: Two-part mould.
ML 1007 – Well-preserved **ribbed neck collar** with mainly broken end plates. The ten rounded ribs of the collar are decorated with a changing, partly weak, notch decoration. The ribs run parallel to the lower curved edge, which leads to a shortening of the top rib and a lenticular space between the upper ribs. The remaining nine ribs terminate all at the same point at the transition to the end plate. The end plate is undecorated. On the back of the collar, the remains of organic material or fabrics are clearly visible under the patina.
Crafting technique: Lost-wax cast, decoration through cold-working.

Østby Mark, Horns herred, Frederiksborg Amt

NM B17528
Nørgaard 2011: 54
Single find from field
NBA II
Plate 22
NM B17528 – **Neck collar** fragment with eight continuous notch-decorated ribs. The ribs are arranged horizontally and do not follow the shape of the collar. Accordingly, the bottom rib is substantially shorter than the central ribs. The ribbed section is framed in a series of triangles accompanied by an incised line. The triangle ribbon is in the bottom (under the lowest rib) expanded. Here a series of opposed triangles is placed at the beginning of the smooth hem. At the transition to the end plate the accompanying line fanned out and is interrupted to some extent. The end plates are probably undecorated and short.
Crafting technique: Rough cast (eventually open mould), post-casting decoration.

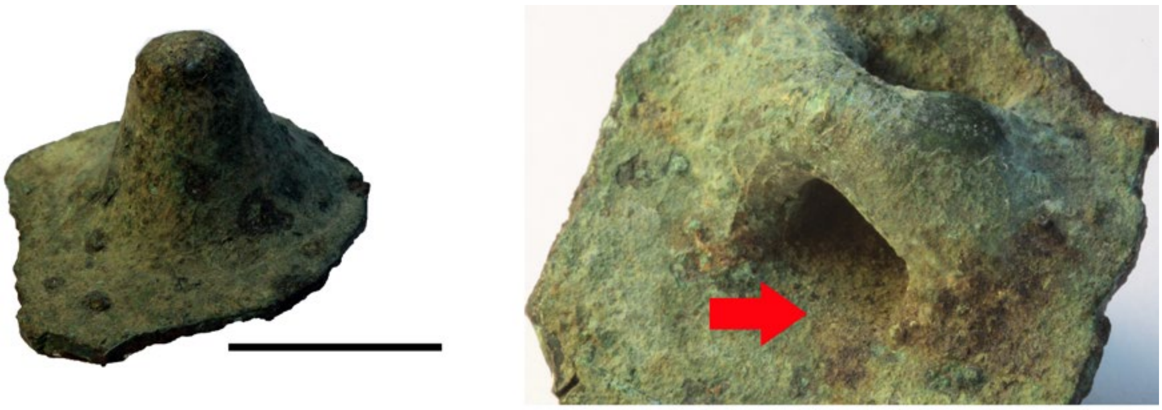
Pisede, Mecklenburgische Seenplatte (MSE), Mecklenburg

ALM 3191-3198
Schubart 1972: 137; Nørgaard 2011: 58-62
Found in burial mound, in Grave 1 cremation
NBA III

1

2

3



4

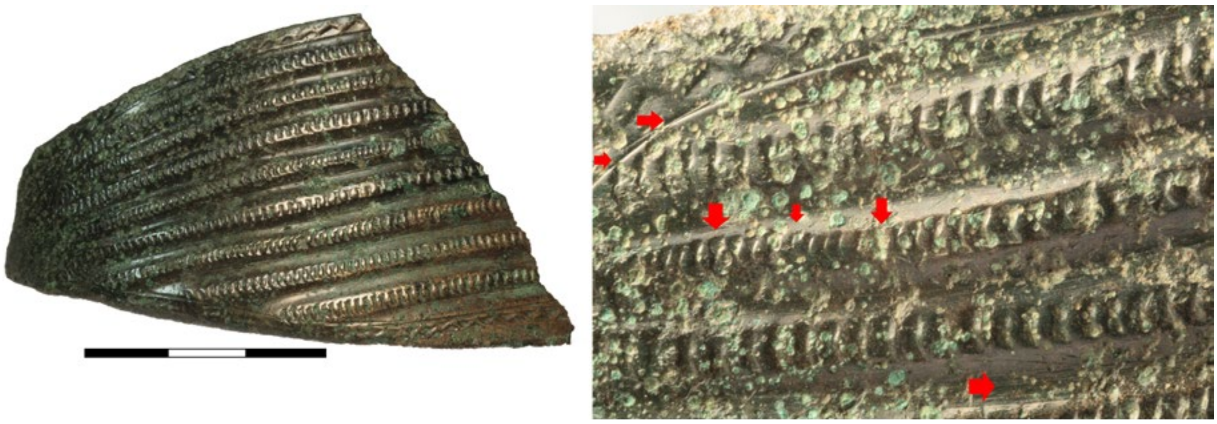


Plate 22:
1) Möllen, Rostock (LRO), Mecklenburg – neck collar ALM Br.438; 2) Rätzlingen, Uelzen, Lower-Saxony – neck collar LMN 13181a; 3) Rätzlingen, Uelzen, Lower-Saxony – neck collar LMN 13182; 4) Østby Mark, Horns, Frederiksborg – neck collar NM B17528.

Ceramic, neck collar, two neck rings, four arm rings different decoration, bronze pin, two leg rings
Figures: 4.020
ALM 3191 – Well-preserved **neck collar** with three groups of two ribs. The ribs are slightly pointed and decorated with elongated grooves that increase in size towards the ends. Between the rib groups the smooth fields are decorated with two parallel opposed triangle series. Towards the centre the spacing in between the triangle series is wider than towards the edge. The rib-valley between the ribs of one group is undecorated. The ribbed section of the collar is separated from the end plate by a decorative ribbon consisting of three parallel lines, two opposed, framed in lines, oblique-notched ribbons and three parallel lines. In between the ribbed section and the vertical decorative ribbon are six lying crosses that enclose each a rib. The decoration of the end plate is apparently only rudimentary. Accompanying the edge a cross-hatched band is visible which is accompanied by standing triangle series towards the undecorated middle.
Additional investigation: Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017; 2015a).
Crafting technique: Lost-wax cast with decoration, slight reworking of decoration.

Poltnitz, Ludwigslust-Parchim (LUP), Mecklenburg

ALM Br. 949-956
Schubart 1972: 139; Nørgaard 2011: 58-62
Found in the 'Sülwerbusch' burial mound with several burials, Grave 1, inhumation in wooden coffin
NBA III
Spiral finger ring, spiral rolls, neck collar, neck ring, fibula (Kreuzbalkenkopffibel), two open arm rings, finger ring with spiral plates, two leg rings with spiral, two simple leg rings.
Figures: 2.112; 2.114-15
Br. 949 – End fragment of a **Mecklenburg-type neck collar** (the rest of the collar is in the Ministry of Culture of Mecklenburg). The piece has a deeply applied decoration that is partly damaged by corrosion. From the decoration the last two spirals, and the vertical decorative ribbon close to the end rolls, are preserved. This decorative ribbon consists of three parallel lines, a framed in lines arch ribbon, three parallel lines, another framed in lines arch ribbon and four parallel lines. The end rolls are strong and only slightly damaged.
Crafting technique: lost-wax cast, heavily reworked.
Br. 954a – Very large and well-preserved **spiral foot ring** with two right-wound spirals. The two very uniform spirals consist of ten turns, of which the innermost two to three turns are undecorated. The fourth turn is decorated with a continuous notch trim and the following are decorated with bundles of three notches and intermediate undecorated areas. On the eighth turn the distances between the notch groups decreases and, in addition, ladder-like notched ribbons occur. The tenth turn is decorated again with regular notch groups until the transition towards the ring, here a decoration with notched ribbons a framing ladder-like notched ribbon (applied halfway around the bar) is applied. The ring approaches out of the last spiral turn and has twice the width of the spiral wire. It is decorated with a bundle of five parallel lines marking the transition from spiral to bar, followed by a decorative ribbon of three parallel lines, a ladder-like notched ribbon and parallel lines. This decorative ribbon is inclined compared to the one on the spiral. This spiral foot ring is part of a very similar pair.
Crafting technique: Forged from a bronze ingot, decorated with chisel-like tools.
Br. 954b – Very large and well-preserved **spiral foot ring** with two right-wound spirals. The two very uniform spirals consist of ten turns, of which the innermost two to three turns are undecorated. The fourth turn is decorated with a continuous notch trim and the following are decorated with bundles of three notches and intermediate undecorated areas. On the eighth turn the distances between the notch groups decreases and, in addition, ladder-like notched ribbons occur. The tenth turn is decorated again with regular notch groups until the transition towards the ring, here a decoration with notched ribbons framing a ladder-like notched ribbon (applied halfway around the bar) is applied. The ring approaches out of the last spiral turn and has twice the width of the spiral wire. It is decorated with a bundle of five parallel lines marking the transition from spiral to bar, followed by a decorative ribbon of three parallel lines, a ladder-like notched ribbon and parallel lines. This decorative ribbon is inclined compared to the one on the spiral. This spiral foot ring is part of a very similar pair.
Crafting technique: Forged from a bronze ingot, decorated with chisel like-tools.
Br. 955a – Massive, **open arm ring** with notch-decoration on the top side. The arm ring described is the less well-preserved piece of a pair with edges, which are heavily damaged by corrosion. On the slightly rounded ends a decoration is applied consisting of a slanting ladder-like notched ribbon, seven parallel lines, two parallel slanting ladder-like notched ribbons (the inclination of the notches is applied in opposite direction) and eight parallel lines. This pattern is repeated at the other end. In between there is a decoration consisting of ladder-like notched ribbons separated by four parallel lines. The cross section of the arm ring is oval with partly heavily bevelled edges.
Crafting technique: Cast in rough form, post-casting decoration and cold-working of the edge.
Br. 955b – Massive, **open arm ring** with notch-decoration on the top side. The arm ring described is the well-preserved piece of a pair. On the slightly rounded ends a decoration is applied consisting of a slanting ladder-like notched ribbon, seven parallel lines, two parallel slanting ladder-like notched ribbons (the inclination of the notches is applied in opposite direction) and eight parallel lines. This pattern is repeated at the other end. In between there is a decoration consisting of ladder-like notched ribbons separated by four parallel lines. The cross section of the ring is oval with partly heavily bevelled edges.
Crafting technique: Cast in rough form, post-casting decoration and cold-working of the edge.

Præstegårdsmark, Melby sogn, Frederiksborg Amt

NM B15847-54
Aner and Kersten 1973: 78-79; Nørgaard 2011: 51
Found within the 'Syvhøje' burial mounds, Mound Sb. 29, stone packing in mound
NBA II
Wood, bronze rolls (corded skirt), wool, dagger, neck collar, belt disc, two tutuli, two amber beads, blue glass beads.
Figures: 2.098; 2.103
B15847 – **Neck collar** with 12 alternating notched ribs. The bottom rib is continuously notched. Over the top and below the bottom rib is a hem decorated with three and four grooves. The ribs terminate at the same position at the

transition to the end plate; they are slightly bevelled and thus flatten towards the end plates. The end plate is separated from the frontal region by a decorative ribbon of two parallel lines, two opposed triangle ribbons, two parallel lines, and a ladder-like notched ribbon. A similar decorative band can be assumed towards the end roll. In the field in between the vertical decorative ribbons on the end plates are nine spirals, three rows of each three spirals. The spirals are connected to each other horizontally and vertically. The spiral row closest to the end rolls is constructed of smaller spirals. The end rolls are not preserved.
Crafting technique: Lost-wax cast, probably parts of the decoration post-casting or heavy reworking (spiral-stamp?).
B15848 – **Tutulus** with long conical spike and flattened tip. The spike is undecorated and the tip is slightly bevelled. Around the foot of the spike and at the transition to the flat disc there are five step-like grooves running in a kind of spiral around the foot of the spike. Directly attached to these step-like grooves or ribs is a broad smooth hem. On the reverse of the tutulus a groove is located directly under the spike. The bar which forms the eyelet has been applied at the inner walls of the spike close to the flat disc.
Crafting technique: Rough lost-wax cast probably with cast on eyelet, post-casting decoration.
B15849 – **Belt disc** with a slightly funnel-shaped undecorated spike with rounded tip. Around the spike is placed a decorative ribbon consisting of two parallel lines, two opposed triangle ribbons, two parallel lines of which the latter is the frame of the following ladder-like notched ribbon, and two parallel lines. Accompanying the edge (at a short distance from the edge) a further decorative ribbon is placed, formed by two parallel lines. On the wide, slightly upwardly curving smooth hem, two partly preserved triangle series are visible. These run parallel to the line decoration and are slightly inclined. The area in between these decorative ribbons is filled with ten concentric circle groups consisting of five circles around a flat central hump. The humps are apparently inserted from the reverse. On the back of the disc a broad and massive eyelet clearly protrudes from the flat disc.
Crafting technique: Rough lost-wax cast with eyelet, post-casting decoration and cold-working.
B15850 – **Small belt disc** (possibly a tutulus) with short, thick and conical spike with a rounded tip. The otherwise undecorated spike is placed on a small podium. Around the same a decorative ribbon is placed consisting of a ladder-like notched ribbon followed by six parallel lines, two parallel series of opposed triangles and five parallel lines. The subsequent decoration is hard to determine due to the state of preservation of the disc, however, apparently the decorative ribbon continues with a ladder-like notched ribbon and more parallel lines towards the smooth hem. On the back below the spike there is a deep groove, over which a bar is placed forming the eyelet. The bar is not protruding.
Crafting technique: Lost-wax cast probably with decoration and clay core.

Rätzlingen, Uelzen, Lower Saxony

LMN 13181-82
Laux 1971; Nørgaard 2011: 32
Found in burial mound
NBA II
Neck collar, belt plate, two arm spirals
Plate 22

LMN 13181a – Neck collar with nine uniform ribs which are notch-decorated. The notched decoration is arranged in a chessboard-pattern and slightly weak. The top and bottom ribs are concomitant to the collar edges, the other ribs move with the shape of the collar, and are therefore slightly wavy. The second rib from the top is significantly reduced. The rib-valleys of the first and second rib meet at the side of the front part of the collar and continue together and end at the height of the remaining ribs. This leads to a lenticular second rib. The rib-valleys become narrower towards the end. The bottom rib is much wider than the rest and the general slope forms a kind of hem. The end plates of the collar stop just behind the frontal side transition; the fracture of the right side is very smooth.
Additional investigation: Trace elemental analysis, data shown in Table 3.
Crafting technique: Lost-wax; reworking and post-casting decoration.
LMN 13182 – **Central spike** probably from a small belt disc. The spike is short, undecorated and has a rounded tip. The spike foot is undecorated and goes smoothly over into the surface of the disc. Around the spike is a weak edge. On the back opposite the spike, the eyehole is composed from a strong bar and a deepened eyehole channel.
Crafting technique: Lost-wax, eyelet formed through clay core.

Raven, Harburg, Lower Saxony

LMN 4932, 14083, 14084
Laux 1971: 202; Nørgaard 2011: 54-56
Bought from private collector as closed find
NBA II (ZG III)
Neck collar, four spike-discs, fibula, arm spiral
Figures: 2.052; 4.015

LMN 4932 – **Neck collar** with seven clearly pronounced ribs, with a triangular cross-section and a smooth seam below the lowest rib. The broad ribs are decorated with deep notches alternately arranged in groups. The uppermost and lowermost ribs are decorated throughout. The hem is attached directly to the bottom rib. The uppermost five ribs follow the shape of the upper edge of the collar. The hem is in the centre much wider and tapers towards the end. Consequently, the bottom rib is greatly reduced, and unites with the second beyond the centre part. At the transition to the undecorated end plate only six ribs terminate at one height. Towards the end the ribs become more narrow. The end plates are just partly preserved and were probably broken in the past.
Additional investigation: Metallography (Fig. 2.127, 2.134; Nørgaard 2015b):
Sampled at the transition front to end (1) and at the end, near the end roll. Microstructure towards the centre displays large irregular grains/ recrystallised small grains, occasionally <delta>-phase, copper-sulfide, shrink-holes and cuprite (corrosion). Microstructure towards the artefact´s rim and ends shows strain lines (up to several generations), annealing twins (single phase/deformed twins), different sized grains, cuprite, arsenic within the matrix, copper-sulfide (oblong deformed), deformed shrink-holes. Trace elemental data is presented in Table 3.
Crafting technique: Each sample shows a different microstructure from an as-cast microstructure (front section) to a fully recrystallised microstructure (end). The different-sized grains of the frontal part might be due to residual heat from annealing the ends. Strain lines indicate final cold-work at rib height. The end is characterised by a fully recrystallised

microstructure with different grain sizes due to a different strength in previous cold-work.

LMN 14083 – Well-preserved **spiked disc** with short, tapered and curved spike. The spike is surrounded by three trapezoidal ribs. The last rib is completed by a rib-valley. From there on, a seam is attached which flattens toward the edge. The groove surrounding the spike is enlarged. Starting at the spike circumferential rib, a raised ridge goes through all the ribs in an extension between the spike and loop plate. This results in an interruption in the rib-valleys. Towards the top, the hem is completed by a wide plate with horizontal rolled loop. The loop is completely preserved. The edges of the plate are broken.

Crafting technique: Probably open-mould cast in similar mould, additional reworking.

LMN 14084 – Well-preserved **spiked disc** with short, tapered and curved spike. The spike is surrounded by three trapezoidal ribs. The last rib is completed by a rib-valley. From there on, a seam is attached which flattens toward the edge. The groove surrounding the spike is enlarged. Starting at the spike circumferential rib, a raised ridge goes through all the ribs in an extension between the spike and loop plate. This results in a interruption in the rib-valleys. Towards the top, the hem is completed by a wide plate with presumable a similar horizontal rolled loop, as seen on LMN14083. The loop is not preserved. The edges of the plate are broken.

Crafting technique: Probably open-mould cast in similar mould, additional reworking.

Rehlingen, Lüneburg, Lower Saxony

LMN 4931, 4755, 5032
Laux 1971: 22; Nørgaard 2011: 56-58
Burial mound 'Koppel Büchenberg', in Mound IV, stone cist and female burial
NBA II (ZG I-II)
Neck collar, wheel-headed pin, belt disc, stud-bracelet
Figures: 1.034; 2.053; 2.057; 2.074; 4.038-39

LMN 4931 – **Neck collar** with eight clearly distinct, alternating notch-decorated ribs. The bottom rib terminates in a wide, unadorned hem. The thickness of the hem decreases towards the edge significantly. The fourth rib from the top is shorter and ends in an arrow-like tip. The enclosing ribs (third from the top and fifth rib) unite at the end, following the fourth rib in a lens-shaped field. The remaining ribs terminate on the same level. The undecorated end plate is short and narrow. The hem continues into the end plate. On the back there are traces of the restoration, including glued paper and painted surfaces.

Additional investigation: Metallography (Fig. 2.133; Nørgaard 2015b):

Sampled near transition front to end, at the lowest rib. Microstructure towards the centre displays large grains, occasionally <delta>-phase and annealing twins, copper-sulfide, shrink-holes, large cuprite inclusion (corrosion?). Microstructure near the surface shows strain lines, annealing twins (single phase ?), different-sized grains, cuprite, copper-sulfide (slightly deformed), arsenic within the matrix, occasionally <delta>-phase at the grain boundaries. Trace elemental data is presented in Table 3.

Crafting technique: The as-cast microstructure indicates that the lost-wax cast piece was partly post-casting cold-worked, also supported by the partly recrystallised microstructure at the hem and ends. The microstructure of the cold-worked parts shows annealing twins pointing towards several annealing phases. Strain lines indicate final cold-work.

LMN 4755 – Very well-preserved **small belt plate** with short conical spike. The spike has a small round tip and a very broad base. Around the spike is an undecorated field framed by a decorative ribbon consisting of inclined imprints (slightly to the right inclined, elongated grooves, the left side of which is straight and the right side slightly curved), three parallel lines and a series of hourglass-shaped notches. In the field following this ribbon is a series of eight spirals, connected by double lines. A further decorative ribbon separates the spiral series from each other. It consists of a series of hourglass-shaped notches, three parallel lines and a further series of hourglass-shaped notches. The next spiral series consists of 14 slightly larger spirals also connected with double lines. The final decorative ribbon consists of four parallel lines that separate the spiral-decoration from a wide undecorated hem. The hem differs in its width and thereby gives the impression as if the decoration of the disc is not centred. On the reverse side opposite the spike is a protruding loop consisting of a roughly oval in cross-section bar.

Crafting technique: Rough lost-wax cast, post-casting decoration.

LMN 5032 – Fragmentary **wheel-headed pin** with incomplete needle shaft. The pin head is composed of three rib-like rings and in line with the needle shaft on the highest point is an oval, damaged loop. The eyelets lying right and left are preserved only in fragments. The inner cross is only partly preserved, wherein the top has not been completely formed in the cast and the bottom portion is damaged. The shaft is, at the transition to the pin head, of rounded trapezoidal cross-section and develops further down into a round cross-section. The back of the needle is flat and has a rough surface structure.

Additional investigation: Metallography (Fig. 2.126, 2.135; Nørgaard 2015b):

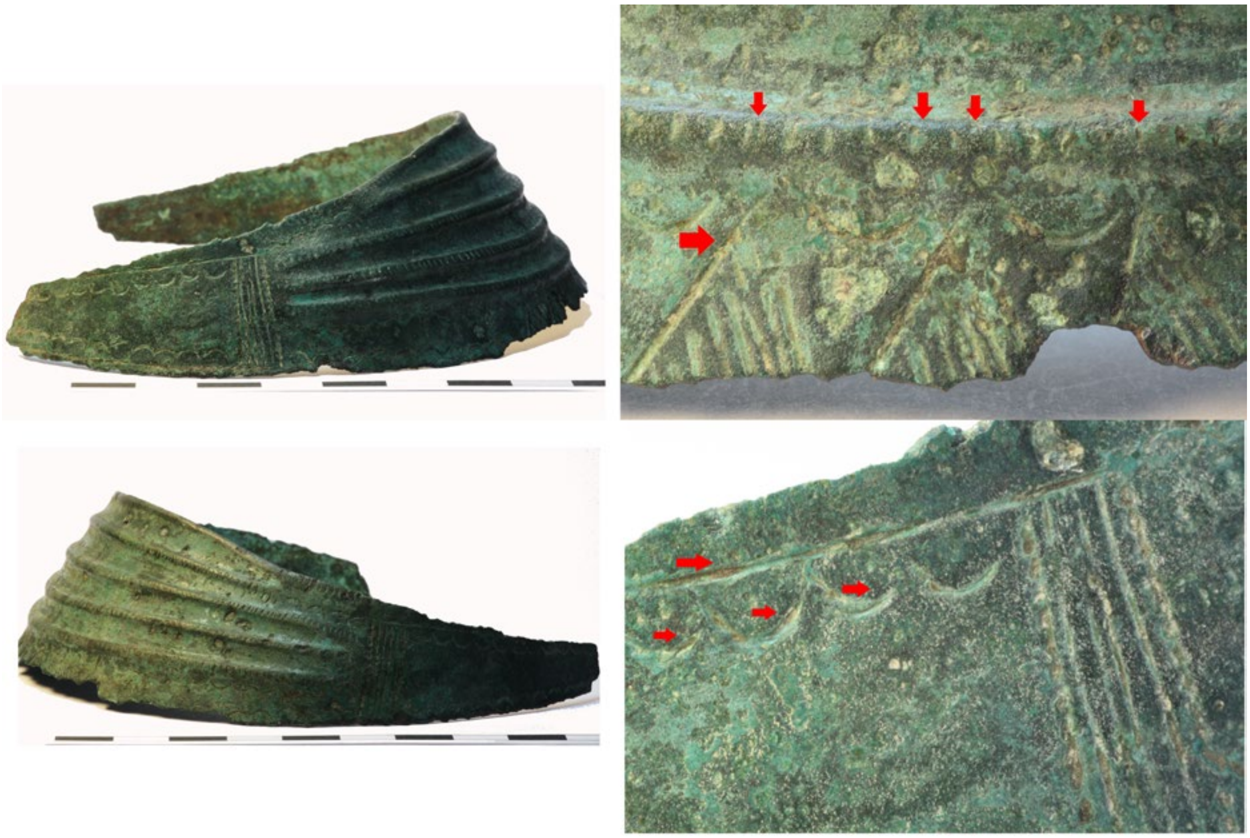
Sampled at the shaft (1) and the wheel-head, at the ribbed ring (2). Microstructure at the centre shows small regular grains (1) versus large irregular grains (2), occasionally <delta>-phase, annealing twins (1), deformed (1) versus speckled (2) copper-sulfide inclusions, lead (0.7 µm) and silver oxide inclusions. Microstructure near the surface reveals strain lines (several systems (1) versus single system(2)), annealing twins (several generations (1) versus single grains in sample 2), differently sized grains, cuprite (accentuating dendritic structure (1) or in corrosion (2)), copper-sulfide inclusions which are in the shaft deformed. Trace elemental data is presented in Table 3.

Crafting technique: The wheel-head can be considered a cast piece, cast in one part mould (probably in standing position), with occasional signs of rework (inside the ring) supported by an as-cast microstructure with large irregular grains. The shaft, however, is characterised by a fully recrystallised microstructure and thus a product of cold-work with several annealing phases. Small grains indicate a high deformation rate. The occasional different grain sizes could be due to a varying cooling temperature (centre to shaft edge).

Rehlingen, Lüneburg, Lower Saxony

LMN 4933
Laux 1971: 22; Nørgaard 2011: 56-58
Burial mound 'Koppel Büchenberg', Mound III, Grave 2, with wood coffin
NBA II (ZG I-II)
Neck collar, bronze pin, arm spiral

1



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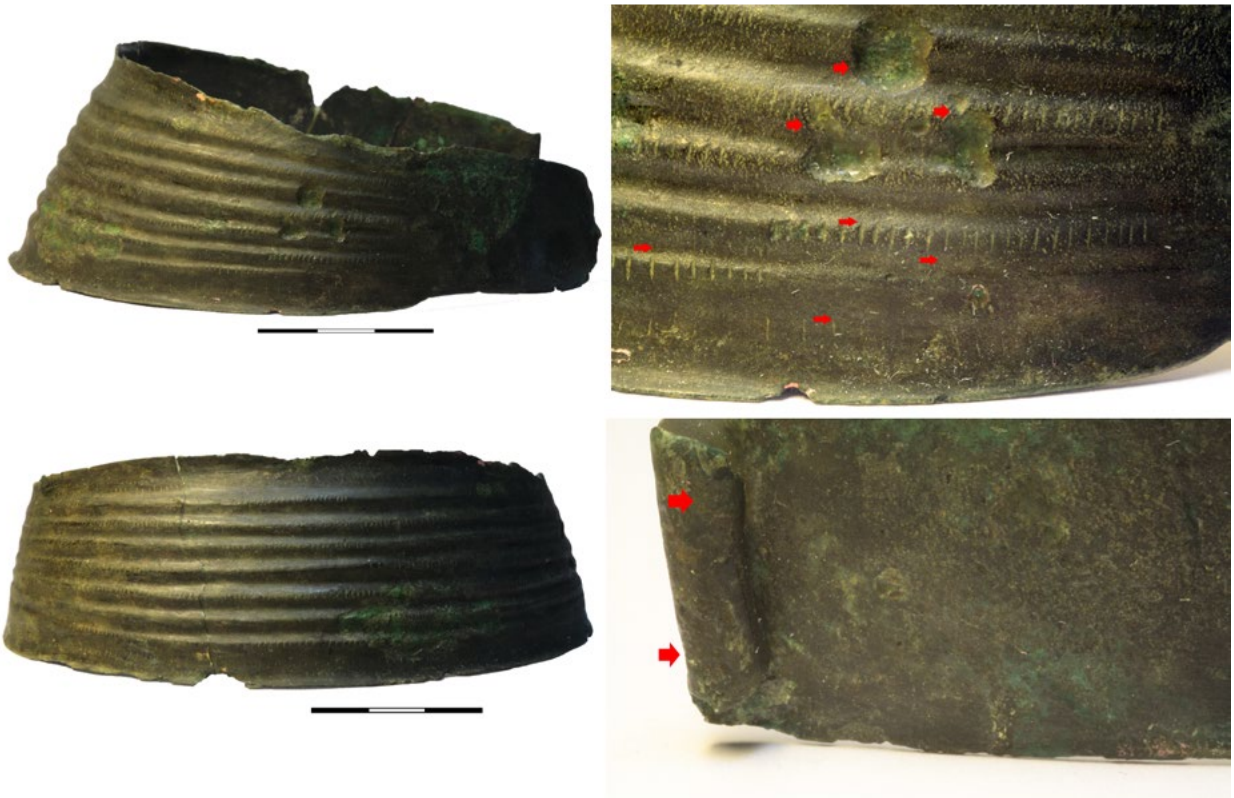

Plate 23:
1) Rehlingen, Lüneburg, Lower-Saxony – neck collar LMN 4933; 2) Ripdorf, Kr. Uelzen, Lower-Saxony – neck collar LMN 247:71.

Plate 23

LMN 4933 – Well-preserved **neck collar** with five sharply defined ribs. The ribs are very narrow and the rib-valleys are wide and flat and in cross-section semi-circular. The top rib is edge-accompanying while the second rib and the other ribs are straight. Following this, between the first and second rib (that is shorter than the others) there is a lenticular field. Under the fifth rib is a smooth broad hem which is decorated just below the rib with a band of pendant arches and at the bottom with a band of standing arches. Within the centre of the hem are, in the free space between the arch series, triangles that are hatched inside. The ribbed section is separated from the end plate through a vertical decorative ribbon of four parallel lines, which are each accompanied by a series of irregular grooves. The vertical band is delimited at the top by a decorative ribbon consisting of a single line on which an arch series is applied. This ribbon has its offspring in the shortened rib and is continuous over the vertical ribbon into the end plate. Here it develops to an edge-accompanying line. The line frames the end plate and exists also parallel to the bottom, where it completes the decorative strip. Parallel to the line frame on the end plates is, each time, a series of irregular arches placed on the line, with the top pointing into the undecorated field. The ribs of the collar are continuously decorated by slightly oblique notches that lengthen towards the ends of each rib.

Crafting technique: Lost-wax cast (ribbed collar), post-casting decoration.

Ripdorf, Kr. Uelzen, Lower Saxony

LMN 247:71

Geschwinde 2000: 210-213

Burial mound with seven burials

NBA II

Plate 23

LMN 247:71 – Well-preserved **neck collar** with seven very irregular, elaborated ribs and a smooth slightly curved hem above and below the ribs. The almost constant wide end plates are undecorated and end in end rolls, the left end roll is broken. The ribs are decorated in a chessboard-pattern with notch groups of different length. Also the hem is decorated with a notch-decoration. The lower hem has these slightly wavy decorative notches within its centre. The hem on the top has a series of long incisions near the ribs and an edge-parallel series of short cuts or lines. The ribs all terminate at a similar height at the transition to the end plate. The end roll is significantly narrower than the end plate and rolled to the outside.

Crafting technique: Lost-wax cast (ribbed collar) with partly post-cast decoration and cold-working.

Ripdorf, Kr. Uelzen, Lower Saxony

LMN 258:71

Geschwinde 2000: 210-213

Burial mound with seven burials

NBA II

Plate 23

LMN 258:71 – The **neck collar** is in good condition and has a uniform dull patina. The ten rounded ribs vary slightly in the width of the rib-valleys and are decorated with weak, slightly oblique, notches. The narrow cuts are arranged in a chessboard-pattern. Underneath the tenth rib on the bottom is a smooth and almost equally wide hem. The hem is decorated with an edge-accompanying series of two superimposed arches. Parallel to the same the remains of a small hump row are visible. The shape of the hem is irregular. The decorative ribbon varies in distance from the edge of the hem. The ribs all terminate on the same level at the transition to the end plate. The decorative ribbon of the hem runs a little into the end plate. The narrow triangular-tapered end plate is undecorated.

Crafting technique: Lost-wax cast with parts of the decoration, partly post-casting decoration.

Rødovre 'Valhøje', Søkkeland sogn, København Amt

NM B13363-65a

Aner and Kersten 1973: 146; Nørgaard 2011: 51

Found in the 'Vallhøje' burial mound, Mound 1, in stone packing with wood coffin

NBA II

Wood, belt plate, two spiral rings, tutulus, neck collar

Figures: 2.151

B13365a – Fragment of a **neck collar** with eleven chessboard-pattern notched ribs. In between the ribs are wide, semi-circular grooves and occasionally the rib backs are very sharp. Over the top and below the bottom rib is a wide, smooth hem that is initiated by a notched ribbon decorated with several parallel lines. This decorative band frames the ribbed section of the collar. At the transition to the end plate the vertical decoration is complemented by two additional lines and a notched ribbon towards the end. On the end plate can be seen the remains of a two-row spiral-decoration.

Crafting technique: Lost-wax cast probably with decoration, reworking.

B13365 – Small **tutulus** with a dome-like hump. The dome-like hump ends in a small flattened tip that is heavily corroded. The hump is decorated with two decorative ribbons arranged in a cross-like manner. The ribbons consist of a ladder-like notched ribbon, a single line, another ladder-like notched ribbon, a line and a concluding ladder-like notched ribbon. The four decorative ribbons (forming the cross) start at the transition to the disc, vertically towards the tip. At the top the different ribbons run arrow-like together. The decorative band on the disc is introduced by a line. Attached to this line is, with tips pointing to the dome, a series of standing triangles. The same is interrupted by the vertical bands. The decorative strip of the disc consists of a series of opposed triangles framed in lines, a line, another triangle ribbon and a line. On the back there is a deep throat below the central dome into which a round bar is placed. The so-formed eyelet is slightly recessed.

Crafting technique: Lost-wax cast with decoration, slightly reworked.

Rosilde, Vindinge herred, Svendborg Amt

NM B10239-43

Aner and Kersten 1977: 201; Nørgaard 2011: 80-83

Female burial in burial mound, Sb. 5

NBA II

Tutulus, neck collar, two spiral rings, awl

Plate 24

B10240 – Three small fragments of a **smooth neck collar** with spiral-decoration. The collar is covered with a brownish patina and thus the decoration is hardly recognisable. Two rows of connected spirals separate the face of the collar into two parts. In between is presumably a slightly curved decorative ribbon. The spiral series are framed with an edge-accompanying ribbon of parallel lines, two stacked arrow

ribbons and further parallel lines. The largest fragment displays a spiral that connects the two spiral rows possibly to the height of the decorative ribbon between the spiral series. The decoration at the transition to the end plate may consist of parallel lines, and an arrow ribbon.
Additional investigation: Photographic documentation of fabric residues under the patina.
Crafting technique: Lost-wax cast probably with decoration, reworking.

Rühlow, Neubrandenburg, Mecklenburg
Neubrandenburg IV65/37d
Hollnagel 1962; Schubart 1972: 148; Nørgaard 2011: 33-35
Complete hoard
NBA II
Five flanged axes, three palstaves, neck collar, two spiral arm rings, eight thin spiral arm rings, two 'Brillenspiralen', spiral rolls, spearhead
Plate 24
IV65/37d – **Neck collar** with nine ribs, rounded and narrowing towards the ends. The rib-valleys are of a semi-circular cross-section near the transition to the ends, and in the centre, with slightly triangular cross-section. The notch-decoration of the ribs is only faintly discernible and on the top, and then every second rib continuously applied. It consists of oblique notches having a triangular cross-section. The end plates are not preserved. The collar is strongly deformed, probably due to intense fire exposure caused by a fire in the museum after WWII.
Additional investigation: Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017; 2015a).
Crafting technique: Lost-wax, slight post-casting reworking (edges).

Rye, Gørlev sogn, Holbæk Amt
NM B7612-53
Aner and Kersten 1976: 25; Nørgaard 2011: 39-40
Hoard next to the Rye bog
NBA II
Three neck collars, two belt plates, seven belt discs, 15 tutuli, six spiral arm rings, seven spiral finger rings, 75 bronze rolls, saw, sickle
Figures: 2.010; 2.048; 2.059; 2.079; 2.085; 2.104; 4.028
B7612 – **Neck collar** with 22 predominantly chessboard-pattern decorated ribs. On the top and bottom rib the notch-decoration is continuous. The ribs in between are decorated with notch groups. At the transition to the end plate, the ribs are terminated by lying triangle impressions that point towards the belly. This is followed by a decorative ribbon of four parallel lines, three parallel ribbons of opposed triangles, four parallel lines and a repetition of that pattern. A horizontal decorative ribbon is placed to accompany the edge on the top and bottom of the end plate, and also in the centre. It consists of three parallel lines and a hanging triangle band (top), as well as five parallel lines, an opposed triangle ribbon and five parallel lines bordered by a row of standing, and in the lower box, hanging triangles (middle), and a final series of standing triangles, two parallel opposed triangle ribbons and five parallel lines (bottom). In the fields formed by this frame are placed three combined spirals, decreasing in size towards the end. The end consists of a high end roll and the horizontal decorative ribbons continue under the end rolls.
Crafting technique: Rough lost-wax, possibly cast with parts of the ornament, post-casting decoration.

B7614 – **Neck collar** with 20 ribs, which towards the ends are decorated on every second rib with groups of small notches, and towards the centre show a type of chessboard-pattern with oval-shaped notches. The bottom rib is wider and higher, and runs out in a steeply sloping hem. The transition to the end plate is decorated with a vertical strip of diamond-shaped impressions, a sunken line, a ladder-like notched ribbon framed in lines, a line and finally a diamond series. At the top and bottom edge of the end plate the vertical ribbons connect to a horizontal decorative ribbon consisting of two parallel lines, an undecorated region framed in a series of lying diamonds and four parallel lines. The central area of the end plate is divided into three parts by decorative strips which consist of parallel lines framing a diamond series. In each of these, in all three rectangular fields, are placed three concentric circles groups one above the other. The end rolls are as wide as the end plate and bend outwards.
Crafting technique: Rough lost-wax, cast possibly with parts of the ornament, post-casting decoration.
B7613 – **Neck collar** with 11 alternating notched ribs. There is a seam on the top and below the bottom rib that is decorated with four stacked bands of opposing triangles. Over the top rib, in addition to the triangle ribbons, there is a group of parallel lines. The outermost decorative series (top and bottom) runs into the decoration of the end plate, however there it transforms into a notched ribbon. The wide end plate is decorated in the centre with four connected spirals which are form a square. They are framed by a series of triangles (pointing towards the spirals) standing on two parallel lines. Towards the frontal region of the collar, the frame is continued by ladder-like notched ribbon, two parallel lines, three opposed triangle ribbons, two parallel lines, a ladder-like notched ribbon and two parallel lines. A similar decorative band is placed right after the other vertical part of the frame. This is concluded towards the end roll by four lying, extended triangles pointing towards the end.
Crafting technique: Lost-wax cast with parts of the ornament (spirals), post-casting line decoration.
B7615 – **Large belt plate** with high conical spike. The disc is decorated with two rows of spiral and a series of concentric circular groups. Around the spike is a decorative band of four adjacent ladder-like notched ribbons, followed by the row of 18 concentric circle groups of four rings each with a groove in the centre. Between these concentric circles and the first row of smaller spirals a decorative ribbon is placed. This consists of parallel lines, ladder-like notched ribbon, parallel lines, and a framed in lines row of rhombic impressions. The 18 spirals are connected by a single line. Between the next spiral sequences another decorative ribbon is placed consisting of a line, ladder-like notched ribbon, two parallel ribbons of opposed triangles, ladder-like notched ribbon, and a line. The largest spiral series consists of 23 double-running spirals, whose spare connective lines extend up and down, while the other spiral series combines the spirals with each other with a double line. A decorative ribbon concludes the decoration before the disc ends in a smooth and slightly upturned hem. It consists of ladder-like notched ribbon framed in extra lines and two parallel ribbons of opposed triangles. The spike is decorated at the bottom with a ladder-like notched ribbon and additionally halfway up with a group of parallel lines.
Crafting technique: Lost-wax cast with parts of the ornament (spirals and triangles series), post-casting circle decoration and reworking, cast-on spike.

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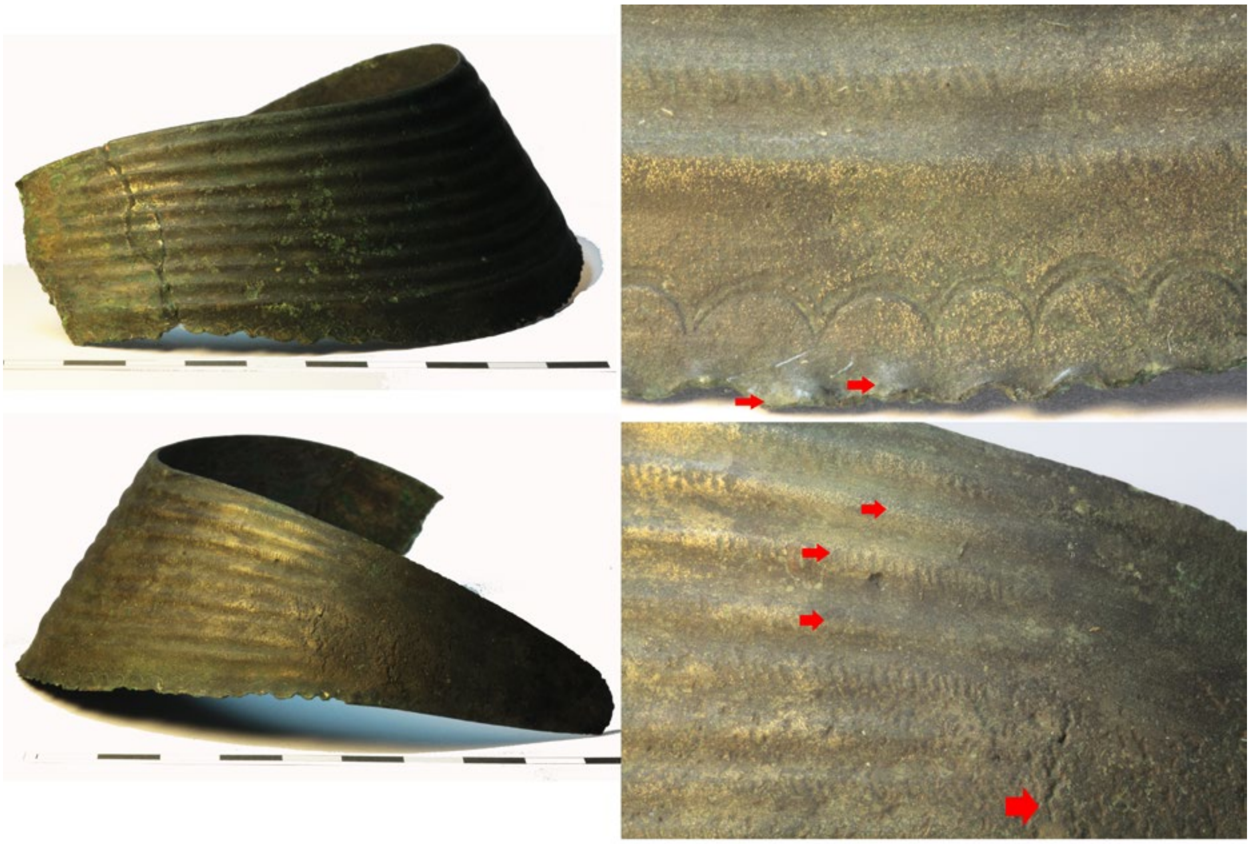

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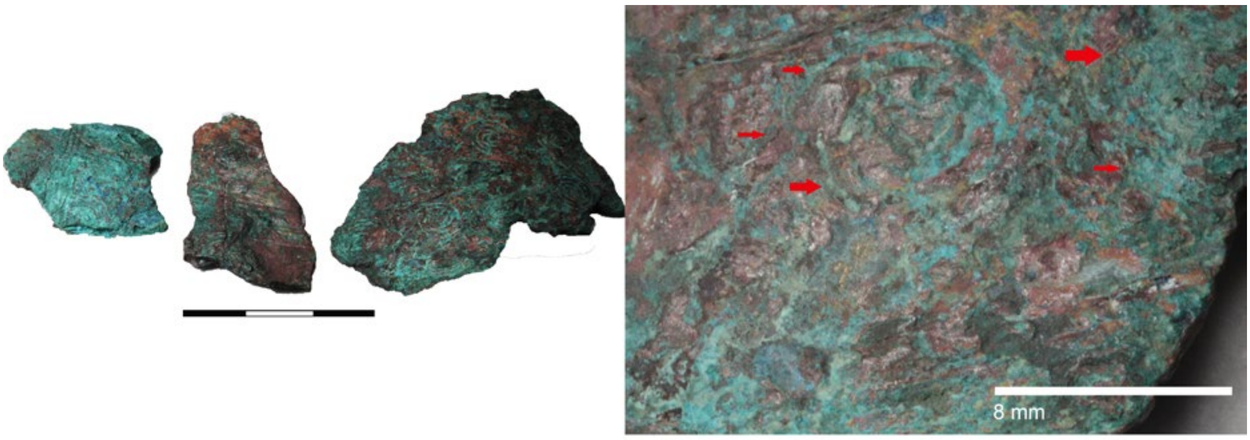

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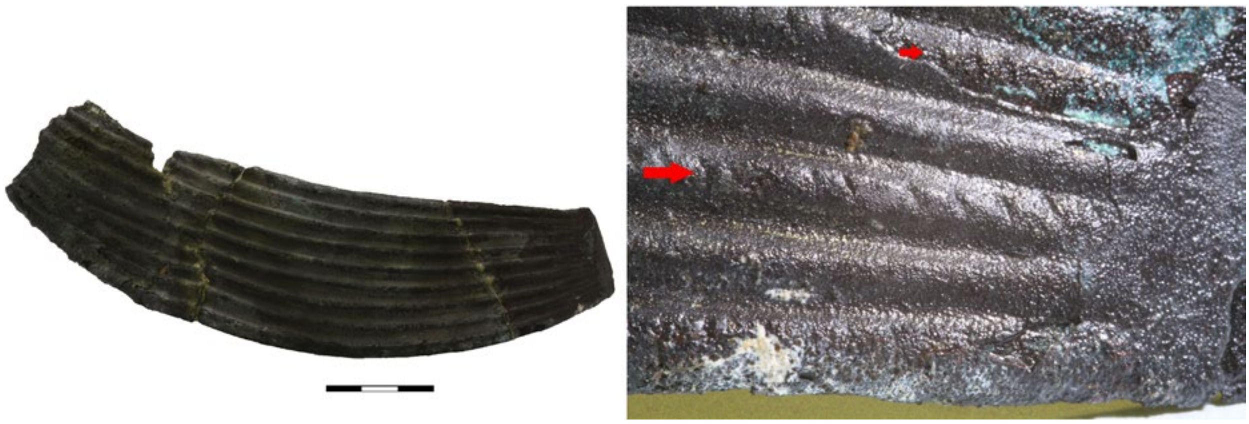

Plate 24:
1) Ripdorf, Kr. Uelzen, Lower-Saxony – neck collar LMN 258:71; 2) Rosilde, Vindinge herred, Svendborg Amt – neck collar NM B10240; 3) Rühlow, Neubrandenburg, Mecklenburg – neck collar WA IV/65/37d.

B7616 – Very badly preserved in parts **belt disc** with short undecorated spike. The disc is decorated with three spiral rows. Around the spike, starting at the bottom of the conical spike, a decorative ribbon consisting of a ladder-like notched ribbon, parallel lines, and another ladder-like notched ribbon. The subsequent series of eight spirals has the smallest diameter of the three series and is connected with double lines. The massive corrosion of the disc makes other statements impossible. Between the next series of in all 12 spirals is another decorative band made of ladder-like notched ribbons and parallel lines that is repeated between the 2nd and 3rd series as well, and additionally repeated at the end. The third spiral series consists of 18 spirals of which 13 are preserved. They differ in size and coil number from the previous ones and are connected by double lines. The disc hem is a smooth and varies slightly in width. Due to the reconstruction on a glass plate the reverse is not accessible for investigation.
Crafting technique: Lost-wax cast with parts of the ornament (spirals and notch series), post-casting reworking, probably cast-on spike.
B7617 – **Small belt disc** with short irregular conical spike. The spike is decorated at the base with three parallel lines. The decoration of the disc consists of a spiral and a hump series. Around the spike, starting directly at the foot, a band of two ladder-like notched ribbons, a line and another ladder-like notched ribbon is placed. The subsequent spiral series consists of 12 real spirals which are connected with each other through double lines. Between the spiral and the humpback series is a decorative ribbon consisting of a ladder-like notched ribbon, three parallel lines, a ladder-like notched ribbon and a line. The 15 humps in total seem to be punched from the back (due to the reconstruction the back is no longer visible) and are surrounded by concentric circles. Each of these three rings is connected to each other with double lines. Two hump-circle units are included in an oval framed by lines. The relatively wide smooth seam is separated from the spiral series by a decorative band made of a ladder-like notched ribbon, three parallel lines and another ladder-like notched ribbon.
Crafting technique: Lost-wax cast with parts of the ornament (spirals), post-casting decoration and reworking.
B7618 – Small well-preserved **belt disc** with a pointed, conical spike whose lower part is much wider and decorated with five step-like ribs. Around the spike runs a decorative band of a narrow ladder-like notched ribbon, three parallel lines, an opposed triangle ribbon and two parallel lines. Between this and the edge-accompanying decorative ribbon, which consists of two parallel lines, an opposed triangle ribbon, and two parallel lines, is a decorative spiral series. This spiral row consist of 11 spirals connected by double lines and is evenly constructed. On the reverse of the disc is located in the hollow spike a loop, which is formed out of a short bar attached to the walls of the groove.
Crafting technique: Lost-wax cast with clay core (spike attached in model), intensive reworking of decoration.
B7619 – Small, well-preserved **belt disc** with a long, pointed conical spike and rear eyelet. The spike is set to a raised foot, which is surrounded by a decorative band of two parallel lines, a ladder-like notched ribbon, and a line. The innermost line being partially covered by the foot of the spike. Following the line decoration, a series of ten humps, which are surrounded by two concentric circles, is placed in the centre of the disc. The completion of the decoration to the edge is formed by a ribbon consisting of a ladder-like notched ribbon, a sunken line, an only partially preserved ladder-like notched ribbon (whose boundary lines are clearly visible, but not the interior notches) and a single line. Between the rounded edge of the disc and the decorative strip is a narrow undecorated hem. The rear eyelet is attached below the spike on a base. The edges of the plate-like base are rounded and cut at two places. Spike and eyelet form a separate unit. On the back the negatives of the ten humps are visible.
Crafting technique: Lost-wax cast with ornament (line decoration), post-casting decoration (humps and circles) and reworking, cast-on spike.
B7624 – **Belt disc** with a long pointed conical spike. The spike ends in a rounded tip and is undecorated. Around the spike, a decorative band of a ladder-like notched ribbon, a wide band filled with five interlocking diamond rows, a framed in lines hatched band, a diamond net of seven rows and a final hatched band set in lines. A wide area between the decorative ribbon and the rounded edge is undecorated. The rear eyelet is located opposite the spike and is applied to a smooth reverse. It consists of a wide hanger which is centrally significantly narrower than at the ends and following X-shaped.
Crafting technique: Lost-wax cast with core, post-casting decoration.

Sarmstorf, Rostock (LRO), Mecklenburg

ALM Br. 93-95
Schubart 1972: 149ff.; Nørgaard 2011: 58-62
Found in burial mounds, within Mound III, cremation
NBA III
Neck collar, spiral arm ring, ceramics (urn)
Plate 25
Br. 93 – Poorly preserved fragments of a **neck collar** with three groups of two ribs and a spiral-decoration on the fields between the rib groups. Presumably parts of the frontal section and the end plate are preserved. The rounded ribs are slope-accompanying and decorated with incisions (dots), which are connected over the back of the rib with notches. The uniformly round spirals are connected with dotted lines and increase in size towards the centre. Further decoration is not preserved.
Additional investigation: Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017; 2015a).
Crafting technique: Lost-wax cast with parts of the decoration, partly post-casting decoration.

Schalkholz, Schalkholz, Schleswig-Holstein

KS 3496, 3485
Aner and Kersten 1991: 76-77; Nørgaard 2011: 56
From the 'Heesberg' burial mound, with several graves, cremation in Grave A, a stone packing and wooden coffin
NBA III
Neck collar, arm ring
KS 3496 – Poorly preserved and heavily reconstructed **neck collar** with three groups of two ribs. The ribs are slightly rounded and no decoration can be seen on the ribs. The smooth fields in between the rib groups appear undecorated. In the rib-valley of the central pair of ribs is a decorative ribbon consisting of a line connected dotted row that was probably present within all the rib-valleys. The ribs are separated from the end plate by a decoration of three adjacent arch groups (vertical). Each arch group is constructed of three stacked arches and the end touches the other arch group. The

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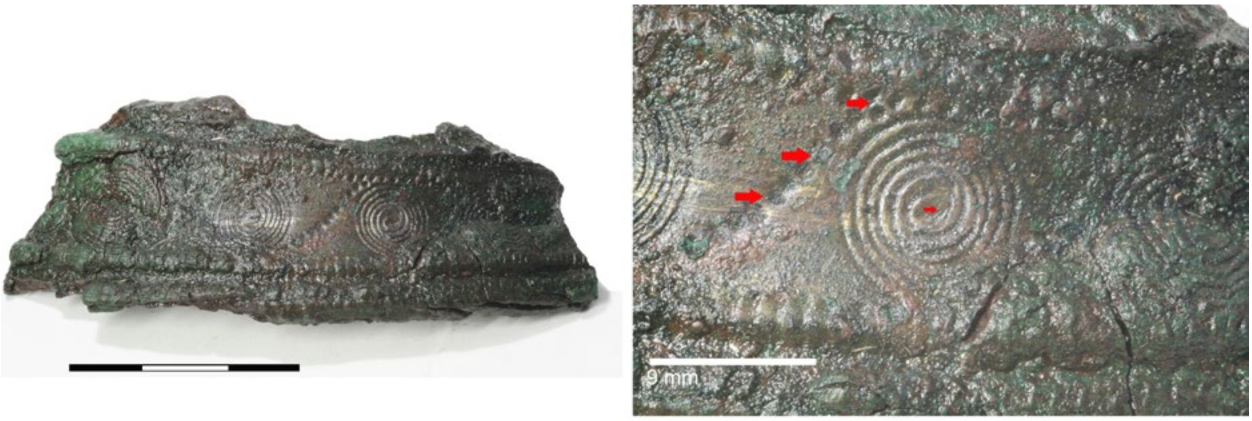

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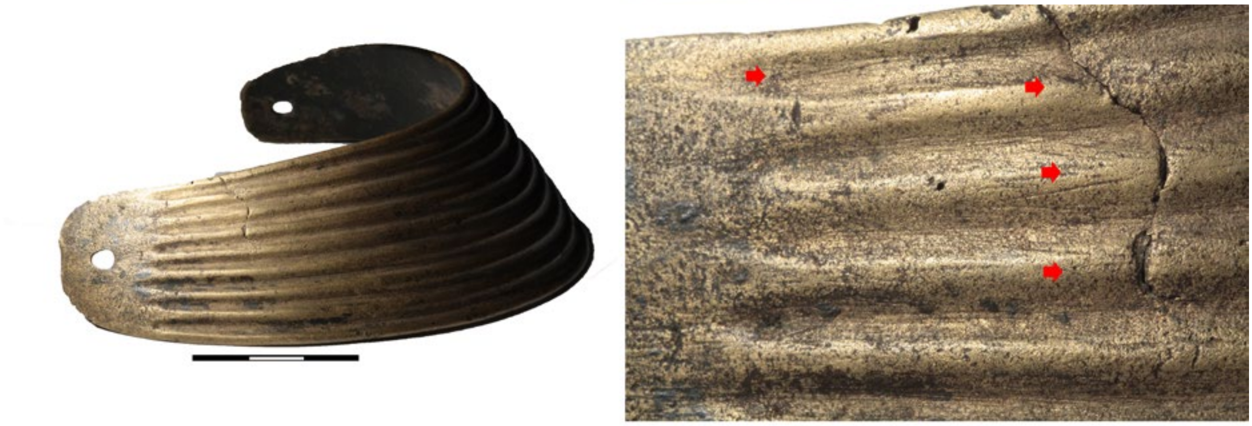

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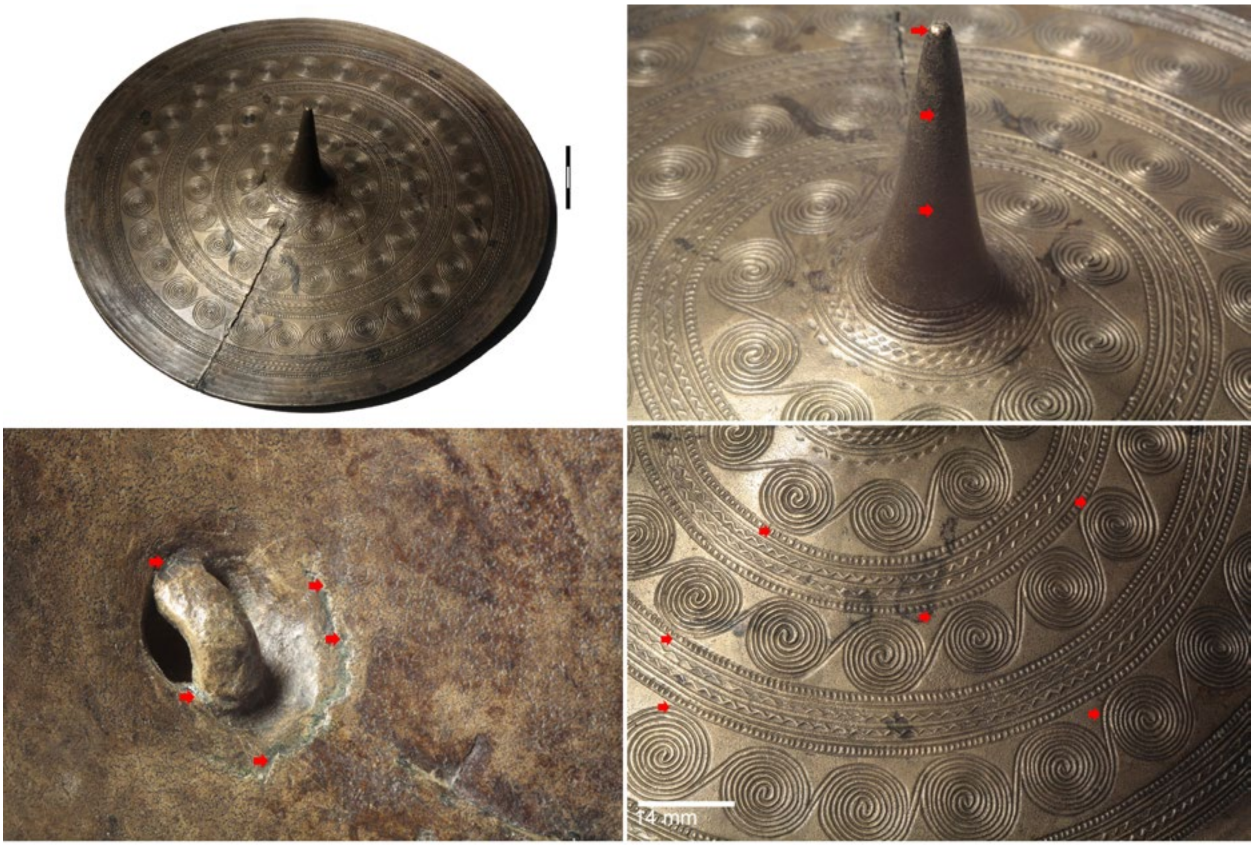

Plate 25:
1) Sarmstorf, Rostock (LRO), Mecklenburg – neck collar ALM Br.93; 2) Skagen (Råbjerg), Horns herred, Ålborg Amt – neck collar NM MDCCCXXI; 3) Skagen (Råbjerg), Horns herred, Ålborg Amt – belt plate NM MDCCCXXI,2.

arches each embrace one pair of ribs. The end plate seems undecorated and ends in narrow end rolls.
Crafting technique: Lost-wax cast, reworking.

Schleswig, Schleswig, Schleswig-Holstein
KS 20284
Aner and Kersten 1978: 144
Hoard (depot 58)
NBA II
Three belt discs, four arm rings with different decoration, two sickles, two awls, two spiral finger rings
Figures: 2.099
KS 20284a – Well-preserved **belt disc** with a short conical spike and a rounded tip. Around the spike a decorative strip is placed consisting of standing hatched triangles. The triangles are arranged star-shaped close to the spike´s foot. The tips of the triangles abut the bordering line. The triangles and the spaces in between are filled with hatching. Within the triangles the hatching is horizontal and the gaps are filled with an oblique hatching. The decorative band, which frames the triangle decorated area, is made of a ladder-like notched ribbon, two parallel lines and a further ladder-like notched ribbon. The following field is decorated with a series of ten spirals, connected with double webs. The spiral-decoration is framed by a decorative ribbon, which consists of a ladder-like notched ribbon, a further ladder-like notched ribbon, a line and a ladder-like notched ribbon. Towards the slightly upwardly curved hem an undecorated area completes the decoration. On the back a very porous casting skin is visible and in the centre a protruding loop.
Crafting technique: Lost-wax cast with core and parts of the decoration, post-casting decoration.
KS 20284b – Fragmented and restored **belt disc** with short rounded spike and spiral-decoration. Around the spike is a free area, which is framed by a decorative band. The decorative ribbon is composed of a slightly oblique hatched band (cuts with widened ends encased in a line), a parallel line and another hatched band. There is a series of connected spirals in the following field. The nine spirals have a hump in the centre and are connected with double lines. The spirals vary slightly in size. The spiral-decoration is framed towards the slightly turned-down hem with a decorative ribbon, which consists of an oblique hatched band framed in lines, a line and another framed hatched band. On the back of the disc,below the spike in a groove, there is a protruding loop. This disc is very similar to disc KS 20284c.
Crafting technique: Lost-wax cast (core), with reworking of decoration.
KS 20284c – Fragmented and restored **belt disc** with short rounded spike and spiral-decoration. Around the spike is a free area which is framed by a decorative band. The decorative ribbon is composed of a slightly oblique hatched band (cuts with widened ends encased in a line) each framed by two parallel lines. There is a series of connected spirals in the following field. The seven spirals have a round undecorated space in the centre and are connected with double lines. The spirals vary slightly in size. The spiral-decoration is framed towards the slightly turned-down hem with a decorative ribbon which consists of an oblique hatched band framed in lines, a line and another framed hatched band. On the back of the disc a protruding loop is located below the spike in a groove.
Crafting technique: Lost-wax cast (core), with reworking of decoration.

Secklendorf, Uelzen, Lower Saxony
ML H107
Laux 1971: 571; Nørgaard 2011: 56-58
Burial mound with two burials, found in Grave 1
NBA II (ZG II)
Neck collar, wheel-headed pin, stud-bracelet, leg ring
Figures: 3.003
ML H107 – Well-preserved, but heavily corroded **neck collar**. The collar is divided by two rib groups of which one consists of three and the other of four ribs. In between the rib groups, in the centre of the neck collar, is a smooth field. The ribs of each group run parallel to their specific edge so that the field in between is lens-shaped. There are eight slightly conical, thorn-like humps applied on this field. There is no negative imprint visible on the back and therefore they should be considered as solid. The right end plate was repaired in the past (a like patina) by means of two rivets, which are installed at the height of the ribs. The end plates are undecorated and the left end plate ends in a narrow end roll. Additionally, the left end plate is exceptionally long and narrow.
Crafting technique: Lost-wax cast, reworking and cold-working at the ends (irregular form), reparation of end plate.

Sibberup, Ørslev herred, Sorø Amt
NM B3574
Aner and Kersten 1976: 160; Nørgaard 2011: 46-47
Probably related to burial mound
NBA III
Figures: 2.067
B3574 – **Neck collar** with 30 narrow, notch-decorated ribs. The notch groups consists of rectangular hourglass-shaped notches which occur at the ends of the ribs on each rib and also in the middle, similar to a chessboard-pattern, on every second rib. The top and bottom rib (they are triangular in cross-section) are wider and taller. The notch-decoration flattens the ribs and thus they are trapezoidal in cross-section. The ribs terminate all on one height at the transition to the end plate. A vertical ribbon series of lying triangles concludes the ribbed section, with the tips pointing towards the middle of the collar, while the open ends are placed on the following decorative strip. The end plate is separated from the frontal region by a decorative ribbon consisting of two parallel ladder-like notched ribbons, two parallel lines, two parallel opposed triangle series in lines, two parallel lines and two ladder-like notched ribbons. Parallel to the upper and lower edge of the end plate a reduced version of the same decorative pattern is placed. Inside the frame there are five rows each of five concentric circle groups of seven rings each and a central groove. The completion of the decoration towards the end is not certain due to the destroyed end plate.
Crafting technique: Lost-wax cast, reworking of decoration.

Sjaelland (unknown location), Denmark
Several artefacts with unknown contexts
Liversage 2000
Unknown
NBA II-III
Figures: 2.080; 3.003
B4745 – **Neck collar** with three groups of ribs and intervening smooth fields. Accompanying each edge is a wide rib and in the middle of the collar are two ribs with a narrow rib-valley. The ribs are continuously decorated with long notches which have a tapered beginning and end. The rib-accompanying smooth fields are decorated by an opposed triangle ribbon.

Due to the curved shape of every field there is in the middle, between the two triangle ribbons, a small undecorated field. The left end plate of the collar is broken at the base and was repaired in the past with the help of two overlapping holes. The right end plate is decorated with a line decoration. At the transition to the end plate vertical arch groups (each of four superimposed arches) separate the fields in between the rib groups from the open end plate. The curved lines connect the ribs above and below the triangle belt with each other. Then follows a vertical decorative band of the four parallel lines, a downward facing arrow ribbon and four parallel lines. The rest of the end plate is divided in the middle by a horizontal decorative ribbon consisting of two opposed triangle ribbons which frame four parallel lines. The decoration towards the end is not visible.
Additional investigation: Trace elemental analysis, data shown in Table 3 (Liversage 2000).
Crafting technique: Lost-wax cast with decoration.
B2659 – Well-preserved **neck collar** with ten clearly separated, trapezoidal ribs. The ribs are decorated with a deep notch trim (hourglass- to ax-shaped notches). The top and bottom ribs are decorated throughout and the intervening ribs are decorated in alternating notch groups. The ribs end at the transition to the end plate at different heights; the notch-decorated ribs are the longest. The end plate is separated from the ribbed section by a decorative ribbon consisting of two vertical lines, a ladder-like notched ribbon (hourglass-shaped notches), two lines, a series of opposed triangle rows, a line, a ladder-like notched ribbon and three repetitions of the last three ribbons. The decorative ribbon is terminated by a single line to which a series of three large, lying triangles is attached. The triangles consist of several parallel lines. The end plate is only decorated up to the middle, the area towards the end rolls is undecorated.
Additional investigation: Trace elemental analysis, data shown in Table 3 (Liversage 2000).
Crafting technique: Lost-wax cast with part of the decoration, post-casting decoration or heavy reworking, possible reparation through cast-on.

Skagen (Råbjerg), Horns herred, Ålborg Amt

NM MDCCCXXI
Kersten 1936; Nørgaard 2011: 31
Probably from a hoard near Råbjerg
NBA II
Belt plate, belt disc, two tutuli, neck collar
Figures: 2.144; Plate 25
MDCCCXXI – Very well-preserved **neck collar** with nine, clearly profiled and slightly trapezoidal ribs. The ribs all terminate at the same height at the transition to the end plate. They are narrower at the end so that the whole collar is slightly contoured towards the end. The end plates appear to have been broken and repaired in the past. On both end plates a hole is inserted and the edges are reworked and rounded. Towards the end, the material thickness of the collar decreases significantly. On the back of the piece is a fine cast skin and a black corrosion layer visible.
Crafting technique: Lost-wax cast with heavy reworking and repair.
MDCCCXXI,2 – Large **belt plate** with long conical spike and three spiral rows. The spike ends in a rounded tip and is decorated at the base with a ladder-like notched ribbon and five parallel lines. This decoration continues on the disc around the spike. It consists of a wide diamond ribbon composed of three superimposed diamond series framed in lines, two parallel lines and a single diamond series. The following first and smallest spiral series consists of ten spirals connected with double lines. This series is separated from the next slightly larger spiral series by a decorative ribbon consisting of a ladder-like notched ribbon, two parallel lines, two parallel rows of opposed triangles separated by a line, two parallel lines, and a ladder-like notched ribbon. The second spiral series consists of 19 spirals connected with double lines. The following decorative ribbon is identical to the previous one and separates this row from the largest spiral series. The third series consists of 27 spirals connected with double lines. The conclusion of the disc decoration towards the edge is formed by a decorative ribbon consisting of a ladder-like notched ribbon, two parallel lines, two parallel rows of opposed triangles separated by a line, two parallel lines and a ladder-like notched ribbon. This is followed by four uniform grooves that run parallel to the edge and unite with the edge. On the back of the disc the negative of the decorative ribbon is weakly visible. In the middle and towards the spike a forged eyelet is placed over the half hollow, half-filled groove of the spike. Around the eyelet an accumulation of material is visible that might point towards a cast-on spike.
Crafting technique: Rough lost-wax cast, post-casting decoration, probably cast-on spike and eyelet.

Skenkelsø, Jørlunde sogn, Frederiksborg Amt

NM B1635
Aner and Kersten 1973: 52; Nørgaard 2011: 43-45
From burial mound on hilltop, probably cremation in stone cist
NBA II
Neck collar, sword or dagger, two tutuli
Plate 26
B1635 – Poorly preserved **neck collar** with nine ribs (originally the collar probably had more ribs). The very pronounced triangular ribs are decorated with broad and deep notches. The notches are arranged in a type of chessboard-pattern, however, each second rib is well decorated from the transition to the end plate into the frontal region of the collar. The surface of the collar is badly damaged by corrosion and the end plates are not preserved. Therefore, the type classification is possible only through the reconstructed drawing.
Crafting technique: Rough lost-wax cast, probably post-casting decoration.

Skrydstrup 'Staldhøj', Haderslev Amt

NM B13725-B13735
Aner and Kersten 1984: 77-79
From the 'Staldhøj' burial mound, Grave A, in stone packing
NBA II
Wooden bucket/bowl with tin application(?), fibula, two golden spiral rings (head ornament), neck collar, belt plate, dagger, two bracelets with spiral ends, two spiral finger rings, bronze rolls, wool, leg ring.
Figures: 2.084; Plate 26
B13727 – Fragmentarily preserved **neck collar** with seven ribs and a wide, smooth edge-accompanying hem. The collar is largely reconstructed and it is hard to detect the original parts. The third rib from the top and the fourth rib from the bottom run into each other. The so-formed lens-shaped space is slightly longer than the centre of the collar. The other three ribs below the fourth rib follow the form of the collar and are

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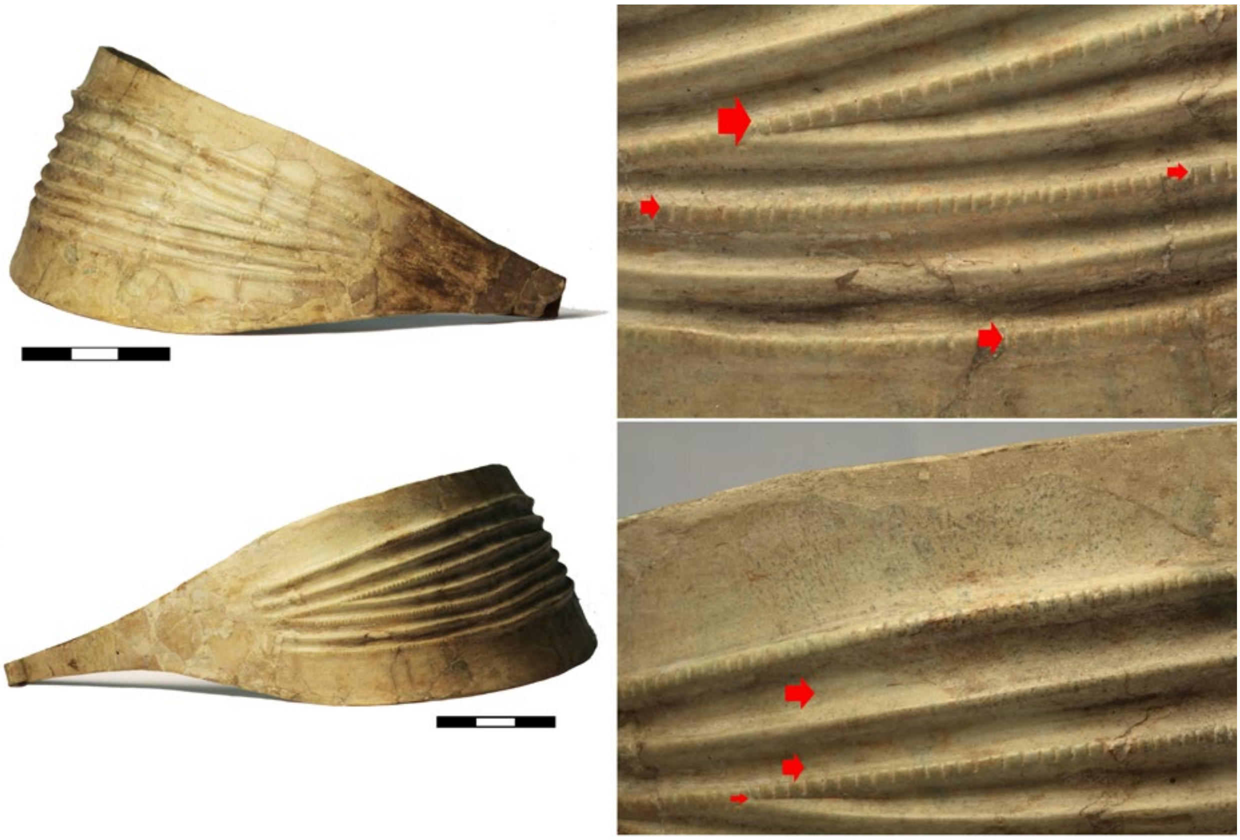

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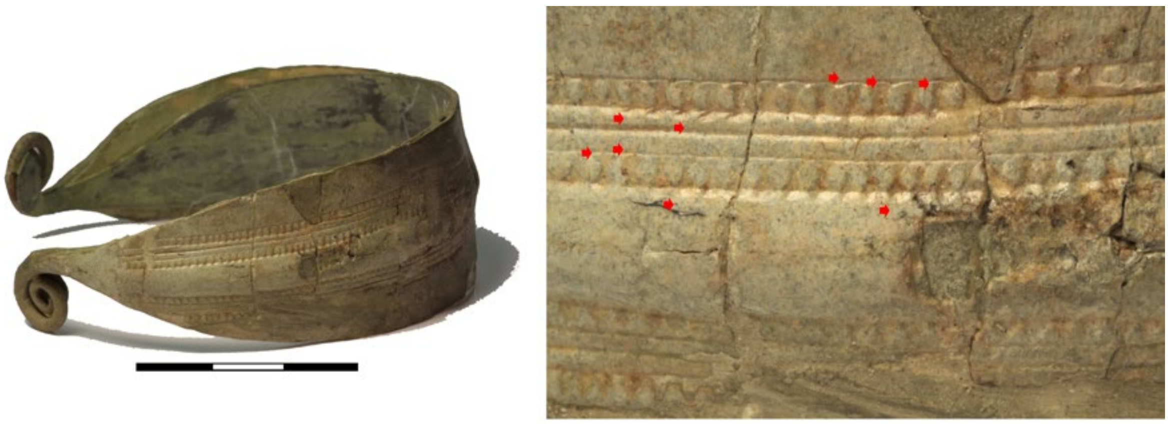

Plate 26:
1) Skenkelsø, Jørlunde, Frederiksborg – neck collar NM B1635.;2) Skrydstrup 'Staldhøj', Haderslev – neck collar NM B13727; 3) Skrydstrup 'Staldhøj', Haderslev – bracelet with spiral ends NM B13730.

therefore slightly bent at the transition to the end plate. The ribs are decorated with notch groups. At the transition to the undecorated end plate, the width of the collar becomes distinctly narrower and the end plate is band-like, ending in end rolls.

Crafting technique: Lost-wax cast, cold-working of the ends. Style and craftsmanship are not of Nordic origin.

B13728 – The **large belt plate** is preserved in small fragments and about half of the plate is reconstructed. The disc has a short, tapered spike which ends in a rounded tip. The transition from spike to the disc is soft. The decorative band around the spike consists of a notch band accompanied by lines, parallel lines, a further ladder-like notched ribbon and, parallel to the line, a series of three superimposed arches. The arches are set in the intermediate spaces which appear within the first row of concentric circles. The ten concentric circle groups consist of three rings around a large hump. They are connected by lying crosses. Additionally a similar series of arches is placed on the opposite decorative band. This ribbon which separates the concentric circle groups of the two spiral series, is similar in structure to the first ribbon. The following two spiral rows are not separated by a decorative ribbon. The spirals are connected horizontally and vertically with double lines, partly filled with notches. The inner series consists of about 20 slightly smaller spirals. The outer row consists of 20 double-wound spirals. Between the spiral line and the disc´s seam is a decorative ribbon of two parallel lines, a notch band, three parallel lines (which are each parallel to a notch band) and another notch band accompanied by a final edge line. The rim-accompanying wide, undecorated hem is trimmed with the help of a step. The back of the disc cannot be investigated because it is applied to a carrier material.

Crafting technique: Lost-wax cast, spirals are applied using a stamp (not related to known stamp-forms), reworking of decoration.

B13730 – Poorly preserved **arm ring** with tapered rod-shaped ends which are rolled into spirals. The wire of the spirals is round in cross-section and flattens towards the actual arm ring. The ring is wide and lenticular-shaped; in the centre, in the extension of the spiral ends, a central rib which is undecorated, parts the ring into two. On each side a decorative ribbon is placed next to the rib, consisting of a ladder-like notched ribbon, three parallel lines and another ladder-like notched ribbon. The main area up to the edge is undecorated. On the back of the ring a metal support frame is mounted, since the item is very unstable and completely corroded.

Crafting technique: Rough lost-wax cast, post-casting, cold-working and decorating. Style and craftsmanship are not of Nordic origin.

Skyttegård, Pedersker sogn, Bornholm Amt

NM17131-17135
Aner and Kersten 1977: 21; Nørgaard 2011: 84
Found in burial mound
NBA II
Belt plate, neck collar, fibula, two ribbed bracelets, knife
Plate 27

NM17132 – Poorly preserved but almost complete **smooth neck collar**, decorated with three spiral rows separated by line groups. A decorative band separates the top spiral row from the slightly outwardly bent, unadorned hem of collar. The decorative ribbon consists of a framed notch ribbon, three parallel lines, two parallel opposed triangle ribbons, three and then two parallel lines beside a notch band. This first series consists of 17 spirals, connected with a simple line. They decrease in size to the sides. A lenticular ribbon consisting of parallel lines, which first begins with the appearance of the large spirals (from the fourth spiral on each side), separates this row from the next spiral series. The decorative ribbon begins with two parallel lines, collected in a tip and towards the centre of the frontal region of the collars develops into two groups of three parallel lines. The single elements are lenticular with a termination point at different heights. The resulting area within this ribbon is a lenticular field which is decorated with standing and hanging triangles. A similar decorative ribbon (consisting of notched ribbons) separates the second of the third spiral series. The second row consists of 18 spirals and the third row of 20 spirals, each connected with simple lines and the first two spirals of each row are much smaller. The small spirals at the end are not only connected horizontally but also vertically with each other. The spiral-decoration is completed towards the end plate with a half-sheet, to which a decorative band, notched bars and parallel lines are connected. The decoration is so fine that it is hardly preserved. At the bottom edge a similar decorative ribbon as on the upper edge is placed. This edge-accompanying decorative band separates the spiral-decoration of the outwardly bent and unadorned hem.

Crafting technique: Probably lost-wax cast with reworking of decoration.

NM17131 – Very poorly preserved and reconstructed (on a brass plate) **belt plate** with long spike and spiral-decoration. The spike is slightly tapered and terminates in a flat disc, slightly wider than the spike. The spike´s middle part is adorned with two groups of six concentric lines. Towards the spike´s foot is an undecorated field, which is completed by a decorative band consisting of five parallel lines, an opposed triangle row, five parallel lines and another triangle series, a line and hanging triangles arranged in parallel. Separated by an undecorated space, the decoration continues with a line of standing triangles, four parallel lines and an undecorated space framed by hanging and standing triangles (similar to the one before), and finally five parallel lines. The first spiral series consists of 18 spirals, all connected by a single line. The next row is constructed of 23 spirals, separated from the inner row by a decorative ribbon of four parallel lines, an opposed triangle series and four parallel lines. Again, this spiral series is connected with simple lines. The edge-accompanying decorative ribbon consists of four parallel lines, two parallel triangle series (placed opposite to each other) and four parallel lines. This decoration is separated from the slightly outwardly curving edge by a narrow unadorned hem.

Crafting technique: Rough lost-wax cast, post-casting decoration, cast-on spike.

NM17133 – Very badly preserved decorative **plate of Bornholm fibula**, decorated with connected spirals. The lenticular decorative plate ends at a side in a peak, on the other is a round knob-like end (probably the pin holder). The plate is framed by a decorative band of two parallel lines, one notch band framed in lines, four framed parallel lines, another framed in lines notched band, five parallel lines and a notched band. The decoration runs parallel to the rounded edge. Within the lenticular inner field are spirals set in line. These very concentric spirals are very similar and they have within their centre a free space. The spirals are connected with simple lines and decrease in size towards the edge. The

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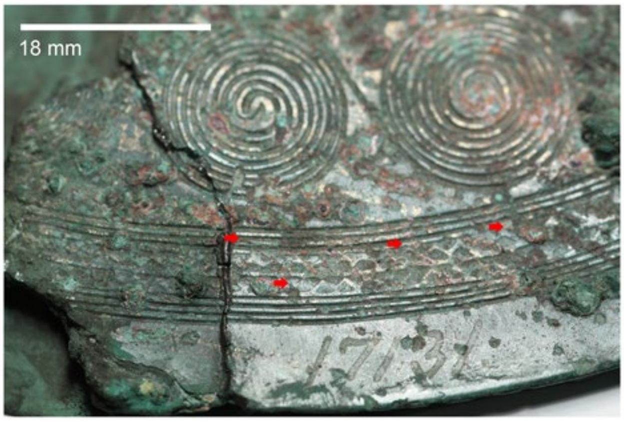

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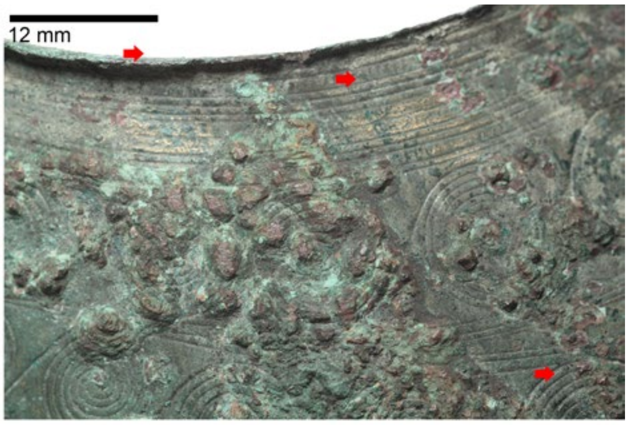

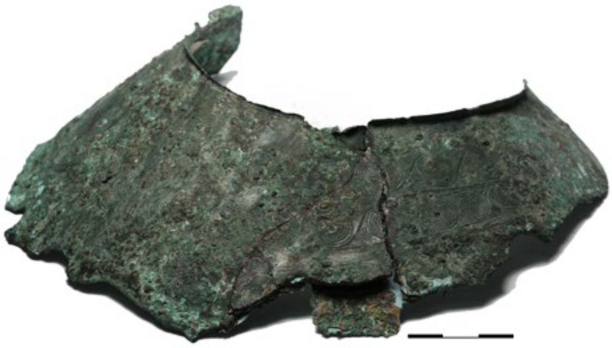

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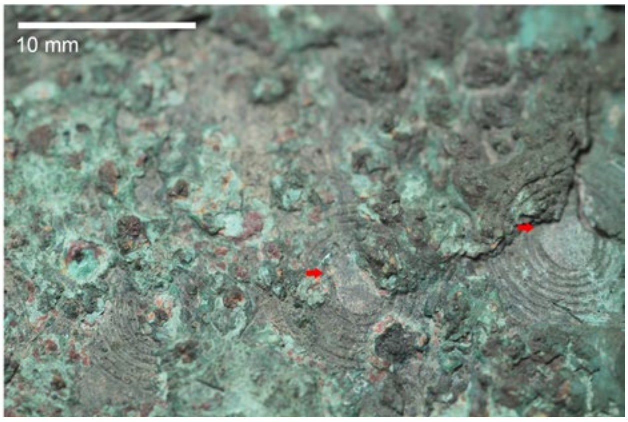

Plate 27:
1) Skyttegård, Pedersker, Bornholm – belt plate NM 17131; 2) Skyttegård, Pedersker, Bornholm – neck collar NM 17132; 3) Skyttegård, Pedersker, Bornholm – fibula Bornholm type NM 17133.

decoration of this fibula plate is severely damaged by the blooming patina.
Crafting technique: Rough lost-wax cast, post-casting decoration, probably cast-on pin and holder.

Sludstrup, Skajærum sn, Hjøring Amt

NM B298-B299
Broholm 1943: Nr.513; Nørgaard 2011: 80-83
Unknown
NBA II
Neck collar, two tutuli, bracelet, fibula and knife (lost)
Figures: 2.036; 2.084; 3.016-17; 4.050
B298 – Smooth and partly badly damaged **neck collar** with spiral-decoration on the face side. The spirals are arranged in two superimposed rows, horizontally and vertically connected. The top row consists of 13 spirals which decrease in size towards the ends. The bottom row also consists of 13 spirals. This spiral series follows the shape of the collar and this results in a wide gap in the middle of the collar between the spiral rows. Thus, the triple vertical connecting lines are centrally much longer. The spirals are formed of three lines of which one line is slightly offset. Parallel to the edge above and below the spiral series is a decorative ribbon consisting of five parallel lines surrounded by ladder-like notched ribbon (hourglass notches). The end plates are not clearly separated from the belly, the spiral-decoration continues into the ends.
Crafting technique: Lost-wax cast with decoration (spiral-stamp), reworking of decoration.
B299a – **Belt disc** with short, thick and undecorated spike. The disc is nearly flat and only the spike is slightly increased. At the foot of the spike is a decorative ribbon consisting of a ladder-like notched ribbon, four parallel lines, a ladder-like notched ribbon, four parallel lines and a final ladder-like notched ribbon. The incisions of the parallel lines are deep while the ladder-like notched ribbon of two opposed triangle notches is only faintly discernible. Another decorative ribbon, similar to the previous one but only in a simple repeat, runs at a small distance parallel to the edge. Between the decorative ribbon is a spiral series consisting of probably 15 uniform spirals (preserved are three spirals). The spirals are connected with single lines. On the back of the disc, below the spike, is a thick, irregularly shaped eyelet. The hole is pierced through the protruding bar.
Crafting technique: Lost-wax cast with parts of the decoration (spiral-stamp), partly post-casting decoration and reworking, eyelet with organic core.
B299b – **Belt disc** with a small and slim spike and a line decoration. Around the undecorated spike is a small undecorated area which is framed by a decorative ribbon consisting of a broad ladder-like notched ribbon (on the slope of the spike), three parallel lines, two adjacent ladder-like notched ribbons separated by a groove, five parallel lines and another ladder-like notched ribbon. The free edge parallel hem is slightly convex. The disc is damaged at the edge and heavily damaged by corrosion (especially on the back). On the back of the disc below the spike there is a broad irregularly shaped eyelet plate construction with a small pierced eyelet. The spike and the eyelet are probably cast-on.
Crafting technique: Lost-wax cast with parts of the decoration, partly post-casting decoration and reworking, cast-on eyelet.

Snertingegård, Præsto Amt

NM B11674-B11675
Aner and Kersten 1976: 185; Nørgaard 2011: 49-50
Bog find
NBA II
Two neck collars
Figures: 2.084
B11674 – **Neck collar** with 15 chessboard-pattern notched ribs. The bottom rib is accompanied by a small smooth hem, decorated with parallel grooves. The relatively sharply defined ribs are separated from the end plate by a wide decorative ribbon. It consists of a ladder-like notched ribbon (hourglass-shaped notches), four parallel diamond series and another ladder-like notched ribbon. The wide end plate is decorated with four connected, double-formed spirals. Another bundle of parallel diamond series and ladder-like notched ribbon separate the spiral-decoration from the end rolls. Attached to the same decorative ribbon are three pointed triangles with the tips pointing towards the ends. The triangles are composed of two grooves; the space between them is filled with slightly oblique cross-hatching.
Crafting technique: Lost-wax cast with decoration (spiral-stamp), reworking and cold-working of the edges.
B11675 – **Neck collar** with eight chessboard-pattern notched ribs. Over the top and below the bottom rib is a narrow, smooth hem. The ribbed section is separated from the decorated end plates by a decorative ribbon consisting of two parallel lines, a narrow ladder-like notched ribbon (hourglass-shaped notches) and two parallel lines. The wide end plate is decorated with four connected spirals that extend to the edge of the end plate. Towards the end roll the spiral-decoration is separated by a decorative ribbon consisting of a line, a ladder-like notched ribbon (the same hourglass-shaped notches) and a further line. Attached to the outer line of this decorative ribbon are four pointed triangles, composed of double, slightly curved lines. The collar is of an exceptionally beautiful golden colour.
Crafting technique: Lost-wax cast, heavily reworked.

Snoldelev (sogn), København Amt

NM6892-6887
Aner and Kersten 1973: 187; Nørgaard 2011
Burial mound, no distinct burial location
NBA II
Probably related: neck collar, belt plate, arm ring(?), fibula, knife
Plate 28
NM6892 – **Neck collar** with nine rounded and relatively flat ribs. The rib-valleys are sometimes very broad and half round in cross section, the slopes flow smoothly into the valleys. The rib-decoration consists of narrow notches. The decoration at the transition to the end plate is not visible on both sides. The ribs terminate at the same position, only the uppermost and lowermost edge-accompanying ribs continue into the end plate. The almost uniformly wide end plate is decorated with a line decoration placed centrally and edge-accompanying. The edge-accompanying decoration consists of a ladder-like notched ribbon, framed and deepened lines, two parallel lines, and a further ladder-liker notched ribbon. On this a line of two superimposed arcs is placed (the exact number cannot be determined). A similar decoration can also be assumed parallel to the lower edge. Centrally of the end plate two parallel lines are placed, which part the decoration in two sections. The back of the collar is covered in a strong patina under which indistinct structures of fabrics are preserved.

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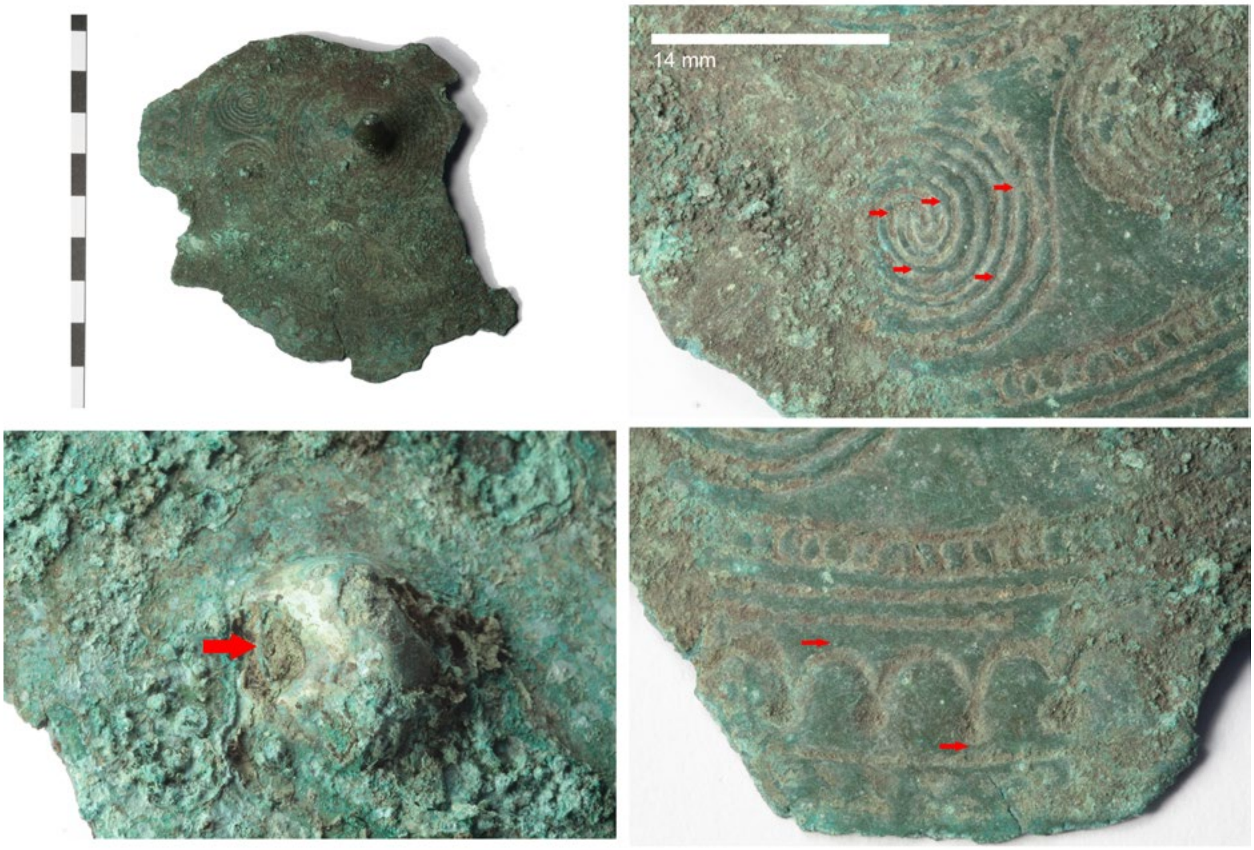

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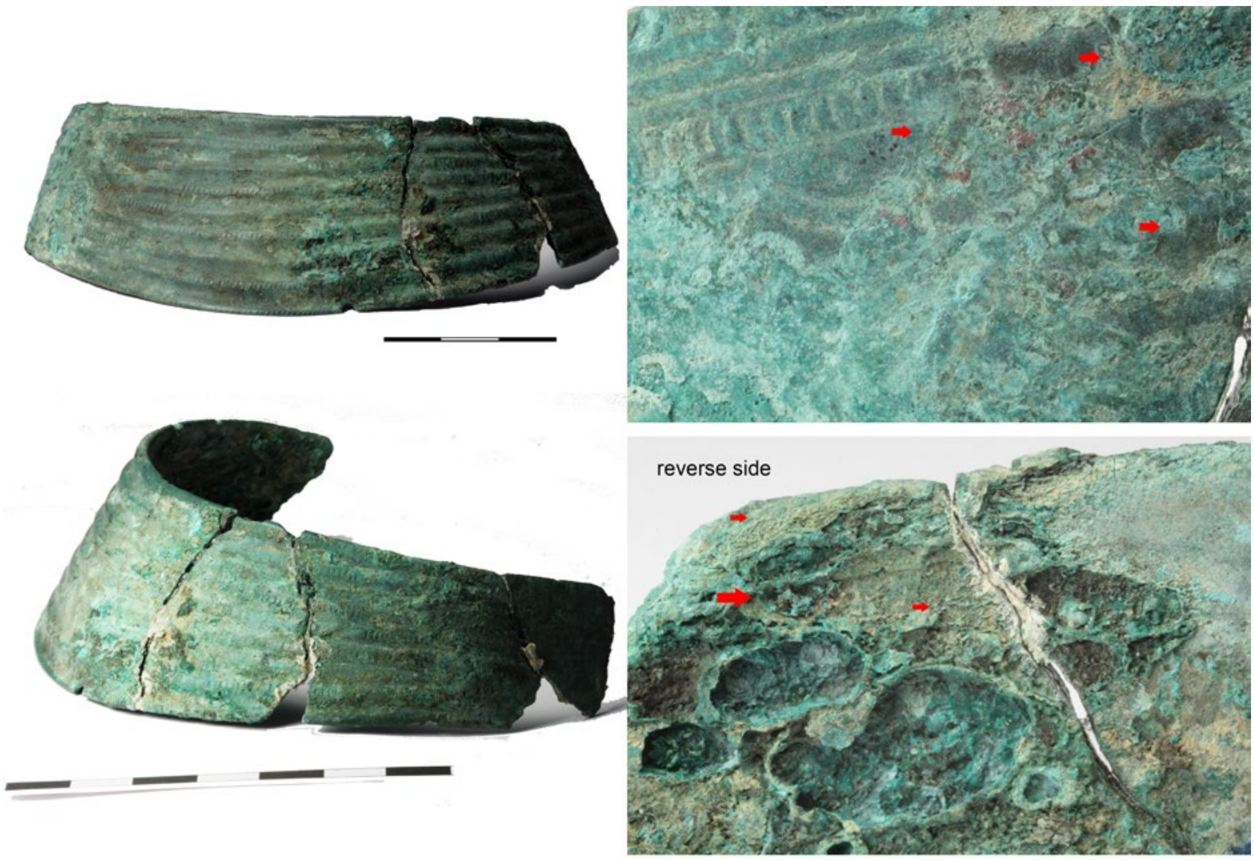

Plate 28:
1) Snoldelev (sogn), København – belt plate NM 6887; 2) Snoldelev (sogn), København – neck collar NM 6892.

Additional investigation: Photographic documentation of fabric residues under the patina.
Crafting technique: Lost-wax cast, probably post-casting decoration.
NM6887 – Heavily patinated and broken **belt disc** with conical spike and spiral-decoration. The tapering pointed spike ends in a rounded tip and is surrounded by a decorative ribbon consisting of a ladder-like notched ribbon framed in lines, two parallel bands of opposed triangles bounded by lines, two parallel lines and a further ladder-like notched ribbon. This is followed by a series of probably 11 or 12 spirals (five are preserved) connected with a single line. The spiral series is surrounded by a decorative ribbon which consists of a ladder-like notched ribbon, two parallel lines, a belt of juxtaposed arcs (outward opened) connected by a round incision at the straight parts of the arc, and a final ladder-like notched ribbon. On the back of the spike is a broad protruding loop. The back of the disc is covered in a strong patina under which indistinct structures of organic material are preserved.
Additional investigation: Photographic documentation of fabric residues under the patina.
Crafting technique: Lost-wax cast probably cast with clay core, partial reworking of decoration.

Søborg Ladegård, Søborg sogn, Frederiksborg Amt
NM B6535
Aner and Kersten 1973: 23; Nørgaard 2011: 35-38; Liversage 2000
Bog find
NBA II
Plate 30
B6535 – Very well-preserved **neck collar** with ten narrow, in cross-section triangular to trapezoidal, ribs. The rib-valleys are wide and semi-circular in cross-section. The ribs are decorated with a notch trim which is continuous on the top and the second rib from above, and thereafter occurs in notch groups. The rib-decoration terminates at the transition to the end plate. The slightly lens-shaped end plate terminates in an end roll which has a similar height to the end plate. The decoration of the end plate forms a frame consisting of two parallel lines, which cut the vertical ribs. Parallel to these lines, a hatched band is placed. The inner area is divided into two fields, the division takes place centrally through six parallel lines and at the ends by four (transition ribs) and six lines. In the so-formed square, standing on the horizontal frame, two opposed arranged arches are placed, each consisting of four superimposed lines. The last centimetre to the end rolls is undecorated.
Additional investigation: Trace elemental analysis, data shown in Table 3 (Liversage 2000).
Crafting technique: Rough lost-wax cast, post-casting decoration.

Soltau, Kr. Soltau, Lower Saxony
LMN 14156 or 115/11/6
Laux 1971: 230; Nørgaard 2011: 71
Wellenkamp Collection, unknown circumstances
NBA II
Figures: 3.003
LMN 14156 – Fragment of a **neck collar** with two notch-decorated rib groups. In between these groups is a smooth field. The lower rib group consists of five weak, rounded ribs. Within these groups the fifth and lowest rib devolve into a narrow hem. The upper group consists of three rounded ribs. Again, the top rib ends in a hem. The central rib of the upper group and the top rib of the lower group are decorated with groups of long rectangular notches. The end plates are probably undecorated and finish in end rolls. The left end plate has an old repair. The broken end is attached to the ribbed side of the collar and secured by a wide staple. The new triangular shaped end is rounded at the edge.
Additional investigation: Trace elemental analysis, data shown in Table 3.
Crafting technique: Lost-wax cast, post-casting decoration and reworking; repair of the end.

Sorgenfri 'Foglevad', Lyngby sogn, København Amt
NM MMXVII
Aner and Kersten 1973: 146; Kersten 1940; Nørgaard 2011: 51
Found in burial mound between cremations
NBA II
Plate 29
NM MMXVII – Very **small neck collar** with seven alternating notched ribs. The hourglass-shaped notch-decoration consists of hanging and standing triangles respectively set under and over the highest point of the ribs and which overlap each other in the middle. Over the top and below the bottom rib there is a small, probably undecorated, and slightly protruding hem. The end plates are badly preserved, only a framework of parallel lines and notched ribbons are recognisable. The hourglass-shaped notches are constructed in a similar way to those decorating the ribs.
Crafting technique: Lost-wax cast, eventually cast with decoration.

Sorø (near), Lynge sogn, Sorø Amt
NM25834
Aner and Kersten 1976: 126; Nørgaard 2011: 48-49
Found in burial mound
NBA II
Plate 29
NM25834 – Fragmentary reconstructed **neck collar**. The collar has nine pointed triangular ribs and a wide undecorated hem below the ninth rib. The ribs are undecorated and run parallel to the upper edge. The seam follows the shape of the collar, and is therefore wider in the centre than towards the sides. It shows no trim on the hem. The right end plate is broken off and the left one is only preserved as a large fragment. The surface of the piece is heavily damaged by corrosion and thus no decoration is visible on the end plate. On the back a rough cast skin can be partly observed and a very fine surface be seen at the bottom hem. A similar fine surface structure features on the top edge; here the surface is significantly compressed, which makes an additional upper hem possible.
Crafting technique: Lost-wax cast, cold-working of the ends and hem.

Søstrup, Søstrup sogn, Holbæk Amt
NM B4950
Aner and Kersten 1976: 32-33; Nørgaard 2011: 43-44
Bought from collector, found near burial mounds
NBA II
Plate 30
B4950 – **Neck collar** with 11 notched ribs (notches arranged in chessboard-pattern). The notches are hourglass-shaped and are continuous on the top and bottom rib. These ribs and the notches are continued on the end plate. The upper rib is

1

2

3

Plate 29:
1) Søborg Ladegård, Søborg, Frederiksborg – neck collar NM B6535; 2) Sorgenfri 'Foglevad', Lyngby, København – neck collar NM MMXVII; 3) Sorø (near), Lynge, Sorø – neck collar NM 25834.

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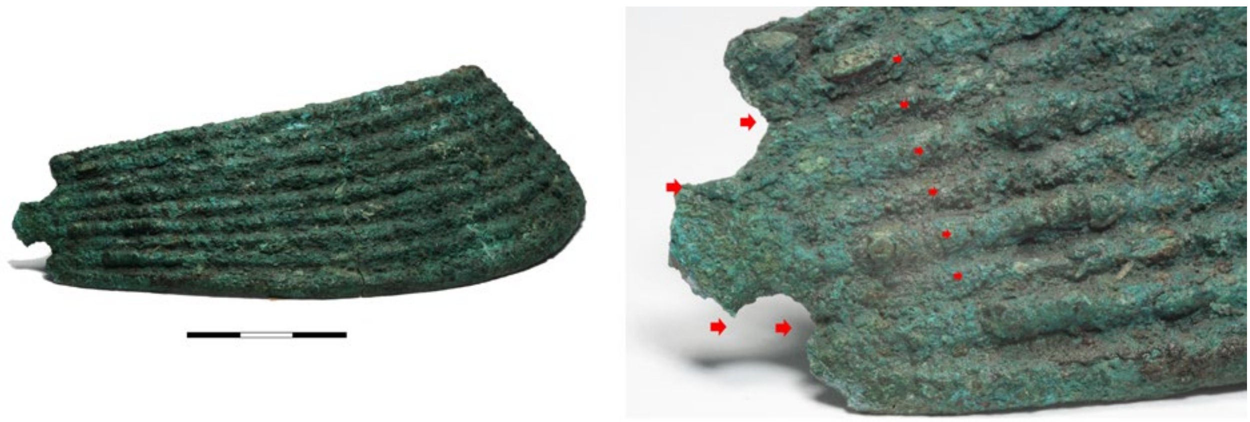

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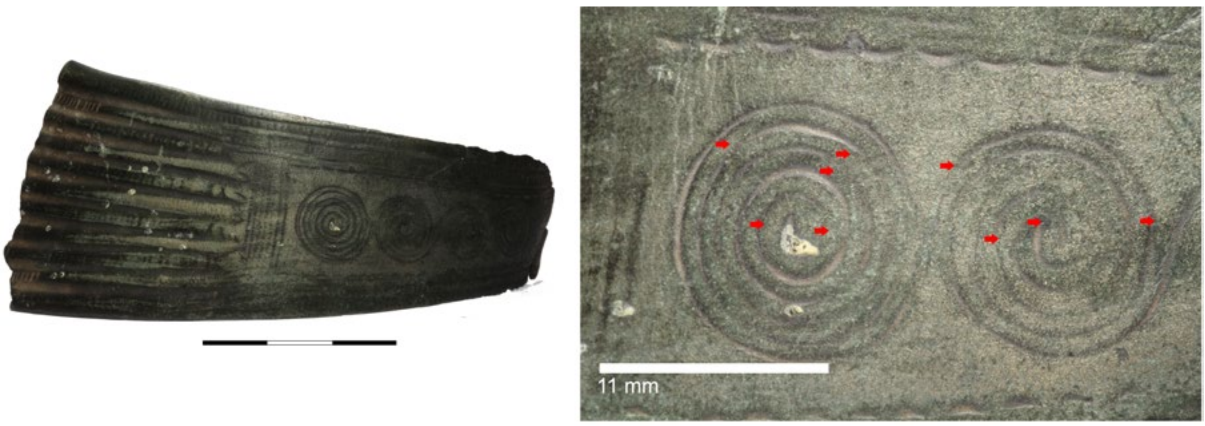

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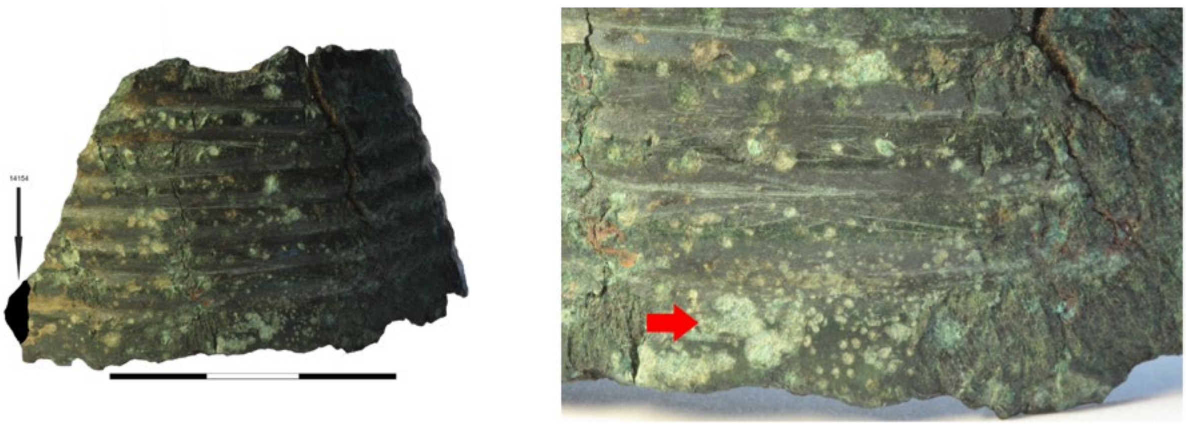

Plate 30:
1) Søstrup, Søstrup, Holbæk – neck collar NM B4950; 2) Svallerup, Svallerup, Holbæk – neck collar NM B723; 3) Svallerup, Svallerup, Holbæk – neck collar NM B727; 4) Tangendorf, Harburg, Lower-Saxony – neck collar LMN 14154.

rounded and much wider and stronger than the rest. The ribs in between end at the same height at the transition to the end plate. Beginning at the fourth rib from the top until the third rib from below the remains of a vertical triangle decoration can be seen, each peak points towards the rib-valley. Parallel to this decoration is a bundle of six parallel lines. A seventh line is continued horizontally, forming a border around the decoration of the end plate. On the horizontal the hourglass-shaped notches (coming from the ribs and continuing on the end plate) are accompanied by lines. A decorative ribbon, consisting of a framed hourglass-shaped notched ribbon, runs parallel to the first notched band. This horizontal decoration concludes the short vertical design. The thus-formed interior is introduced by an arch series (only partly preserved) placed on the inner line. In the open field is a set of four spirals, decreasing in size, that are connected with a line. The decoration is open towards the end and is probably terminated by an end roll.
Crafting technique: Lost-wax cast, slight reworking, mostly spirals.

Sparow, Mecklenburgische Seenplatte (MSE), Mecklenburg
ALM LII C, X, Q,3, Z
Schubart 1972: 156; Nørgaard 2011: 58-62
Found in burial mounds, Mound I, probable female burial
NBA III
Razor knife, neck collar, two leg spirals, disc-headed pin, spiral rolls, bronze pin, ball-headed pin, 34 glass beads, ceramics
Figures: 2.090; 2.113
ALM LII Q,3 – Well-preserved **neck collar** with three groups of two ribs. The ribs are rounded and are accompanied on both slopes by incision (dots) rows. These dots are connected over the rib back with a notch. In each of the two smooth fields is a spiral series (11 spirals), connected with dotted lines. The spiral-decorated fields are concluded by four superimposed arches, framing the smooth field and the rib groups, due to their point of departure within the outer rib. The arches meet at the height of the throat of the middle rib-pair and merge into the next arches. A vertical decoration consisting of two groups of four parallel lines and a framed in lines ribbon of stacked arches separates the decoration of the ribbed section from the one on the end plate. The spiral ornament of the end plate, two rows of three-pointed and connected spirals, is edge-accompanying and framed by a ribbon of stacked arches, which are accompanied by lines. The end rolls are not present.
Additional investigation: Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017; 2015a).
Crafting technique: Rough lost-wax cast, eventually with rib-decoration, post-casting decoration and cold-working.
ALM LII Z1g,1 – **Large disc-headed pin** with irregular, oval-shaped disc on which a four-row hump-decoration is applied. The disc is heavily fragmented and fixed to a carrier material (modern reconstruction). In the centre there is dome of 1.5 cm diam. which is framed by rounded rectangular impressions. There are four edge-accompanying rows of differently sized humps. The innermost row consists of 45 larger and deeper humps. The next two rows are composed of around 80 smaller and slightly irregular humps. The outermost series consists of very small bumps (around 84). Close to the area where the shaft and disc combine the material thickness is significantly increased. This transition from shaft and disc is decorated with a line decoration consisting of a dash-filled triangle, parallel lines and notched ribbons. The decoration adorns *c.* 1 cm of the face side of the shaft. The edged shaft is broken off and seems undecorated.
Additional investigation: Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017; 2015a).
Crafting technique: Cast probably in a two-part mould, cold-working and post-casting decoration of disc and shaft.

Stülow, Bad Doberan, Mecklenburg
ALM Br.523-529
Schubart 1972: 161ff.; Nørgaard 2011: 58-62
From the 'Vossberg' burial mound, with several burials, Grave 1, with stone packing and inhumation
NBA III
Bones, two open arm rings, neck collar, two golden spiral finger rings, two arm rings, ten tutuli, two double-buttons, 'Kreuzbalkenkopf' fibula
ALM Br.524 – Two very poorly preserved **end plates** of the same neck collar. Since the ribbed section is not preserved, the allocation to the Mecklenburg type of collar can only be made with caution. The larger fragment shows the start of the ribbed section. Accompanying the edge are two rounded thin ribs which are lined with dotted lines. A vertical decorative ribbon of three parallel lines, a hatched band and three lines form the separation towards the end plate, which is not preserved on this piece. However, on the smaller fragment the decorative frame around the end plate is visible and consists of three parallel lines and a hatched band. Within this frame are two superimposed rows each of three spirals and a seventh spiral that connects the rows towards the end. The vertical decorative ribbon towards the end roll consists of a hatched band.
Additional investigation: Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017: 2015a).
Crafting technique: Lost-wax cast probably with decoration, reworking.

Sulsted, Sulsted sogn, Ålborg Amt
FHM 2826
Broholm 1943: Nr. 642; Nørgaard 2011: 35-38
Unknown context
NBA II
Figures: 3.003
FHM 2826 – **Neck collar** with ten flat and very rounded, chessboard-pattern, notched ribs. The decoration of the ribs is hardly recognisable. The end plate is separated by four vertical parallel lines from the frontal area. Connected to these lines three tapered triangles are attached at right-angles, consisting of two parallel grooves which meet at the end. The triangles are arranged horizontally and fill approximately two-thirds of the area until the end. The end, probably broken in the past, is now equipped with three different-sized holes.
Crafting technique: Lost-wax cast, partly post-casting decoration (ends).

Svallerup, Svallerup sogn, Holbæk Amt
NM B723-726
Aner and Kersten 1976: 8-9; Nørgaard 2011: 43-44
From the 'Store Maglehøj' burial mound, Grave B
NBA II
Neck collar, two belt plates, tutulus, dagger, wood and seaweed

Plate 30

B723 – Very poorly preserved **neck collar** with ten notch-decorated ribs. The notched trim is only visible as a shadow due to the strong blooming patina. The highest and lowest rib are wider and the ribs are smaller in width towards the edge. On the heavily damaged end plate can be assumed a decoration consisting of a series of concentric circles framed in triangle ribbons. At the right side a three-quarters cut-like break is visible with old patina. On the back of the collar there is a similarly strong patina.

Crafting technique: Lost-wax cast, probably reworking of ornaments.

Svallerup, Svallerup sogn, Holbæk Amt

NM B727-734

Aner and Kersten 1976: 8-9; Nørgaard 2011: 43-44

Found in the 'Store Maglehøj' burial mound, Grave D

NBA II

Neck collar, fibula (weidenblattförmiger Bügel), four tutuli, ribbed bracelet, bronze rolls, spiral rolls, ribbed bracelet with spiral ends, arm ring, spiral finger ring

Plate 30

B727 – Poorly preserved **neck collar** with nine broad, rounded ribs. Both end plates were broken in the past and repaired presumably by overlapping sections and rivet with two pins. At the transitions to the end plate the remains of this repair are visible (two perforations on each side). The end plates are preserved only in small fragments and heavily corroded. The decoration of the resulting pieces is a series of connected spirals framed by a line decoration. On the back of the collar a similarly strong blooming patina is visible.

Crafting technique: Lost-wax cast, probably reworking of ornaments.

Svenstrup, Tårnborg sogn, Sorø Amt

NM10927 -10944

Aner and Kersten 1976: 148-149; Nørgaard 2011: 39-40

Hoard found in 1848 in a bog

NBA II

Neck collar, three spiral arm rings, wheel-headed pin, three belt plates, five belt discs, nine small belt discs, 12 tutuli, two round tutuli, bone fragments, stone ball

Figures: 1.029; 2.037-38; 2.045; 2.071; 2.076; 2.086; 2.109; 2.151; 4.023-25; 4.032; 4.034

NM10927 – **Neck collar** with 13 rounded ribs, decorated with broad notches in a chessboard-pattern. The bottom ribs follow the shape of the lower edge and are therefore curved. The ribs terminate at the same height at the transition to the end plate. They are completed by a decoration of standing triangles. The end plate is framed with a wide, decorative ribbon composed of a ladder-like notched ribbon, two parallel lines, an opposed triangular ribbon, two parallel lines, and a further triangular ribbon. The horizontal edge-accompanying decoration is slightly reduced and is made of a ladder-like notched ribbon, two parallel lines and a triangle ribbon. Within this frame, there are six whole spirals, both horizontally and vertically interconnected. The end plate tapers until the wide, rolled closure. The final decorative strip at the end is similar to the decoration between the ribs and end plate.

Crafting technique: Lost-wax with post-casting reworking.

NM10931 – One half of this **belt plate** is well preserved with a long, conical and decorated spike and flattened tip. The plate is decorated with four spiral rows of decreasing size. The long spike is decorated from the base with a decorative band that is very badly preserved and is only partially visible. The spike is decorated from the middle with a group of five parallel lines, parallel hatched lines, a further group of five parallel lines and an inclined narrower band of parallel hatched lines. The decoration extends to the bottom of the spike. The decorative band around the spike connects to this ribbon and is made of interwoven diamond-like notches, five parallel lines, a slightly narrow ribbon of interwoven diamonds, at least four rows, two opposed triangle ribbons, and a final three parallel lines. The following spiral ribbon consists of 17 spirals connected with double lines. This series is separated from the next series by a decorative band. The decorative band is composed of two parallel lines, an opposed triangle ribbon and a single line. The following spiral series is made up of 23 spirals connected with double lines. The decorative ribbon between the second and the third spiral series consists of interwoven diamonds framed in lines, at least four rows of lying diamonds. The third spiral row consists of 30 slightly larger spirals, which are connected with double lines. The decorative ribbon which separates the third and fourth spiral series is composed of two parallel lines, two opposed triangle ribbons and two parallel lines. The last spiral row is composed of 35 spirals connected with double lines and is terminated by a decorative ribbon consisting of three parallel lines, four interwoven rows of lying diamonds, a ladder-like notched ribbon and a single line. Three wide grooves, weakly pronounced, run parallel to the rounded edge. On the back a wide, prominent eyelet on a base plate can be seen. The material required for the second cast stands out in several places.

Crafting technique: Lost-wax with post-casting reworking, cast-on spike.

NM10932 – Badly preserved **belt plate** with a broken spike and three spiral rows. The disc is highly fragmented and attached to a glass plate, making an examination of the back impossible. Right around the assumed long spike is a decorative band. This is still visible to a small extent. It consists of a ladder-like notched ribbon framed in lines, an opposed triangle ribbon, a ladder-like notched ribbon and another triangle ribbon. The ensuing spiral series consists of 11 or 12 spirals connected with double lines. This series is separated from the next series consisting of 19 spirals with double lines by a decorative ribbon. The decorative ribbon is made of a ladder-like notched ribbon, two adjacent rows of opposed triangles and a ladder-like notched ribbon. The third and largest spiral series consists of 28 spirals, which are connected with double lines. A decorative ribbon accompanies the edge and is just separated by two parallel channels from the broad, slightly upwardly curving edge. This ribbon consists of a single line, a broad notched ribbon of hourglass-like notches, two adjacent rows of opposed triangles and a final hourglass punch line.

Crafting technique: Lost-wax with post-casting reworking, cast-on spike.

NM10933 – Badly preserved **belt disc** with a broken spike and two spiral rows. The disc is heavily fragmented which makes a study of the central region and the back impossible. The spike and the surrounding decoration have not survived. The first spiral row consists of *c.* 10 spirals, of which seven are visible and connected with double lines. This series is separated from the following spiral row consisting of a likely 17 spirals and connected with double lines by a decorative strip. The decorative strip is made of a ladder-like notched ribbon, two parallel lines, between which there is a row of opposed triangles, and a ladder-like notched ribbon.

The second spiral row is slightly larger and only partially preserved, presumably only 13 of the *c.* 17 spirals can be examined. An edge-accompanying decorative ribbon finishes the decoration, consisting of a ladder-like notched ribbon, a row of opposed triangles, and a ladder-like notched ribbon with an additional band of hanging triangles on a single line and a band of standing triangles on a single line. A slightly outwardly curving and undecorated hem completes the decoration up to the rounded edge.
Crafting technique: Lost-wax with post-casting reworking.
NM10935a – Well-preserved **small belt disc** with a short conical spike and rounded tip. Around the spike, directly connected to the bottom of the spike there is decorative ribbon consisting of a ladder-like notched ribbon, two parallel lines with a good distance between the lines, and a further ladder-like notched ribbon. Between this and an edge-accompanying, similarly constructed, decorative band, although slightly closer together, there is a decoration consisting of eight concentric circle groups. The concentric circle groups are made up of four rings with a hump sitting in the centre of each. The concentric circle groups are connected with double lines. Between the edge-accompanying decoration and the rounded edge is a narrow undecorated hem. On the back below the spike is a faint groove with the remains of a core filling. Above the groove, a curved bar is attached to form the eyelet. The negative impressions of the humps are clearly preserved and the impressions of the decoration are faintly discernible.
Crafting technique: Lost-wax around a clay core, additional post-casting decoration and reworking.
NM10935b – Well-preserved **small belt disc** with decorative spiral ornamentation and a short, conically tapered spike with a rounded tip. Around the spike, directly connected to the bottom of it, there is a decorative ribbon consisting of a ladder-like hourglass-notched ribbon, on each side two parallel lines, a further ladder-like notched ribbon, two parallel lines and a ribbon of side-by-side hourglass punch marks. Following this is a series of 12 spirals connected with simple lines. Parallel to the rounded edge and only separated by a narrow unadorned hem is a decorative band consisting of an hourglass-notched ribbon, three parallel lines and another hourglass-notched ribbon. On the back of the disc below the spike is the eyelet. The bulge of the attached bar forms the hole which does not cut into the surface of the disc.
Crafting technique: Lost-wax, additional post-casting decoration and reworking.
NM10935c – Well-preserved **belt disc** with short, slightly tapered spike with broad rounded tip. The decoration of the belt disc is only faintly discernible because the disc is affected by the corrosion. The bottom of the spike is surrounded by a small open area that is ended by a decorative band, consisting of four parallel lines, opposed triangle ribbon, four parallel lines and an opposed triangle ribbon framed in lines. On this decorative ribbon follows a series of ten spirals connected with double lines. This is followed by another decorative ribbon consisting of an opposed triangle ribbon framed in lines, two parallel lines and another framed opposed triangle ribbon. The edge is rounded and slightly curved upwards and is accompanied by an undecorated narrow hem. Opposite the spike on the reverse is a protruding bar which forms the loop. The perforation does not go into the disc.
Crafting technique: Lost-wax, additional post-casting decoration and reworking.
NM10938a – Well-preserved **small belt disc** (possibly a belt hump) with a pointed, tapered spike. The spike is unadorned and ends in a slightly rounded tip. Attached to the bottom of the spike is a decorative band, consisting of a ladder-like notched ribbon framed in lines, a line accompanying the lines of the notched ribbon, an opposed triangle ribbon, three parallel lines and a ladder-like notched ribbon. The ladder-like notched ribbons consist of differently shaped hourglass punches. There is a wide smooth seam between the decorative band and the rounded edge. On the smooth reverse side a broad bar which forms the eyelet is placed in the spike groove.
Crafting technique: Lost-wax around a clay core, additional post-casting decoration.
NM10938b – Well-preserved **small belt disc** (possibly a belt hump) with a pointed, tapered spike. The spike is unadorned and ends in a slightly rounded tip. Attached to the bottom of the spike is a decorative band, consisting of a ladder-like notched ribbon framed in lines, a line accompanying the lines of the notched ribbon, an opposed triangle ribbon, three parallel lines and a ladder-like notched ribbon. The ladder-like notched ribbons consist of differently shaped hourglass punches. There is a slightly wider smooth seam between the decorative band and the rounded edge than on the previous disc. On the smooth reverse side there is a broad, slightly tailored bar in the spike groove, forming the eyelet.
Crafting technique: Lost-wax around a clay core, additional post-casting decoration.
NM10938c – Well-preserved **small belt disc** (probably a belt hump) with a pointed, tapered spike. The spike is unadorned and ends in a slightly rounded tip, the bottom of the spike gently declines in contrast to the other two discs (10938a and b). Attached to the bottom of the spike is a decorative band, consisting of a ladder-like notched ribbon framed in lines, two parallel lines and a ladder-like notched ribbon. The ladder-like notched ribbons consist of differently shaped hourglass punches. There is a wide smooth seam between the decorative band and the rounded edge. On the smooth reverse side there is in the spike groove a broad bar which forms the eyelet.
Crafting technique: Lost-wax around a clay core, additional post-casting decoration.
NM10942 – Well-preserved **tutulus** with a dome-like spike. The dome is slightly conical and from the base to the middle decorated with a ladder-like notched band and a total of seven parallel lines, in two groups of three lines. The highest point of the dome is probably damaged by corrosion. The disc surrounding the dome-shaped spike is completely covered with a decorative ribbon. The decoration consists of a ladder-like notched ribbon starting from the bottom of the spike, two parallel lines, an opposed triangle ribbon, two parallel lines and another ladder-like notched ribbon. On the back, a round, slightly bent bar is inserted in the groove of the spike, forming the eyelet.
Crafting technique: Lost-wax around a clay core, additional post-casting decoration and reworking.
NM10942a – Well-preserved **tutulus** with dome-shaped spike. The dome is slightly conical and decorated from the foot to slightly beyond the middle with a ladder-like notched band and seven parallel lines. The highest point of the dome is slightly flattened and probably damaged by modern archaeological traces. The disc around the dome-shaped spike is decorated with a band separated from the bottom of the spike and at the edge by a narrow undecorated hem.

The decoration in between consists of a ladder-like notched ribbon around the bottom of the spike, two parallel ribbons of opposed triangles and a further ladder-like notched ribbon. On the back, a round, slightly thinner and bent bar is inserted at the edge of the groove of the spike, forming the eyelet.
Crafting technique: Lost-wax around a clay core, additional post-casting decoration and reworking.

Tangendorf, Harburg, Lower Saxony
LMN 14154
Laux 1971: 206; Nørgaard 2011: 56-58
From the Wellenkamp Collection
NBA II
Neck collar, spiked disc
Plate 30
LMN 14154 – Fragment of a **neck collar** with nine beautifully pronounced, trapezoidal ribs. The bottom rib merges into the seam, which has the width of two ribs and is undecorated. The belly fragment is heavily corroded at several points and has been damaged through cleaning (scratches). The end plates are not preserved.
Additional investigation: Metallography (Fig. 2.133; Nørgaard 2015b):
Sampled near transition front to end, at the lowest rib. Microstructure in the sample centre shows large irregular grains, <delta>-phase, speckled copper-sulfide, shrink-holes. Microstructure near the surface displays strain lines and annealing twins (towards the hem), different-sized grains, cuprite (accentuating dendritic structure towards ribs), copper-sulfide (deformed) and deformed shrink-holes. Trace elemental data is presented in Table 3.
Crafting technique: Lost-wax cast with parts of the decoration. The partly recrystallised as-cast microstructure indicates local restricted cold-working at the hem. Annealing twins indicate at least two annealing phases at the hem. Strain lines near the rib back and the grain deformation at the hem indicate final cold-work. The different-sized grains towards the ribbed section are due to residual heat while annealing the hem.

Tårup (Torup), Auning sogn, Randers Amt
AM 7248
unpublished
Probably hoard context, found on a field
NBA II
Figures: 2.084
AM 7248 – **Belt plate** preserved in small fragments (about half the plate). The plate is spiral-decorated and has a short and broad conical spike. The spike has a rounded tip and the foot of the spike is cut off from the surrounding decorative ribbon. The decorative ribbon consists of a three-time repetition of a ladder-like notched ribbon (broad hourglass-shaped notches), two parallel lines, a ladder-like notched ribbon and four parallel lines. The following spiral series consists of probably 18 spirals, of which ten are preserved; they are connected with double lines. A decorative ribbon consisting of a line, a ladder-like notched ribbon and a line is the separation towards the next spiral series. This series consists probably of 25 spirals, of which nine spirals are preserved, partly in fragments. The rim is not preserved. However, remains of the edge-accompanying decorative ribbon are preserved. The same consists of a line, ladder-like notched ribbon and a line. On the back of the disc there is an eyelet opposite the spike. The eyelet is formed by a bar that is placed over the half-hollow spike. The bar widens towards the ends and is X-shaped following the eyelet.
Crafting technique: Lost-wax cast with decoration, ceramic core.

Thürkow, Rostock (LRO), Mecklenburg
ALM 2003/1201
Schmidt 2004: 4; Schmidt 2004: 199; Schmidt 2007: 95ff.; Nørgaard 2011: 64-66
Burial mound, Burial 1 (central), a female aged 30-40, inhumation
NBA IIIa
Amber bead, neck collar, nine tutuli, fibula, 23 cone-shaped tutuli, two arm rings, two spiral finger rings, two leg spirals, bones, flint sickle, ceramic
Figures: 2.102
ALM 2003/1201 – **Neck collar** with three groups of two ribs, which are continuously decorated with notches. In the intervening smooth fields is a rib-accompanying decoration of hanging and standing, finely crafted triangles. Towards the sides the space between the triangular impressions is very narrow (they almost touch) whereas within the centre there is an undecorated space between them. The transition to the end plate is initiated by six lying crosses. One open end of the crossed lines borders the rib end (around each rib is framed). The other end connects to the vertical decorative ribbon at the start of the end plate consisting of four parallel lines, opposed hatched bands (pine branch band) and four parallel lines. The end plate has, parallel to the edge, a decorative strip of three parallel lines, hanging and standing triangle series, two parallel lines and a triangle series standing on the innermost line. In the centre is an elongated undecorated field, which is limited by the decorative ribbon. The triangles point inside into the centre of the field. The decoration is probably completed towards the end by a vertical band of parallel lines and opposed hatched bands (pine branch band). The end rolls were presumably broken during prehistory. The collar is covered on the reverse side by several layers of fabric remains under the patina.
Additional investigation: Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017; 2015a); SEM analysis of fabric remains (Schmidt 2007: 103).
Crafting technique: Lost-wax cast with part of the decoration (rib and triangle), post-casting decoration (line and triangle) and reworking.

Tinnum (Sylt), Südtondern, Schleswig-Holstein
KS 18257 IIa
Aner and Kersten 1979: 116; Nørgaard 2011: 87-88
Found in burial mound, Grave B, with stone packing, inhumation and wooden coffin
NBA II
Neck collar, amber bead, teeth enamel
KS 18257 IIa – **Smooth neck collar** with slightly flared edges. A decorative ribbon composed of line and a ladder-like notched ribbon, and presumably accompanied by a further line, frames the collar decoration. The face side of the collar is divided into two fields by a decorative ribbon of a ladder-like notched ribbon, two parallel lines and another ladder-like notched ribbon. This ribbon converges towards the side. The fields above and below this ribbon are decorated with 12 humps (on the top row) and ten (in the lower row). The humps are framed by concentric circles of different numbers, around which a spiral series is applied. The spiral-

decoration connects two humps and frames them into an oval line frame. The resulting five hump pairs are connected with each other through a single line. Both series are connected at the transition to the end plate, where the spiral series of the bottom row continues into the top row. The end plate is highly fragmented, but seems undecorated and terminates in a rounded triangle.
Crafting technique: Lost-wax cast with part of the decoration, partial post-casting decoration and heavily reworked.

Toppenstedt, Harburg, Lower Saxony
HH 62375-62376
Laux 1971: 207; Nørgaard 2011: 71-72
Toppenstedt Collection, unknown burial mound
NBA II
Neck collar, four spike-discs, two arm spirals
Figures: 2.068; 4.014
HH 62375 – Very well-preserved **neck collar** with two groups of four notch-decorated ribs. In between the rib groups is a smooth undecorated field. The notched decoration of the ribs is applied in a chessboard-pattern with alternating groups of about 20 notches. The ribs converge at the transition to the end plate, so that the centrally positioned field is lens-shaped. The field-parallel rib of the lower group is slightly shortened. The ribs distinctively flatten towards the end plate. The end plates are narrower than the frontal ribbed part of the collar; following this a kink at the bottom hem occurs at the level of the transition from front to end part. The ends are relatively long and unadorned and finish in end rolls (partially preserved). Below the rib group, parallel to the edge, there is a small smooth hem. This is edge-accompanying and decorated with a series of small humps. The hem is also slightly curved outwards. On the back of the collar the remains of fabrics are preserved under the corrosion. Probably a layer of heavy fabric is covered by a layer of a finer fabric.
Additional investigation: Photographic documentation of fabric residues under the patina.
Crafting technique: Lost-wax cast, post-casting reworking and decoration.
HH 62376a – The **spike-disc** is preserved for the most part and decorated with a small spike with rounded top. Around the spike are four circumferential ribs. The ribs are rounded and irregular in thickness and the width of the valley. Starting at the back of the last rib is an undecorated smooth hem. It goes from the rib-slope to the rounded edge. Accompanying the edge was a series of small humps that are almost completely destroyed; only a few small humps are preserved. However, the edge is mostly broken or the humps are abraded. The top-placed wide suspension (broad eyelet) of the disc is not preserved. The back is flat.
Crafting technique: Probably cast in a two-part mould, cold-working of the ends and post-casting hump decoration.
HH 62376b – The **spike-disc** is preserved for the most part and decorated with a small spike with rounded top. Around the spike are four circumferential ribs. The ribs are rounded and irregular in thickness and the width of the valley. Starting at the back of the last rib is an undecorated smooth hem. It goes from the rib-slope to the rounded edge. There was an edge-accompanying series of small humps that are now almost completely destroyed; only a few small humps are preserved. However, the edge is mostly broken or the humps are abraded. The top-placed wide suspension (broad eyelet) of the disc is not preserved. The back is flat.
Crafting technique: Probably cast in a two-part mould, cold-working of the ends and post-casting hump decoration.
HH 62376c – The **spike-disc** is preserved for the most part and decorated with a small spike with rounded top. The spike is slightly oblique and not within the disc's centre. Around the spike are four circumferential ribs. The ribs are rounded and irregular in thickness and the width of the valley. Occasionally the ribs are disturbed and interrupted. Starting at the back of the last rib is an undecorated smooth hem. It goes from the rib-slope to the rounded edge. There was an edge-accompanying series of small humps that is now almost completely destroyed; only a few small humps are preserved. However, the edge is mostly broken or the humps are abraded. On the back the negatives of the humps are clearly visible. The rest of the disc plate is flat and has a regular surface. The top-placed wide suspension (broad eyelet) of the disc is largely intact and is constructed as a flat, slightly tapered tongue that is longitudinally rolled to form an eye.
Crafting technique: Probably cast in a two-part mould, cold-working of the ends and post-casting hump decoration.

Turloff, Ludwigslust-Parchim (LUP), Mecklenburg
ALM Br.371
Schubart 1972: 166; Nørgaard 2011: 58-62
Found in burial mound group, within Mound IV
NBA III
Neck collar, twisted neck ring, two open arm rings, stone axe
Plate 31
Br.371 – Poorly preserved **neck collar** with three groups of two ribs. The decoration is only partly visible. The rounded ribs are slope-accompanying and decorated with grooves that are apparently connected by notches. The individual spirals (of the spiral series in every smooth field) are only preserved as outlines. They are connected by dotted lines. The spiral series run into a ladder-like ribbon that is probably designed with stacked arches and terminates in several parallel curved lines. The left end plate is only partly preserved, their decoration is not recognisable. The right end plate is almost completely preserved and decreases in height towards the end roll. On the end plate a weak vertical decorative ribbon (presumably a broad ladder-like notched ribbon) is visible. The probable spiral series are not preserved.
Additional investigation: Photographic documentation of fabric residues under the patina. Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017; 2015a).
Crafting technique: Lost-wax cast with parts of the decoration, partly post-casting decoration (dots).

Vaale, Steinburg, Schleswig-Holstein
KS 6027
Aner and Kersten 1993: 85ff.; Hachmann 1957: Nr. 257
Found in the 'Rugenbarg' burial mound, inhumation grave with stone packing and wooden coffin
NBA II
Wood, textiles, leather, fibula, dagger, four arm rings, bracelet, two belt discs, spiral finger ring, leg ring, bronze
KS 6027f – Well-preserved but heavily corroded **small belt disc** with a short, round spike and spiral-decoration. Around the spike is a wide undecorated field that is framed by a decorative ribbon, consisting of four parallel lines, which are accompanied by U-curved lines. Accompanying the edge runs a similar group of five parallel lines which is accompanied inwardly by U-curved lines. Within the intermediate field is a

series of 16 spirals, connected with double lines. A tiny groove is situated on the back of the disc, opposite the spike, over which a projecting eyelet is attached. The spike is not hollow.
Crafting technique: Lost-wax technique and core, partly post-casting decoration.
KS 6027g – Good and completely intact, but heavily corroded, **small belt disc** with wide conical spike and line decoration. The spike has a wide slope at the bottom that goes gently into the surface. Around the spike is a decoration of a series of two stacked, adjacent large U-shaped arches. This arch series is pointing with the open side outwards and is placed onto the following decoration: The arches meet at the bottom of the long sides forming star-like rays. The decorative ribbon on which the arch series is placed consists of six parallel lines. On the reverse of the disc is a groove at the height of the spike. A broad bar is placed at the edge of the groove. Following this, the back is flat and the eyelet is not protruding.
Crafting technique: Lost-wax technique, a clay core, partly post-casting decoration.

Vejlebymark, Horns herred, København Amt

FHM 877
Aner and Kersten 1973: 37
Single find on field
NBA III
Figures: 2.066
FHM 877 – Well-preserved **tutulus with step-like ribs** around the slightly conical spike. The actual spike rises straight and forms a long pulled tip that terminates in a disc where the step-like ribs terminate. The top plate is decorated with a star pattern. The straight (and round in cross-section) spike is undecorated. The step-like ribs are alternately decorated with elongated notches that end partly enlarged and point-like. The final step at the foot of the steps is undecorated. Towards the small disc the ribs are framed by a triangle ribbon (standing triangles). Accompanying the triangle tips is a dotted line. The triangles are placed on a line towards the ribs. On the back of the tutulus the start of a bar (eyelet) can be detected, placed within the hollow spike.
Crafting technique: Lost-wax cast with decoration, slight reworking, cast-on eyelet (metal bar in wax model).

Vellinge Mose, Bederslev sogn, Odense Amt

NM25787-89, B2653-58, B3140
Aner and Kersten 1977: 129; Nørgaard 2011: 43-44
Bog find
NBA II
Neck collar, two belt plates, two belt discs, six tutuli
Figures: 2.026; 2.034; 2.067; 2.071; 2.074; 2.099; 2.144; 4.020
NM25787 – **Neck collar** with 16 chessboard-pattern notched ribs. The narrow triangular expiring end plates are elaborately ornamented. A vertical decorative strip separates the frontal region from the end plate. It consists of a ribbon of hourglass-shaped notches, five parallel lines, two opposed standing triangle series separated by two parallel lines, a further five parallel lines and a further band of triangle series and lines. Parallel to the edge a horizontal decorative band is attached to the vertical one. These run towards the end in a pointed triangle together. Each band consists of a ribbon of hourglass-shaped notches, two opposed triangle ribbons and four parallel lines. In the interior, framed by the decorative bands, are a series of three connected spirals which become smaller towards the end. The end plate finishes in narrow end roll.
Crafting technique: Lost-wax cast presumably with the decoration.
NM25788 – Very well-preserved **belt plate** with long tapering spike which ends in a rounded tip. Around the foot of the spike is a free area which is closed by a decorative ribbon consisting of a ladder-like notched ribbon (the notches are hourglass-shaped), an opposed triangle ribbon, two parallel lines and a further ladder-like notched ribbon. A row of 10 spirals connected by double lines is in between this decorative band and the next similarly constructed decorative band. The spirals vary slightly in their size. After the decorative strip (a ladder-like notched ribbon, an opposed triangle ribbon and ladder-like notched ribbon) is another series of 14 large spirals, connected with double lines. Another identical decorative strip separates these spiral series from the third and largest series consisting of 20 spirals, connected with double lines. Parallel to the edge and only separated by three inwardly curved grooves, a decorative band completes the decoration. This is composed of a ladder-like notched ribbon and an opposed triangle ribbon. At the spike on the back a very small loop is placed over the hollow spike.
Crafting technique: Lost-wax cast presumably with decoration, reworking of decoration, clay core in spike.
NM25789 – Very well-preserved **small belt disc** with conical spike and rounded tip. Around the spike is a free space enclosed by a wide decorative band. This decorative ribbon is composed of two parallel and ladder-like notched ribbons, four parallel lines, two parallel opposed triangle ribbons, five parallel lines and a final ribbon with hourglass-shaped notches accompanied by lines. On the back of the disc an irregularly shaped bar is set up as a loop on the disc right below the spike.
Crafting technique: Rough lost-wax cast probably with a clay core, post-casting decoration.
NM25789a – Very well-preserved **small belt disc** with short conical spike and rounded tip. Around the spike is a slightly oval free space enclosed by a wide decorative band. This decorative ribbon is composed of a ladder-like notched ribbon, three parallel lines, a ladder-like notched ribbon, three parallel lines and a final ladder-like notched ribbon. Parallel to the rounded edge is an undecorated, slightly curved upwards hem. On the back there is a preceding loop opposite to the spike. It consists of an X-shaped bar placed over a hole within the disc's surface.
Crafting technique: Lost-wax cast with core, heavy reworking of decoration.
B2654 – Very well-preserved **belt plate** with long conical spike which ends in a rounded tip. Around the foot of the spike is an undecorated area that is limited by a decorative ribbon. This consists of a ribbon of hourglass-shaped notches, two parallel lines and two opposed triangle ribbons, two parallel lines and another ribbon of hourglass-shaped notches. A series of 12 spirals connected by double lines lies between this band and the next identical decorative ribbon. The spirals vary slightly in their size. The next decorative ribbon is accompanied by a series of 19 larger spirals, connected through double lines. Parallel to the edge, and only separated from the same by two inwardly curved grooves, a decorative band is placed. This is composed of a single line, a ribbon of hourglass-shaped notches, an opposed triangle ribbon, two parallel lines and a ribbon of hourglass-shaped notches. On the back there is a loop opposite the spike. It consists of an X-shaped bar placed over a hollow groove within the spike. A crack runs around the spike at the border of the decorative band.

Crafting technique: Lost-wax cast, reworking of decoration partly post-casting decoration.

B2655 – Very well-preserved **small belt disc** with pointed conical spike and rounded tip. A small area around the foot of the spike is undecorated. This space is limited by the disc decoration. This decorative ribbon starts with a line which is not particularly well drawn and has many edges. The next four parallel lines, however, are round and very regular, so that the sequence of the decoration appears even. The decoration consists of a diamond series (consisting of two offset rows of lying diamond series), 11 parallel lines, a diamond band (consisting of three lying diamond series), and finally five parallel lines. Parallel to the rounded edge is an undecorated, slightly curved upwards hem. On the back of the disc an irregularly shaped bar is set up as a loop on the disc right below the spike.

Crafting technique: Lost-wax cast, cold-working of the rim, probably post-casting decoration.

B2657 – Well-preserved **belt disc** with a conical spike with rounded tip. Around the spike is a free space enclosed by a wide decorative band. This decorative ribbon is composed of a ladder-like notched ribbon, four parallel lines, an opposed triangle ribbon, five parallel lines and a final ribbon of hourglass-shaped notches without accompanying line. Between the decoration and the rounded hem is a free undecorated hem. On the back opposite the spike there is a bar forming the loop.

Crafting technique: Rough lost-wax cast, probably post-casting decoration.

B3140 – Well-preserved **belt disc** with a conical spike with rounded tip. Around the spike is a free space enclosed by a wide decorative band. This decorative ribbon is introduced by an hourglass-shaped notch ribbon and further composed of seven parallel lines and a final ribbon of hourglass-shaped notches framed in lines. Between the decoration and the rounded hem is a free undecorated hem. On the back opposite the spike and slightly off centre there is an irregularly shaped bar forming the loop. This eyelet is placed over a shallow groove under the spike.

Crafting technique: Rough lost-wax cast, probably post-casting decoration.

Vendsyssel, **København herred, København Amt**

NM B4750-B4754

Broholm 1943: M. 51; Kersten 1936; Nørgaard 2011: 35-38

Hoard find, unknown context

NBA II

Two neck collars, spiral arm ring, neck ring, 12 belt discs, 11 tutuli

Figures: 2.039; 2.091; 2.105; 2.109; 2.142; 2.148-49; 4.020-21; 4.048

B4750 (1) – Fragment of a **neck collar** with 12 rounded, trapezoidal and clearly pronounced ribs. The ribs are decorated with simple cuts arranged in few groups and have a uniformly smooth surface. The top two ribs are shortened and do not run through to the end. As a result the rib-valleys are lenticular. The right end plate is still preserved in residues and shows a line decoration consisting of four parallel lines forming four lying triangles. Two of these triangles are preserved. The peak starting from the transition to the ribs points to the end.

Crafting technique: Lost-wax cast, post-casting reworking (rib-valleys).

B4750 (2) – Several fragments of a **neck collar** decorated with 13 notched ribs. The rib-decoration is impressed deeply and occurs on each second rib. The upper and lower ribs are continuously decorated with these hourglass-like notches. Starting at the transition from ribs to the end plate, a vertically lined pattern fills the entire end plate. The decoration consists of vertically arranged ribbons of opposed triangles, two parallel lines, a ladder-like ribbon with hourglass-shaped impressions, a row of opposed triangles, a ladder-like notched ribbon and two parallel lines. Intervening empty spaces, the edges lined with triangles, separate the four similar ribbons. The third decorative band, consisting of two parallel lines and a hatched band framed in lines terminated by two parallel lines, differs slightly from the others. The end rolls were broken in the distant past. Placed in the last decorative ribbon the remains of a perforation is visible, probably an old repair.

Crafting technique: Lost-wax cast, partly reworking of decoration.

B4750 (3) – Simple **ribbed neck collar** with nine triangular, unadorned ribs. The width of the ribs varies from the frontal area towards the end and they terminate slightly offset from one another. The very short end plate appears to have been broken in the past and repaired by two holes. The edge of the collar is rounded and goes into the end.

Crafting technique: Lost-wax cast, reworking and repair.

B4753-1 – Fragment of a **small belt disc** with central spike, rear eyelet and hump decoration. The spike is broken shortly after the conical bottom. Running around the bottom of the spike a decorative band is placed consisting of two adjacent ladder-like notched ribbons, framed in lines and with a slight gap between the bands. Following this decoration a series of humps which lie in and are connected through spiral-like lines. The rim of the disc is not preserved. On the reverse side opposite the spike is a flat groove and above an irregular eyelet. The negative imprints of the humps can be documented in the form of funnel-shaped indentations.

Crafting technique: Lost-wax cast with rough decoration and humps, intensive reworking of decoration; loop might be attached through lost-wax cast and reparation of hollow spike.

B4753-763 – Well-preserved **small belt disc** with a long, slightly conical spike with rounded tip. The surface of the disc is severely damaged by corrosion, so that the decoration is partially not visible. Around the spike, a notched ribbon consisting of slightly square hourglass punch marks is placed, but it is partially destroyed. This notched ribbon is followed by three parallel lines. This is followed by a band of opposed triangles, two parallel lines, another triangle band and again two parallel lines. The ensuing notched ribbon is very irregular and may be constructed of square hourglass-shaped punch marks or opposed triangles. A similar notch-band closes the decoration of the disc towards the rim. In between is placed an opposed triangle ribbon accompanied by two parallel lines. The area between the decorative band and the slightly upwardly curved hem is undecorated. On the back of the disc is a raised eyelet.

Crafting technique: Lost-wax cast; eyelet is attached in the model; post-casting decoration.

B4753-885 – Well-preserved **small belt disc** with a broken spike. Around the spike a slightly oval undecorated area, which is enclosed by parallel lines, can be documented. These five parallel lines are followed by a band of three rows, slightly offset, horizontal diamonds. These are separated from the next diamond series, consisting of four rows of slightly offset diamonds, by two parallel lines. Towards the edge of the disc a group of four parallel lines completes the decoration. The area between the decorative ribbon and the slightly upwardly curved hem is undecorated. On the back of the disc is a raised eyelet.

Crafting technique: Rough lost-wax cast includes spike and eyelet, post-casting decoration.

B4753-890 – Well-preserved **small belt disc** with a long, slightly conical spike with broken tip. The surface of the disc is very well preserved. Around the spike a slightly oval undecorated area, which is enclosed by parallel lines, can be documented. These five parallel lines are followed by a ladder-like notched ribbon, consisting of hourglass punch marks. This is followed by three parallel lines and a band of opposed triangles, three parallel lines, another ladder-like notched ribbon and again three parallel lines. A similar band of opposed triangles followed by four parallel lines closes the decoration of the disc towards the rim. The area between the decorative band and the slightly upwardly curved hem is undecorated. On the back of the disc is a raised eyelet.

Crafting technique: Lost-wax cast; eyelet is attached in the model; post-casting decoration.

B4754-873 – Well-preserved **small belt hump (tutulus)** with long spike. The decoration of the disc consists of step-like grooves arranged with soft to hard transitions. The ten narrow steps ascend from a smooth, straight hem onto the area surrounding the spike. The open space around the spike is undecorated and the conical spike is sloping. The spike is regular, cone-shaped, and terminates in a rounded tip. The tip is damaged by corrosion. On the back of the disc is the web-shaped eyelet. This round, equally wide web is attached to the oblique cavity of the spike. At the connection between the web and spike cavity an increasing thickness in the material can be detected. The web is attached just below the rim. The interior of the spike is hemispherical with a smooth surface.

Crafting technique: Lost-wax cast with intensive reworking, eyelet is attached in the model and fixed with a clay core.

B4754-875 – Well-preserved **small belt hump (tutulus)** with long spike. The decoration of the disc consists of step-like grooves arranged with soft to hard transitions. The 12 narrow steps ascend from a smooth, straight hem onto the area surrounding the spike. The open space around the spike is undecorated and the conical spike is sloping. The spike is regular, cone-shaped, and terminates in a rounded tip. The tip is damaged by corrosion. On the back of the disc is the web-shaped eyelet. This round, equally wide web is attached to the oblique cavity of the spike. At the connection between web and spike cavity an increasing thickness in the material can be detected. The web is attached just below the rim. The interior of the spike is irregularly hemispherical with a smooth surface.

Crafting technique: Lost-wax cast with intensive reworking, eyelet is attached in the model and fixed with a clay core.

B4754-878 – Well-preserved **small belt hump (tutulus)** with long spike. The decoration of the disc consists of step-like grooves arranged with soft to hard transitions. The 12 narrow steps ascend from a smooth, straight hem onto the area that surrounds the spike. The open space around the spike is undecorated and the conical spike is sloping. The spike is regular, cone-shaped, and terminates in a rounded tip. The tip is broken. On the back of the disc is the web-shaped eyelet. This round, equally wide web is attached to the oblique cavity of the spike. At the connection between web and spike cavity an increasing thickness in the material can be detected. The web is attached just below the rim. The interior of the spike is irregularly hemispherical with a rough surface.

Crafting technique: Lost-wax cast with intensive reworking, eyelet is attached in the model and fixed with a clay core.

B4754-884 – Well-preserved **small belt hump (tutulus)** with long spike. The decoration of the disc consists of step-like grooves arranged with soft transitions. The four narrow steps ascend from a smooth, straight hem onto the area that surrounds the spike. The wide open space around the spike is undecorated and slightly curved. The spike is irregularly cone-shaped, with an accumulation of material at the bottom, and terminates in a rounded tip. The tip is damaged by corrosion. On the back of the disc the protruding eyelet is placed beneath the spike. The interior of the spike is filled with a rough surface. The steps are clearly visible from the back.

Crafting technique: Rough lost-wax cast, steps are forged post-casting from both sides.

Vognserup Enge, Kunby herred, Holbæk Amt

NM VM 1680

Frost 2011; Nørgaard 2011: 35-38

Bog find

NBA II

Two belt plates, four neck collars, four finger spirals, 25 belt discs, 15 tutuli, 2 tutuli with rounded spike, 193 bronze rolls, wool thread

Figures: 2.028-31; 2.043-44; 2.072; 2.092; 2.097; 2.103; 2.107; 3.014; 4.020; 4.024; 4.035

VM 1680 KF – Quite well-preserved **neck collar** with nine rounded ribs, which are alternatively decorated with groups of notches. The ribs all end at the same height at the transition to the end plate and are cut off by a vertical decoration ribbon. The decoration frames the end plate, although without a vertical conclusion up to the end roll. The decorative ribbon consists of two parallel lines, two parallel rows of opposed triangle ribbons and two parallel lines. An edge-parallel ribbon of standing triangles is placed pointing with the tip into the formed centre zone of the end plate. The end plate finishes in a narrow end roll. On the back many smaller and larger casting defects are recognisable.

Crafting technique: Lost-wax cast, no distinct reworking but cold-working of the ends.

VM 1680 KE – Well-preserved **neck collar** with four rounded and edge-accompanying ribs. A wide rib is placed in the middle of the collar which separates two smooth areas from one another. The ribs are alternately notch-group decorated. The smooth areas are decorated with spiral series. The top row consists of uniform small spirals. Within the spiral series of the lower row the size increases towards the centre, proportionate to the field's size, which follows the shape of the collar. The ribs terminate at the transition to the end plate at the same height. The end plate is separated from the frontal section by a vertical ladder-like notched ribbon and two parallel lines. Horizontally the end is framed in a decoration of parallel lines and a ladder-like notched ribbon. The field in between is filled with a spiral-decoration consisting of six spirals, of which each three spirals form a triangle. The triangles are opposed. The fully preserved end roll is decorated with grooves and is separated from the end plate decoration by a vertical hatched band.

Crafting technique: Lost-wax cast, slight reworking and cold-working of the end rolls.

VM 1680 AD – Very well-preserved **small belt disc**, possibly a tutulus, with short undecorated conical spike. The spike ends in a rounded tip and has a gently inclined foot. Around the spike is a decorative ribbon consisting of two adjacent ladder-like notched ribbons. Separated by a narrow undecorated area, another decorative ribbon follows, consisting of two adjacent ladder-like notched ribbons. This ribbon is separated by the narrow hem of the irregularly rounded edge. On the foot of the spike is a large hole, presumably a void. On the back of the disc, a bar is placed on the edge of the spike´s weak groove, which is considerably narrower in the middle.

Crafting technique: Lost-wax cast probably clay core, no distinctive signs of reworking.

VM 1680 AG – Well-preserved **small belt disc** (possibly tutulus) with long conical spike and narrow rounded tip. The disc is broken on one side and has old casting defects on the other. Around the smooth unadorned spike a decorative band is placed directly on the foot of the spike and it extends across the entire width of the disc. The decoration consists of three parallel lines, an opposed triangle band, four parallel lines, an opposed triangle band, five parallel lines and another opposed triangle band. The line decoration ends with a single line and a narrow unadorned hem up to the edge of the disc. On the back of the disc, a round in cross-section bar is placed over the deep groove of the spike. It is slightly wider at the transition from the flat disc to the groove.

Additional investigation: Trace elemental analysis, data shown in Table 3 (Liversage 2000)

Crafting technique: Lost-wax cast with clay core, no distinct sign of reworking.

VM 1680 AH – Very well-preserved **small belt disc**, possibly a tutulus, with long undecorated conical spike. The spike ends in a rounded tip and has a gently inclined foot. Around the spike there is a decorative ribbon, consisting of three parallel lines, an opposed triangle ribbon, four parallel lines, another opposed triangle band and two parallel lines. This ribbon is separated by a narrow undecorated hem from the irregularly rounded edge. On the back of the flat disc, a circular in cross-section bar forms the eyelet. It is set on the edge of a very deep spike-groove and the ends are enclosed in additional material. The disc is flat and the back shows a porous casting skin with many casting mistakes.

Crafting technique: Lost-wax cast with clay core, slight reworking.

VM 1680 AL – Very well-preserved **small belt disc**, possibly a tutulus, with long undecorated conical spike. The spike ends in a rounded tip and has a gently inclined foot. Around the spike is a decorative band, consisting of a sunken line, an opposed triangle ribbon, three parallel lines and another triangle ribbon, four parallel lines, an opposed triangle ribbon and three parallel lines. The line decoration is separated by an irregular, sometimes quite wide, unadorned hem from the rounded edge. On the back of the disc, an oval in cross-section bridge is placed on the edge of the deep, cone-shaped groove of the spike. The ends are flattened and triangular. The disc plate is flat at the rim, increased up to the loop and has a porous cast skin.

Crafting technique: Lost-wax cast probably with core, partial reworking.

VM 1680 KC – Very well-preserved **large belt disc**, with a long cone-shaped spike which is grooved at the bottom. The spike ends in a rounded tip and is mostly undecorated. At the lower part of the spike, however, are five parallel grooves. The spike is placed on a step-like foot, which is decorated with a radiating line decoration around the spike. Spike and spike-foot form a unit separately attached to the disc. Around the spike is a decorative strip consisting of a ladder-like notched ribbon, three parallel lines and two adjacent opposed triangle series, three parallel lines, a ladder-like notched ribbon and a final line. This line decoration is followed by a spiral series, consisting of 14 smaller spirals connected with single lines. The spiral series is separated from the next one by a decorative ribbon, which consists of a single line, a ladder-like notched ribbon, two adjacent opposed triangle ribbons, three parallel lines, a ladder-like notched ribbon and a final line. The second spiral series is larger by one turn and is composed of 23 spirals, all connected with single lines. The following line decoration is identical to the previous one. The ensuing spiral series is made of 31 spirals, again larger by one turn and connected with single lines. From the edge the spiral series is separated by eight parallel lines and three incised edge-accompanying grooves. On the back of the disc a rectangular/oval in cross-section loop with slightly widening, protruding ends is mounted on a bottom plate opposite the spike. The negative shape of the spiral series and the line decoration are just visible. Eyelet and spike form an independent element of the disc.

Crafting technique: Lost-wax cast, additional reworking of spirals and notches, cast-on spike.

VM 1680 KD – Well-preserved **medium-sized belt disc**, with a long cone-shaped spike. Two-thirds of the spike is decorated with ten grooves, of which ten are arranged equally and two are slightly further away. The spike ends in a rounded tip and is smooth and undecorated at the top. The spike is placed on top of the disc with a small gap visible. Around the spike, a decorative band is placed composed of two ladder-like notched ribbons (the notches are hourglass-shaped), two parallel lines and two similar ladder-like notched ribbons. The outer line is attached slightly displaced. This line decoration is followed by a spiral series, consisting of 12 smaller spirals connected with single lines. The spiral series is separated from the next by a line decoration consisting of two ladder-like notched ribbons (the notches are hourglass-shaped), two parallel lines and similar ladder-like notched ribbons. The second spiral series is larger and consists of 20 spirals, all connected with single lines. From the edge this spiral series is separated by a decorative ribbon identical to the previous one. A narrow hem of irregular shape lies between the decoration and the rounded edge. On the back of the disc an oval in cross-section protruding loop is mounted opposite the spike. The widening ends give the bar an X-form shape. The negative shape of the spiral series and the line decoration are nearly visible. Eyelet and spike form an independent element of the disc.

Crafting technique: Lost-wax cast, slightly reworking in spirals and notches, cast-on spike.

VM 1680 KG – Very well-preserved **medium-sized belt disc** with a short, wide, undecorated conical spike. The spike ends in a broad rounded tip and has a slightly curved foot. Around the spike there is a decorative ribbon consisting of a single line, a ladder-like notched ribbon, two parallel lines and four opposed triangle bands separated by a line. From this decorative ribbon follows a series of 12 spirals connected with double lines. The spirals are quite large and even. Another decorative ribbon includes the spiral series. The decoration is made of a ladder-like notched ribbon, three parallel lines, and a ladder-like notched ribbon. This band is separated by an irregular, sometimes quite wide and unadorned hem from the rounded and slightly flared edge. On the back of the disc there is a raised bar, round/oval in cross-section, attached to the spike. The ends of the bar are wider and go over into

the surface of the disc, sometimes with a groove. The disc is flat, showing a partly rough casting skin with many casting mistakes and the negative forms of the spirals slightly visible.
Additional investigation: Trace elemental analysis, data shown in Table 3 (Liversage 2000)
Crafting technique: Lost-wax cast, slight to no reworking, spike cast with core.
VM 1680 KJ – Very well-preserved **small belt disc**, possibly a tutulus, with short conical undecorated spike whose foot ends in four wide sloping steps. The spike´s tip is a small dome-like shape. Around the spike is a spiral band, consisting of eight small spirals, coupled with double lines. From the edge the spiral series is separated by a decorative ribbon consisting of two parallel ladder-like notched ribbons. Between this strip and the irregularly rounded edge is a narrow, smooth hem. On the back of the disc, a rectangular bar is set onto the edge of the irregular spike groove. The bar is considerably narrower in the centre, widening at the ends and concluding in a stretched X-form. The wide groove shows a rough surface and the surface of the disc is finely structured, possibly a dendritic cast structure.
Crafting technique: Lost-wax cast, no reworking.
VM 1680 KK – Well-preserved **small belt disc** with short and wide conical spike (possible tutulus). The tip of the spike is flattened and rounded. Around the foot of the spike is a decorative band consisting of a line, framed hourglass notches and four parallel lines. A parallel edge-accompanying decorative ribbon of two parallel lines is the base on which a decoration of two overlapping semi-circles is placed. This line of 15 arches, which meet at each of the straight arms, and thus form a continuous band, fills the area between the line decorations. The hem that separates the decorative ribbon and the edge is different in its widths. On the back the negatives of the arches are slightly visible. The round cross-section of the eyelet bar is inserted into the groove of the spike. The ends of the bar are flattened and in the deep groove some organic remains are visible.
Crafting technique: Lost-wax rough cast with core, intensive reworking of decoration.
VM 1680 KL – Very well-preserved **medium-sized belt disc** with a wide, undecorated conical spike. The spike ends in a broad rounded tip and has a slightly curved foot. Around the spike is a decorative ribbon, consisting of a ladder-like notched ribbon, three parallel lines, two opposed triangular bands, each separated by a line, two parallel lines and a notch band. On this decorative ribbon follows a series of nine humps. Each hump is surrounded by a 'shining sun' line decoration. The fields between the humps are filled with hatched triangles, with the tip pointing to the spike. Another decorative ribbon frames the hump series and forms the basis on which the triangles are placed. It consists of a notch band, three parallel lines, a slightly oblique notched ribbon, two parallel lines and an edge-accompanying notch band. A narrow unadorned hem separates the rounded and slightly flared edge from the decoration. On the back of the disc a raised, round/oval in cross-section bar is visible opposite the spike. The ends of the bar are greatly enlarged, so that it is nicely X-shaped. The so-formed eyelet is slightly sunk into the disc surface. The disc is flat, showing a partly rough casting skin with many casting mistakes and the clear negative imprint of the humps.
Crafting technique: Lost-wax cast with core, reworking of notch-decoration and humps.
VM 1680 KM – Very well-preserved **belt disc** with a long, narrow and conical tapered spike. The undecorated spike ends in a rounded tip and has a gently inclined foot. A disc-filling decorative band is placed around the spike. The decoration is separated only by a narrow hem from the rounded edge. It consists of a ladder-like notched ribbon (the notches are hourglass-shaped), three parallel lines, a ladder-like notched ribbon, a hatch band of inclined notches framed in lines, a ladder-like notched ribbon, two parallel lines, a series of vertical stacked triangles, two parallel lines, a ladder-like notched ribbon, and three parallel lines. The edge of the plate is heavily damaged. On the back of the disc, the transition of each decorative part is visible. Below the spike there is a protruding loop with irregular cross section. The eyelet is only slightly incised into the disc surface.
Additional investigation: Trace elemental analysis, data shown in Table 3 (Liversage 2000).
Crafting technique: Lost-wax cast, decoration is heavily reworked or partly attached post-cast.
VM 1680 R – Very well-preserved **belt disc** with a long, narrow and conical tapered spike. The undecorated spike ends in a rounded tip and has a gently inclined foot. A disc-filling decorative band is placed around the spike. The decorative ribbon consists of three parallel lines, a row of hourglass notches, four parallel lines, a notch band (hourglass-shaped notches), four parallel lines, a notch band and three parallel lines. The decoration is separated only by an irregularly wide hem from the rounded edge. On the back there is a protruding loop. The bar is oval in cross-section ridge and the eyelet is irregular in shape. The spike is solid.
Additional investigation: Trace elemental analysis, data shown in Table 3 (Liversage 2000).
Crafting technique: Lost-wax cast with pierced eyelet, post-casting decoration.
VM 1680 X – Very well-preserved **belt disc** with a long, narrow and conical tapered spike. The undecorated spike ends in a rounded tip and has a gently inclined foot. A disc-filling decorative band is placed around the spike. Close to the spike is a line on which the hourglass-shaped notches are arranged. The remaining decoration consists of three parallel lines, a line on which the second row of hourglass-shaped notches is arranged, three parallel lines and a third line with hourglass notches. The decoration is separated from the rounded edge by a narrow unadorned hem. On the flat back of the disc there is a protruding loop. The bar is oval in cross-section ridge and the eyelet is irregular in shape. The spike is solid.
Crafting technique: Lost-wax cast with pierced eyelet, post-casting decoration.
VM 1680 P – Very well-preserved **tutulus** with hemispherical spike and single eyelet on the back. The dome-like spike is on top slightly pointed and decorated with line decoration. The decoration consists of six parallel lines framed by dotted lines, running as two broad ribbons over the dome crossing each other. At the foot of the dome a wide brim is placed, decorated with an oblique notch trim. The decoration of the small disc is connected directly to the brim and consists of an opposed triangle ribbon, three parallel lines, a similar triangle ribbon, three parallel lines and a triangle edge-accompanying ribbon. The ribbon parallel to the rounded edge is very worn. On the back the round in cross-section bar is inserted into the hollow dome. On the surface the dendritic cast structure is partly visible.
Crafting technique: Lost-wax cast, probably just reworking of decoration.

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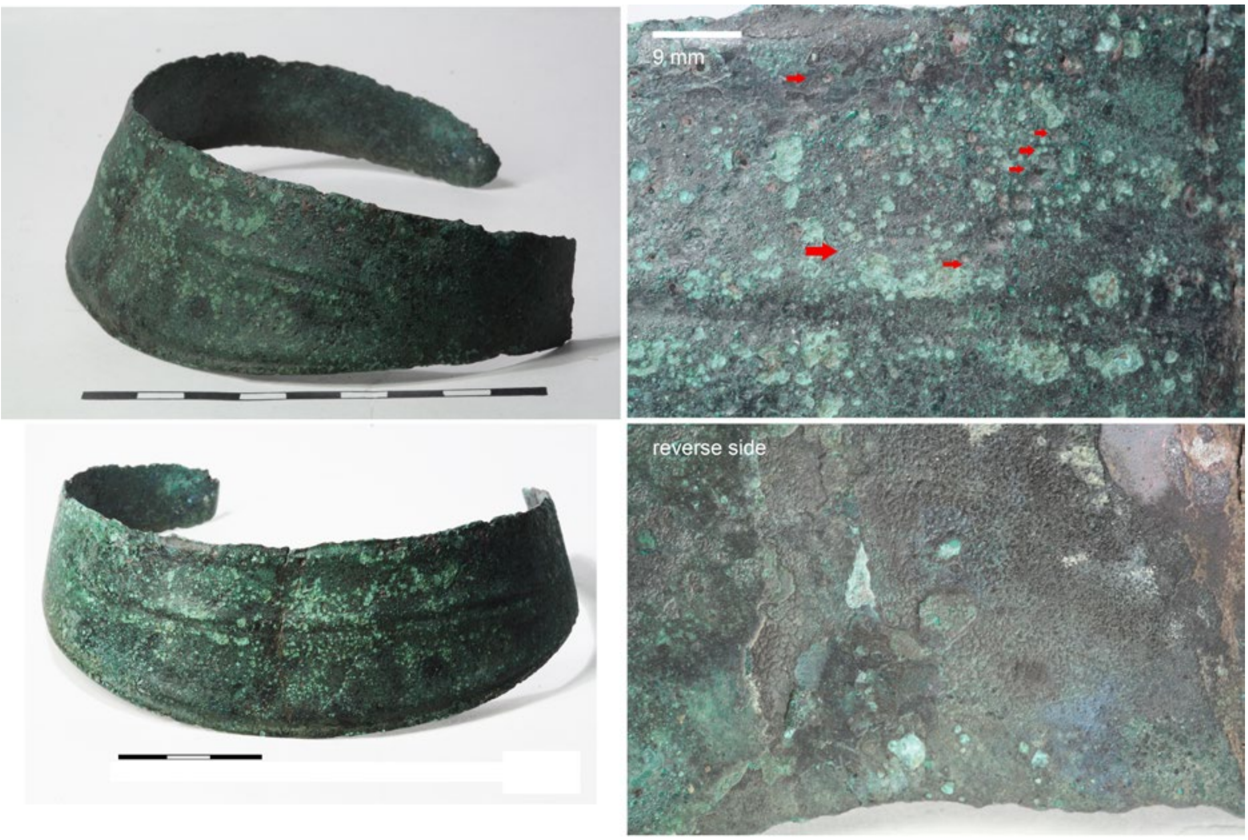

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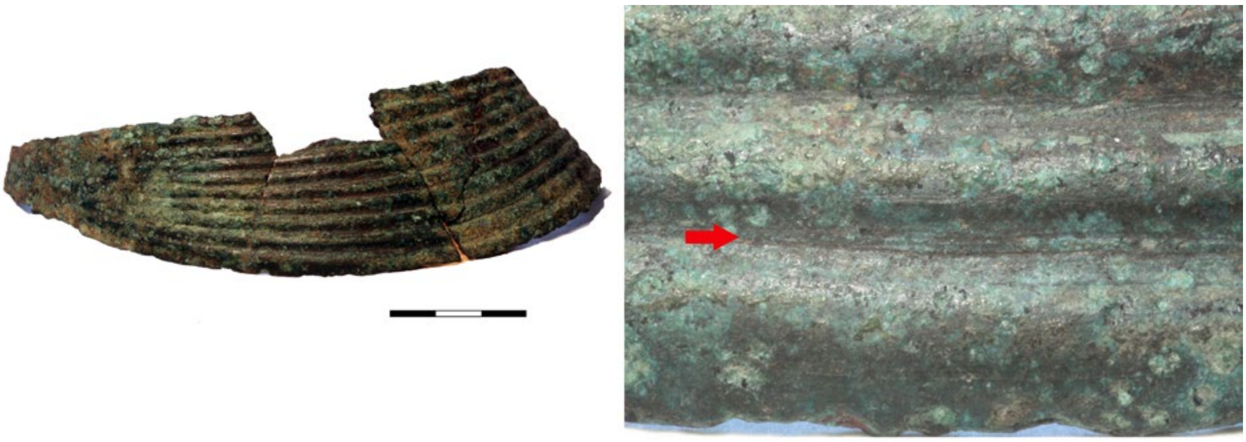

3

Plate 31:
1) Turloff, Ludwigslust-Parchim (LUP), Mecklenburg – neck collar ALM Br.371; 2) Vorder-Bollhagen, Bad Doberan, Mecklenburg – neck collar ALM 3139; 3) Vorder-Bollhagen, Bad Doberan, Mecklenburg – belt disk ALM 3140.

Vorder-Bollhagen, Bad Doberan, Mecklenburg
ALM 31393140
Schubart 1972: 168; Nørgaard 2011: 33-35
Found in burial mound
NBA II
Neck collar, belt disc
Figures: 2.036; Plate 31
ALM 3139 – N**eck collar** with ten rounded ribs and strong patina. The rib-valleys between the ribs are rounded and have elongated grooves. The one preserved end plate is undecorated. The collar is broken into three pieces. On the back patinated fabric residues are visible.
Additional investigation: Photographic documentation of fabric residues under the patina. trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017; 2015a).
Crafting technique: Lost-wax, post-casting decoration and reworking.
ALM 3140 – Slightly curved, **medium-sized belt disc** with short roundish spike. The spike is unadorned and irregular. The disc is slightly convex with its highest point at height of the spike. Around the spike is an undecorated area. At the decorative ribbon the disc flattens. The decorative band consists of a series of upright triangles whose tips point to the inside. Below are seven parallel lines and there is a series of triangles framed by two lines located between the next groups of parallel lines. The smooth edge of the narrow disc is slightly turned upwards. Opposite the spike at the back of the disc is an attached eyelet shaped out of a rather clumsily made pierced bridge.
Crafting technique: Lost-wax cast, the eyelet is formed in the model around a core, post-casting reworking (edge).

Vorup, Vejen herred, Ribe Amt
NM B6620-23
Aner and Kersten 1986: 84-85; Nørgaard 2011: 80-83
Found in burial mound
NBA II
Two arm rings, two neck collars, two belt plates
Figures: 4.032; 4.051
B6622a – Large **smooth neck collar** with two spiral series on the face side. The collar is exceptionally high and has a large diameter. The strong corrosion of the collar has badly damaged the decoration and the shape of the collar. The 22 evenly crafted and very large spirals are applied in two rows. The bottom row displays 13 spirals and the top row nine spirals. In between is a lenticular decorative ribbon. The outermost spirals of the lower ribbon combine both series without forming a peak. The spirals themselves are connected with double lines. The lenticular-shaped decorative ribbon in between the spiral rows is badly damaged. It probably consists of a ladder-like notched ribbon, a series of opposed triangle rows and another ladder-like notched ribbon. A row of standing triangles pointing into the undecorated space in the middle of this ribbon cannot be excluded (in contrast to the drawing in Aner and Kersten 1986). Accompanying the edge is another decorative ribbon that also frames the spiral-decoration. This ribbon is placed on the slightly outwardly curved hem and consists of a ladder-like notched ribbon, five parallel lines, a series of opposed triangle rows, another five parallel lines and a concluding ladder-like notched ribbon. This decorative ribbon continues into the end plates where it is cut off just before the end rolls by a triangular decorative element (facing towards the centre of the end plate). The decoration of the end plate consists of semi-circular line groups which are connected to the edge-accompanying ribbon and are applied alternatively vertically or horizontally. The arc groups consist of at least four raised parallel lines. The fields in between are deepened.
Crafting technique: Lost-wax with decoration (probably spiral-stamp), cold-working at the ends and reworking.
B6622b – Fragment of a **smooth neck collar** with two spiral series on the face side. The fragment shows a part of the decoration that is close to the end plate. Accompanying the edge is a decorative ribbon, consisting of a line, ladder-like notched ribbon (elongated hourglass-shaped notches), a series of opposed triangle rows, another ladder-like notched ribbon and a final line. Towards the edge this decorative strip is concluded by a narrow smooth hem. Within the thus-created frame is a broad, slightly pointed oval open field in which a spiral-decoration is inserted. The spirals are applied in two rows, one above the other and close to each other. The spirals increase in their size and coil number towards the centre. They are connected with double lines. The further decoration of the collar is unknown.
Crafting technique: Lost-wax cast with decoration, reworking of decoration.
B6623a – Small fragment of a **belt disc** with spiral-decoration. The plate is decorated with a series of connected spirals (probably 11 or 12 spirals). Around the spike (on the inside of the fragment can be detected an undecorated area which might be the spike's foot) and edge-accompanying is a decorative ribbon consisting of a ladder-like notched ribbon, four parallel lines and a ladder-like notched ribbon. Between the rounded edge of the disc and the outermost decorative band is an undecorated, slightly outwardly curved hem, *c.* 1 cm wide.
Crafting technique: Lost-wax cast with decoration (probably spiral-stamp), reworking.
B6623b – Small fragment of a **belt disc** with spiral-decoration. The plate is decorated with a series of connected spirals. Accompanying the edge, and only separated from the upwardly bent edge by a small hem, there is a decorative ribbon consisting of two deep, parallel lines, a ladder-like notched ribbon, four parallel lines and a further ladder-like notched ribbon. Towards the centre of the disc, surrounded by the spiral series is another decorative ribbon which is incomplete. It consists of a ladder-like notched ribbon, five parallel lines and a further ladder-like notched ribbon. The disc bulges out within its centre, so that the inner decoration might be around the spike.
Crafting technique: Lost-wax cast with decoration (probably spiral-stamp), reworking.

Vranum, Almind sogn, Viborg Amt
NM B7070-88
Broholm 1943: Nr. 695; Aner and Kersten 2008: 169-173; Nørgaard 2011: 48
Found within burial mound, secondary Burial D on stones
NBA II
Neck collar, five tutuli, belt plate, wool fabric, three arm rings, bracelet, four spiral finger rings, bronze fragments
Plate 32
B7071 – Well-preserved **neck collar** with nine ribs, triangular in cross-section. The ribs are decorated with slanted lenticular notches in a chessboard-pattern. Top and below the ribs is a slightly flared undecorated hem, the edges are broken. The ribs move with the shape of the collar, and are therefore narrower at the edge than in the middle. All ribs terminate

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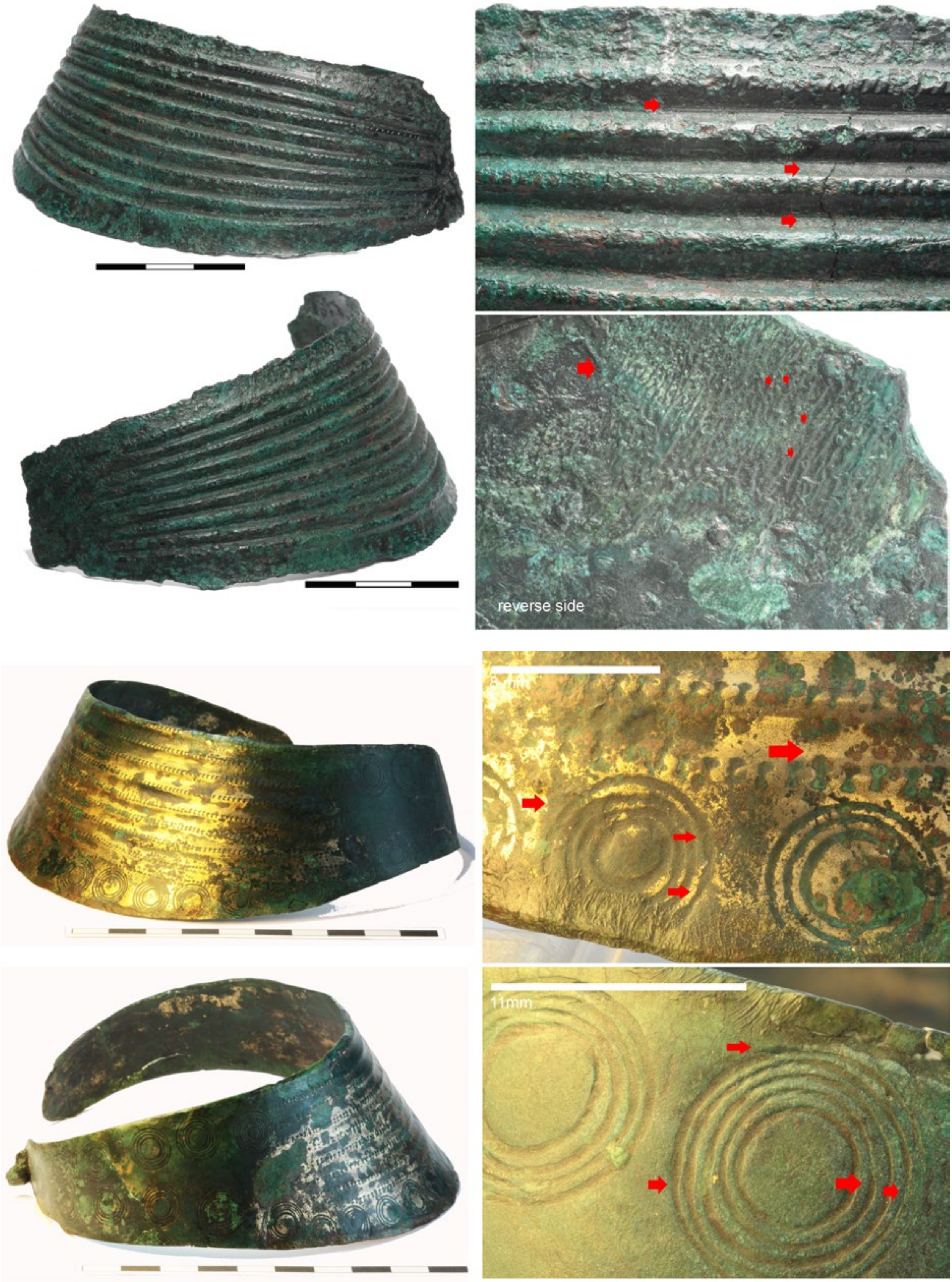

Plate 32:
1) Vranum, Almind, Viborg – neck collar NM B7071; 2) Wardböhmen (Hengstberg), Celle, Lower-Saxony – neck collar LMN 1159:76.

at the same height at the transition to the undecorated end plate. The end plates are only about one-third preserved. On the back of the collar scattered remnants of fabric are preserved under the corrosion.
Additional investigation: Photographic documentation of fabric residues under the patina.
Crafting technique: Lost-wax cast, post-casting cold-working of the hem.

Wardböhmen (Hengstberg), Celle, Lower Saxony

LMN 1159:76-1161:76
Laux 1971: 179ff.; Piesker 1958: 31. Nørgaard 2011: 56-58
Found in the 'Hengstberg' mound group, Mound 5, Grave 5
NBA II
Neck collar, 15 cone-shaped tutuli, five spiral rings, neck ring, spiral rolls, belt disc, disc-headed pin, two arm spirals, finger ring, leg spirals, leg rings, ring
Figures: 2.143; Plate 32
LMN 1159:76 – Very well-preserved **neck collar** with nine clearly separated ribs and a wide hem at the lower edge. The hem is decorated with concentric circle groups consisting of four rings around a large open middle. The size of the circle group increases to the sides. The ribs are decorated throughout with hourglass-shaped notches. At the transition to the end plate the ribs terminate almost all at one height, the bottom and top ribs run a little longer into the end plate. The wide end plate is decorated with concentric circle groups in two accompanying series. The bottom row is a continuation of the decorative ribbon on the hem, but varies considerably in size and consists of four (on the right side five) circle groups. The top row is at the upper three ribs and consist of four (on the right side five) circle groups. At the narrow end a single slightly smaller circle group combines the two rows. The closure was probably used in a hook-line principle, as it can be assumed from the bent end and two remains of holes.
Crafting technique: Lost-wax with additional post-casting decoration and reworking.
LMN 1161:76 – **Medium-sized belt disc** with small round spike and rearward eyelet. The disc has a relatively wide undecorated area around the spike, until a circulating decorative band of six parallel lines with adjacent hourglass punch lines. The area between the decorative band and the next decorative ribbon consisting of six parallel lines is decorated with a running series of 20 small spirals. The spirals are connected with double lines of different lengths. The spiral line that follows the decorative ribbon is made of 29 significantly larger spirals and is also connected with double lines. The spiral line is separated from the smooth undecorated hem by a decorative ribbon of seven parallel lines. The hem flattens off towards the end. The disc is slightly convex so that the entire rearward eyelet is covered by the disc. The eye is mounted approximately below the spike, slightly away from the centre.
Crafting technique: Probably cast in rough forms (plate), additional post-casting decoration and reworking.

Wardböhmen (Worbsloh), Celle, Lower Saxony

LMN 693:76
Laux 1971: 181; Nørgaard 2011: 546-58
Found in the 'Worbsloh' mound group, Mound 7, Grave 1
NBA II
Neck collar, bronze-sheet 'diadem', hook, two spiral rings, neck ring, wheel-headed pin, 70 cone-shaped tutuli, six bronze rolls, stud-bracelet, arm ring, leg ring, ceramics.
Plate 33
LMN 693:76 – The much-restored **neck collar** is only preserved in the original in a few places. Large parts are reconstructed and covered with modern working traces. The piece consists of eight well-marked ribs each of which is decorated with elongated notches. The decoration of the upper rib covers the whole edge and continues into the end plate. Under the lowest rib a smooth, wide hem is attached that bends outwards toward the edge. The hem continues directly into the undecorated end plate.
Crafting technique: Lost-wax cast (ribbed collar) post-casting decoration and cold-working.

Weitgendorf, Prignitz, Brandenburg

MM II 8269-8270
Kiekebusch 1929: 270; Nørgaard 2011: 58-62.
Found in 'Kegelgräberfeld 1', Mound X, from several burials
NBA III
Figures: 2.100; 4.033
MM II 8270 – **Neck collar** with three groups of two diagonally cut ribs. In the smooth fields in between each of the rib groups is a spiral series connected with dotted lines. Towards the end plate the spiral series ends in a framed in lines arch ribbon. This decorative ribbon terminates in five parallel curved lines which connect the rib groups. The ribbed section is separated from the end plate by a decorative ribbon of four parallel lines, a stacked arch ribbon and four parallel lines. The end plate is framed by a simple decorative ribbon of two parallel lines with a vertical line filling (ladder-like notched ribbon), which can be regarded as an extension of the top and bottom rib. Within this frame two rows of three spirals are placed, slightly increasing in their width. The spirals are connected with dotted lines.
Crafting technique: Lost-wax cast, heavily reworked.
MM II 8269 – **Neck collar** with three groups of notch-decorated ribs. The decoration consists of rib-accompanying decorative grooves which are connected by notches. A spiral series connected with dotted lines is located in the smooth fields in between the rib groups. Towards the end plate the spiral series ends in a framed in lines arch ribbon. This decorative ribbon terminates in four parallel curved lines which connect the innermost ribs. The ribbed section is separated from the end plate by a decorative ribbon of three parallel lines, a stacked arch ribbon and three parallel lines. The end plate is framed by parallel lines filled with a hatched line decoration. Within this frame two rows of three spirals are placed which are similar to those of the main field and connected with dotted lines. The last two spirals overlap slightly. A vertical decoration of a wide framed in lines arrow ribbon and parallel lines forms the transition between the decoration of the end plate and the end rolls.
Crafting technique: Lost-wax cast probably with decoration, reworking of decoration.

Weitgendorf, Prignitz, Brandenburg

MM II 8302
Kiekebusch 1929: 270; Nørgaard 2011: 58-62
Found in 'Kegelgräberfeld 1', Mound XVII, as central and very rich burial
NBA III
Neck collar, bronze pin, arm ring, gold spiral ring, arm spiral, leg spirals
Figures: 2.010; 2.086

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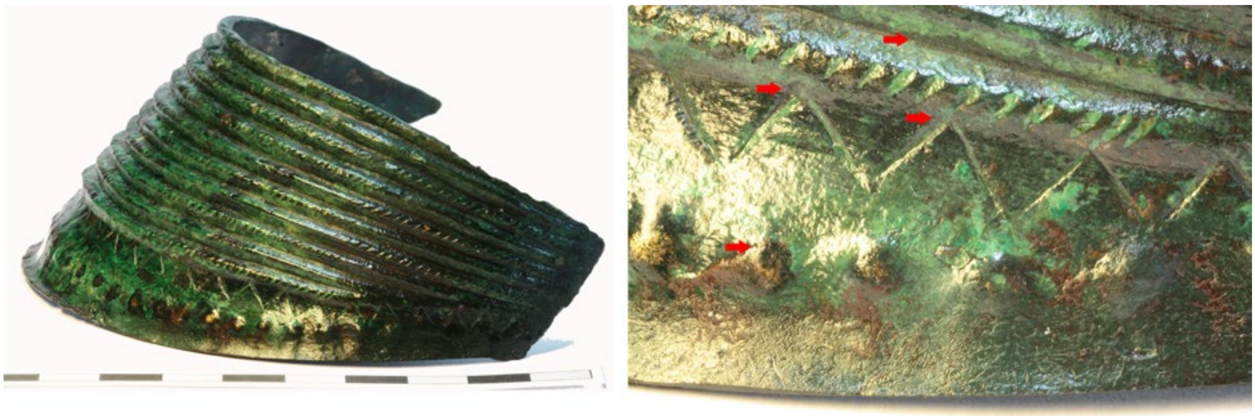

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Plate 33:
1) Wardböhmen (Worbsloh), Celle, Lower-Saxony – neck collar LMN 693:76; 2) Westerweyhe, Uelzen, Lower-Saxony – neck collar LMN 4930; 3) Westerweyhe, Uelzen, Lower-Saxony – stud-bracelet LMN 14164; 4) Wittenmoor (Grabow), Ludwigslust-Parchim (LUP), Mecklenburg – neck collar ALM LII Q,5.

MM II 8302 – **Neck collar** with three groups of notch-decorated ribs. The decoration consists of rib-accompanying decorative grooves, connected by notches. A spiral series connected with dotted lines is located in the smooth fields in between the rib groups. Towards the end plate the spiral series ends in a framed in lines arch ribbon. The pairs of ribs are connected by four parallel curved lines. The ribbed section is separated from the end plate by a decorative ribbon of four parallel lines, a stacked arch ribbon (almost arrows) and four parallel lines. The end plate is framed by arch ribbons framed in lines. Within this frame two rows of three spirals are placed, which are similar to those of the main field and connected with dotted lines. Towards the end rolls another decorative ribbon consisting of parallel lines and an arch ribbon is attached. Within the ribbed section of the collar an area which has been changed by subsequent heat can be detected (probably reparation).
Crafting technique: Lost-wax cast with decoration (spiral-stamp), reworking of decoration and probably reparation through cast-on.

Werder, Zauch-Belzig, Brandenburg
MM II 6284
Bohm 1935: 135; Horst 1966; Sommerfeld 1994: 365; Nørgaard 2011: 62-64
Hoard in bronze vessel
NBA III
Bronze vessel, neck collar, bronze pin (several?), sickle (several?), arm spiral, arm ring (several?), flanged axe, fibula
Figures: 3.007
MM II 6284 – **Neck collar** with three groups of two slightly pronounced and weakly rounded ribs. In the broad and deep rib-valley between the ribs is a decorative dotted line at the lowest point. The two smooth fields in between the rib groups are decorated each with a spiral series. The spirals are connected by dotted lines. At the transition from the ribbed section to the end plates is a vertical decorative ribbon consisting of a weak dotted line. The end plate is decorated with two very large spirals. The spirals are framed in an accompanying dotted line.
Crafting technique: Lost-wax cast, partly post-casting decoration.

Weisin, Ludwigslust-Parchim (LUP) (alt: Lübz), Mecklenburg
ALM 2193 -2195
Schubart 1972: 171; Nørgaard 2011: 58-62
Within the 'Tannenkamp' burial mounds, Mound II, with stone circle
NBA III
Two arm rings, two twisted neck rings, neck collar, bronze Weitgendorf-type pin, ceramics
Figures: 1.040; 2.081; 2.095; 2.116
ALM 2195 – Fragment of the front part of a **spiral-decorated neck collar**. The fragment shows four complete and two half spirals out of the series that is placed within the lower field between two sets of ribs. There are more residues of spirals visible in the upper field. The uniform spirals are connected with dot lines. The whole fragment is covered with a bluish patina. A weak notch trim is applied onto the rounded ribs.
Crafting technique: Lost-wax cast with decoration, slight reworking.
ALM 2196a – A large **Weitgendorf-type pin** with flat, about 3 mm thick, top plate. Just below the top plate, at the connection to the shaft, an irregular perforation is detectable. The 45 cm long needle shaft is decorated with seven groups of lenticular shaped beads within the first 10 cm. The first three groups consist each of three lenses, followed by a group of six rather irregular lenses, and following again three groups each of three lenses. Between these groups, the shaft displays a uniform diameter which only slightly decreases towards the end. Close towards the lower end of the shaft an irregular notch is visible. This, together with the hole under the top plate, was probably constructed as a pin attachment.
Crafting technique: Possibly cast in a two-part mould (sand or clay), model formed of two parts (head and shaft), heavily cold-worked shaft.

Weisin, Ludwigslust-Parchim (LUP) (alt: Lübz), Mecklenburg
ALM 2197-2199
Schubart 1972: 171; Nørgaard 2011: 58-62
Within the 'Tannenkamp' burial mounds, Mound III, with stone circle
NBA III
Neck collar, leg spirals, two arm rings
Figures: 4.009
ALM 2199 – Almost complete **neck collar** with three groups of two notch-decorated ribs (the shape of the notches is not clearly identifiable). The right end plate is not preserved. In the free areas between the rib groups one spiral series connected with dotted lines is placed in each field. Towards the end plate the spiral series ends in an arrow ribbon. The rib groups are connected with each other by three parallel semi-circular arches. The end plate is framed by parallel lines and arrow tapes. Within this frame are two rows of three connected spirals, the connections consist of dotted lines. The end rolls have not survived. The entire collar is covered by a thick patina and details are hardly recognisable.
Crafting technique: Lost-wax cast with decoration, slight reworking.
ALM 2185 – Very well-preserved **large leg ring** with spiral ends ('Fussberge') with two large spirals equal in diameter. The spirals consist of nine and ten turns, the wire diameter increases towards the outside. The decoration of the spirals begins in the middle of the fourth turn as a uniform incision pattern. From the fifth turn the notches occur as groups of four notches and in between the undecorated areas. The last turn (the one with the largest diameter) is decorated with groups of four lines, and an intermediate ladder-like notched ribbon. This pattern extends to the connecting bracket between the spirals. The flattened (oval in cross-section) bar is decorated with oblique ladder-like notched ribbons and parallel lines.
Crafting technique: Probably forged from an ingot, decorated with chisel-like tools and heavily reworked.
ALM 2197 – Very well-preserved **large leg ring** with spiral ends ('Fussberge') with two large spirals equal in diameter. The spirals consist of nine turns, the wire diameter increases towards the outside. The decoration of the spirals begins in the middle of the fourth turn as a uniform incision pattern. From the fifth turn the notches occur as groups of four notches and in between the undecorated areas. The last turn (the one with the largest diameter) is decorated with groups of four lines, and an intermediate ladder-like notched ribbon. This pattern extends to the connecting bracket between the spirals. The flattened (oval in cross-section) bar is decorated with oblique ladder-like notched ribbons and parallel lines.

Crafting technique: Probably forged from an ingot, decorated with chisel-like tools and heavily reworked.

Westerweyhe, Uelzen, Lower Saxony
LMN 4930, LMN 12018, LMN 14164
Laux 1971: 266; Nørgaard 2011: 56-58
Found in burial mound, female burial. Includes the wheel-headed pin (LMN 12018) which is incorrectly (after Laux 1971) labelled 'im Lüneburgischen'.
NBA II
Neck collar, wheel-headed pin, stud-bracelet, leg spirals
Figures: 2.053; Plate 33
LMN 4930 – **Neck collar** with ten distinctly pronounced, triangular in cross-section ribs, decorated with a chessboard-pattern notch-ornament. The notched-decoration is spacious and the notches tend to the left. Below the lowest rib is a smooth hem, decorated with humps and a triangle strip. The decorative strip of hanging triangles is not raised, but consists of depressions that are placed directly under the lowermost rib and bounded by two lines. The ribs follow the shape of the upper edge-accompanying rib except for the lowermost rib. Accordingly, this rib is slightly shortened and unites with the second-last rib approximately before it ends equal with the other ribs at the transition to the end plate. The triangular decoration continues even after the connection of the two ribs and ends at the same height as the ribs. Running parallel to this the hump series consists of about 30 small egg-shaped humps and ends similar to the lowest rib. The hump series does not run parallel to the edge of the hem. Thus, a broader central region can be traced before the hem ends in a slight outward curve. The end plates are broken and undecorated. The whole collar is heavily restored and the surface is partially modified through the paint.
Additional investigation: Metallography (Fig. 2.134; Nørgaard 2015b):
Sampled at the transition to end, near the upper ribs. Microstructure towards the centre displays regular grains (larger), <delta>-phase, annealing twins, deformed copper-sulfide inclusions. Microstructure near the surface shows strain lines (several systems), annealing twins (several generations), small grains, cuprite (corrosion) and deformed copper-sulfide inclusions. Trace elemental data is presented in Table 3.
Crafting technique: Lost-wax, additional post-casting decoration (bulges and triangle) and reworking. The sample shows a fully recrystallized microstructure with annealing twins indicating several annealing phases. The slight difference in grain size is due to an increasing strength of cold-work towards the end. It seems as if the edge-accompanying decoration is added post-casting. Final cold-work is indicated by strain lines.
LMN 12018 – The **wheel-headed pin** is preserved only in fragments and heavily patinated, so the details of the design are not recognisable. The rest of the shaft has a slightly oval cross-section and has a flat oval shape towards the needle head. At the transition to the pin head the shaft is broadened. The head consists of a ring of three slightly elongated rounded ribs. Centrally in the hollow space is a cross of bars triangular in cross-section. The cross is only partially preserved. At the top of the pin head are three eyelets attached to the circle of ribs, one at the middle, and one on the right and left of it. Only the right of the eyelets is completely preserved, the others are broken at the weakest point of the bar.
Additional investigation: Metallography (Fig. 2.127; Nørgaard 2015b):
Sampled at the head, near rib circle. Microstructure in the sample centre displays Cu-rich-dendrites, small <delta>-phase, copper-sulfide, small shrink-holes. Microstructure near the surface shows more regularly formed grains, strain lines, cuprite (mostly within the corroded area), copper-sulfide, <delta>-phase. Trace elemental data is presented in Table 3.
Crafting technique: Cast in open mould with post-casting cold-working (shaft). As-cast microstructure of the wheel-head has partly recrystallized sections (probably due to the annealing of the pin shaft). Strain lines indicate a moderate amount of final cold-work at the surface.
LMN 14164 – The heavily restored and partially reconstructed **stud-bracelet** consists of seven, clearly separated, triangular in cross-section ribs. Towards the ends the bracelet tapers. The ribs become narrower towards the end and terminate all on one level just before a smooth undecorated end button (a slightly broadened roundish end part of the bracelet). The ends are slightly bent outward and the bracelet is slightly oval.
Crafting technique: Lost-wax, post-casting reworking.

Wildberg, Ruppin, Brandenburg
MM II 4381
Nørgaard 2011: 62-64
Unknown
NBA III
Figures: 3.007
MM II 4381 – Well-preserved **neck collar** with round edge-accompanying ribs and two central ribs. The rib-decoration is formed of dotted lines on the foot of the slope on both sides of the rib. These puncture rows are connected with notches over the back of the rib. In the rib-valley of the pair of ribs, a dotted line is placed at the lowest point. The smooth fields in between the rib groups are decorated each with a spiral series (above seven and at the bottom eight spirals). The pair of ribs in the middle of the collar is terminated at the transition to the end plate by a large spiral that is part of the end decoration. This spiral is probably associated with a further smaller spiral. The end plates are only rudimentarily preserved on both sides. The rest of a decorative edge-accompanying frame shows a ladder-like notched ribbon, which arises from the top rib, and a parallel notched ribbon of hourglass-shaped notches.
Crafting technique: Lost-wax cast with decoration (perhaps spiral-stamp), partly post-casting decoration or heavy reworking.

Wittenmoor (Grabow), Ludwigslust-Parchim (LUP), Mecklenburg
ALM L II Q,5
Schubart 1972: 182; Nørgaard 2011: 58-61
Unknown
NBA III
Plate 33
ALM L II Q,5 – Six fragments of probably one and the same **neck collar**. The material thickness of the collar is very thin and it displays the typical elements of a Mecklenburg-type neck collar. The three groups of two ribs are made of round curvatures (very weak ribs). In the valleys are stacked arrow-like notches. The spirals are of different quality and different depths, its centre is sometimes tightly wound and sometimes fanned out. The connecting lines consisting of punctures are barely recognisable. The existing fragments of the end plate

suggest that the same is framed in a decorative ribbon of oblique notches. The ribbed section is separated from the end plate by a vertical decorative ribbon of three parallel lines, a stacked arrow ribbon or stacked arches and three lines. Towards the non-preserved end rolls is a decorative ribbon of three parallel lines, a stacked arrow ribbon or stacked arches, three lines, stacked arrow ribbon and final lines.
Crafting technique: Lost-wax cast with rib-decoration, post-casting spiral-decoration.

Wotenitz, Nordwestmecklenburg (NMW), Mecklenburg
ALM 3374a
Schubart 1972: 175; Nørgaard 2011: 39-40
Hoard
NBA II
Eight tutuli, neck collar
Plate 34
ALM 3374a – **Neck collar** with nine flattened rounded ribs. The decoration of the ribs is only faintly visible and consisted of fairly uniform notches which develop into cuts in different sizes towards the edge. On the right side between the fifth and sixth rib there is a hole 4 mm wide. Its edges are partly rounded. The 'hole' is slightly triangular in shape and appears to have been introduced by semi-circular devices. At the interfaces of the semi-circular tool, cracks in the metal are visible. The end decoration is barely visible; however, a separation of the ends by a decorative band of parallel lines and triangle strips (?) can be inferred. Between two such bands are probably six vertically and horizontally merged spirals.
Additional investigation: Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017; 2015a).
Crafting technique: Lost-wax cast with post-casting decoration.

Wozinkel, Ludwigslust-Parchim (LUP), Mecklenburg
ALM 4124
Schubart 1972: 176; Nørgaard 2011: 58-62
Found in a burial mound, with inhumation
NBA III
Bones and teeth, neck collar, twisted neck ring, open arm ring.
Plate 34
ALM 4124 – **Neck collar** with three groups of two ribs and intervening smooth, spiral-decorated areas. The collar is partly damaged by patina. The ribs are edge-accompanying and decorated with incisions. In each of the smooth fields is a spiral series of ten spirals, connected with dotted lines. The spirals increase towards the centre in their size and number of turns. The spiral series are terminated by four superimposed curved lines which connect the innermost ribs. From the last spiral down to the arch frame runs a framed in lines arch ribbon. A vertical decorative ribbon of three parallel lines, a framed in lines arch ribbon, and four parallel lines separates the ribbed section from the decoration of the end plate. The end plate is decorated with two rows each of three spirals, connected by dotted lines. The last spirals of each horizontal row are also vertically connected towards the end rolls. The vertical decorative ribbon towards the end rolls consists of four parallel lines, a framed in lines arch ribbon (double on the left side). The decoration of the end plates is not identical. On the right end plate the parallel lines in the vertical decoration are missing towards the spiral side. Parts of the end rolls are preserved. On the back there are visible remains of a patinated fabric.
Additional investigation: Photographic documentation of fabric residues under the patina. Trace elemental analysis via hhXRF, data shown in Table 3 (Nørgaard 2017; 2015a).
Crafting technique: Lost-wax cast, probably with part of the decoration, partly post-casting decoration.

Zeestow, Westhavelland, Brandenburg
MM II 10301
Bohm 1935: 141; Nørgaard 2011: 58-62 (probably wrong formal typological classification)
Unknown
NBA II/III
Plate 34
MM II 10301 – Well-preserved **neck collar** with three groups of three ribs and intermediate smooth areas. The ribs terminate at the same height at the transition to the end plate. The smooth fields are narrower towards the end, so that the ribs almost meet. The ribs are, respectively from the outermost rib of every group consistently decorated with an oblique notch-decoration. In the smooth fields a weakly recognisable decoration consisting of stacked arches (similar to a wolf-tooth pattern) is applied, which run parallel to the field-limiting ribs. There are around 24 arch groups in each row with stacks of three (at the sides), and four (in the middle). The entire collar is covered with a blooming patina. The end plates appear undecorated.
Crafting technique: Lost-wax cast with rib-decoration, post-casting arch-decoration.

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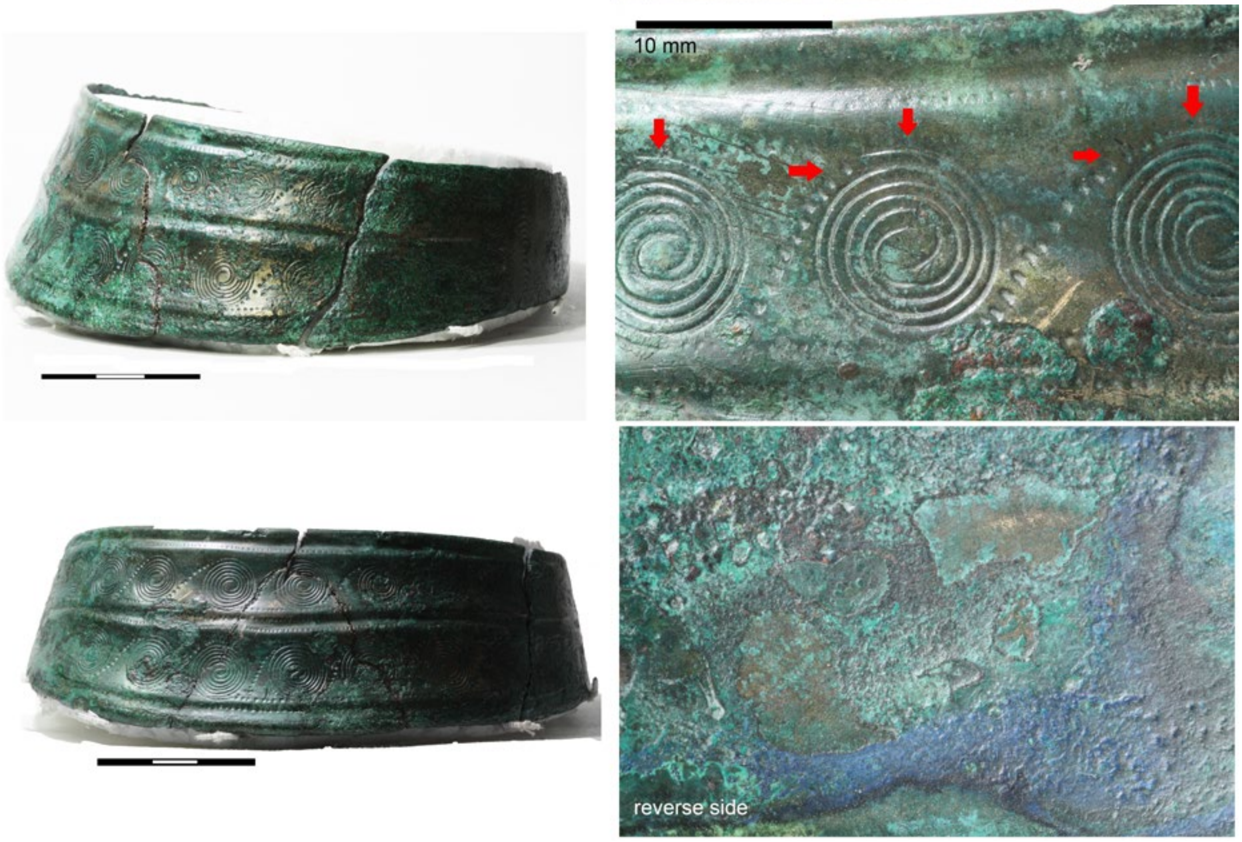

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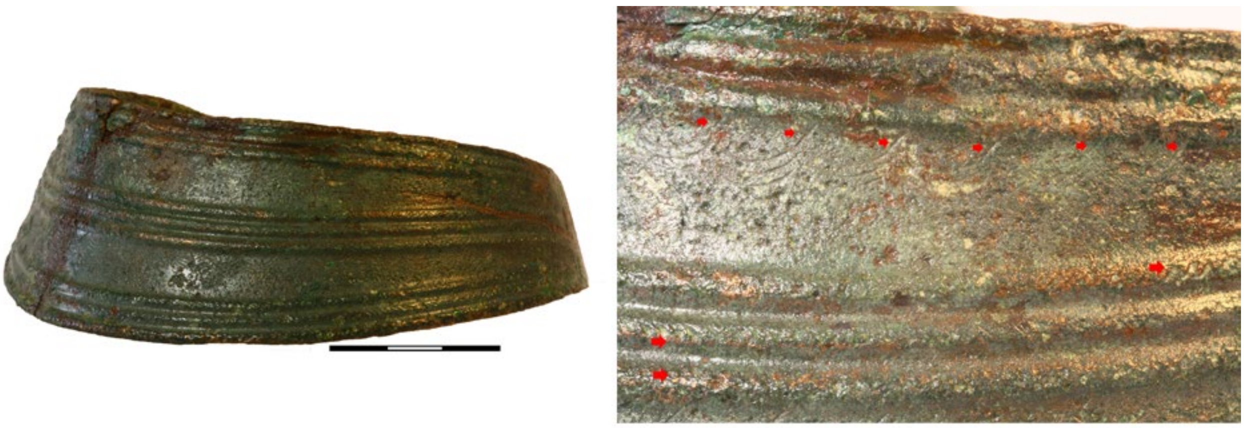

Plate 34:
1) Wotenitz, Nordwestmecklenburg (NMW), Mecklenburg – neck collar ALM 3374a; 2) Wozinkel, Ludwigslust-Parchim (LUP), Mecklenburg – neck collar ALM 4124; 3) Zeestow, Westhavelland, Brandenburg – neck collar MM II10301.

Table 1: Morphological data

museums number	location	context	object	object type	period	weight g	height cm	length cm	width cm	diameter cm	thickness mm	spike lenghth	rib number	spiral diameter in mm	cicle diameter in mm
ALM 2303	Alt Sammit, Rostock	cremation	neck collar	Mecklenburg	3	117,1	4,86			11,1; 12,35	1		6	7,8 - 10,8; 6,3 - 8,8; 8,2	
ALM 2300	Alt Samnit, Rostock, Mecklenburg	cremation	knive	ringknive	3			6,1	1,05	2.2					
LMN 13174	Amelinghausen, Lüneburg, Niedersachsen	burial	belt disc	Ifa	2	16,5	0,5			5,69	0.7				
LMN 13176	Amelinghausen, Lüneburg, Niedersachsen	burial	arm ring		2	30,4			0,57	7,95; 5,01	3.5				
LMN 13178	Amelinghausen, Lüneburg, Niedersachsen	burial	arm ring	studbracelet	2	28	3,3			6.2	1.2		9		
LMN 13177 (13179)	Amellinghausen, Lüneburg, Niedersachsen	burial	neck collar	Quarrendorf	2	66	5,35	13,3	5,35	oA; 13,3	0.9		6	14,2; 13,7; 12,7; 9,2	
ALM LIH16	Amt (municipality) Grabow, Ludwigslust - Parchim, Mecklenburg	burial	belt plate	IIB2	2	121	4,5			16,1	1.1	ca. 3,5 cm		12,4; 12,6; 12,8; 13,3; 14,2; 14,7	
NM B996	Annebjerg Skov, Højby, Holbæk	bog find	neck collar	Paatorp	2	8,4	3,11	6,33			1			6,6; 8,7	
NM B997	Annebjerg Skov, Højby, Holbæk	bog find	belt plate	IIb2	2	339				17,4	1.7	4,45 cm		12,3 - 14,1; 19,4 - 20,1	
NM B1000	Annebjerg Skov, Højby, Holbæk	bog find	tutuli round	Iva	2	42,1	2,25			5,63	0.7	2,25 cm			
NM B995	Annebjerg Skov, Højby, Holbæk	bog find	neck collar	Svenstrup	2	237,9	7,31		4,9	10,33; 14,4	2		18	11,4; 12,2; 12,8	
NM Z672	Annisse, Holbo, Frederiksborg	cremation	neck collar	Sibberup	2	27	6,4	6,07	4,89		1,2				6,8 - 8,1
LMN 14082	Appel, Harburg, Niedersachsen	hoard	belt disc	Ia	2	40,4				7,47	1	broken			
LMN 4769	Appel, Harburg, Niedersachsen	hoard	belt disc	IE1	2	29,3	1,5			6,41	0.7	0,84 cm			
LMN 4770	Appel, Harburg, Niedersachsen	hoard	belt disc	IE1	2	22,2	1,5			6,04	0.9	0,86 cm			
LMN 4771	Appel, Harburg, Niedersachsen	hoard	belt disc	IE1	2	26,5	1,45			5,65	0.8	0,72 cm			
AM 2330 (g)	Assing (sn), Hammerum, Ringkøping	burial	belt disc	Ib	2	oA	1			9,56	1			11,9 - 12,3	
FHM 2330 (h)	Assing (sn), Hammerum, Ringkøping	burial	neck collar	Hedvigsdahl	2	29,4	4,08	10,7	2,74		1.16			10,4 - 12,3	
NM B11391	Bagsværd, Gladsakse, København	burial	neck collar	Melby	2		6,18		3,6	11,5; 18	1.4		9		
AM 5171	Ballemose, Balle, Viborg	bog find	neck collar	Drage	2		4,51			9,9; 10,8	0.8		7		
LMN 1026:76	Becklingen, Celle, Niedersachsen	burial	neck collar	Hollenstedt	2	69,9	4,6		2,76	10,7; 12,3	1.3		10		
LMN 1032:76a	Becklingen, Celle, Niedersachsen	burial	disc	V1a5	2	17,9	0,95			6,07	1.1	0,75 cm	5		
LMN 1032:76b	Becklingen, Celle, Niedersachsen	burial	disc	V1a5	2	10,7	0,92			5,88	1.1	0,76 cm	5		
LMN 1033:76	Becklingen, Celle, Niedersachsen	burial	disc	V1a5	2	20,2	0,76			6,12	1.1	0,76 cm	5		
LMN 13135a	Becklingen, Celle, Niedersachsen	burial	neck collar	Rehlingen	2	52,8	4,48		2,56	10,7; 12,1	1.2		8		
LMN 13135b	Becklingen, Celle, Niedersachsen	inhumation	neck collar	Mistorf	2	34,7	3,66	7,38	2,3		1,9		7		
LMN 13135c	Becklingen, Celle, Niedersachsen	burial	neck collar	Rehlingen	2	14,9	3,92	5,54	3,92		1.6		8		
NM B1568	Bidstrup, Jørgens, København	inhumation	neck collar	Seeland	2	86,1	4,12		2,92	10,5; 12,5	1.1		9		
LMN 953:76	Bleckmar, Celle, Niedersachsen	inhumation	neck collar	Rehlingen	2	96,8	4,71		2,3	10,9; 11,7	2.4		8 (9)		
LMN K851:76	Bleckmar, Celle, Niedersachsen	inhumation	neck collar	Rehlingen	2	21,5	2,55	4,5	2,24	9,8; 10,3	1.5		6		
ALM Br. 281	Boldebuck, Rostock, Mecklenburg	cremation	tutuli	IIIa3	3	31,3	3,2			4,85	2	3,2 cm			
ALM Br. 284	Boldebuck, Rostock, Mecklenburg	cremation	tutuli	IIIa3	3	16,7	1,26			3,5		broken			
ALM Br. 285	Boldebuck, Rostock, Mecklenburg	cremation	tutuli	IIIa3	3	21	3,1			3,24		ca. 2,1 cm			
ALM Br. 271	Boldebuck, Rostock, Mecklenburg	cremation	neck collar	Mecklenburg	3	158,8	4,66		3,12	10,55; 12,04	2.5		6	not measured	
NM B2884	Bornholm, unknown location	burial	neck collar	Krasmose	3	165,7	6,6		3/ 12,97	12,97; 19,3	0.8			10,8 - 11,4	4.8
NM B2885	Bornholm, unknown location	burial	fibula	Bornholmer Typ	3	37,7		12,7	7,18		1			7,1; 7,5; 8,2; 9,5	
KS 8021b	Bornhöved, Segeberg, Schleswig - Holstein	cremation	neck collar	Pisede	2	62,0	5,11		3,88/ 10,62	10,62; 12,0	1.2		5		
NM B4351	Bragergården, Ørslev, Præsto	inhumation	neck collar	Svenstrup	3a	205,5	6,2		4,0	11,4; 15,94	1.7		20		6,1 - 6,4
NM B4357	Bragergården, Ørslev, Præsto	inhumation	tutuli	IIIa4	3a	32,3	4,22			5,02; 2,15	1.8	2,98 cm	12		
KS 12149	Bredenbeck (ehem. Kronsburg), Rendsburg, Schleswig - Holstein	burial	neck collar	Rehlingen	2	69,8	4,61		2,46	9,23; 10,4	1.7		10		
ALM Br. 733	Bredentin, Rostock, Mecklenburg	inhumation	neck collar	Mecklenburg (?)	3										
ALM Br. 738ab	Bredentin, Rostock, Mecklenburg	inhumation	spiral legring		3										
ALM Br. 741	Bredentin, Rostock, Mecklenburg	inhumation	pin	Weitgendorf	3										
NM B3486	Bringe, Værlose, København	bog find	neck collar	Øresund	2	265,4	8,61		5,07	12,2; 17,4	0.9		18	8,8 - 9,7	
NM B13888	Brøndbyvester (sogn), København	inhumation	neck collar	København	2	oA	4,2	7,4	3,1		not measured		9	9	
NM B11250	Bustrup, Ramsig, Viborg	cremation	neck collar	Pisede	3	58,5	4,07		1,75	10; 11,51	1.1		4		
NM B11252	Bustrup, Ramsing, Viborg	cremation	tutuli	IIIa3	3	25,6	4			5,22	2.2	3,8 cm			
LMN 5552	Bülkau, Hadeln, Niedersachsen	bog find	neck collar	Bütow	2	104,3	5,0		1,96/ 13,8	13,8; 15,1	1.1		17		
ALM Br. 1204	Bütow, Mecklenburgische Seenplatte (MES), Mecklenburg	burial	neck collar	Bütow	2	131,8	4,17		2,84	9,92; 12,4	1.33		9		
ALM Br.239	Dabel, Sternberg, Mecklenburg	burial	belt disc	Ie2	2	47,5	1,81			8,38	1.6	1,65 cm			

museums number	location	context	object	object type	period	weight g	height cm	length cm	width cm	diameter cm	thickness mm	spike lenghth	rib number	spiral diameter in mm	cicle diameter in mm
MM IIa507a	Damerow, Uecker - Randow, Mecklenburg	hoard	neck collar	Mecklenburg	3				3,26/ 10,4	10,4			6		
KS 6976c	Drage, Steinburg, Schleswig - Holstein	inhumation	neck collar	Drage	2a	61	4,54		2,39	9,4; 10,7	1.2		6		
KS 6976g	Drage, Steinburg, Schleswig - Holstein	inhumation	tutuli round	IV b	2a	22,3	1,62			5,69; 3,06	1.37	1,29 cm			
KS 6976gg	Drage, Steinburg, Schleswig - Holstein	inhumation	tutuli round	IV b	2a	23	1,66			5,74; 3,06	1.23	1,43 cm			
LMN 14144 (1)	Edendorf, Uelzen, Niedersachsen	burial	neck collar	Hollenstedt	2	17,3	3,77	5,5	3,77		1.8		6		
LMN 14144 (2)	Edendorf, Uelzen, Niedersachsen	burial	neck collar	Hollenstedt	2	16,2	4,25	7,95	3,1		1.2		6		10.7
LMN 14145	Edendorf, Uelzen, Niedersachsen	single find	neck collar	simple ribbed	2	34,4	4,2	6,65	4,2		1.7		11		
LMN 5027	Edendorf, Uelzen, Niedrsachsen	inhumation	Radpin	double wheel Typ Netrae	2		15	7,3		5,8	3		1		
ML SLg. Becker	Ehlbeck, Lüneburg, Niedersachsen	inhumation	neck collar	Hollenstedt	2	66,8	5,0		3,75	9,3; 12,5	1.54		8	11 - 13,5	
ML Slg. Becker	Ehlbeck, Lüneburg, Niedersachsen	inhumation	pin	disc head	2	49,4	16,8	14,8		4,8	2.2			8,4 - 8,9	9.6
ML 884	Eitzen, Uelzen, Niedersachsen	burial	neck collar	Rehlingen	2	81,2	4,1		2,7	9,3; 11,8	1,6		7		
NM B11964	Estrup, Ringsted, Sorø	burial	tutuli	IIIa3a	3	25,4	3,4			6,09	1.6	3,24 cm			
NM B11969	Estrup, Ringsted, Sorø	burial	neck collar	København KK	3	158,7	6,36			11,33; 14,7	1.2		20		7,1/ 7,9
NM B11957	Estrup, Ringsted . Sorø	inhumation	neck collar	Mistorf	2	26	3,58	8,08			1.4		8		
ML H55	Eyendorf, Harburg, Niedersachsen	burial	belt plate	IIB2	2	56	1,92			12,4	0.98	1,15		7,3; 8,2; 8,5; 9,8	
NM B4237	Ferslev „Dansehøj", Frederiksborg	inhumation	neck collar	Svenstrup	2b	121,7	5,55		3,61	9,92; 12,1	1.2		14	7,6; 9,4; 9,6; 10	
NM B4238	Ferslev „Dansehøj", Frederiksborg,	inhumation	tutuli	IIIb1	2b	12,1	1,5			4,18	0.9	1,5 cm			
CMXIV	Frankerup, Eggeslevmagle, Sorø	bog find	neck collar	Frankerup	2	211,44	7,11		4,45	11,24; 14,6			13	11,6 - 13	
NM CMXII	Frankerup, Eggeslevmagle, Sorø	bog find	belt plate	IIb3	2	383,28	6,25			22,98	0.5	5,75 cm		12; 15; 22,1	
NM CMXIII	Frankerup, Eggeslevmagle, Sorø	bog find	belt plate	IIb3	2	357,12	5,03			23,8	0.4	4,63 cm	4(6)	10,6; 15,6; 21,5	
ALM Br. 149.17	Friedrichsruhe, Ludwigslust - Parchim, Mecklenburg	burial	neck collar	Mecklenburg	3	110,5	4,5		3,1/ 10,03	10,03; 11,8	1.6		6	7,9; 9; 10,4; 12,4; 12,9	
ALM Br. 149.25	Friedrichsruhe, Ludwigslust - Parchim, Mecklenburg	cremation	neck collar	Pisede	3	131,6	4,40		3,04/ 10,75	10,75; 12,08	1.8		6	8	
ALM 26	unknown location, Mecklenburg	single find	neck collar	Mecklenburg	3	47,2	4,42	9,39	3,22		1.6		6	10; 10,5; 10,8; 11,3	
ALM LIIQ,8	unknown location, mecklenburg	single find	neck collar	Mecklenburg	3	87,8	4,63	6,61	3,4		1.6		6	9; 10,5; 11,2	
ALM S6	unknown location, Mecklenburg	single find	neck collar	Seeland	2	121,1	4,89		3,05	11,4; 13,39	1.5		9		
NM B11458	Gerdrup, Kirkerup, København,	inhumation	neck collar	Sonnerup	2	oA	4,8		3,27	10,1; 11	0.9			8,2; 9,2; 10,6	9,3; 9,6; 10,1
NM B11459	Gerdrup, Kirkerup, København,	inhumation	belt disc	IIb2	2	54	4,52 cm			7,95	1.34	4,52 cm		12,1; 12,5; 13; 13,4	
NM B11459 - 2	Gerdrup, Kirkerup, København,	inhumation	belt plate	IIb2	2	27,2	3,49	4,1	3,76		1.3	3,49 cm		not measured	
ALM IV/64/561c	Gielow, Mecklenburgische Seenplatte (MES), Mecklenburg	burial	arm ring	6	3	36,9	6,9		1,23	6,9	2.56				
ALM IV/64/561d	Gielow, Mecklenburgische Seenplatte (MES), Mecklenburg	burial	arm ring	6	3	50	7,6		1,26	7,6	4				
WAIV/64/561b	Gielow, Mecklenburgische Seenplatte (MES), Mecklenburg	burial	neck collar	Pisede	3	119,9	4,47		3,13/ 11,4	11,4; 13,2	1.3		6		
NM B13259	Gjedsted „Hverrehus", Viborg	inhumation	neck collar	Krasmose	2	61,7	5,58		3,51/ 11,8	11,8; 15,8	1.16			7,6 - 9,2	
NM B13260	Gjedsted „Hverrehus", Viborg	inhumation	belt plate	IIb3	2	354,4	5,5			22,2; 2,07	1.15	3,46 cm		12,5 - 13,8; 11,7 - 12,3; 10,2 - 12	
NM B9530	Glæsborg, Nørre, Randers	hoard	belt plate	IIb3	2		4			23,46	0.7	3,3 cm		11,4; 15,4; 18,7	
NM B9531	Glæsborg, Nørre, Randers	hoard	neck collar	Frankerup	2	88,01	4,18	6,54	3,1	8,27; 11,8	1.7		9	9,7; 10,7	
NM B9532	Glæsborg, Nørre, Randers	hoard	neck collar	Frankerup	2	35,41	4,3	10,3	2,59	oA	1.2		9	7.9	
NM B9534	Glæsborg, Nørre, Randers	hoard	belt disc	Ib	2	30,76	1,24			7,77	0.8	1,24 cm		11,7 - 14,7	
NM B9535a	Glæsborg, Nørre, Randers	hoard	tutuli	Ig	2	16,27	1,42			5,61	0.9	1,32 cm			
NM B9535b	Glæsborg, Nørre, Randers	hoard	tutuli	Ig	2	18,85	1,6			5,88	0.9	1,5 cm			
NM B9542	Glæsborg, Nørre, Randers	hoard	belt disc	Ic/d	2	9,98	0,89			4,6	0.3	0,85 cm			7,5 - 7,9
LMN 4753	Gollern, Uelzen, Niedersachsen	burial	belt plate	IIB2	2	121,3	1,15			13	1.3	1,08 cm		6,4; 6,8; 7; 7,6	
KS B145 - 1a	Handewitt, Flensburg, Schleswig - Holstein	cremation	neck collar	Traisbach	3	130,6	5,03		3,06/ 10,12	10,12; 11,95	1.78		6		
KS B145 - 1b	Handewitt, Flensburg, Schleswig - Holstein	cremation	tutuli	IIIa4	3	62,6	5,03	3,03		7,16; 1,84	1.78	3,03 cm	12		
HH 62886	Harburg, Harburg, Niedersachsen	burial	neck collar	Rehlingen	2	4,8	2,32	3,65	2,32		1.9		6 (?)		
ML 46	Heidekreis (vermutl. Behringen, Soltau), unknown location, Niedersachsen	burial	neck collar	Ebertshausen (!)	2	74,3	4,94		2,4/ 9,66	9,66; 11,1	1.4		7		
HH 63928	Heidenau, Harburg, Niedersachsen	inhumation	neck collar	Heidenau	2	89,5	4,88		3,2	10; 12,1			7		
HH 63931	Heidenau, Harburg, Niedersachsen	inhumation	pin	wheel head pin sceme A	2			6,36	0,74	4,04; 2,41			3		
ALM 7236a	Heinrichswalde, Ludwigslust, Mecklenburg	hoard	neck collar	Mistorf	2	80,5	4,33		2,69	10,18; 12,2	1		9		
ALM 7236b	Heinrichswalde, Ludwigslust, Mecklenburg	hoard	pin	disc head	2	41,5	23,2	14,9	0,58	9,5	3.3				

museums number	location	context	object	object type	period	weight g	height cm	length cm	width cm	diameter cm	thickness mm	spike lenghth	rib number	spiral diameter in mm	cicle diameter in mm
LMN 137:81	Heitbrack, Uelzen, Niedersachsen	hoard	pin	disc head	2	59,6	24	14,9 cm		9.1	1.1			8,4; 9,8; 10,2	
LMN 138:81	Heitbrack, Uelzen, Niedersachsen	hoard	arm ring		2	85,2	7,2		7,9 cm	7.9	7				
LMN 139:81	Heitbrack, Uelzen, Niedersachsen	hoard	arm ring		2	74,7	6,3		7,9	7,9	6				
LMN 148:81	Heitbrack, Uelzen, Niedersachsen	hoard	neck collar	Quarrendorf	2	129,1	5,63		2,84	9,1; 11,2	1.5		9	5,5; 6,2; 7,1	
LMN 151:81	Heitbrack, Uelzen, Niedersachsen	hoard	belt disc	Ic	2	24,5	1,44			8,25	0.7	REC		11.8	
LMN 24976	Hohenbünstorf, Uelzen, Niedersachsen	burial	belt disc	Ib	3	53,2	1,36			13,1	2.5	1,11 cm		12.3	
LMN 24977	Hohenbünstorf, Uelzen, Niedersachsen	burial	pin	disc head pin Lüneburger Typ	3	32,3	10,17	4,09		6,08	2			15,9; 17,4; 17,9	
AM 6333	Hornslet Ø, Lisbjerg, Randers	burial	tutuli	IIIa4	3	45,6	2,6			7,38; 2,76	1.5	ca. 1,4 cm	8		
NM B12931	Høve "Esterhøj", Ods, Holbæk	inhumation	neck collar	Seeland	2	96,7	4,23		2,84	9,82; 10,7	1.1		9		
ML 1133	Im Lüneburgischen, Lüneburg, Niedersachsen	burial	pin	disc head pin	2	13,3	6,1	6,4		6,2	0.86			11; 12,2	14.7
ML 1135	Im Lüneburgischen, Lüneburg, Niedersachsen	burial	neck collar	Hollenstedt	2	48,6	4,8		3,36	9,8; 11,9	0.9		6		8.5
NM B3059	Jægersborg Hegn "Rundforbi", Søllerød, København	burial	neck collar	Frankerup	2 - 3a	160,48	6,24		3,79	10,62; 13,3	1.6		12	12,5; 13,1; 14,3; 14,8	
NM B3060	Jægersborg Hegn "Rundforbi", Søllerød, København	burial	belt plate	IIb3	2 - 3a										
NM B3061	Jægersborg Hegn "Rundforbi", Søllerød, København	burial	tutuli round	IIIb	2 - 3a	12,69	1,37			2,83	1	1,36 cm			
ALM Br. 92	Karbow, Ludwigslust - Parchim, Mecklenburg	burial	pin	Weitgendorf	3	102,4		20		3,3	5.3		20		
ALM Br. 88	Karbow, Ludwigslust - Parchim, Mecklenburg	burial	neck collar	Mecklenburg	3	78	4,33		9,20		1		6	11,1; 9,8; 8,8	
NM 4185	Karlslunde, København	inhumation	neck collar	Øresund	2	298,1	8,31		6,33	11,3; 18,1	3.1		31	10.2	
ALM Br. 178	Karow, Ludwigslust - Parchim, Mecklenburg	burial	neck collar	Mecklenburg	3	75,8	4,7		10,6		1.5		6	10,8; 11,2; 11,6; 12; 12,3	
ALM Br. 179	Karow, Ludwigslust - Parchim, Mecklenburg	burial	arm ring		3	61,4	6,29		8,7	7,26	6.2				
AM 5106	Kobeldal, Tørrild, Vejle	cremation	tutuli	IIIa4	3	69,5	5,22			7,42	1.4	5,22 cm			
ML 238:84,b11	Kolkhagen, Lüneburg, Niedersachsen	inhumation	belt plate	IIB1	2	73,5	1,96			13,7	1	1,31 cm		12.7	
ML 238:84,b4	Kolkhagen, Lüneburg, Niedersachsen	inhumation	neck collar	Hollenstedt	2	83,1	5,03		3,1	9,75; 11,1	1.9		9		
NM B7030	Kolsbæk „Bavnehøj", Blistrup, Frederiksborg	burial	neck collar	Øresund	3	340,3	9,42		5,49	13,9; 20,1	2.3		19	8,1 - 9,8	
NM B647	Krasmose, Klemensker, Bornholm	bog find	neck collar	Krasmose	3	123,4	9,54 cm			11,44; 21,3	0.8			16,3 (15)	
ALM LIIQ, 4	Kremmin, Ludwigslust, Mecklenburg	burial	neck collar	Mecklenburg	3	47,4	4,39	8,21	4,39		1.8		6	10,9; 11,8; 9,9	
NM B3348 - 49	Kværkeby (sn), Sorø	inhumation	neck collar	København SP	2	60,8	4,41		2,24	9,53; 11,52	2		9		
NM B2307	Langstrup, Asminderød, Frederiksborg	bog find	belt plate	IIb4	2	oA	5,85			28	1.5	5,85 cm		10,1 - 10,3; 13,3 – 13,6; 17,4 - 17,8; 19,8 – 20	
NM B11684	Lavø, Helsinge, Frederiksborg	hoard	belt plate	IIa2	2										
NM B11685	Lavø, Helsinge, Frederiksborg	hoard	belt plate	IIb3	2	216,73				21,5	0.5			10,7; 12,4; 16,2	
NM B11686	Lavø, Helsinge, Frederiksborg	hoard	neck collar	Frankerup	2	135,86	6,03		4,16	9,27; 12,8	0.6		13	12	
NM B11687	Lavø, Helsinge, Frederiksborg	hoard	belt disc	Ij	2	15,79	1,4			5,1	0.6	1,34 cm			
NM B11688	Lavø, Helsinge, Frederiksborg	hoard	tutuli	IIIa	2	17,47	2,65			4,05	0.4	2,4 cm	5		
KS 18214a	Lockstedter Lager, Steinburg, Schleswig - Holstein	inhumation	neck collar	Bütow	2	68	4,04		2,57	10,0; 12,00	1.6		9		
ALM 94/3/1	Lubmin, Ostvorpommern, Mecklenburg	cremation	neck collar	Pisede	3	100,7	4,5		2,54/ 9,2	9,2; 10,9	1.2		6		
LMN 14161	Luttmissen, Uelzen, Niedersachsen	burial	neck collar	Mistorf (?)	2	8	2,31	5,08	2,09		1.24		5		
LMN 14161 S	Luttmissen, Uelzen, Niedersachsen	burial	arm ring	studbracelet	2	7,8	2,62	2,55/ 2,54	2,62	5,5	1.4		7		
ALM 2000/1277,10	Lübz, Ludwigslust - Parchim, Mecklenburg	burial	tutuli	IIIa2a	3	6,6	1,56		2,6	2,23	1	1 cm; 0,26 cm			
ALM 2000/1277,3	Lübz, Ludwigslust - Parchim, Mecklenburg	inhumation	neck collar	Mecklenburg	3	111,7	4,57		3,26/ 10,43	10,43; 11,9	1.4		6	8,6; 9,6; 9,8; 10,9	
LMN 12041	Lüneburg, Lüneburg, Niedersachsen	burial	pin	disc head	2	24,9	10,7		4,26		0.8			8,5 - 9,6	
LMN 14066	Lüneburg, Lüneburg, Niedersachsen	burial	neck collar	Bütow	2	39,3	4,8	10,2	4,8		1.4		8		
LMN 4754	Lüneburg, Lüneburg, Niedersachsen	burial	belt plate	IIb3	2	77				12,23	0.8	0,54 cm		7,7 - 8,1	
LMN 14146	Lüneburgisches, Lüneburg, Niedersachsen	single find	neck collar	Mistorf	2	13,5	3,23	5,48	3,23		1.2		7 (?)		
LMN 14147	Lüneburgisches, Lüneburg, Niedersachsen	single find	neck collar	Babbin	2	24,2	3,45	5,14	3,45		1.9		9		
NM B10523	Løserup, Udby, Holbæk	inhumation	belt plate	IIB2	2	123				12,89	1.28	2 cm		9,4; 13,3	
NM B10524	Løserup, Udby, Holbæk	inhumation	neck collar	simple ribbed	2	43,9	4,99	7,8	3,62		1.8		14		
NM B1027	Martofte, Stubberup, Odense	inhumation	neck collar	Seeland	2	148,6	6,12		3,56	8,9; 11,2	1.9		17		

museums number	location	context	object	object type	period	weight g	height cm	length cm	width cm	diameter cm	thickness mm	spike lenghth	rib number	spiral diameter in mm	cicle diameter in mm
ALM 94/1032/4	Mecklenburg, unbekannter Fundort	single find	neck collar	Mecklenburg	3	23,7	3,07	8	2,8		1.6		6	11; 10,6; 9,3	
ML 242:84b	Molzen, Uelzen, Niedersachsen	hoard	belt disc	Ie1	2	33,2	2,11			7,88	1.03	0,74 cm			
ML 242:84c	Molzen, Uelzen, Niedersachsen	hoard	belt disc	Ie1	2	27,4	1,32			7,56	0.9	0,71 cm			
ML 242:84d	Molzen, Uelzen, Niedersachsen	hoard	belt disc	IcA	2	45,8	1,62			8,65	0.93	0,97 cm		19,1; 19,5; 19,8	
ML 242:84e	Molzen, Uelzen, Niedersachsen	hoard	belt disc	IcA	2	19,5	1,25			8,15	0.7	0,78 cm		13,6; 13,7; 13,8	
ML 242:84f	Molzen, Uelzen, Niedersachsen	hoard	belt disc	IcA	2	29,2	1,64			7,22	0.7	0,96 cm		14,7; 15,6; 15,8; 16	
ML 242:84g	Molzen, Uelzen, Niedersachsen	hoard	belt disc	IcA	2	16,8	1,26			7,4	0.75	0,62 cm		10 - 10,8	
ML 242:84h	Molzen, Uelzen, Niedersachsen	hoard	disc	V2a	2	24,1	1,19	7,74	6,08	6,08	0.69	1,0 cm		10; 11; 12,2; 12,6	
ML 242:84i	Molzen, Uelzen, Niedersachsen	hoard	disc	V2a	2	15,8	1,15	6,39		ca. 6	0.8	0,99 cm		11,3; 11,4	
LMN 99:33	Moorkathe, Fallingbostel, Niedersachsen	burial	neck collar	Quarrendorf	2	82,1	5,13		4,14	10,7; 12,2	0.9		9	0,81 cm - 1,07 cm	
ALM Br. 438	Möllen, Rostock, Mecklenburg	hoard	neck collar	Mistorf	2	118,4	5,25		2,94	13,83; 16	1.4		9		
LMN 195:78	Niedersachsen, unknown location	single find	neck collar	Babbin	2	52	4,65		2,56	10,7; 13,3	0.9		11		
AM 5337	Norre Snede, Vrads, Skanderborg	burial	belt plate	IIB2	2	228,4	1,91			15,84	0.8	1,91 cm		9,9; 13,8; 14,9	
ML 1007	Oldendorf a.d. Luhe, Lüneburg, Niedersachsen	inhumation	neck collar	Seeland (ehem. Bütow)	2a	79,6	4,36			9,1; 11,1	1.1		10		
ML 1008	Oldendorf a.d. Luhe, Lüneburg, Niedersachsen	burial	pin	wheel head pin	2a	9,8	4,92	15,3		3,9	2.8				
ML 1009	Oldendorf a.d. Luhe, Lüneburg, Niedersachsen	burial	pin	Lüneburger wheel head pin	2a	15,7	7,9	23,6		6,4	2.1		3		
ALM 3191	Pisede, Mecklenburgische Seenplatte (MES), Mecklenburg	cremation	neck collar	Pisede	3	87,8	4,2		2,8; 10,3	10,3; 11,9	1.5		6		
ALM Br. 949	Poltnitz, Ludwigslust - Parchim, Mecklenburg	inhumation	neck collar	Mecklenburg	3	8,5	2,39	3,96			1.7				
ALM Br. 954a	Poltnitz, Ludwigslust - Parchim, Mecklenburg	inhumation	spiral legring		3	492,6	20			9,37; 9,25	6,5 - 2,55			93,7; 92,5	
ALM Br. 954b	Poltnitz, Ludwigslust - Parchim, Mecklenburg	inhumation	spiral legring		3	492,5	19,8			9,32; 9,2	7,4 - 2,5			93,2; 92	
ALM Br. 955a	Poltnitz, Ludwigslust - Parchim, Mecklenburg	inhumation	arm ring		3	88									
ALM Br. 955b	Poltnitz, Ludwigslust - Parchim, Mecklenburg	inhumation	arm ring		3	98,2	7,8		1,57	8,28	9,8 x 5,3				
NM B15847	Præstegårdsmark, Melby, Frederiksborg	inhumation	neck collar	Melby	2	133,90	6,86		4,49	11,45; 14,4	1.2		12	13,1; 11,4	
NM B15848	Præstegårdsmark, Melby, Frederiksborg	inhumation	tutuli	IIIa2	2	12,87	2,1			3,53	0.8	1,92 cm			
NM B15849	Præstegårdsmark, Melby, Frederiksborg	inhumation	belt disc	Ih	2	18,92	1, 25			6,05	1.2	1,13 cm			13,6; 14,4; 14,8
NM B15850	Præstegårdsmark, Melby, Frederiksborg	inhumation	belt disc	Ig	2	9,08	1,49			5,46	0.8	1,41 cm			
LMN 14083	Raven, Harburg, Niedersachsen	burial	disc	V1b	2	10	0,93	5,15		4,4	1,3	ca. 0,8 cm	3		
LMN 4932	Raven, Harburg, Niedersachsen	burial	neck collar	Rehlingen	2		4,25		2,11	9,4; 10,5			7		
LMN 14084	Raven, Harburg, Niedersachsen	burial	disc	V1b	2	9,6	0,92	4,42		3,2	1,35	ca. 0,8 cm	3		
LMN 4755	Rehlingen, Lüneburg, Niedersachsen	inhumation	belt plate	IIB2	2a	110,9	1,23			12,5	0.72	1,23 cm		8,2; 9,6; 10,7; 11,4	
LMN 4931	Rehlingen, Lüneburg, Niedersachsen	inhumation	neck collar	Rehlingen	2a	65	5,19		2,2	9,56; 11,43	1.1		8		
LMN 4933	Rehlingen, Lüneburg, Niedersachsen	inhumation	neck collar	Heidenau	2a	74,1	3,92		2,4	10,6; 11,8	1.5		5		
LMN 5032	Rehlingen, Lüneburg, Niedersachsen	inhumation	Radpin	sceme E	2a	35,2	14,2		6,13	6,13	1.3		3		
LMN 258:71	Ripdorf, Uelzen, Niedersachsen	inhumation	neck collar	Heidenau	2	86,1	4,6		2,93	10,1; 12,4	1.3		10		
LMN 247:71	Ripdorf, Uelzen, Niedersachsen	inhumation	neck collar	Drage	2	103,3	4,52		2,61	9,78; 11,08	1.3		7		
NM B10240	Rosilde, Vindinge, Svendborg	burial	neck collar	Krasmose	2	16,4	3,66	4,94			1.4			5,9 - 7,7	
NM B7612	Rye, Gorlev, Holbaek	bog find	neck collar	Svenstrup	2	250,47	8,66		5,64	9,73	1.8		23	15; 11,8; 10	
NM B7613	Rye, Gorlev, Holbaek	bog find	neck collar	Frankerup	2	124,9	6,43		3,9	9,49; 11,8	1.3		11	10	
NM B7614	Rye, Gorlev, Holbaek	bog find	neck collar	København K	2	176,5	7,13		4,89	10,71; 14,55	1.8		19		8,3; 6,6; 4,6
NM B7615	Rye, Gorlev, Holbaek	bog find	belt plate	IId1b2	2	426,8	5,78			22,7	0.9	5,78 cm		14,8; 19,4	0,8 cm
NM B7616	Rye, Gorlev, Holbaek	bog find	belt plate	IIb3	2										
NM B7617	Rye, Gorlev, Holbaek	bog find	belt disc	IICb1a1	2	60,35	2,5			9,75	0.7	2,5 cm			
NM B7618	Rye, Gorlev, Holbæk	bog find	belt disc	Ib	2	29,2	2			6,74	1	2,0 cm		5,8 - 6,6	
NM B7619	Rye, Gorlev, Holbæk	bog find	belt disc	Id2	2	37,5	2,95			6,81	0.7	2,41 cm			7,1 - 7,8
NM B7624	Rye, Gorlev, Holbæk	bog find	belt disc	Ig	2	17,5	1,83			5,77	0.9	1,8 cm			
IV65/37d	Rühlow, Neubrandenburg, Mecklenburg	hoard	neck collar	Bütow	2		5			12,3; 14,1	2.1		9		
LMN 13181a	Rätzlingen, Uelzen, Niedersachsen	burial	neck collar	Mistorf	2	99,3	4,13		2,46	9,18; 10,72	1.5		9		
LMN 13182	Rätzlingen, Uelzen, Niedersachsen	burial	belt disc	unbekannt	2	4,7	1,26			1,75; 1,85	1.32	1,13 cm			
NM B13365a	Rødovre “Valhøje”, Søkkelund, København	inhumation	neck collar	Melby	2	153,7	6,44	18,4			1.6		12		
NM B13365	Rødovre “Valhøje“, Søkkelund, København	inhumation	tutuli round	IVb	2	16,68				3,72	1.3				
ALM Br. 93	Sarmstorf, Rostock, Mecklenburg	cremation	neck collar	Mecklenburg	3	56	3,08	7,68			1.6		6	9,2; 10,1; 8	
KS 3496	Schalkholz, Schalkholz, Schleswig - Holstein	cremation	neck collar	Traisbach C (?)	3	64,5	3,95		2,85/ 10,3	10,3; 11,4	1,6		6		

museums number	location	context	object	object type	period	weight g	height cm	length cm	width cm	diameter cm	thickness mm	spike lenghth	rib number	spiral diameter in mm	cicle diameter in mm
KS 20284a	Schleswig, Schleswig, Schleswig - Holstein	hoard	belt disc	Ib	2	74,2	1,9	10,2	10,6	10,6	1.5	1,34 cm		14,6 - 16	
KS 20284b	Schleswig, Schleswig, Schleswig - Holstein	hoard	belt disc	IcA	2	54,9	1,14			10,01	1.19	0,59 cm		12 - 14; 8,1 - 9,2	
KS 20284c	Schleswig, Schleswig, Schleswig - Holstein	hoard	belt disc	Ib	2	36,8	1,0	8,55	8,85	8,85	0.84	0,39 cm		14 - 16,2	
ML H107	Secklendorf, Uelzen, Niedersachsen	burial	neck collar	Bliederstedt	2	112,4	4,97		2,65/ 10,5	10,5; 11,4	1.1		7		
NM B3574	Sibberup, Ørslev, Sorø	burial	neck collar	Sibberup	3	270,1	9,9		4,8	12,5; 17,9	1.1		30		10.4
NM MDCCCXXI_G	Skagen (Råbjerg), Horns, Ålborg	hoard	belt plate	IIb3	2	306,2	4,9			19,6; 1,4	1.23	4,9 cm		10,1 - 11,9; 12,0 - 12,6; 13,2 - 14,5	
NM MDCCCXXI_HK	Skagen (Råbjerg), Horns, Ålborg	hoard	neck collar	6	2	95,2	4,16		2,4	10,13; 12,1	1.59		9		
NM B1635	Skenkelsø, Jørlunde, Frederiksborg	burial	neck collar	Svallerup	2	53,1	3,4		3,15	9,8; 11,4	1.7		9		
NM B13727	Skrydstrup “Staldhøj”, Haderslev	inhumation	neck collar	Drage (Sonderform)	3	47,9	5,09		3,8	11,5; 12	1.6		7		
NM B13728	Skrydstrup “Staldhøj”, Haderslev	inhumation	belt plate	IIId1b2	3	oA	2,1			16,8	oA	2,1 cm		11,8; 12,9; 10,8; 11,2	7.3
NM B13730	Skrydstrup “Staldhøj”, Haderslev	inhumation	arm ring		3	oA	2,65		0,93	6,15	0.9			10.9	
NM 17131	Skyttegård, Pedersker, Bornholm	burial	belt plate	IIB2	2	oA	5,25			21,8	2.2	5,25 cm		18,2 - 19,1	
NM 17132	Skyttegård, Pedersker, Bornholm	burial	neck collar	Stockhult	2	209,5	8,6		3,85	10,7; 18	1.4			9,7 - 11,5; 13,4 - 14,2	
NM 17133	Skyttegård, Pedersker, Bornholm	burial	fibula	Bornholmer Fibel	2	37,2		9,4	6,4		0.95			7,4; 8,7; 11,8;9,3; 9,9;9	
NM B298	Sludstrup, Skajærum, Hjøring	burial	neck collar	Krasmose	2	54,6	5,4		4,4	10,84; 12	1.5			12,6; 12; 11,8; 10,5; 8,8; 7,4; 5,8	
NM B299a	Sludstrup, Skajærum, Hjøring	burial	belt disc	Ib	2	17,7	1,68			8,2	1	1,67 cm		7,4 x 8,9	
NM B299b	Sludstrup, Skajærum, Hjøring	burial	belt disc	Ig	2	19,8	2,2			6,32	1.1	2,1 cm			
NM B11674	Snertingegård, Præsto	bog find	neck collar	Frankerup	2	185,6	6,2		3,8	10,5; 13,2	1,4		15		
NM B11675	Snertingegård, Præsto	bog find	neck collar	Frankerup	2	137,1	5,36		3,21	10,38; 13	1		10		
NM 6887	Snoldelev (sogn), København	burial	belt disc	Ib	2	33,9	2,1			9,73	0.8	2,1 cm		13,9; 14,5; 15,2	
NM 6892	Snoldelev (sogn), København	burial	neck collar	Seeland	2	58,9	3,93		2,99	9,66; 11,07	1.2		9		
LM Han 14156	Soltau, Soltau	single find	neck collar	Toppenstedt	2	47,2	3,32		9,04	9,04; 9,38	1.4		8		
NM MMXVII	Sorgenfri “Foglevad”, Lyngby, København	cremation	neck collar	Melby	2	39,6	3,53			8,15; 10,09	1.5		7		
NM 25834	Sorø bei, Lynge, Sorø,	burial	neck collar	Drage	2	99,1	4,99		3,61	10,8; 13,3			9		
ALM LII Q, 3	Sparow, Mecklenburgische Seenplatte (MES), Mecklenburg	burial	neck collar	Mecklenburg	3	106,5	4,86		3,1/ 10,24	10,24; 11,5	1.1		6	7; 8; 8,6; 9,3; 10; 11; 11,7	
ALM LIIZ1g1	Sparow, Mecklenburgische Seenplatte (MES), Mecklenburg	burial	pin	disc head	3	oA		11,43	10,06	0,3; 0,34					
ALM Br.524	Stülow, Rostock, Mecklenburg	inhumation	neck collar	Mecklenburg	3	25,6	2,96	7,31	2,86				?	?	
AM 2826	Sulsted, Ålborg	hoard	neck collar	Seeland	2		4,01	9,6		9,78; 11,36	0.9		10		
NM B723	Svallerup, Svallerup, Holbæk	burial	neck collar	Svallerup	2	125,6	5,48			12,7; 13,6	2.8		10		8.1
NM B727	Svallerup, Svallerup, Holbæk	burial	neck collar	Svallerup	2	55,1	4,85		3,04	11; 13,3	2		9	10.8	
NM 10927	Svenstrup, Tårnborg, Sorø	bog find	neck collar	Svenstrup	2	oA	6,9		4,02	10,6; 13,5	1		13	7,9 - 9,3	
NM 10931	Svenstrup, Tårnborg, Sorø	bog find	belt plate	IIb4	2	370,8	3,54			23,6; 2,78	1.5	3,34 cm		8,1 - 9,2; 11,3; 10,9 - 11,4; 12,4 - 13,5	
NM 10932	Svenstrup, Tårnborg, Sorø	bog find	belt plate	IIb3	2	oA	oA			21,19	0.8	not measured		8,4 9,2; 14 - 14,2; 13,6 - 15,2	
NM 10933	Svenstrup, Tårnborg, Sorø	bog find	belt plate	IIb2	2	81,5	oA			12,5	1.1	not measured		8,4 - 9,6; 10 - 10,8	
NM 10935a	Svenstrup, Tårnborg, Sorø	bog find	belt disc	Icb	2	19,5	1,35			6,66; 1,23	0.6	1,08 cm			10,5 - 11,6
NM 10935b	Svenstrup, Tårnborg, Sorø	bog find	belt disc	Ib	2	21,5	1,54			6,2; 0,94	0.8	1,20 cm		6,8 - 7,3	
NM 10935c	Svenstrup, Tårnborg, Sorø	bog find	belt disc	Ib	2	29,9	1,3			7,46; 1,0	0.8	0,79 cm		8,2 - 9,6	
NM 10938a	Svenstrup, Tårnborg, Sorø	bog find	belt disc	Ig	2	17,0	1,6			4,57; 0,96	0.9	1,38 cm			
NM 10938b	Svenstrup, Tårnborg, Sorø	bog find	belt disc	Ig	2	16,5	1,73			4,53; 0,94	0.7	1,51 cm			
NM 10938c	Svenstrup, Tårnborg, Sorø	bog find	belt disc	Ig	2	16,0	1,55			4,53; 1,0	0,7	1,38 cm			
NM 10942	Svenstrup, Tårnborg, Sorø	bog find	tutuli round	Ivb	2	20,8	1,85			4,58; 2,26	1	1,85 cm			
NM 10942a	Svenstrup, Tårnborg, Sorø	bog find	tutuli round	Ivb	2	24	1,55			4,49; 2,47	1.7	1,55 cm			
NM B6535	Søborg Ladegård, Søborg, Frederiksborg	bog find	neck collar	Seeland	2	112,1	4,58		2,58	9,79; 11,59	1		10		
NM B4950	Søstrup, Søstrup, Holbæk	burial	neck collar	Svallerup	2b	35,3	4,5	6,5	4	oA; 12,5	0.8		11	11,8; 10; 8,3; 8,6	
LMN 14154	Tandgndorf, Harburg, Niedersachsen	hoard	neck collar	Quarrendorf	2	23,9	3,28	6,5	3,0		1.6		9		
ALM 2003/1201	Thürkow, Rostock, Mecklenburg	burial	neck collar	Pisede	3a	89,5	4,49		10,8	12,5	1.5		6		

museums number	location	context	object	object type	period	weight g	height cm	length cm	width cm	diameter cm	thickness mm	spike lenghth	rib number	spiral diameter in mm	cicle diameter in mm
KS 18257 Iia	Tinnum, Sylt, Südtondern, Schleswig - Holstein,	inhumation	neck collar	Sonnerup A	2	38,1	4,68		1,69	9,81; 10,64	1.3				8 - 9,1
HH 62375	Toppenstedt, Harburg, Niedersachsen	burial	neck collar	Toppenstedt	2	116,8	4,8		2,7; 9,2	9,2; 11,3	1		8		
HH 62376a	Toppenstedt, Harburg, Niedersachsen	burial	disc	V1a	2	34,6	1		1,52	5,82	0.8	1 cm	4		
HH 62376b	Toppenstedt, Harburg, Niedersachsen	burial	disc	V1a	2	33,6	1		1,98	5,89	1.2	1,1 cm	4		
HH 62376c	Toppenstedt, Harburg, Niedersachsen	burial	disc	V1a	2	30	1	7,09	1,04	5,02	90.8	1 cm	4		
ALM Br. 371	Turloff, Ludwigslust - Parchim, Mecklenburg	burial	neck collar	Mecklenburg	3	66,4	4,3		2,64; 11,07	11,07; 12,17	1.2		6		
AM 7248	Tårup (Torup), Auning, Randers	single find	belt plate	IIb2	2	66,5	2,3			13,53; 1,46	1.5	1,8 cm		12,5 - 13,1	
ALM LIIQ,2	unbekannt, Mecklenburg	burial	neck collar	Mecklenburg	3	74,3	4,49		10,15	10,15; 12,2	1.9		6	11,7; 13,5; 10,2; 8,6	
ALM LIIQ,7	unbekannt, Mecklenburg	single find	neck collar	Mecklenburg	3	4	2,59	2,69			1.4			8,5 x 9,7	
ALM LIIQ,7	unbekannt, Mecklenburg	single find	neck collar	Mecklenburg	3	6,6	2,12	4,6			1.4		2 (6)	8,4; 11,6	
AM 548	Unbekannter Fundort, Jütland, Dänemark	single find	neck collar	6	2	104,5	4,73		3,02	10,7; 12,5	1.6		9		
NM B4745	unebekannt, Dänemark ?	single find	neck collar	Pisede	3	61,7	4,29		2,34	10,2; 11,4	0.7		4		
NM B2659	unhbekannter Fundort, Seeland, Dänemark	single find	neck collar	Seeland	2	104,6	4,19		2,61	11,1; 12,5	1.4		10		
AM 877	Veilbymark, Horns, København	burial	tutuli	IIIa4	3	21,4	5,5			5,03	1.55	3,52 cm			
NM 25787	Vellinge Mose, Bederslev, Odense	bog find	neck collar	Svallerup	2	138,2	6,53		4,15	11,6; 13,6	1.18		16	11,9 - 10,4; 8 - 7,1; 5,6	
NM 25788	Vellinge Mose, Bederslev, Odense	bog find	belt plate	IIb3	2	252,9	3,75			17,5; 0,96	1.3	2,39 cm		15,7 - 17; 13,1 - 14,4; 9,6 - 10,9	
NM 25789	Vellinge Mose, Bederslev, Odense	bog find	belt disc	Ig	2	15,2	1,72			5,09; 1,2	0.8	1,47 cm			
NM 25789a	Vellinge Mose, Bederslev, Odense	bog find	belt disc	Ig	2	11,8	0,97			4,29; 0,86	1.5	0,68 cm			
NM B2654	Vellinge Mose, Bederslev, Odense	bog find	belt plate	IIb2	2	88,3	2,9			12,3; 1,05	1.15	2,13 cm		8,4 - 10; 6,4 - 7,8	
NM B2655	Vellinge Mose, Bederslev, Odense	bog find	belt disc	Ig	2	40,8	2,27			7,44; 1,29	1.18	1,83 cm			
NM B2657	Vellinge Mose, Bederslev, Odense	bog find	belt disc	Ig	2	12,5	1,49			4,42; 1,25	1.17	1,31 cm			
NM B3140	Vellinge Mose, Bederslev, Odense	bog find	belt disc	Ig	2	11,4	1,57			4,46	0.89	1,33 cm			
NM B4754_873	Vendsyssel, København, København	hoard	tutuli	IIIa2	2	22,2	2,19			3,95	1.1	1,23 cm			
NM B4754_875	Vendsyssel, København, København	hoard	tutuli	IIIa2	2	21,1	1,99			4	1.4	1,14 cm			
NM B4754_878	Vendsyssel, København, København	hoard	tutuli	IIIa2	2	20,1	1,90			3,95	1.1	1,11			
NM B4754_884	Vendsyssel, København, København	hoard	tutuli	IIIa1a	2	17,2	2,5			5,11	0.8	1,4 cm			
NM B4750_1	Vendsyssel, København, København	hoard	neck collar	Seeland	2	47,3	4,74	9,4		9,4; 11,03	1.5		12		
NM B4750_2	Vendsyssel, København, København	hoard	neck collar	Seeland	2	28,9	3,4	8,96	3,4		1.08		13		
NM B4750_3	Vendsyssel, København, København	hoard	neck collar	6	2	25,9	3,83	9,88	3,83		1.2		9		
NM B4753_1	Vendsyssel, København, København	hoard	belt disc	Ic	2	7,4	0,9	3,31	2,47		1.08	0,9 cm		7.5	
NM B4753_763	Vendsyssel, København, København	hoard	belt disc	Ig	2	15,9	1,84			5,88	0.6	1,84 cm			
NM B4753_885	Vendsyssel, København, København	hoard	belt disc	Ig	2	17,9				5,8	0.8	0,3 cm			
NM B4753_890	Vendsyssel, København, København	hoard	belt disc	Ig	2	8,6	1,41			4,33		1,4 cm			
VM 1680 AD	Vognserup Enge, Kunby, Holbæk	bog find	belt disc	Ig	2	11,7	1,34			4,8; 0,96	0,4 - 0,8	1,04 cm			
VM 1680 AG	Vognserup Enge, Kunby, Holbæk	bog find	belt disc	Ig	2	11,3	1,79			4,6; 0,6	1.2	1,48 cm			
VM 1680 AH	Vognserup Enge, Kunby, Holbæk	bog find	belt disc	Ig	2	31	3			5,4; 1,2	1.25	2,8 cm			
VM 1680 AL	Vognserup Enge, Kunby, Holbæk	bog find	belt disc	Ig	2	16,8	1,9			5,6; 1,08	0,76	1,72 cm			
VM 1680 KC	Vognserup Enge, Kunby, Holbæk	bog find	belt plate	IIb3	2	495,2	7,8			25,8	1.03	6,6 cm		12,3 - 12,8; 14,3 - 15,1; 15,4 - 16,7	
VM 1680 KD	Vognserup Enge, Kunby, Holbæk	bog find	belt plate	IIb2	2	234,8	4,3			17,8; 2,0	1.02	3,36 cm		10,3 - 11,7;,4 - 16,1	
VM 1680 KE	Vognserup Enge, Kunby, Holbæk	bog find	neck collar	Zepkow	2	110,3	5,5		3,5; 0,7	9,7; 11,74	0.63		9	0,4 cm; 0,64 - 0,93 cm; 0,61 - 0,83 cm	
VM 1680 KF	Vognserup Enge, Kunby, Holbæk	bog find	neck collar	Seeland	2	91,3	4,2		2,8	10,8; 14,3	1.4		9		
VM 1680 KG	Vognserup Enge, Kunby, Holbæk	bog find	belt disc	Ib	2	39,1	1,6			9,4; 1,65	0.5	0,95 cm		10,7 - 12,1	
VM 1680 KJ	Vognserup Enge, Kunby, Holbæk	bog find	belt disc	Ib	2	22,8	1,47			4,7; 1,93	0.8	1,2 cm		4,8 - 5,8	
VM 1680 KK	Vognserup Enge, Kunby, Holbæk	bog find	belt disc	Ij	2	9,4	0,84			4,4; 0,65	0.74	0,66 cm			
VM 1680 KL	Vognserup Enge, Kunby, Holbæk	bog find	belt disc	Ia	2	31,7	2,3			7,22; 0,96	0.91	1,88 cm			

museums number	location	context	object	object type	period	weight g	height cm	length cm	width cm	diameter cm	thickness mm	spike lenghth	rib number	spiral diameter in mm	cicle diameter in mm
VM 1680 KM	Vognserup Enge, Kunby, Holbæk	bog find	belt disc	Ig	2	23,4	2,3			7,1; 1,66	0.7	2,0 cm			
VM 1680 P	Vognserup Enge, Kunby, Holbæk	bog find	tutuli round	IVb	2	18,4	1,39			3,9; 1,99	1.4	1,28 cm			
VM 1680 R	Vognserup Enge, Kunby, Holbæk	bog find	belt disc	Ig	2	11,2	2,1			5,16; 0,81	0.6	1,6 cm			
VM 1680 X	Vognserup Enge, Kunby, Holbæk	bog find	belt disc	Ig	2	12,8	1,6			4,7; 1,01	0.75	1,25 cm			
ALM 3140	Vorder - Bollhagen, Rostock, Mecklenburg	burial	belt disc	Ig	2	37,5	1,66	6,58	8,52		1.1	1,5 cm			
ALM 3139	Vorder - Bollhagen, Rostock, Mecklenburg	burial	neck collar	Bütow	2	61,4	4,37		2,39	10,8; 12,6	1.8		10		
NM B6622b	Vorup, Vejen, Ribe	burial	neck collar	Krasmose	2	5,6	3,72	2,3			1.1			4,7; 5,4; 6,9	
NM B6622	Vorup, Vejen, Ribe	burial	neck collar	Krasmose	2	266,4	10,53		6,1	12,96; 15,4	2.2			17,2; 17,7; 18,1; 8,8; 20	
NM B6623a	Vorup, Vejen, Ribe	burial	belt disc	Ib	2	9,8		4,36	4,12	6,3				15,3 - 15,5	
NM B6623b	Vorup, Vejen, Ribe	burial	belt disc	Ib	2	12,1		4,06	4,34	6,5				15.5	
NM B7071	Vranum, Almind, Viborg	inhumation	neck collar	Drage	2	67,1	4,82		3,3	9,88; 10,9	1.5		9		
KS 6027f	Vaale, Steinburg, Schleswig - Holstein	inhumation	belt disc	Ib	2	24,5	0,95			6,76	1.05	ca. 0,5 cm		5,7 - 6,6	
KS 6027g	Vaale, Steinburg, Schleswig - Holstein	inhumation	belt disc	Ij	2	32,1	0,96			6,37	1.4	ca. 0,8 cm			
LMN 1159:76	Wardböhmen (Hengstberg), Celle, Niedersachsen	inhumation	neck collar	Quarrendorf	2	86,2	5,68		4,43	10,5; 12,06	0.9		9		11; 8,2
LMN 1161:76	Wardböhmen (Hengstberg), Celle, Niedersachsen		belt plate	IIa2	2	67,6	1,8			13,8	1.5	0,49 cm		5; 6,6	
LMN 693:76	Wardböhmen, Celle, Niedersachsen	inhumation	neck collar	Rehlingen	2	84,6	4,9		3,2	9,8; 11,8	1.3		8		
ALM 2185	Weisin, Ludwigslust - Parchim, Mecklenburg	burial	spiral legring		3	480	22			0,64; 0,28				93,8; 87,4	
ALM 2195	Weisin, Ludwigslust - Parchim, Mecklenburg	burial	neck collar	Mecklenburg	3	17,8	3,01	5,42			1.1		4(6)	9.1	
ALM 2196a	Weisin, Ludwigslust - Parchim, Mecklenburg	burial	pin	Weitgendorf	3	164,3	44,83			5,34	3				
ALM 2197	Weisin, Ludwigslust - Parchim, Mecklenburg	burial	spiral legring		3	394,9	ca. 20 cm			0,59; 0,23				83,5; 83,1	
ALM 2199	Weisin, Ludwigslust - Parchim, Mecklenburg	burial	neck collar	Mecklenburg	3	85,2	4,3		10,23	12,1	1		6	11,5; 11,1; 10,8; 10,4	
MM II8269	Weitgendorf, Priegnitz, Brandenburg	cremation	neck collar	Mecklenburg	3		4,5		3,4; 9,9	9,9; 11,2	1.1		6	11	
MM II8302	Weitgendorf, Priegnitz, Brandenburg	cremation	neck collar	Mecklenburg	3		4,5			10; 11,5			6	11; 12	
MM II8670	Weitgendorf, Priegnitz, Brandenburg	cremation	neck collar	Mecklenburg	3		4,1		10,4	11,0			6	11;,9	
MM II 6284	Werder, Zauch - Belzig, Brandenburg	hoard	neck collar	Zepkow	3		5,1		3,3; 8,9	8,9; 10,2	1.5		6	11; 12; 13	
LMN 14164	Westerweyhe, Uelzen, Niedersachsen	burial	arm ring	studbracelet	2a	37,1	2,7		1,68	5,99	1.9		7		
LMN 4930	Westerweyhe, Uelzen, Niedersachsen	burial	neck collar	Hollenstedt	2a	89,2	5,67		2,49	9,9; 11,09	1.7		10		
LMN 12018	Westerweyhe, Uelzen, Niedersachsen	burial	pin	wheel head pin	2a	21,1	7,98	2,84	1	5,16; 3,08	1.7		3		
MM II4381	Wildberg, Ruppin, Brandenburg	burial	neck collar	Zepkow	3		4,5		2,9	09-Nov	ca. 1,5		4	11; 12; 14; 18	
ALM LIIQ,5	Wittenmoor, Ludwigslust - Parchim, Mecklenburg	burial	neck collar	Mecklenburg	3	46,8	4,9 cm	7,53	4,9		1.2		6	8; 9,4; 7,7; 8,5; 7,1	
ALM 3374a	Wotenitz, Nodwestmecklenburg (NWM), Mecklenburg	hoard	neck collar	Svenstrup	2	59,8	4,17	6,03	2,91	8,96; 9,98	1.2		9	not measured	
ALM 4124	Wozinkel, Ludwigslust - Parchim, Mecklenburg	inhumation	neck collar	Mecklenburg	3	96,6	4,63		3,12; 10,4	10,4; 11,5	1.5		6	7,8; 9,4; 11; 11,9; 12,9	
MM II10301	Zeestow, Westhavelland, Brandenburg	single find	neck collar	Pisede	2	oA	4,5		2,6; 8,9	8,9; 10,5	1.4		9		
NM B17528	Østby Mark, Horns, Frederiksborg	single find	neck collar	Heidenau NS	2	45,4	5,69	8,33	1,94		1.7		8		

Table 2: Skill and production units

museums number	site	ID	artefact category	artefact	type	Date/ period	skill category	surface fine	surface medium	surface coarse	DECOR 01	DECOR 02	DECOR 03	LEVEL high	LEVEL medium	LEVEL low	WORK very	WORK middle	WORK low	Production Unit	PU >300	PU 190-260	PU 160-190	PU 130-150	PU 100-120	PU 60-90	PU 50-60	PU 30-50	PU <30
ALM LIIZ1g1	Sparow, Mecklenburgische Seenplatte (MES), Mecklenburg	LIIZ1g1	4	disc-head pin		3	1221	1	0	0	0	1	0	0	1	0	1	0	0	351	1								
NM B3574	Sibberup, Ørslev, Sorø	193	1	neck collar	Sibberup	3	1111	1	0	0	1	0	0	1	0	0	1	0	0	346	1								
NM Z672	Annisse, Holbo, Frederiksborg	189	1	neck collar	Sibberup	2	2312	0	1	0	0	0	1	1	0	0	0	1	0	312	1								
NM B2307	Langstrup, Asminderød, Frederiksborg	B2307	2	belt plate	IIb4	2	1111	1	0	0	1	0	0	1	0	0	1	0	0	311	1								
NM B6622	Vorup, Vejen, Ribe	414	1	neck collar	Krasmose	2	1111	1	0	0	1	0	0	1	0	0	1	0	0	304	1								
NM B11684	Lavø, Helsinge, Frederiksborg	B11684	2	belt plate	IIa2	2	1112	1	0	0	1	0	0	1	0	0	0	1	0	299	1								
NM B647	Krasmose, Klemensker, Bornholm	409	1	neck collar	Krasmose	3	1111	1	0	0	1	0	0	1	0	0	1	0	0	280	1								
NM B2884	Bornholm, Fundort unbekannt	405	1	neck collar	Krasmose	3	1212	1	0	0	0	1	0	1	0	0	0	1	0	265		1							
NM B13260	Gjedsted „Hverrehus“, Viborg	B13260	2	belt plate	IIb3	2	1112	1	0	0	1	0	0	1	0	0	0	1	0	252		1							
ALM 2000/1277,3	Lübz, Ludwigslust-Parchim, Mecklenburg	279	1	neck collar	Mecklenburg	3	1212	1	0	0	0	1	0	1	0	0	0	1	0	250		1							
NM B995	Annebjerg Skov, Højby, Holbæk	160	1	neck collar	Svenstrup	2	2112	0	1	0	1	0	0	1	0	0	0	1	0	242		1							
NM 4185	Karlslunde, København	186	1	neck collar	Øresund	2	2112	0	1	0	1	0	0	1	0	0	0	1	0	235		1							
NM B3486	Bringe, Værløse, København	184	1	neck collar	Øresund	2	1111	1	0	0	1	0	0	1	0	0	1	0	0	233		1							
NM B11685	Lavø, Helsinge, Frederiksborg	B11685	2	belt plate	IIb3	2	1112	1	0	0	1	0	0	1	0	0	0	1	0	232		1							
ALM 2185	Weisin, Ludwigslust-Parchim	2185	10	leg ring		3	1212	1	0	0	0	1	0	1	0	0	0	1	0	224		1							
NM B13728	Skrydstrup "Staldhøj", Haderslev	B13728	2	belt plate	IIId1b2	3	1112	1	0	0	1	0	0	1	0	0	0	1	0	224		1							
ALM 2197	Weisin, Ludwigslust-Parchim	2197	10	leg ring		3	1212	1	0	0	0	1	0	1	0	0	0	1	0	218		1							
ALM Br. 954a	Poltnitz, Ludwigslust-Parchim, Mecklenburg	Br.954a	10	leg ring		3	1121	1	0	0	0	1	0	0	1	0	1	0	0	214		1							
ALM Br. 954b	Poltnitz, Ludwigslust-Parchim, Mecklenburg	Br.954b	10	leg ring		3	1121	1	0	0	1	0	0	0	1	0	1	0	0	214		1							
ALM Br. 738ab	Bredentin, Rostock, Mecklenburg	Br.738	10	leg ring		3	2221	0	1	0	0	1	0	0	1	0	1	0	0	213		1							
NM B7030	Kolsbæk „Bavnehøj“, Blistrup., Frederiksborg	187	1	neck collar	Øresund	3	1112	1	0	0	1	0	0	1	0	0	0	1	0	207		1							
NM B11674	Snertingegård, Præsto	212	1	neck collar	Frankerup	2	2112	0	1	0	1	0	0	1	0	0	0	1	0	207		1							
NM B7614	Rye, Gorlev, Holbaek	176	1	neck collar	København K	2	1211	1	0	0	0	1	0	1	0	0	1	0	0	204		1							
NM B7612	Rye, Gorlev, Holbaek	166	1	neck collar	Svenstrup	2	1211	1	0	0	0	1	0	1	0	0	1	0	0	200		1							
NM B11686	Lavø, Helsinge, Frederiksborg	211	1	neck collar	Frankerup	2	1111	1	0	0	1	0	0	1	0	0	1	0	0	199		1							
NM CMXIII	Frankerup, Eggeslevmagle, Sorø	CMXIII	2	belt plate	IIb3	2	1211	1	0	0	0	1	0	1	0	0	1	0	0	196		1							
NM B4237	Ferslev „Dansehøj“, Frederiksborg	162	1	neck collar	Svenstrup	2b	2112	0	0	1	1	0	0	1	0	0	0	1	0	195		1							
MM II8302	Weitgendorf, Priegnitz, Brandenburg	300	1	neck collar	Mecklenburg	3	1112	1	0	0	1	0	0	1	0	0	0	1	0	194		1							
NM B11458	Gerdrup, Kirkerup; København;	439	1	neck collar	Sonnerup	2	1112	1	0	0	1	0	0	1	0	0	0	1	0	194		1							
NM MDCCCXXI_G	Skagen (Råbjerg), Horns hd, Ålborg	MDCCCXXI	2	belt plate	IIb3	2	1211	1	0	0	0	1	0	1	0	0	1	0	0	192		1							
NM 25787	Vellinge Mose, Bederslev, Odense;	182	1	neck collar	Svallerup	2	1112	1	0	0	1	0	0	1	0	0	0	1	0	186			1						
ALM 2303	Alt Sammit, Rostock	262	1	neck collar	Mecklenburg	3	1212	1	0	0	0	1	0	1	0	0	0	1	0	186			1						

museums number	site	ID	artefact category	artefact	type	Date/ period	skill category	surface fine	surface medium	surface coarse	DECOR 01	DECOR 02	DECOR 03	LEVEL high	LEVEL medium	LEVEL low	WORK very	WORK middle	WORK low	Production Unit	PU >300	PU 190-260	PU 160-190	PU 130-150	PU 100-120	PU 60-90	PU 50-60	PU 30-50	PU <30
NM B11969	Estrup, Ringsted, Sorø	175	1	neck collar	København KK	3	1211	1	0	0	0	1	0	1	0	0	1	0	0	184			1						
LMH 1159:76	Wardböhmen (Hengstberg), Kr. Celle, Lower-Saxony	249	1	neck collar	Quarrendorf	2	1212	1	0	0	0	1	0	1	0	0	0	1	0	182			1						
NM CMXII	Frankerup, Eggeslevmagle, Sorø	CMXII	2	belt plate	IIb3	2	1111	1	0	0	1	0	0	1	0	0	1	0	0	182			1						
ALM LIIQ,8	Mecklenburg, unknown location	281	1	neck collar	Mecklenburg	3	1212	1	0	0	0	1	0	1	0	0	0	1	0	178			1						
MM II8670	Weitgendorf, Priegnitz, Brandenburg	298	1	neck collar	Mecklenburg	3	1111	1	0	0	1	0	0	1	0	0	1	0	0	178			1						
NM 17132	Skyttegård, Pedersker, Bornholm	426	1	neck collar	Stockhult	2	1211	1	0	0	0	1	0	1	0	0	1	0	0	178			1						
NM B 3060	Jægersborg Hegn "Rundforbi", Søllerød, København	B3060	2	belt plate	IIb3	2-3a	1112	1	0	0	1	0	0	1	0	0	0	1	0	176			1						
NM B7613	Rye, Gorlev, Holbaek	214	1	neck collar	Frankerup	2	1211	1	0	0	0	1	0	1	0	0	1	0	0	175			1						
ALM 2199	Weisin, Ludwigslust-Parchim, Mecklenburg	297	1	neck collar	Mecklenburg	3	1212	1	0	0	0	1	0	1	0	0	0	1	0	172			1						
ALM Br. 149.17	Friedrichsruhe, Ludwigslust-Parchim, Mecklenburg	305	1	neck collar	Mecklenburg	3	2211	0	1	0	0	1	0	1	0	0	1	0	0	170			1						
ALM 94/3/1	Lubmin, Ostvorpommern, Mecklenburg	319	1	neck collar	Pisede	3	1212	0	0	0	0	0	0	0	0	0	0	0	0	169			1						
NM B9530	Glæsborg, Nørre, Randers	B9530	2	belt plate	IIb3	2	1112	1	0	0	1	0	0	1	0	0	0	1	0	169			1						
NM 10931	Svenstrup, Tårnborg, Sorø	10931	2	belt plate	IIb4	2	1111	1	0	0	1	0	0	1	0	0	1	0	0	167			1						
NM B11459-2	Gerdrup, Kirkerup, København	B11459-2	2	belt plate	IIb2	2	1212	1	0	0	0	1	0	1	0	0	0	1	0	163			1						
NM 17131	Skyttegård, Pedersker, Bornholm	17131	2	belt plate	IIB2	2	1211	1	0	0	0	1	0	1	0	0	1	0	0	161			1						
NM B 15847	Præstegårdsmark, Melby, Frederiksborg	218	1	neck collar	Melby	2	1211	1	0	0	0	1	0	1	0	0	1	0	0	161			1						
ALM LIIQ,5	Wittenmoor, Grabow, Mecklenburg	270	1	neck collar	Mecklenburg	3	1212	1	0	0	0	1	0	1	0	0	0	1	0	161			1						
VM 1680 KC	Vognserup Enge, Kunby, Holbæk	1680 KC	2	belt plate	IIb3	2	1111	1	0	0	1	0	0	1	0	0	1	0	0	160			1						
ALM Br. 88	Karbow, Ludwigslust-Parchim, Mecklenburg	271	1	neck collar	Mecklenburg	3	1212	1	0	0	0	1	0	1	0	0	0	1	0	160			1						
ALM Br. 949	Poltnitz, Ludwigslust-Parchim, Mecklenburg	286	1	neck collar	Mecklenburg	3	2212	0	1	0	0	1	0	1	0	0	0	1	0	160			1						
MM II8269	Weitgendorf, Kr. Priegnitz, Brandenburg	299	1	neck collar	Mecklenburg	3	1112	1	0	0	1	0	0	1	0	0	0	1	0	160			1						
NM B7615	Rye, Gorlev, Holbaek	B7615	2	belt plate	IId1b2	2	1111	1	0	0	1	0	0	1	0	0	1	0	0	160			1						
MM IIa707a	Damerow, Uecker-Randow, Mecklenburg	267	1	neck collar	Mecklenburg	3	2212	0	1	0	0	1	0	1	0	0	0	1	0	159			1						
NM B13259	Gjedsted „Hverrehus", Viborg	406	1	neck collar	Krasmose	2	1222	1	0	0	0	1	0	0	1	0	0	1	0	158			1						
ALM 94/1032/4	Mecklenburg, unknown location	94/1032/4	1	neck collar	Mecklenburg	3	3212	0	0	1	0	1	0	1	0	0	0	1	0	152				1					
ALM Br. 955a	Poltnitz, Ludwigslust-Parchim, Mecklenburg	Br.955a	8	armring		3	2211	0	1	0	0	1	0	1	0	0	1	0	0	151				1					
ALM Br. 955b	Poltnitz, Ludwigslust-Parchim, Mecklenburg	Br.955b	8	armring		3	2211	0	1	0	0	1	0	1	0	0	1	0	0	151				1					
ALM LII Q, 3	Sparow, Mecklenburgische Seenplatte (MES), Mecklenburg	292	1	neck collar	Mecklenburg	3	2212	0	1	0	0	1	0	1	0	0	0	1	0	150				1					
ALM 4124	Wozinkel, Ludwigslust-Parchim, Mecklenburg	301	1	neck collar	Mecklenburg	3	1211	1	0	0	0	1	0	1	0	0	1	0	0	150				1					
NM 25788	Vellinge Mose, Bederslev, Odense	25788	2	belt plate	IIb3	2	2111	0	1	0	1	0	0	1	0	0	1	0	0	148				1					
NM B2659	Seeland, Denmark	B2659	1	neck collar	Seeland	2	1222	1	0	0	0	1	0	0	1	0	0	1	0	146				1					
ALM 2195	Weisin, Ludwigslust-Parchim, Mecklenburg	296	1	neck collar	Mecklenburg	3	1212	1	0	0	0	1	0	1	0	0	0	1	0	143				1					
NM B4351	Bragergården, Ørslev, Præsto	165	1	neck collar	Svenstrup	3a	1212	1	0	0	0	1	0	1	0	0	0	1	0	142				1					
NM B 4750_2	Vendsyssel, København, København	156	1	neck collar	Seeland	2	1221	1	0	0	0	1	0	0	1	0	1	0	0	141				1					
LMH 138:81	Heitbrack, Uelzen, Lower-Saxony	138:81	8	armring		2	1222	1	0	0	0	1	0	0	1	0	0	1	0	140				1					
LMH 14144 (1)	Edendorf, Uelzen, Lower-Saxony	258	1	neck collar	Hollenstedt	2	1212	1	0	0	0	1	0	1	0	0	0	1	0	140				1					

museums number	site	ID	artefact category	artefact	type	Date/ period	skill category	surface fine	surface medium	surface coarse	DECOR 01	DECOR 02	DECOR 03	LEVEL high	LEVEL medium	LEVEL low	WORK very	WORK middle	WORK low	Production Unit	PU >300	PU 190-260	PU 160-190	PU 130-150	PU 100-120	PU 60-90	PU 50-60	PU 30-50	PU <30
LMH 258:71	Ripdorf, Uelzen; Lower-Saxony	258:71	1	neck collar	Heidenau	2	2121	0	1	0	1	0	0	0	1	0	1	0	0	140				1					
ALM Br. 271	Boldebuck, Rostock, Mecklenburg	263	1	neck collar	Mecklenburg	3	2212	0	1	0	0	1	0	1	0	0	0	1	0	140				1					
ALM Br. 178	Karow, Ludwigslust-Parchim, Mecklenburg	273	1	neck collar	Mecklenburg	3	1212	1	0	0	0	1	0	1	0	0	0	1	0	140				1					
NM B298	Sludstrup, Skajærum, Hjøring	411	1	neck collar	Krasmose	2	1112	1	0	0	1	0	0	1	0	0	0	1	0	140				1					
ALM Br. 149.25	Friedrichsruhe, Ludwigslust-Parchim, Mecklenburg	316	1	neck collar	Pisede	3	1212	1	0	0	0	1	0	1	0	0	0	1	0	138				1					
LMH 4933	Rehlingen, Lüneburg, Lower-Saxony	242	1	neck collar	Heidenau	2a	1322	1	0	0	0	0	1	0	1	0	0	1	0	137				1					
ALM 2003/1201	Thürkow, Rostock, Mecklenburg	322	1	neck collar	Pisede	3a	2111	0	1	0	1	0	0	1	0	0	1	0	0	136				1					
AM 7248	Tårup (Torup), Auning, Randers	7248	2	belt plate	IIb2	2	2111	0	1	0	1	0	0	1	0	0	1	0	0	136				1					
ALM 26	Mecklenburg, unknown location	ALM 26	1	neck collar	Mecklenburg	3	1212	1	0	0	0	1	0	1	0	0	0	1	0	136				1					
MM II10301	Zeestow, Westhavelland, Brandenburg	323	1	neck collar	Pisede	2	2322	0	1	0	0	0	1	0	1	0	0	1	0	135				1					
NM B6535	Søborg Ladegård, Søborg, Frederiksborg	152	1	neck collar	Seeland	2	1222	0	0	0	0	0	0	0	0	0	0	0	0	134				1					
LMH 14144 (2)	Edendorf, Uelzen, Lower-Saxony	259	1	neck collar	Hollenstedt	2	1212	1	0	0	0	1	0	1	0	0	0	1	0	133				1					
NM B6622b	Vorup, Vejen, Ribe	415	1	neck collar	Krasmose	2	1212	1	0	0	0	1	0	1	0	0	0	1	0	133				1					
CMXIV	Frankerup, Eggeslevmagle, Sorø	206	1	neck collar	Frankerup	2	1211	1	0	0	0	1	0	1	0	0	1	0	0	132				1					
ALM Br.524	Stülow, Rostock, Mecklenburg	293	1	neck collar	Mecklenburg	3	2212	0	1	0	0	1	0	1	0	0	0	1	0	132				1					
NM B 3059	Jægersborg Hegn "Rundforbi", Søllerød, København	210	1	neck collar	Frankerup	2-3a	1121	1	0	0	1	0	0	0	1	0	1	0	0	131				1					
ALM LIIQ,2	Mecklenburg, unknown location	280	1	neck collar	Mecklenburg	3	1212	1	0	0	0	1	0	1	0	0	0	1	0	131				1					
ALM LIIQ,7	Mecklenburg, unknown location	282	1	neck collar	Mecklenburg	3	1312	1	0	0	0	0	1	1	0	0	0	1	0	131				1					
NM B13365a	Rødovre "Valhøje", Søkkelund, København	219	1	neck collar	Melby	2	1111	1	0	0	1	0	0	1	0	0	1	0	0	130				1					
NM B4950	Søstrup, Søstrup, Holbæk	179	1	neck collar	Svallerup	2b	1222	1	0	0	0	1	0	0	1	0	0	1	0	125				1					
VM 1680 KE	Vognserup Enge, Kunby, Holbæk	308	1	neck collar	Zepkow	2	2212	0	1	0	0	1	0	1	0	0	0	1	0	125				1					
HH 62375	Toppenstedt, Harburg, Lower-Saxony	355	1	neck collar	Toppenstedt	2	1221	1	0	0	0	1	0	0	1	0	1	0	0	122					1				
ALM Br. 93	Sarmstorf, Rostock, Mecklenburg	289	1	neck collar	Mecklenburg	3	2212	0	1	0	0	1	0	1	0	0	0	1	0	118					1				
FHM 2330 (h)	Assing (sn), Hammerum, Ringkøping	434	1	neck collar	Hedvigsdahl	2	1212	1	0	0	0	1	0	1	0	0	0	1	0	118					1				
KS 18257 Iia	Tinnum, Sylt, Südtondern, Schleswig-Holstein	437	1	neck collar	Sonnerup A	2	2212	0	1	0	0	1	0	1	0	0	0	1	0	117					1				
KS B145-1b	Handewitt, Kr. Flensburg, Schleswig-Holstein	B145-1b	5	tutuli	IIIa4	3	1222	1	0	0	0	1	0	0	1	0	0	1	0	117					1				
NM B7616	Rye, Gorlev, Holbaek	B7616	2	belt plate	IIb3	2	2111	0	1	0	1	0	0	1	0	0	1	0	0	117					1				
NM B4745	Denmark, unknown location	B4745	1	neck collar	Pisede	3	2212	0	1	0	0	1	0	1	0	0	0	1	0	116					1				
ALM LIH16	municipality Grabow, Mecklenburg	LIH16	2	belt plate	IIB2	2	1212	1	0	0	0	1	0	1	0	0	0	1	0	116					1				
NM 6892	Snoldelev (sogn), København	150	1	neck collar	Seeland	2	1232	1	0	0	0	1	0	0	0	1	0	1	0	115					1				
WAIV/64/561b	Gielow, Mecklenburgische-Seenplatte (MES), Mecklenburg	317	1	neck collar	Pisede	3	2212	0	1	0	0	1	0	1	0	0	0	1	0	114					1				
NM B7617	Rye, Gorlev, Holbaek	B7617	3	belt disc	IICb1a1	2	1112	1	0	0	1	0	0	1	0	0	0	1	0	114					1				
ALM LIIQ, 4	Kremmin, Kr. Ludwigslust, Mecklenburg	276	1	neck collar	Mecklenburg	3	2211	0	1	0	0	1	0	1	0	0	1	0	0	113					1				
LMH 4753	Gollern, Uelzen, Lower-Saxony	4753	2	belt plate	IIB2	2	2212	0	1	0	0	1	0	1	0	0	0	1	0	111					1				
NM B10523	Løserup, Udby, Holbæk	B10523	2	belt plate	IIB2	2	2211	0	1	0	0	1	0	1	0	0	1	0	0	111					1				
ALM 3191	Pisede, Mecklenburgische-Seenplatte (MES), Mecklenburg	320	1	neck collar	Pisede	3	2112	0	1	0	1	0	0	1	0	0	0	1	0	110					1				
ML 1135	Im Lüneburgischen, Lüneburg, Lower-Saxony	1135	1	neck collar	Hollenstedt	2	2211	0	1	0	0	1	0	1	0	0	1	0	0	109					1				
NM B11675	Snertingegård, Præsto	213	1	neck collar	Frankerup	2	1212	1	0	0	0	1	0	1	0	0	0	1	0	108					1				

museums number	site	ID	artefact category	artefact	type	Date/ period	skill category	surface fine	surface medium	surface coarse	DECOR 01	DECOR 02	DECOR 03	LEVEL high	LEVEL medium	LEVEL low	WORK very	WORK middle	WORK low	Production Unit	PU >300	PU 190-260	PU 160-190	PU 130-150	PU 100-120	PU 60-90	PU 50-60	PU 30-50	PU <30
ALM Br. 371	Turloff, Sternberg, Mecklenburg	294	1	neck collar	Mecklenburg	3	2212	0	1	0	0	1	0	1	0	0	0	1	0	108					1				
NM 10932	Svenstrup, Tårnborg, Sorø	10932	2	belt plate	IIb3	2	1211	1	0	0	0	1	0	1	0	0	1	0	0	107					1				
VM 1680 KL	Vognserup Enge, Kunby, Holbæk	1680 KL	3	belt disc	Ia	2	1222	1	0	0	0	1	0	0	1	0	0	1	0	107					1				
AM 5337	Norreede, Vrads, Skanderborg	5337	2	belt plate	IIB2	2	2312	0	1	0	0	0	1	1	0	0	0	1	0	107					1				
NM B2654	Vellinge Mose, Bederslev, Odense	B2654	2	belt plate	IIb2	2	1212	1	0	0	0	1	0	1	0	0	0	1	0	106					1				
NM B 997	Annebjerg Skov, Højby, Holbæk	B997	2	belt plate	IIb2	2	1211	1	0	0	0	1	0	1	0	0	1	0	0	104					1				
VM 1680 KM	Vognserup Enge, Kunby, Holbæk	1680 KM	3	belt disc	Ig	2	1211	1	0	0	0	1	0	1	0	0	1	0	0	103					1				
LMH 4930	Westerweyhe, Uelzen, Lower-Saxony	257	1	neck collar	Hollenstedt	2a	2221	0	1	0	0	1	0	0	1	0	1	0	0	103					1				
VM 1680 KD	Vognserup Enge, Kunby, Holbæk	1680 KD	2	belt plate	IIb2	2	1211	1	0	0	0	1	0	1	0	0	1	0	0	102					1				
VM 1680 KF	Vognserup Enge, Kunby, Holbæk	158	1	neck collar	Seeland	2	1222	1	0	0	0	1	0	0	1	0	0	1	0	101					1				
NM B1635	Skenkelsø, Jørlunde, Frederiksborg	183	1	neck collar	Svallerup	2	1122	1	0	0	1	0	0	0	1	0	0	1	0	101					1				
ML SLg. Becker	Ehlbeck, Lüneburg, Lower-Saxony	260	1	neck collar	Hollenstedt	2	1221	1	0	0	0	1	0	0	1	0	1	0	0	100					1				
KS 8021b	Bornhöved, Segeberg, Schleswig-Holstein	313	1	neck collar	Pisede	2	2212	0	1	0	0	1	0	1	0	0	0	1	0	100					1				
NM B2885	Bornholm, unknown location	B2885	9	fibula	type Bornholm	3	1211	1	0	0	0	1	0	1	0	0	1	0	0	100					1				
NM 10927	Svenstrup, Tårnborg, Sorø	169	1	neck collar	Svenstrup	2	1112	1	0	0	1	0	0	1	0	0	0	1	0	99					1				
NM B11459	Gerdrup, Kirkerup; København	B11459	3	belt disc	IIb2	2	1212	1	0	0	0	1	0	1	0	0	0	1	0	97					1				
KS 20284a	Schleswig, K. Schleswig, Schleswig-Holstein	20284a	3	belt disc	Ib	2	2332	0	1	0	0	0	1	0	0	1	0	1	0	96					1				
NM B996	Annebjerg Skov, Højby, Holbæk	417	1	neck collar	Paatorp	2	1212	1	0	0	0	1	0	1	0	0	0	1	0	95					1				
LMH 99:33	Moorkate, Heidekreis, Lower-Saxony	247	1	neck collar	Quarrendorf	2	1211	1	0	0	0	1	0	1	0	0	1	0	0	93						1			
NM B1568	Bidstrup, Jørgens , København	131	1	neck collar	Seeland	2	1221	1	0	0	0	1	0	0	1	0	1	0	0	92						1			
NM B15849	Præstegårdsmark, Melby, Frederiksborg	B15849	3	belt disc	Ih	2	2212	0	1	0	0	1	0	1	0	0	0	1	0	91						1			
NM B1027	Martofte, Stubberup, Odense	145	1	neck collar	Seeland	2	1221	1	0	0	0	1	0	0	1	0	1	0	0	90						1			
NM B13365	Rødovre “Valhøje“, Søkkelund, København	B13365	6	tutuli dome	IVb	2	1121	1	0	0	1	0	0	0	1	0	1	0	0	90						1			
ML 238:84,b4	Kolkhagen, Lüneburg, Lower-Saxony	254	1	neck collar	Hollenstedt	2	1232	1	0	0	0	1	0	0	0	1	0	1	0	88						1			
NM B 4750_1	Vendsyssel, København,	157	1	neck collar	Seeland	2	1232	1	0	0	0	1	0	0	0	1	0	1	0	87						1			
ALM 3374a	Wotenitz, Nordwestmecklenburg (NWM), Mecklenburg	170	1	neck collar	Svenstrup	2	2222	0	1	0	0	1	0	0	1	0	0	1	0	87						1			
ML H55	Eyendorf, Harburg, Lower-Saxony	H55	2	belt plate	IIB2	2	2212	0	1	0	0	1	0	1	0	0	0	1	0	87						1			
NM B10240	Rosilde, Vindinge, Svendborg	410	1	neck collar	Krasmose	2	2212	0	1	0	0	1	0	1	0	0	0	1	0	86						1			
NM B1000	Annebjerg Skov, Højby, Holbæk	B1000	6	tutuli dome	Iva	2	1212	1	0	0	0	1	0	1	0	0	0	1	0	86						1			
LMH 4754	Lüneburg, Lüneburg, Lower-Saxony	4754	2	belt plate	IIb3	2	1222	1	0	0	0	1	0	0	1	0	0	1	0	84						1			
LMH 148:81	Heitbrack, Uelzen, Lower-Saxony	148:81	1	neck collar	Quarrendorf	2	1322	1	0	0	0	0	1	0	1	0	0	1	0	83						1			
NM MMXVII	Sorgenfri “Foglevad”, Lyngby, København	221	1	neck collar	Melby	2	1221	1	0	0	0	1	0	0	1	0	1	0	0	83						1			
MM II4381	Wildberg, Ruppin, Brandenburg	II4381	1	neck collar	Zepkow	3	1211	1	0	0	0	1	0	1	0	0	1	0	0	82						1			
LMH 139:81	Heitbrack, Uelzen, Lower-Saxony	139:81	8	armring		2	1122	1	0	0	1	0	0	0	1	0	0	1	0	81						1			
KS 12149	Bredenbeck (Kronsburg), Rendsburg, Schleswig-Holstein	232	1	neck collar	Rehlingen	2	1231	1	0	0	0	1	0	0	0	1	1	0	0	81						1			
ALM S6	Mecklenburg, unknown location	146	1	neck collar	Seeland	2	1222	1	0	0	0	1	0	0	1	0	0	1	0	80						1			
MM II 6284	Werder, Zauch-Belzig, Brandenburg	309	1	neck collar	Zepkow	3	1312	1	0	0	0	0	1	1	0	0	0	1	0	80						1			
LMH 4755	Rehlingen, Lüneburg, Lower-Saxony	4755	2	belt plate	IIB2	2a	1212	1	0	0	0	1	0	1	0	0	0	1	0	80						1			

museums number	site	ID	artefact category	artefact	type	Date/ period	skill category	surface fine	surface medium	surface coarse	DECOR 01	DECOR 02	DECOR 03	LEVEL high	LEVEL medium	LEVEL low	WORK very	WORK middle	WORK low	Production Unit	PU >300	PU 190-260	PU 160-190	PU 130-150	PU 100-120	PU 60-90	PU 50-60	PU 30-50	PU <30
LMH 1161:76	Wardböhmen (Hengstberg), Celle, Lower-Saxony	1161:76	2	belt plate	IIa2	2	2212	0	1	0	0	1	0	1	0	0	0	1	0	76						1			
NM 17133	Skyttegård, Pedersker, Bornholm	17133	9	fibula	type Bornholm	2	2111	0	1	0	1	0	0	1	0	0	1	0	0	76						1			
AM 2826	Sulsted, Ålborg	151	1	neck collar	Seeland	2	1222	1	0	0	0	1	0	0	1	0	0	1	0	75						1			
NM B11391	Bagsværd, Gladsakse, København	215	1	neck collar	Melby	2	1221	1	0	0	0	1	0	0	1	0	1	0	0	75						1			
LMH 13177 (13179)	Amellinghausen, Lüneburg, Lower-Saxony	244	1	neck collar	Quarrendorf	2	1211	1	0	0	0	1	0	1	0	0	1	0	0	73						1			
NM 10935a	Svenstrup, Tårnborg, Sorø	10935a	3	belt disc	Icb	2	1322	1	0	0	0	0	1	0	1	0	1	1	0	71						1			
NM B723	Svallerup, Svallerup, Holbæk	180	1	neck collar	Svallerup	2	2222	0	1	0	0	1	0	0	1	0	0	1	0	70						1			
KS 20284b	Schleswig, Schleswig, Schleswig-Holstein	20284b	3	belt disc	IcA	2	1232	1	0	0	0	1	0	0	0	1	0	1	0	70						1			
NM B299a	Sludstrup, Skajærum, Hjøring	B299a	3	belt disc	Ib	2	1121	1	0	0	1	0	0	0	1	0	1	0	0	69						1			
VM 1680 P	Vognserup Enge, Kunby, Holbæk	1680 P	6	tutuli dome	IVb	2	1121	1	0	0	1	0	0	0	1	0	1	0	0	68						1			
ALM Br.239	Dabel, Sternberg, Mecklenburg	Br.239	3	belt disc	Ie2	2	1322	1	0	0	0	0	1	0	1	0	0	1	0	68						1			
ML 242:84g	Molzen, Uelzen, Lower-Saxony	242:84g	3	belt disc	IcA	2	1222	1	0	0	0	1	0	0	1	0	0	1	0	67						1			
AM 2330 (g)	Assing (sn), Hammerum, Ringkøping	2330 (g)	3	belt disc	Ib	2	1121	1	0	0	1	0	0	0	1	0	1	0	0	66						1			
ML 242:84c	Molzen, Uelzen, Lower-Saxony	242:84c	3	belt disc	Ie1	2	1112	1	0	0	1	0	0	1	0	0	0	1	0	66						1			
ML 242:84i	Molzen, Uelzen, Lower-Saxony	242:84i	3	hanging disc	V2a	2	1112	1	0	0	1	0	0	1	0	0	0	1	0	66						1			
LMH 24977	Hohenbünstorf, Uelzen, Lower-Saxony	24977	4	disc-head pin	type Lüneburg	3	2112	0	1	0	1	0	0	1	0	0	0	1	0	66						1			
ML 242:84h	Molzen, Uelzen, Lower-Saxony	242:84h	3	hanging disc	V2a	2	1212	1	0	0	0	1	0	1	0	0	0	1	0	64						1			
NM MDCCCXXI_HK	Skagen (Råbjerg), Horns, Ålborg	56	1	neck collar	6	2	2231	0	1	0	0	1	0	0	0	1	1	0	0	64						1			
ALM Br. 179	Karow, Ludwigslust-Parchim, Mecklenburg	Br.179	8	armring		3	2222	0	1	0	0	1	0	0	1	0	0	1	0	64						1			
LMH 137:81	Heitbrack, Uelzen, Lower-Saxony	137:81	4	disc-head pin		2	1212	1	0	0	0	1	0	1	0	0	0	1	0	63						1			
NM B3348-49	Kværkeby (sn), Sorø	172	1	neck collar	København SP	2	1221	1	0	0	0	1	0	0	1	0	1	0	0	63						1			
NM B727	Svallerup, Svallerup, Holbæk	181	1	neck collar	Svallerup	2	2222	0	1	0	0	1	0	0	1	0	0	1	0	63						1			
KS 6027f	Vaale, Steinburg, Schleswig-Holstein	6027f	3	belt disc	Ib	2	2223	0	1	0	0	1	0	0	1	0	0	0	1	63						1			
AM 6333	Hornslet Ø, Lisbjerg, Randers	6333	5	tutuli	IIIa4	3	2332	0	1	0	0	0	1	0	0	1	0	1	0	63						1			
NM B6623b	Vorup, Vejen, Ribe	B6623b	3	belt disc	Ib	2	1211	1	0	0	0	1	0	1	0	0	1	0	0	63						1			
NM B12931	Høve "Esterhøj", Ods, Holbæk	139	1	neck collar	Seeland	2	1222	1	0	0	0	1	0	0	1	0	0	1	0	62						1			
LMH 24976	Hohenbünstorf, Uelzen, Lower-Saxony	24976	3	belt disc	Ib	3	1112	1	0	0	1	0	0	1	0	0	0	1	0	62						1			
NM 10933	Svenstrup, Tårnborg, Sorø;	10933	2	belt plate	IIb2	2	1211	1	0	0	0	1	0	1	0	0	1	0	0	61						1			
LMH 14082	Appel, Harburg, Lower-Saxony	14082	3	belt disc	Ia	2	1223	1	0	0	0	1	0	0	1	0	0	0	1	61						1			
AM 877	Veilbymark, Horns, København	877	5	tutuli	IIIa4	3	1122	1	0	0	1	0	0	0	1	0	0	1	0	61						1			
ML 1133	Im Lüneburgischen, Lüneburg, Lower-Saxony	1133	4	disc-head pin		2	1322	1	0	0	0	0	1	0	1	0	0	1	0	60						1			
LMH 5552	Bülkau, Hadeln, Lower-Saxony	35	1	neck collar	Bütow	2	3232	0	0	1	0	1	0	0	0	1	0	1	0	60						1			
NM B11687	Lavø, Helsinge, Frederiksborg	B11687	3	belt disc	Ij	2	2121	0	1	0	1	0	0	0	1	0	1	0	0	59						1			
ML 242:84e	Molzen, Uelzen, Lower-Saxony	242:84e	3	belt disc	IcA	2	1121	1	0	0	1	0	0	0	1	0	1	0	0	58							1		
ML H107	Secklendorf, Uelzen, Lower-Saxony	343	1	neck collar	Bliederstedt	2	1322	1	0	0	0	0	1	0	1	0	0	1	0	58							1		
NM B10524	Løserup, Udby, Holbæk	49	1	neck collar	6	2	2232	0	1	0	0	1	0	0	0	1	0	1	0	58							1		
NM B9531	Glæsborg, Nørre, Randers	208	1	neck collar	Frankerup	2	1222	1	0	0	0	1	0	0	1	0	0	1	0	57							1		
NM B9532	Glæsborg, Nørre, Randers	209	1	neck collar	Frankerup	2	1222	1	0	0	0	1	0	0	1	0	0	1	0	57							1		
LMH 247:71	Ripdorf, Uelzen, Lower-Saxony	247:71	1	neck collar	Drage	2	1332	1	0	0	0	0	1	0	0	1	0	1	0	57							1		

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NM B17528	Østby Mark, Horns, Frederiksborg	241	1	neck collar	Heidenau NS	2	2222	0	1	0	0	1	0	0	1	0	0	1	0	56							1		
NM B2655	Vellinge Mose, Bederslev, Odense;	B2655	3	belt disc	Ig	2	1222	1	0	0	0	1	0	0	1	0	0	1	0	56							1		
NM B6623a	Vorup, Vejen, Ribe	B6623a	3	belt disc	Ib	2	1211	1	0	0	0	1	0	1	0	0	1	0	0	56							1		
ML 884	Eitzen, Uelzen, Lower-Saxony	227	1	neck collar	Rehlingen	2	1232	1	0	0	0	1	0	0	0	1	0	1	0	55							1		
ML 242:84f	Molzen, Uelzen, Lower-Saxony	242:84f	3	belt disc	IcA	2	1212	1	0	0	0	1	0	1	0	0	0	1	0	55							1		
ML 1007	Oldendorf a.d. Luhe, Lüneburg, Lower-Saxony	125	1	neck collar	Seeland (ehem. Bütow)	2a	1232	1	0	0	0	1	0	0	0	1	0	1	0	54							1		
ALM 2196a	Weisin, Ludwigslust-Parchim, Mecklenburg	2196a	4	pin	Weitgendorf	3	2212	0	1	0	0	1	0	1	0	0	0	1	0	54							1		
LMH 5032	Rehlingen, Lüneburg, Lower-Saxony	5032	4	wheel-headed pin	sceme E	2a	1232	1	0	0	0	1	0	0	0	1	0	1	0	54							1		
NM 6887	Snoldelev (sogn), København	6887	3	belt disc	Ib	2	1212	1	0	0	0	1	0	1	0	0	0	1	0	54							1		
NM B7618	Rye, Gorlev, Holbæk	B7618	3	belt disc	Ib	2	1112	1	0	0	1	0	0	1	0	0	0	1	0	54							1		
VM 1680 KK	Vognserup Enge, Kunby, Holbæk	1680 KK	3	belt disc	Ij	2	1222	1	0	0	0	1	0	0	1	0	0	1	0	53							1		
LMH 4931	Rehlingen, Lüneburg, Lower-Saxony	234	1	neck collar	Rehlingen	2a	1231	1	0	0	0	1	0	0	0	1	1	0	0	53							1		
HH 63928	Heidenau, Harburg, Lower-Saxony	240	1	neck collar	Heidenau	2	1232	1	0	0	0	1	0	0	0	1	0	1	0	53							1		
ML 242:84d	Molzen, Uelzen, Lower-Saxony	242:84d	3	belt disc	IcA	2	1221	1	0	0	0	1	0	0	1	0	1	0	0	53							1		
LMH 14154	Tandgndorf, Harburg, Lower-Saxony	251	1	neck collar	Quarrendorf	2	2231	0	1	0	0	1	0	0	0	1	1	0	0	53							1		
VM 1680 KG	Vognserup Enge, Kunby, Holbæk	1680 KG	3	belt disc	Ib	2	2222	0	1	0	0	1	0	0	1	0	0	1	0	52							1		
KS 3496	Schalkholz, Schalkholz, Schleswig-Holstein	330	1	neck collar	Traisbach C (?)	3	2232	0	1	0	0	1	0	0	0	1	0	1	0	52							1		
NM B7619	Rye, Gorlev, Holbæk	B7619	3	belt disc	Id2	2	1122	1	0	0	1	0	0	0	1	0	0	1	0	52							1		
ML Slg. Becker	Ehlbeck, Lüneburg, Lower-Saxony	Becker	4	disc-head pin		2	2222	0	1	0	0	1	0	0	1	0	0	1	0	52							1		
NM B 11250	Bustrup, Ramsig, Viborg	314	1	neck collar	Pisede	3	1122	1	0	0	1	0	0	0	1	0	0	1	0	51							1		
ALM 7236b	Heinrichswalde, Ludwigslust, Mecklenburg	7236b	4	disc-head pin		2	1222	1	0	0	0	1	0	0	1	0	0	1	0	51							1		
NM B 3061	Jægersborg Hegn "Rundforbi", Søllerød, København	B3061	6	tutuli dome	IIIb	2-3a	2212	0	1	0	0	1	0	1	0	0	0	1	0	51							1		
ML 242:84b	Molzen, Uelzen, Lower-Saxony	242:84b	3	belt disc	Ie1	2	1212	1	0	0	0	1	0	1	0	0	0	1	0	50							1		
LMH 13135c	Becklingen, Celle, Lower-Saxony	31	1	neck collar	Rehlingen	2	2232	0	1	0	0	1	0	0	0	1	0	1	0	50							1		
NM B9542	Glæsborg, Nørre, Randers	B9542	3	belt disc	Ic/d	2	1322	1	0	0	0	0	1	0	1	0	0	1	0	49							1		
KS 20284c	Schleswig, Schleswig, Schleswig-Holstein	20284c	3	belt disc	Ib	2	1232	1	0	0	0	1	0	0	0	1	0	1	0	48							1		
LMH 693:76	Wardböhmen, Celle, Lower-Saxony	237	1	neck collar	Rehlingen	2	2232	1	0	0	0	1	0	0	0	1	0	1	0	48							1		
NM B15850	Præstegårdsmark, Melby, Frederiksborg	B15850	3	belt disc	Ig	2	1221	1	0	0	0	1	0	0	1	0	1	0	0	48							1		
LMH 195:78	Lower Saxony, unknown location	195:78	1	neck collar	Babbin	2	2222	0	1	0	0	1	0	0	1	0	0	1	0	47							1		
NM B7071	Vranum, Almind, Viborg	204	1	neck collar	Drage	2	2232	0	1	0	0	1	0	0	0	1	0	1	0	47							1		
ALM Br. 92	Karbow, Ludwigslust-Parchim	Br.92	4	Weitgendorf pin	Weitgendorf	3	1222	1	0	0	0	1	0	0	1	0	0	1	0	47							1		
LMH 151:81	Heitbrack, Uelzen, Lower-Saxony	151:81	3	belt disc	Ic	2	1212	1	0	0	0	1	0	1	0	0	0	1	0	46							1		
ML 46	Heidekreis (Behringen, Soltau), Lower-Saxony	348	1	neck collar	Ebertshausen	2	1232	1	0	0	0	1	0	0	0	1	0	1	0	45							1		
ALM 7236a	Heinrichswalde, Ludwigslust, Mecklenburg	86	1	neck collar	Mistorf	2	1231	1	0	0	0	1	0	0	0	1	1	0	0	45							1		
NM B11964	Estrup, Ringsted, Sorø	B11964	5	tutuli	IIIa3a	3	2232	0	1	0	0	1	0	0	0	1	0	1	0	45							1		
KS 18214a	Lockstedter Lager, Steinburg, Schleswig-Holstein	122	1	neck collar	Bütow	2	1232	1	0	0	0	1	0	0	0	1	0	1	0	44								1	
LMH 14066	Lüneburg, Lüneburg, Lower-Saxony	124	1	neck collar	Bütow	2	2131	0	1	0	1	0	0	0	0	1	1	0	0	44								1	

museums number	site	ID	artefact category	artefact	type	Date/ period	skill category	surface fine	surface medium	surface coarse	DECOR 01	DECOR 02	DECOR 03	LEVEL high	LEVEL medium	LEVEL low	WORK very	WORK middle	WORK low	Production Unit	PU >300	PU 190-260	PU 160-190	PU 130-150	PU 100-120	PU 60-90	PU 50-60	PU 30-50	PU <30
LMH 953:76	Bleckmar, Celle, Lower-Saxony	224	1	neck collar	Rehlingen	2	2232	0	1	0	0	1	0	0	0	1	0	1	0	44								1	
LMH 4769	Appel, Harburg, Lower-Saxony	4769	3	belt disc	IE1	2	1222	1	0	0	0	1	0	0	1	0	0	1	0	44								1	
LMH 4771	Appel, Harburg, Lower-Saxony	4771	3	belt disc	IE1	2	1222	1	0	0	0	1	0	0	1	0	0	1	0	44								1	
NM B4750_3	Vendsyssel, København, København	68	1	neck collar	6	2	1232	0	1	0	0	1	0	0	0	1	0	1	0	44								1	
KS 6976g	Drage, Steinburg, Schleswig-Holstein	6976g	6	tutuli dome	IV b	2a	2323	0	1	0	0	0	1	0	1	0	0	0	1	44								1	
KS 6976gg	Drage, Steinburg, Schleswig-Holstein	6976gg	6	tutuli dome	IV b	2a	2221	0	1	0	0	1	0	0	1	0	1	0	0	44								1	
NM B9534	Glæsborg, Nørre, Randers	B9534	3	belt disc	Ib	2	1322	1	0	0	0	0	1	0	1	0	0	1	0	44								1	
LMH 13181a	Rätzlingen, Uelzen, Lower-Saxony	102	1	neck collar	Mistorf	2	1221	1	0	0	0	1	0	0	1	0	1	0	0	43								1	
NM B13727	Skrydstrup "Staldhøj", Haderslev	200	1	neck collar	Drage	3	1232	1	0	0	0	1	0	0	0	1	0	1	0	43								1	
LMH 4770	Appel, Harburg, Lower-Saxony	4770	3	belt disc	IE1	2	1222	1	0	0	0	1	0	0	1	0	0	1	0	43								1	
LMH 14147	Lüneburgisches, Lüneburg, Lower-Saxony	14147	1	neck collar	Babbin	2	1222	1	0	0	0	1	0	0	1	0	0	1	0	42								1	
LMH 13135a	Becklingen, Celle, Lower-Saxony	223	1	neck collar	Rehlingen	2	1232	1	0	0	0	1	0	0	0	1	0	1	0	42								1	
LM Han 14156	Soltau, Soltau, Lower-Saxony	353	1	neck collar	Toppenstedt	2	1232	1	0	0	0	1	0	0	0	1	0	1	0	42								1	
NM B4753_763	Vendsyssel, København, København	B4753_763	3	belt disc	Ig	2	1212	1	0	0	0	1	0	1	0	0	0	1	0	42								1	
AM 5171	Ballemose, Balle, Viborg	196	1	neck collar	Drage	2	1232	1	0	0	0	1	0	0	0	1	0	1	0	41								1	
NM B4753_890	Vendsyssel, København, København	B4753_890	3	belt disc	Ig	2	1211	1	0	0	0	1	0	1	0	0	1	0	0	41								1	
NM B7624	Rye, Gorlev, Holbæk	B7624	3	belt disc	Ig	2	1111	1	0	0	1	0	0	1	0	0	1	0	0	41								1	
LMH 12041	Lüneburg, Lüneburg, Lower-Saxony	12041	4	disc-head pin		2	1121	1	0	0	1	0	0	0	1	0	1	0	0	40								1	
IV65/37d	Rühlow, Neubrandenburg, Mecklenburg	127	1	neck collar	Bütow	2	2231	0	1	0	0	1	0	0	0	1	1	0	0	40								1	
HH 62886	Harburg, Harburg, Lower-Saxony	228	1	neck collar	Rehlingen	2	1232	1	0	0	0	1	0	0	0	1	0	1	0	40								1	
ML 238:84,b11	Kolkhagen, Lüneburg, Lower-Saxony	238:84,b11	2	belt plate	IIB1	2	1222	1	0	0	0	1	0	0	1	0	0	1	0	40								1	
NM 25789	Vellinge Mose, Bederslev, Odense;	25789	3	belt disc	Ig	2	1212	1	0	0	0	1	0	1	0	0	0	1	0	40								1	
KS B145-1a	Handewitt, Flensburg, Schleswig-Holstein	326	1	neck collar	Traisbach	3	1232	1	0	0	0	1	0	0	0	1	0	1	0	40								1	
KS 6027g	Vaale, Steinburg, Schleswig-Holstein	6027g	3	belt disc	Ij	2	2333	0	1	0	0	0	1	0	0	1	0	0	1	40								1	
NM B4753_1	Vendsyssel, København, København	B4753_1	3	belt disc	Ic	2	1322	1	0	0	0	0	1	0	1	0	0	1	0	40								1	
NM 10935c	Svenstrup, Tårnborg, Sorø	10935c	3	belt disc	Ib	2	1121	1	0	0	1	0	0	0	1	0	1	0	0	39								1	
LMH K851:76	Bleckmar, Celle, Lower-Saxony	225	1	neck collar	Rehlingen	2	2332	0	1	0	0	0	1	0	0	1	0	1	0	39								1	
ALM Br. 438	Möllen, Rostock, Mecklenburg	99	1	neck collar	Mistorf	2	2332	0	1	0	0	0	1	0	0	1	0	1	0	39								1	
NM B4357	Bragergården, Ørslev, Præsto	B4357	5	tutuli	IIIa4	3a	1232	1	0	0	0	1	0	0	0	1	0	1	0	39								1	
NM B4753_885	Vendsyssel, København, København	B4753_885	3	belt disc	Ig	2	1211	1	0	0	0	1	0	1	0	0	1	0	0	39								1	
NM 25834	Sorø bei, Lynge, Sorø	201	1	neck collar	Drage	2	1231	1	0	0	0	1	0	0	0	1	1	0	0	38								1	
LMH 4932	Raven, Harburg, Lower-Saxony	233	1	neck collar	Rehlingen	2	1231	1	0	0	0	1	0	0	0	1	1	0	0	38								1	
NM B 11957	Estrup, Ringsted, Sorø	82	1	neck collar	Mistorf	2	2232	0	1	0	0	1	0	0	0	1	0	1	0	38								1	
NM B13730	Skrydstrup "Staldhøj", Haderslev	B13730	8	armreif		3	1222	1	0	0	0	1	0	0	1	0	0	1	0	38								1	
VM 1680 R	Vognserup Enge, Kunby, Holbæk	1680 R	3	belt disc	Ig	2	1322	1	0	0	0	0	1	0	1	0	0	1	0	37								1	
NM B299b	Sludstrup, Skajærum, Hjøring	B299b	3	belt disc	Ig	2	2222	0	1	0	0	1	0	0	1	0	0	1	0	37								1	

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LMH 14146	Lüneburgisches, Lüneburg, Lower-Saxony	14146	1	neck collar	Mistorf	2	2222	0	1	0	0	1	0	0	1	0	0	1	0	36								1	
NM B4754_875	Vendsyssel, København	B4754_875	5	tutuli	IIIa2	2	2322	1	0	0	0	0	1	0	1	0	0	1	0	36								1	
NM B4754_878	Vendsyssel, København	B4754_878	5	tutuli	IIIa2	2	2322	1	0	0	0	0	1	0	1	0	0	1	0	36								1	
ALM IV/64/561c	Gielow, Mecklenburgische-Seenplatte (MES), Mecklenburg	IV/64/561c	8	armring	6	3	1331	1	0	0	0	0	1	0	0	1	1	0	0	36								1	
ALM IV/64/561d	Gielow, Mecklenburgische-Seenplatte (MES), Mecklenburg	IV/64/561d	8	armring	6	3	1331	1	0	0	0	0	1	0	0	1	1	0	0	36								1	
NM 10935b	Svenstrup, Tårnborg, Sorø	10935b	3	belt disc	Ib	2	1323	1	0	0	0	0	1	0	1	0	0	0	1	35								1	
NM 25789a	Vellinge Mose, Bederslev, Odense	25789a	3	belt disc	Ig	2	2222	0	1	0	0	1	0	0	1	0	0	1	0	35								1	
NM B9535b	Glæsborg, Nørre, Randers	B9535b	5	tutuli	Ig	2	1322	1	0	0	0	0	1	0	1	0	0	1	0	35								1	
NM B11688	Lavø, Helsinge, Frederiksborg	B11688	5	tutuli	IIIa	2	2211	0	1	0	0	1	0	1	0	0	1	0	0	34								1	
ALM 3139	Vorder-Bollhagen, Rostock, Mecklenburg	128	1	neck collar	Bütow	2	3232	0	0	1	0	1	0	0	0	1	0	1	0	33								1	
AM 5106	Kobeldal, Tørrild, Vejle	5106	5	tutuli	IIIa4	3	1121	1	0	0	1	0	0	0	1	0	1	0	0	33								1	
LMH 13135b	Becklingen, Celle, Lower-Saxony	77	1	neck collar	Mistorf	2	2232	0	1	0	0	1	0	0	0	1	0	1	0	33								1	
NM B2657	Vellinge Mose, Bederslev, Odense;	B2657	3	belt disc	Ig	2	1322	1	0	0	0	0	1	0	1	0	0	1	0	33								1	
AM 548	Jutland, Denmark, unknown location	548	1	neck collar	6	2	2232	0	1	0	0	1	0	0	0	1	0	1	0	32								1	
LMH 14161	Luttmissen, Uelzen, Lower-Saxony	84	1	neck collar	Mistorf (?)	2	1232	1	0	0	0	1	0	0	0	1	0	1	0	32								1	
NM B4754_873	Vendsyssel, København	B4754_873	5	tutuli	IIIa2	2	2322	1	0	0	0	0	1	0	1	0	0	1	0	32								1	
VM 1680 AG	Vognserup Enge, Kunby, Holbæk	1680 AG	3	belt disc	Ig	2	1121	1	0	0	1	0	0	0	1	0	1	0	0	31								1	
NM B9535a	Glæsborg, Nørre, Randers	B9535a	5	tutuli	Ig	2	1222	1	0	0	0	1	0	0	1	0	0	1	0	31								1	
VM 1680 AL	Vognserup Enge, Kunby, Holbæk	1680 AL	3	belt disc	Ig	2	2222	0	1	0	0	1	0	0	1	0	0	1	0	30								1	
KS 6976c	Drage, Steinburg, Schleswig-Holstein	197	1	neck collar	Drage	2a	2232	0	1	0	0	1	0	0	0	1	0	1	0	30								1	
NM B3140	Vellinge Mose, Bederslev, Odense	B3140	3	belt disc	Ig	2	2323	0	1	0	0	0	1	0	1	0	0	0	1	30								1	
ALM Br. 1204	Bütow, Mecklenburgische Seenplatte (MES), Mecklenburg	119	1	neck collar	Bütow	2	1131	1	0	0	1	0	0	0	0	1	1	0	0	29									1
VM 1680 KJ	Vognserup Enge, Kunby, Holbæk	1680 KJ	3	belt disc	Ib	2	2322	0	1	0	0	0	1	0	1	0	0	1	0	29									1
LMH 14145	Edendorf, Uelzen, Lower-Saxony	14145	1	neck collar	6	2	1232	1	0	0	0	1	0	0	0	1	0	1	0	28									1
HH 63931	Heidenau, Harburg, Lower-Saxony	63931	4	wheel-headed pin	sceme A	2	2232	0	1	0	0	1	0	0	0	1	0	1	0	28									1
ALM Br. 281	Boldebuck, Rostock, Mecklenburg	Br.281	5	tutuli	IIIa3	3	2232	0	1	0	0	1	0	0	0	1	0	1	0	28									1
ALM Br. 284	Boldebuck, Rostock, Mecklenburg	Br.284	5	tutuli	IIIa3	3	2232	0	1	0	0	1	0	0	0	1	0	1	0	28									1
ALM Br. 285	Boldebuck, Rostock, Mecklenburg	Br.285	5	tutuli	IIIa3	3	2232	0	1	0	0	1	0	0	0	1	0	1	0	28									1
NM 10942	Svenstrup, Tårnborg, Sorø	10942	6	tutuli dome	Ivb	2	1222	1	0	0	0	1	0	0	1	0	0	1	0	27									1
NM 10942a	Svenstrup, Tårnborg, Sorø	10942a	6	tutuli dome	Ivb	2	2221	0	1	0	0	1	0	0	1	0	1	0	0	27									1
VM 1680 X	Vognserup Enge, Kunby, Holbæk	1680 X	3	belt disc	Ig	2	1222	1	0	0	0	1	0	0	1	0	0	1	0	27									1
ML 1009	Oldendorf a.d. Luhe, Lüneburg, Lower-Saxony	1009	4	wheel-headed pin	Lüneburge	2a	2322	0	1	0	0	0	1	0	1	0	0	1	0	26									1
VM 1680 AH	Vognserup Enge, Kunby, Holbæk	1680 AH	3	belt disc	Ig	2	2322	0	1	0	0	0	1	0	1	0	0	1	0	26									1
HH 62376a	Toppenstedt, Harburg, Lower-Saxony	62376a	3	hanging disc	V1a	2	2323	0	1	0	0	0	1	0	1	0	0	0	1	26									1
HH 62376b	Toppenstedt, Harburg, Lower-Saxony	62376b	3	hanging disc	V1a	2	2323	0	1	0	0	0	1	0	1	0	0	0	1	26									1

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HH 62376c	Toppenstedt, Harburg, Lower-Saxony	62376c	3	hanging disc	V1a	2	2323	0	1	0	0	0	1	0	1	0	0	0	1	26									1
LMH 13178	Amelinghausen, Lüneburg, Lower-Saxony	13178	7	bracelet	stud	2	1232	1	0	0	0	1	0	0	0	1	0	1	0	25									1
ALM 3140	Vorder-Bollhagen, Rostock	3140	3	belt disc	Ig	2	1222	1	0	0	0	1	0	0	1	0	0	1	0	25									1
NM B11252	Bustrup, Ramsing, Viborg	B11252	5	tutuli	IIIa3	3	2232	0	1	0	0	1	0	0	0	1	0	1	0	25									1
ML 1008	Oldendorf a.d. Luhe, Lüneburg, Lower-Saxony	1008	4	wheel-headed pin		2a	2223	0	1	0	0	1	0	0	1	0	0	0	1	24									1
NM B4754_884	Vendsyssel, København	B4754_884	5	tutuli	IIIa1a	2	1222	1	0	0	0	1	0	0	1	0	0	1	0	24									1
VM 1680 AD	Vognserup Enge, Kunby, Holbæk	1680 AD	3	belt disc	Ig	2	2322	0	1	0	0	0	1	0	1	0	0	1	0	23									1
NM B4238	Ferslev „Dansehøj", Frederiksborg	B4238	5	tutuli	IIIb1	2b	1222	1	0	0	0	1	0	0	1	0	0	1	0	22									1
LMH 14161 S	Luttmissen, Uelzen, Lower-Saxony	14161S	7	bracelet	stud	2	1232	1	0	0	0	1	0	0	0	1	0	1	0	21									1
LMH 5027	Edendorf, Uelzen, Niedrsachsen	5027	4	wheel-headed pin	type Netrae	2	2322	0	1	0	0	0	1	0	1	0	0	1	0	21									1
NM B15848	Præstegårdsmark, Melby, Frederiksborg	B15848	5	tutuli	IIIa2	2	2333	0	1	0	0	0	1	0	0	1	0	0	1	21									1
ALM 2000/1277,10	Lübz, Ludwigslust-Parchim, Mecklenburg	2000/1277,10	5	tutuli	IIIa2a	3	2232	0	1	0	0	1	0	0	0	1	0	1	0	20									1
NM 10938a	Svenstrup, Tårnborg, Sorø	10938a	3	belt disc	Ig	2	2322	0	1	0	0	0	1	0	1	0	0	1	0	19									1
NM 10938b	Svenstrup, Tårnborg, Sorø	10938b	3	belt disc	Ig	2	2222	0	1	0	0	1	0	0	1	0	0	1	0	19									1
NM 10938c	Svenstrup, Tårnborg, Sorø	10938c	3	belt disc	Ig	2	2222	0	1	0	0	1	0	0	1	0	0	1	0	19									1
LMH 1026:76	Becklingen, Celle, Lower-Saxony	252	1	neck collar	Hollenstedt	2	2121	0	1	0	1	0	0	0	1	0	1	0	0	19									1
LMH 1032:76a	Becklingen, Celle, Lower-Saxony	1032:76a	3	hanging disc	V1a5	2	3232	0	0	1	0	1	0	0	0	1	0	1	0	18									1
LMH 1032:76b	Becklingen, Celle, Lower-Saxony	1032:76b	3	hanging disc	V1a5	2	3232	0	0	1	0	1	0	0	0	1	0	1	0	18									1
LMH 1033:76	Becklingen, Celle, Lower-Saxony	1033:76	3	hanging disc	V1a5	2	3232	0	0	1	0	1	0	0	0	1	0	1	0	18									1
LMH 13176	Amelinghausen, Lüneburg, Lower-Saxony	13176	8	Armring		2	2212	0	1	0	0	1	0	1	0	0	0	1	0	18									1
LMH 13174	Amelinghausen, Lüneburg, Lower-Saxony	13174	3	belt disc	Ifa	2	2232	0	1	0	0	1	0	0	0	1	0	1	0	15									1
LMH 14164	Westerweyhe, Uelzen, Lower-Saxony	14164	7	bracelet	stud	2a	3233	0	0	1	0	1	0	0	0	1	0	0	1	14									1
LMH 14083	Raven, Harburg, Lower-Saxony	14083	3	hanging disc	V1b	2	1231	1	0	0	0	1	0	0	0	1	1	0	0	13									1
LMH 14084	Raven, Harburg, Lower-Saxony	14084	3	hanging disc	V1b	2	1231	1	0	0	0	1	0	0	0	1	1	0	0	13									1
LMH 12018	Westerweyhe, Uelzen, Lower-Saxony	12018	4	wheel-headed pin		2a	2332	0	1	0	0	0	1	0	0	1	0	1	0	12									1

Table 3: Metal analysis

ID				general information					metal composition													Corrosion		Reference
Museum ID	Analysis ID	INFO	Metallography	find location	region	Date	laboratory	method	Cu in %	Sn in %	Sb in %	Pb in %	Fe in %	Ni in %	Zn in %	As in %	Ag in %	Bi in %	Au in %	Co in %	S in %	measured corrosion elements in %	corrosion elements	
ALM 2303	DBB-259	surface	no	Alt Sammit, Rostock (LRO)	D	NBA III	DBM	hhXRF	**66.7**	**21.50**	**0.20**	**0.84**	**0.43**	**0.35**	**0.22**	**0.51**	nM	**0.04**	nM	**0.02**	nM	9.2	Ti	Nørgaard 2015a; Nørgaard 2017
ALM 2300	DBB-209	centre part	no	Alt Sammit, Rostock (LRO)	D	NBA III	DBM	hhXRF	**54.1**	**32.99**	**0.16**	**0.67**	**0.22**	**0.67**	**0.35**	**0.89**	nM	**0.04**	nM	nM	nM	9.9	Ti/W	Nørgaard 2015a; Nørgaard 2017
ALM 2300	DBB-210	ring part	no	Alt Sammit, Rostock (LRO)	D	NBA III	DBM	hhXRF	**57.7**	**26.21**	**0.14**	**0.65**	**0.25**	**0.51**	**0.26**	**0.62**	nM	**0.03**	nM	nM	nM	13.6	Ti/V	Nørgaard 2015a; Nørgaard 2017
ALM 2300	DBB-208	tip	no	Alt Sammit, Rostock (LRO)	D	NBA III	DBM	hhXRF	**31.9**	**32.19**	**0.83**	**31.23**	**0.18**	**0.22**	**1.65**	nM	nM	nM	nM	nM	nM	1.8		Nørgaard 2015a; Nørgaard 2017
ALM 2303	DBB-221	surface	no	Alt Sammit, Rostock (LRO)	D	NBA III	DBM	hhXRF	**65.6**	**23.96**	**0.20**	**0.80**	**0.41**	**0.35**	**0.22**	**0.63**	nM	**0.05**	nM	nM	nM	7.8	Mo/Ti	Nørgaard 2015a; Nørgaard 2017
ALM 2303	DBB-201	artificial covering	no	Alt Sammit, Rostock (LRO)	D	NBA III	DBM	hhXRF	**58.0**	**29.52**	**0.22**	**1.11**	**0.93**	**0.44**	**0.32**	**0.69**	nM	**0.05**	nM	**0.03**	nM	8.7	Ti/W	Nørgaard 2015a; Nørgaard 2017
LMN 13178	13178	ground sample	yes	Amelinghausen, Lüneburg	D	ZG I-III	DBM	SEM	**81.2**	**12.77**	nM	nM	nM	nM	nM	nM	nM	nM	nM	nM	**0.57**	5.4	O/C	Nørgaard 2015b
LMN 13176	13176	ground sample	yes	Amelinghausen, Lüneburg	D	ZG I-III	DBM	SEM	**84.1**	**15.20**	nM	nM	nM	nM	nM	**0.27**	nM	nM	nM	nM	**0.25**	0.1		Nørgaard 2015b
LMN 13176	4331_12	drill cuttings	yes	Amelinghausen, Lüneburg	D	ZG I-III	DBM	ICP-MS	**81.2**	**13.50**	**0.16**	**0.08**	**0.06**	**0.81**	**0.01**	**0.42**	nM	nM	nM	nM	**0,16**	3.4		Nørgaard 2015b
LMN 13175	13175	drill cuttings	yes	Amelinghausen, Lüneburg	D	ZG I-III	DBM	ICP-MS	**80.8**	**15.60**	**0.05**	**0.00**	**0.39**	**0.50**	**0.00**	**0.09**	nM	nM	nM	nM	nM	2.6		Nørgaard 2015b
LMN 13177/ 13179	13177 B	ground sample	yes	Amelinghausen, Lüneburg	D	ZG I-III	DBM	SEM	**82.5**	**16.22**	nM	nM	nM	nM	nM	**0.58**	nM	nM	nM	nM	**0.67**	0.1		Nørgaard 2015b
LMN 13179/ 13177	13177 B2	ground sample	yes	Amelinghausen, Lüneburg	D	ZG I-III	DBM	SEM	**82.2**	**16.98**	nM	nM	nM	nM	nM	**0.02**	nM	nM	nM	nM	**0.79**	0.1		Nørgaard 2015b
Stralsund 1962:165o	33056	drill cuttings	no	Babbin, Woiw. Szczecin	P	NBA Ic-IIa	Stuttgart	OES	**83.0**	**7.41**	**0.08**	**0.03**	**1.50**	**0.37**	**0.10**	**0.53**	**0.06**	**0.01**	**0.02**	**0.02**	nM	6.9		Krause 2003; Junghans et al. 1974
Stralsund 1962:165o	33539	drill cuttings	no	Babbin, Woiw. Szczecin	P	NBA Ic-IIa	Stuttgart	OES	**88.2**	**9.90**	**0.09**	**0.01**	**0.06**	**0.63**	**0.10**	**0.93**	**0.06**	**0.01**	**0.01**	**0.02**	nM	0.0		Krause 2003; Junghans et al. 1974
LMN 13135b	13135b B	ground sample	yes	Becklingen, Celle	D	NBA II	DBM	SEM	**90.1 (88.2)**	**9.6 (11.37)**	nM	nM	nM	nM	nM	nM	nM	nM	nM	nM	**0,29 (0,39)**	0.1		Nørgaard 2015b
LMN 13135b	13135b E	ground sample	yes	Becklingen, Celle	D	NBA II	DBM	SEM	**88.0**	**11.54**	nM	nM	nM	nM	nM	nM	nM	nM	nM	nM	**0.46**	0.1		Nørgaard 2015b
LMN 13135c	13135c	ground sample	yes	Becklingen, Celle	D	NBA II	DBM	SEM	**86.4**	**12.90**	nM	nM	nM	nM	nM	nM	nM	nM	nM	nM	**0.67**	0.1		Nørgaard 2015b
LMN 13135a	13135a	ground sample	yes	Becklingen, Celle	D	NBA II	DBM	SEM	**85.3 (85.8)**	**13.68 (13.26)**	nM	nM	nM	nM	nM	0.32	nM	nM	nM	nM	**1,05 (0,64)**	0.1		Nørgaard 2015b
LMN 13135a	4346_12	drill cuttings	yes	Becklingen, Celle	D	NBA II	DBM	ICP-MS	**75.4**	**13.10**	**0.33**	**0.03**	**0.07**	**1.09**	**0.01**	0.45	nM	nM	nM	nM	**0,17**	9.0		Nørgaard 2015b
LMN 13135a	13135a E	ground sample	yes	Becklingen, Celle	D	NBA II	DBM	SEM	**85.5**	**13.24**	nM	nM	nM	nM	nM	**0.28**	nM	nM	nM	nM	**0.97**	0.1		Nørgaard 2015b
LMN K 851:76	K 851:76 R	ground sample	yes	Bleckmar, Celle	D	NBA II	DBM	SEM	**73.8**	**16.04**	nM	nM	nM	nM	nM	**0.36**	nM	nM	nM	nM	**0,07**	9.8		Nørgaard 2015b
ALM Br. 271	DBB-205	surface	no	Boldebuck, Rostock (LRO)	D	NBA III	DBM	hhXRF	**85.7**	**12.53**	**0.14**	**0.37**	**0.07**	**0.04**	**0.14**	**0.29**	nM	**0.01**	nM	nM	nM	0.7	Cr	Nørgaard 2015a; Nørgaard 2017
Waren IV/64/737 b	32291	drill cuttings	no	Borntin, Vorpommern-Greifswald (VP)	D	NBA III	Stuttgart	OES	**79.0**	**9.14**	**0.43**	**0.01**	**0.28**	**0.73**	**0.10**	**1.32**	**0.01**	**0.01**	**0.02**	**0.06**	nM	8.9		Krause 2003; Junghans et al. 1974
ALM Br. 733		drill cuttings	no	Bredentin, Rostock (LRO)	D	NBAIII	Stuttgart	OES	**71.8**	**7.05**	nM	nM	nM	nM	nM	nM	nM	nM	nM	nM	**0.39**	20.8		Otto/ Witter 1952
LMN 5552	5552	ground sample	yes	Bülkau, Hadeln	D	NBA II	DBM	SEM	**86.5**	**5.47**	nM	nM	nM	nM	nM	**0.40**	nM	nM	nM	nM	**0.22**	7.4		Nørgaard 2015b
LMN 5552	4329_12	drill cuttings	yes	Bülkau, Hadeln	D	NBA II	DBM	ICP-MS	**93.1**	**4.58**	**0.03**	**0.01**	**0.04**	**0.47**	**0.01**	**0.51**	nM	nM	nM	nM	**0,23**	6.9		Nørgaard 2015b
ALM Br. 1204	DBB-222	surface	no	Bütow, Mecklenburgische Seenplatte (MSE)	D	NBA II	DBM	hhXRF	**56.5**	**26.23**	**0.68**	**0.03**	**1.32**	**0.34**	**0.13**	**0.37**	nM	nM	nM	nM	nM	14.4	Ti/V/W	Nørgaard 2015a; Nørgaard 2017
ALM Br. 1204	DBB-262	fracture surface	no	Bütow, Mecklenburgische Seenplatte (MSE)	D	NBA II	DBM	hhXRF	**84.8**	**11.83**	**0.39**	**0.09**	**0.15**	**0.42**	nM	**0.20**	nM	nM	nM	**0.04**	nM	2.1	Ti	Nørgaard 2015a; Nørgaard 2017
ALM Br. 1204	DBB-224	fracture surface	no	Bütow, Mecklenburgische Seenplatte (MSE)	D	NBA II	DBM	hhXRF	**83.7**	**11.55**	**0.38**	**0.02**	**0.18**	**0.38**	nM	**0.19**	nM	nM	nM	**0.04**	nM	3.6	Ti	Nørgaard 2015a; Nørgaard 2017
ALM Br. 1204	33104	drill cuttings	no	Bütow, Mecklenburgische Seenplatte (MSE)	D	NBA II	Stuttgart	OES	**88.0**	**9.60**	**0.34**	**0.01**	**0.10**	**0.41**	**0.10**	**0.21**	**0.01**	**0.01**	**0.01**	**0.06**	nM	1.2		Krause 2003; Junghans et al. 1974
ALM Br. 239	DBB-232	surface	no	Dabel, Ludwigslust-Parchim (LUP)	D	NBA III	DBM	hhXRF	**82.1**	**13.96**	**0.15**	**0.23**	**0.24**	**0.28**	**0.08**	**0.34**	nM	nM	nM	**0.01**	nM	2.7		Nørgaard 2015a; Nørgaard 2017
LMN 14145	14145	ground sample	yes	Edendorf, Uelzen	D	NBA II (?)	DBM	SEM	**89.3**	**10.48**	nM	nM	nM	nM	nM	nM	nM	nM	nM	nM	**0.23**	0.1		Nørgaard 2015b
LMN 14144/ 1	14144/1	ground sample	yes	Edendorf, Uelzen	D	NBA II (?)	DBM	SEM	**84.7**	**14.88**	nM	nM	nM	nM	nM	nM	nM	nM	nM	nM	**0.46**	0.1		Nørgaard 2015b
LMN 14144/ 2	14144/2	ground sample	yes	Edendorf, Uelzen	D	NBA II (?)	DBM	SEM	**85.2**	**14.33**	nM	nM	nM	nM	nM	nM	nM	nM	nM	nM	**0.45**	0.1		Nørgaard 2015b

ID				general information					metal composition													Corrosion		Reference
Museum ID	Analysis ID	INFO	Metallography	find location	region	Date	laboratory	method	Cu in %	Sn in %	Sb in %	Pb in %	Fe in %	Ni in %	Zn in %	As in %	Ag in %	Bi in %	Au in %	Co in %	S in %	measured corrosion elements in %	corrosion elements	
ALM Br. 149, 17 (7)	DBB-234	fracture surface	no	Friedrichsruhe, Ludwigslust-Parchim (LUP)	D	NBA III	DBM	hhXRF	**77.2**	**16.03**	**0.06**	**0.35**	**0.10**	**0.31**	**0.10**	**0.38**	nM	**0.01**	nM	nM	nM	5.4	Mn/Ti/V	Nørgaard 2015a; Nørgaard 2017
ALM IV/ 64/ 561d	DBB-194	surface patina	no	Gielow, Mecklenburgische Seenplatte (MSE)	D	NBA III	DBM	hhXRF	**81.3**	**14.31**	**0.18**	**0.13**	**0.08**	**0.62**	**0.10**	**0.38**	nM	nM	nM	**0.02**	nM	2.9		Nørgaard 2015a; Nørgaard 2017
ALM IV/ 64/ 561d	DBB-193	surface polished (patina free)	no	Gielow, Mecklenburgische Seenplatte (MSE)	D	NBA III	DBM	hhXRF	**84.7**	**11.46**	**0.14**	**0.11**	**0.12**	**0.71**	**0.08**	**0.30**	nM	nM	nM	**0.02**	nM	2.4	Ti	Nørgaard 2015a; Nørgaard 2017
ALM IV/ 64/ 561c	DBB-192	surface patina	no	Gielow, Mecklenburgische Seenplatte (MSE)	D	NBA III	DBM	hhXRF	**81.7**	**12.24**	**0.11**	**0.17**	**0.11**	**0.49**	**0.13**	**0.23**	nM	nM	nM	**0.02**	nM	4.8		Nørgaard 2015a; Nørgaard 2017
ALM IV/ 64/ 561c	DBB-191	surface polished (patina free)	no	Gielow, Mecklenburgische Seenplatte (MSE)	D	NBA III	DBM	hhXRF	**85.7**	**11.27**	**0.09**	**0.22**	**0.16**	**0.39**	**0.13**	**0.17**	nM	nM	nM	**0.03**	nM	1.9	Nb/Ti/Zr	Nørgaard 2015a; Nørgaard 2017
ALM IV/ 64/ 561b	DBB-260	surface	no	Gielow, Mecklenburgische Seenplatte (MSE)	D	NBA III	DBM	hhXRF	**80.8**	**11.86**	**0.09**	**0.31**	**1.26**	**0.13**	**0.26**	**0.07**	nM	**0.02**	nM	**0.05**	nM	5.1	Mn/ Ti/V/Zr	Nørgaard 2015a; Nørgaard 2017
ALM LII Q, 5	DBB-244	surface	no	Grabow (in Wittenmoor), Ludwigslust-Parchim (LUP)	D	NBA III	DBM	hhXRF	**58.3**	**23.35**		**1.33**	**0.28**	**0.42**	**0.21**	**0.52**	nM	**0.06**	nM	**0.03**	nM	15.5	Ti	Nørgaard 2015a; Nørgaard 2017
ALM LII Q, 5	DBB-293	surface inside	no	Grabow (in Wittenmoor), Ludwigslust-Parchim (LUP)	D	NBA III	DBM	hhXRF	**50.5**	**23.83**	nM	**1.35**	**0.46**	**0.17**	**0.16**	**0.37**	nM	**0.05**	nM	nM	nM	23.1	Ti/V/W	Nørgaard 2015a; Nørgaard 2017
ALM LIH 16	DBB-227	surface	no	Grabow, Ludwigslust-Parchim (LUP)	D	NBA II/III	DBM	hhXRF	**71.5**	**19.91**	**0.31**	**0.10**	**0.31**	**0.60**	**0.11**	**0.72**	nM	nM	nM	**0.03**	nM	6.4	Ti	Nørgaard 2015a; Nørgaard 2017
ALM 7236b	DBB-238	surface	no	Heinrichswalde, Ludwigslust-Parchim (LUP)	D	NBA II	DBM	hhXRF	**86.7**	**9.25**	nM	**0.77**	**0.46**	**0.21**	**0.05**	**0.20**	nM	nM	nM	nM	nM	2.4	Ti/Zr	Nørgaard 2015a; Nørgaard 2017
LMN 138:81	138:81	drill cuttings	no	Heitbrack, Uelzen	D	NBA II	DBM	ICP-MS	**85.8**	**10.59**	**0.03**	**0.01**	**0.01**	**0.40**	**0.00**	**0.09**	nM	nM	nM	nM	nM	3.0		Nørgaard 2015b
LMN 139:81	139:81	drill cuttings	no	Heitbrack, Uelzen	D	NBA II	DBM	ICP-MS	**84.1**	**12.17**	**0.17**	**0.09**	**0.04**	**0.53**	**0.01**	**0.29**	nM	nM	nM	nM	nM	2.6		Nørgaard 2015b
LMN 148:81	148:81	drill cuttings	no	Heitbrack, Ülzen	D	NBA II	DBM	ICP-MS	**82.5**	**14.30**	**0.04**	**0.01**	**0.07**	**0.98**	**0.00**	**0.43**	nM	nM	nM	nM	nM	1.7		Nørgaard 2015b
ALM Br. 88	DBB-212	surface	no	Karbow, Ludwigslust-Parchim (LUP)	D	NBA III	DBM	hhXRF	**78.8**	**14.85**	nM	**0.18**	**0.10**	**0.31**	**0.15**	**0.32**	nM	nM	nM	**0.02**	nM	5.3	Ti/Zr	Nørgaard 2015a; Nørgaard 2017
ALM Br. 92	DBB-231	surface	no	Karbow, Ludwigslust-Parchim (LUP)	D	NBA III	DBM	hhXRF	**76.7**	**9.45**	**0.06**	**0.27**	**0.74**	**0.38**	**0.12**	**0.15**	nM	nM	nM	**0.03**	nM	12.1	Mn/ Ti/V/Zr	Nørgaard 2015a; Nørgaard 2017
Szczecin A 16 561	34053	drill cuttings	no	Klempenow, Mecklenburgische Seenplatte (MSE)	D	NBA II	Stuttgart	OES	**91.0**	**8.10**	**0.01**	**0.01**	**0.05**	**0.23**	**0.10**	**0.47**	**0.01**	**0.01**	**0.01**	**0.02**	nM	0.0		Krause 2003; Junghans et al. 1974
ALM LII Q, 4	DBB-246	surface	no	Kremmin, Ludwigslust-Parchim (LUP)	D	NBA III	DBM	hhXRF	**68.5**	**10.71**	**0.04**	**0.19**	**0.38**	**0.15**	**0.06**	**0.11**	nM	**0.01**	nM	**0.02**	nM	19.8	Mn/ Ti/Zr	Nørgaard 2015a; Nørgaard 2017
ALM LII Q, 4	DBB-286	surface	no	Kremmin, Ludwigslust-Parchim (LUP)	D	NBA III	DBM	hhXRF	**67.0**	**8.78**	nM	**0.18**	**0.38**	**0.22**	**0.07**	**0.11**	nM	**0.01**	nM	**0.01**	nM	23.3	Mn/ Ti/Zr	Nørgaard 2015a; Nørgaard 2017
ALM LII Q, 4	DBB-287	surface	no	Kremmin, Ludwigslust-Parchim (LUP)	D	NBA III	DBM	hhXRF	**67.1**	**8.71**	**0.03**	**0.24**	**0.52**	**0.15**	**0.06**	**0.12**	nM	**0.01**	nM	**0.01**	nM	23.1	Mn/ Ti/W/Zr	Nørgaard 2015a; Nørgaard 2017
MVF II 5687	33596	drill cuttings	no	Lemmersdorf, Prenzlau	D	NBA II	Stuttgart	OES	**86.0**	**6.35**	**0.05**	**0.06**	**0.36**	**0.51**	**0.10**	**0.47**	**0.01**	**0.01**	**0.02**	**0.04**	nM	6.0		Krause 2003; Junghans et al. 1974
MVF II 5688	33598	drill cuttings	no	Lemmersdorf, Prenzlau	D	NBA II	Stuttgart	OES	**87.0**	**6.14**	**0.18**	**0.08**	**0.07**	**0.31**	**0.10**	**0.30**	**0.01**	**0.01**	**0.02**	**0.05**	nM	5.7		Krause 2003; Junghans et al. 1974
MVF If 395	33652	drill cuttings	no	Lichterfelde, Märkisch-Oderland	D	NBA II	Stuttgart	OES	**86.0**	**5.74**	**0.03**	**0.17**	**1.33**	**0.36**	**0.10**	**0.44**	**0.01**	**0.01**	**0.02**	**0.02**	nM	5.8		Krause 2003; Junghans et al. 1974
ALM 94/3/1	DBB-263	surface	no	Lubmin, Vorpommern-Greifswald (VP)	D	NBA III	DBM	hhXRF	**38.5**	**49.36**	nM	**0.15**	**6.10**	nM	**0.15**	**0.22**	nM	**0.03**	nM	nM	nM	5.5	Ti	Nørgaard 2015a; Nørgaard 2017
ALM 94/3/1	DBB-264	surface	no	Lubmin, Vorpommern-Greifswald (VP)	D	NBA III	DBM	hhXRF	**34.0**	**46.40**	nM	**0.14**	**2.78**	nM	**0.12**	**0.17**	nM	**0.02**	nM	nM	nM	16.4	Ti/W	Nørgaard 2015a; Nørgaard 2017
ALM 94/3/1	DBB-235	artificial covering	no	Lubmin, Vorpommern-Greifswald (VP)	D	NBA III	DBM	hhXRF	**36.0**	**40.67**	nM	**0.15**	**7.73**	nM	**0.12**	**0.21**	nM	**0.02**	nM	nM	nM	15.1	Ti	Nørgaard 2015a; Nørgaard 2017
LMN 14148	14148	ground sample	yes	Luneburgian	D	NBA II	DBM	SEM	**84.49**	**14.21**	nM	nM	nM	nM	nM	**0.81**	nM	nM	nM	nM	**0,49**	0.1		Nørgaard 2015b
LMN 14147	14147	ground sample	yes	Luneburgian	D	NBA II (?)	DBM	SEM	**84.5 (84.2)**	**14.21 (14.38)**	nM	nM	**0.69**	nM	nM	**0.81**	nM	nM	nM	nM	**0,49 (0,76)**	0.1		Nørgaard 2015b
LMN 14147	4340_12	drill cuttings	yes	Luneburgian	D	NBA II (?)	DBM	ICP-MS	**74.3**	**10.00**	**0.07**	**0.06**	**0.51**	**0.35**	**0.01**	**0.19**	nM	nM	nM	nM	**0,13**	14.2		Nørgaard 2015b
LMN 14146	14146	ground sample	yes	Luneburgian	D	NBA II (?)	DBM	SEM	**83.4**	**15.92**	nM	nM	nM	nM	nM	nM	nM	nM	nM	nM	**0.65**	0.1		Nørgaard 2015b
LMN 14147	14147 E	ground sample	yes	Luneburgian	D	NBA II (?)	DBM	SEM	**82.6**	**16.90**	nM	nM	nM	nM	nM	**0.05**	nM	nM	nM	nM	**0.40**	0.1		Nørgaard 2015b
LMN 14161	14161 E	ground sample	yes	Luttmissen, Uelzen	D	NBA II	DBM	SEM	**86.1 (85.2)**	**13.54 (14.59)**	nM	nM	nM	nM	nM	nM	nM	nM	nM	nM	**0,38 (0,24)**	0.1		Nørgaard 2015b
LMN 14161	14161 B	ground sample	yes	Luttmissen, Uelzen	D	NBA II	DBM	SEM	**84.7 (85.2)**	**14.75 (14.96)**	nM	nM	nM	nM	nM	nM	nM	nM	nM	nM	**0,51 (0,39)**	0.1		Nørgaard 2015b

ID				general information					metal composition													Corrosion		Reference
Museum ID	Analysis ID	INFO	Metallography	find location	region	Date	laboratory	method	Cu in %	Sn in %	Sb in %	Pb in %	Fe in %	Ni in %	Zn in %	As in %	Ag in %	Bi in %	Au in %	Co in %	S in %	measured corrosion elements in %	corrosion elements	
LMN 14161 S	4357_12	drill cuttings	yes	Luttmissen, Uelzen	D	NBA II	DBM	ICP-MS	79.5	14.00	0.18	0.03	0.06	0.70	0.01	0.34	nM	nM	nM	nM	0,25	4.8		Nørgaard 2015b
LMN 14161 S	14161 S	ground sample	yes	Luttmissen, Uelzen	D	NBA II	DBM	SEM	79.3	20.09	nM	nM	nM	nM	nM	nM	nM	nM	nM	nM	0,27	0.3		Nørgaard 2015b
ALM 2000/1277,3	DBB-247	surface outside	no	Lübz, Ludwigslust-Parchim (LUP)	D	NBA III	DBM	hhXRF	81.6	12.93	0.40	0.61	0.04	0.17	0.12	0.09	nM	0.02	nM	nM	nM	4.0	Ti/W	Nørgaard 2015a; Nørgaard 2017
ALM 2000/1277,3	DBB-248	surface inside	no	Lübz, Ludwigslust-Parchim (LUP)	D	NBA III	DBM	hhXRF	82.5	12.95	0.37	0.59	nM	0.33	0.16	0.18	nM	0.02	nM	0.01	nM	2.8	Ti/W/Zr	Nørgaard 2015a; Nørgaard 2017
LMN 14066	14066	drill cuttings	no	Lüneburg, Lüneburg	D	NBA II	DBM	ICP-MS	78.2	13.21	0.22	0.02	0.06	0.57	0.00	0.42	nM	nM	nM	nM	nM	7.3		Nørgaard 2015b
ALM 26	DBB-226	surface	no	Mecklenburg	D	NBA III	DBM	hhXRF	66.2	19.41	0.15	1.05	0.49	0.46	0.13	0.45	nM	0.08	nM	nM	nM	11.6	Ti	Nørgaard 2015a; Nørgaard 2017
ALM 94/1032/4	DBB-195	surface	no	Mecklenburg	D	NBA III	DBM	hhXRF	80.0	15.16	0.05	0.16	0.05	0.28	0.11	0.20	nM	nM	nM	nM	nM	4.0	Ti/Zr	Nørgaard 2015a; Nørgaard 2017
Güstrow I 58/9	33139	drill cuttings	no	Mistorf, Rostock (LRO)	D	NBA Ic-IIa	Stuttgart	OES	88.7	10.40	0.04	0.02	0.10	0.24	0.10	0.38	0.01	0.01	0.01	0.01	nM	0.0		Krause 2003; Junghans et al. 1974
LMN 99:33	99:33	ground sample	yes	Moorkate, Fallingbostel	D	NBA II	DBM	SEM	80.52	15.19	nM	nM	nM	nM	nM	nM	nM	nM	nM	nM	nM	4.3		Nørgaard 2015b
ALM Br. 438	32745	drill cuttings	no	Möllen, Rostock (LRO)	D	NBA II	Stuttgart	OES	86.0	6.50	0.05	0.08	0.42	0.19	0.10	0.48	0.02	0.01	0.02	0.02	nM	6.1		Krause 2003; Junghans et al. 1974
ALM Br. 438	33163	drill cuttings	no	Möllen, Rostock (LRO)	D	NBA II	Stuttgart	OES	88.6	10.20	0.04	0.14	0.11	0.24	0.10	0.53	0.02	0.01	0.01	0.01	nM	0.0		Krause 2003; Junghans et al. 1974
ALM Br. 438	DBB-200	surface	no	Möllen, Rostock (LRO)	D	NBA II	DBM	hhXRF	78.3	16.26	nM	0.20	1.22	0.14	0.13	0.27	nM	nM	nM	nM	nM	3.5	Ti	Nørgaard 2015a; Nørgaard 2017
Stralsund 7208	33050	drill cuttings	no	Neddesitz, Vorpommern-Rügen (LVR)	D	NBA II	Stuttgart	OES	46.0	23.86	0.20	0.48	2.08	1.19	0.20	1.52	0.01	0.01	0.02	0.06	nM	24.4		Krause 2003; Junghans et al. 1974
Stralsund 7208a	33541	drill cuttings	no	Neddesitz, Vorpommern-Rügen (LVR)	D	NBA II	Stuttgart	OES	86.8	11.40	0.07	0.10	0.30	0.70	0.10	0.52	0.01	0.01	0.01	0.03	nM	0.0		Krause 2003; Junghans et al. 1974
ALM 3191	DBB-196	surface	no	Pisede, Mecklenburgische Seenplatte (MSE)	D	NBA III	DBM	hhXRF	77.5	18.50	0.17	0.56	0.10	0.57	0.08	0.38	nM	0.03	nM	0.02	nM	2.1		Nørgaard 2015a; Nørgaard 2017
ALM 3191	DBB-197	surface	no	Pisede, Mecklenburgische Seenplatte (MSE)	D	NBA III	DBM	hhXRF	81.3	12.89	0.13	0.48	0.08	0.62	0.18	0.32	nM	0.03	nM	0.01	nM	4.0	Ti/Zr	Nørgaard 2015a; Nørgaard 2017
ALM 3191	DBB-265	surface	no	Pisede, Mecklenburgische Seenplatte (MSE)	D	NBA III	DBM	hhXRF	80.0	13.96	0.11	0.52	0.06	0.68	0.16	0.33	nM	0.03	nM	0.02	nM	4.1	Ti	Nørgaard 2015a; Nørgaard 2017
ALM Br. 949	DBB-236	surface	no	Poltnitz, Ludwigslust-Parchim (LUP)	D	NBA III	DBM	hhXRF	73.5	21.46	nM	0.04	0.77	0.09	0.15	0.09	nM	nM	nM	nM	nM	3.9	Ti/W/Zr	Nørgaard 2015a; Nørgaard 2017
ALM Br. 952a	DBB-233	surface	no	Poltnitz, Ludwigslust-Parchim (LUP)	D	NBA III	DBM	hhXRF	71.8	8.88	nM	0.32	0.42	0.46	0.05	0.10	nM	nM	nM	0.03	nM	17.9	Mn/Ti/V	Nørgaard 2015a; Nørgaard 2017
ALM Br. 952a	DBB-261	surface	no	Poltnitz, Ludwigslust-Parchim (LUP)	D	NBA III	DBM	hhXRF	82.9	10.01	0.07	nM	0.36	0.87	nM	0.30	nM	nM	nM	0.08	nM	5.4	Ti/V	Nørgaard 2015a; Nørgaard 2017
ALM Br. 954a	DBB-252	surface	no	Poltnitz, Ludwigslust-Parchim (LUP)	D	NBA III	DBM	hhXRF	83.6	9.34	0.50	0.30	0.15	0.52	0.15	0.30	nM	0.01	nM	0.02	nM	5.1	Mn/Nb/ Ti/V/Zr	Nørgaard 2015a; Nørgaard 2017
ALM Br. 954b	DBB-215	surface	no	Poltnitz, Ludwigslust-Parchim (LUP)	D	NBA III	DBM	hhXRF	83.4	11.48	nM	0.16	0.32	0.35	0.12	0.19	nM	nM	nM	0.02	nM	4.0	Mn/ Ti/V/Zr	Nørgaard 2015a; Nørgaard 2017
ALM Br. 949	DBB-237	surface	no	Poltnitz, Ludwigslust-Parchim (LUP)	D	NBA III	DBM	hhXRF	73.5	22.45	nM	0.04	1.00	0.08	0.12	0.07	nM	nM	nM	nM	nM	2.8	Mn/Ti/W	Nørgaard 2015a; Nørgaard 2017
LMN 4932	4932 B	ground sample	yes	Raven, Harburg	D	ZG III	DBM	SEM	84.9	14.41	nM	nM	nM	nM	nM	0.06	nM	nM	nM	nM	0.58	0.1		Nørgaard 2015b
LMN 4932	4932 E	ground sample	yes	Raven, Harburg	D	ZG III	DBM	SEM	84.7	14.69	nM	nM	nM	nM	nM	0.11	nM	nM	nM	nM	0.48	0.1		Nørgaard 2015b
LMN 4931	4931	ground sample	yes	Rehlingen, Lüneburg	D	ZG I-II	DBM	SEM	82.16	11.33	nM	nM	nM	nM	nM	nM	nM	nM	nM	nM	0,58	2.9		Nørgaard 2015b
LMN 4931	4324_12	drill cuttings	yes	Rehlingen, Lüneburg	D	ZG I-II	DBM	ICP-MS	74.1	12.00	0.77	0.00	0.03	0.36	0.01	0.19	nM	nM	nM	nM	0,35	12.2		Nørgaard 2015b
LMN 5032	5032	ground sample	yes	Rehlingen, Lüneburg	D	ZG I-II	DBM	SEM	85.0	14.04	nM	nM	nM	nM	nM	0.51	nM	nM	nM	nM	0.44	0.1		Nørgaard 2015b
LMN 5032	4327_12	drill cuttings	yes	Rehlingen, Lüneburg	D	ZG I-II	DBM	ICP-MS	76.9	11.50	0.11	0.06	0.22	0.44	0.01	0.58	nM	nM	nM	nM	0,16	23.1		Nørgaard 2015b
LMN 5032	5032 K	ground sample	yes	Rehlingen, Lüneburg	D	ZG I-II	DBM	SEM	84.8	14.59	nM	nM	nM	nM	nM	nM	nM	nM	nM	nM	0.62	0.1		Nørgaard 2015b
LMN 258:71	285:71	drill cuttings	no	Ripdorf, Uelzen	D	NBA II	DBM	ICP-MS	85.3	10.55	0.31	0.01	0.09	0.50	0.01	0.44	nM	nM	nM	nM	nM	2.8		Nørgaard 2015b
Neubrandenburg IV/65/37d	32254	drill cuttings	no	Rühlow, Mecklenburgische Seenplatte (MSE)	D	NBA II	Stuttgart	OES	86.0	4.47	0.01	1.63	0.79	0.18	0.10	0.02	0.01	0.02	0.02	0.08	nM	6.7		Krause 2003; Junghans et al. 1974
Waren IV/64/37d	32433	drill cuttings	no	Rühlow, Mecklenburgische Seenplatte (MSE)	D	NBA II	Stuttgart	OES	88.8	9.10	0.03	0.74	0.19	0.23	0.10	0.73	0.03	0.01	0.01	0.03	nM	0.0		Krause 2003; Junghans et al. 1974

ID				general information					metal composition													Corrosion		Reference
Museum ID	Analysis ID	INFO	Metallography	find location	region	Date	laboratory	method	Cu in %	Sn in %	Sb in %	Pb in %	Fe in %	Ni in %	Zn in %	As in %	Ag in %	Bi in %	Au in %	Co in %	S in %	measured corrosion elements in %	corrosion elements	
LMN 13181a	13181a	drill cuttings	no	Rätzlingen, Uelzen	D	NBA II	DBM	ICP-MS	80.4	12.55	0.14	0.02	0.06	0.82	0.00	0.41	nM	nM	nM	nM	nM	5.6		Nørgaard 2015b
ALM Br. 93	DBB-204	surface	no	Sarmstorf, Rostock (LRO)	D	NBA III	DBM	hhXRF	85.4	9.10	nM	0.04	0.19	0.16	0.08	0.02	nM	nM	nM	nM	nM	5.0	Mn/Zr	Nørgaard 2015a; Nørgaard 2017
LMN 14156	14156	drill cuttings	no	Soltau, Soltau	D	NBA II	DBM	ICP-MS	81.0	9.95	0.33	0.07	0.03	0.20	0.00	0.27	nM	nM	nM	nM	nM	8.2		Nørgaard 2015b
ALM LII Q, 3	DBB-249	surface	no	Sparow, Mecklenburgische Seenplatte (MSE)	D	NBA III	DBM	hhXRF	73.8	19.98	0.18	0.42	0.12	0.62	0.12	0.52	nM	0.02	nM	0.03	nM	4.2	Ti/W	Nørgaard 2015a; Nørgaard 2017
ALM LII Q, 3	DBB-250	surface	no	Sparow, Mecklenburgische Seenplatte (MSE)	D	NBA III	DBM	hhXRF	72.5	21.83	0.19	0.45	0.17	0.74	0.08	0.64	nM	0.02	nM	0.03	nM	3.3	Ti/W	Nørgaard 2015a; Nørgaard 2017
ALM LII Z1g1	DBB-211	surface	no	Sparow, Mecklenburgische Seenplatte (MSE)	D	NBA III	DBM	hhXRF	81.8	14.53	0.11	0.26	0.19	0.52	0.10	0.34	nM	0.01	nM	0.03	nM	2.2	Ti	Nørgaard 2015a; Nørgaard 2017
NM B 6535	437	drill cuttings	no	Søborg Lagegård, Søborg	DK	NBA II	Oxford University Department of Materials	EPMA	84.8	14.01	0.01	0.09	0.24	0.15	0.01	0.16	0.01	0.00	0.03	0.05	0.45	0.0		Liversage 2000
LMN 14154	14154	ground sample	yes	Tangendorf, Harburg	D	ZG I-III	DBM	SEM	86.7	12.23	nM	nM	nM	nM	nM	0.48	nM	nM	nM	nM	0.57	0.1		Nørgaard 2015b
ALM 2003/1201, 134	DBB-242	artificial covering	no	Thürkow, Rostock (LRO)	D	NBA IIIa	DBM	hhXRF	51.6	39.46	0.09	1.07	3.02	0.33	0.08	0.46	nM	0.07	nM	nM	nM	3.8		Nørgaard 2015a; Nørgaard 2017
ALM 2003/1201, 134	DBB-243	artificial covering	no	Thürkow, Rostock (LRO)	D	NBA IIIa	DBM	hhXRF	41.9	43.56	0.13	1.14	2.12	0.68	0.16	0.48	nM	0.07	nM	0.05	nM	9.7	Ti	Nørgaard 2015a; Nørgaard 2017
NM 9864	137	drill cuttings	no	Tolstrup, Hjørring	DK	NBA II	Oxford University Department of Materials	EPMA	85.7	12.34	0.54	0.02	0.13	0.81	0.00	0.34	0.05	0.00	0.00	0.06	nM	0.0		Liversage 2000
ALM Br. 371	DBB-228	surface	no	Turloff, Ludwigslust-Parchim (LUP)	D	NBA III	DBM	hhXRF	84.1	13.75	0.05	0.30	0.07	0.06	0.08	0.07	nM	nM	nM	nM	nM	1.5	Zr	Nørgaard 2015a; Nørgaard 2017
LMN 195:78	195:78	ground sample	yes	unknown location	D	NBA II (?)	DBM	SEM	88.5	11.13	nM	nM	nM	nM	nM	nM	nM	nM	nM	nM	0.41	0.1		Nørgaard 2015b
LMN 195:78	4358_12	drill cuttings	yes	unknown location	D	NBA II (?)	DBM	ICP-MS	79.8	14.20	0.06	0.04	0.16	0.37	0.01	0.16	nM	nM	nM	nM	0,08	5.2		Nørgaard 2015b
NM B 2659	530	drill cuttings	no	unknown location, Danmark	DK	NBA II (?)	Oxford University Department of Materials	EPMA	84.7	11.43	0.12	0.01	0.37	0.85	0.00	1.27	0.00	0.02	0.00	0.06	1.19	0.0		Liversage 2000
NM B 4745	435	drill cuttings	no	unknown location, Danmark	DK	NBA II (?)	Oxford University Department of Materials	EPMA	83.3	14.98	0.00	0.00	0.13	0.17	0.00	1.34	0.02	0.02	0.00	0.04	0.05	0.0		Liversage 2000
ALM LII Q, 8	DBB-258	fracture surface	no	unknown location, Mecklenburg	D	NBA III	DBM	hhXRF	70.7	22.36	0.05	0.57	0.14	0.31	0.19	0.35	nM	0.02	nM	0.02	nM	5.3	Ti	Nørgaard 2015a; Nørgaard 2017
ALM LII Q, 2	DBB-239	surface	no	unknown location, Mecklenburg	D	NBA III	DBM	hhXRF	76.2	11.76	nM	0.02	0.83	0.04	0.11	0.03	nM	nM	nM	nM	nM	11.0	Ti/V/Zr	Nørgaard 2015a; Nørgaard 2017
ALM LII Q, 2	DBB-292	fracture surface	no	unknown location, Mecklenburg	D	NBA III	DBM	hhXRF	59.4	35.13	nM	0.06	0.20	nM	nM	0.13	nM	nM	nM	nM	nM	5.1		Nørgaard 2015a; Nørgaard 2017
ALM LII Q. 2	DBB-291	fracture surface	no	unknown location, Mecklenburg	D	NBA III	DBM	hhXRF	75.8	18.70	nM	0.03	0.05	0.13	0.14	0.11	nM	nM	nM	nM	nM	5.1	Mn/Ti/V	Nørgaard 2015a; Nørgaard 2017
ALM LII Q, 7	DBB-202	surface	no	unknown location, Mecklenburg	D	NBA III	DBM	hhXRF	33.5	55.56	nM	0.05	0.90	0.08	0.11	0.06	nM	nM	nM	nM	nM	9.7	Ti/V	Nørgaard 2015a; Nørgaard 2017
ALM LII Q, 7	DBB-203	surface	no	unknown location, Mecklenburg	D	NBA III	DBM	hhXRF	41.6	42.28	nM	1.57	0.59	0.09	0.13	0.55	nM	0.08	nM	nM	nM	13.1	Ti/W	Nørgaard 2015a; Nørgaard 2017
ALM LII Q, 7	DBB-288	surface at end	no	unknown location, Mecklenburg	D	NBA III	DBM	hhXRF	29.6	57.23	nM	1.67	1.10	0.15	0.12	0.46	nM	0.09	nM	nM	nM	9.6	W	Nørgaard 2015a; Nørgaard 2017
ALM LII Q, 7	DBB-289	small piece	no	unknown location, Mecklenburg	D	NBA III	DBM	hhXRF	37.4	47.73	nM	1.74	0.75	0.09	0.11	0.55	nM	0.09	nM	nM	nM	11.6	Ti/W	Nørgaard 2015a; Nørgaard 2017
ALM LII Q, 7	DBB-290	surface large piece	no	unknown location, Mecklenburg	D	NBA III	DBM	hhXRF	34.1	56.21	nM	0.05	0.92	0.06	0.11	0.06	nM	nM	nM	nM	nM	8.5	Cd/ Ti/V/W	Nørgaard 2015a; Nørgaard 2017
ALM LII Q, 8	DBB-220	surface	no	unknown location, Mecklenburg	D	NBA III	DBM	hhXRF	68.8	23.96	0.06	0.61	0.18	0.39	0.21	0.40	nM	0.03	nM	0.03	nM	5.3	Ti/W	Nørgaard 2015a; Nørgaard 2017
ALM LII Q, 8	DBB-256	surface at end	no	unknown location, Mecklenburg	D	NBA III	DBM	hhXRF	62.0	31.37	0.06	0.49	0.33	0.24	0.12	0.25	nM	0.03	nM	nM	nM	5.1	W	Nørgaard 2015a; Nørgaard 2017
ALM LII Q, 8	DBB-257	fracture surface	no	unknown location, Mecklenburg	D	NBA III	DBM	hhXRF	69.2	24.76	0.06	0.59	0.29	0.23	0.20	0.41	nM	0.04	nM	nM	nM	4.2	Ti/W	Nørgaard 2015a; Nørgaard 2017
ALM LII Q, 8	DBB-219	surface	no	unknown location, Mecklenburg	D	NBA III	DBM	hhXRF	77.3	18.35	0.04	0.41	0.22	0.15	0.14	0.22	nM	0.01	nM	nM	nM	3.2	W/Zr	Nørgaard 2015a; Nørgaard 2017
ALM S6	DBB-198	surface	no	unknown location, Mecklenburg	D	NBA III	DBM	hhXRF	80.8	13.72	0.07	0.17	0.11	0.34	0.09	0.38	nM	0.01	nM	0.02	nM	4.2	Ti/Zr	Nørgaard 2015a; Nørgaard 2017

ID				general information					metal composition													Corrosion		Reference
Museum ID	Analysis ID	INFO	Metallography	find location	region	Date	laboratory	method	Cu in %	Sn in %	Sb in %	Pb in %	Fe in %	Ni in %	Zn in %	As in %	Ag in %	Bi in %	Au in %	Co in %	S in %	measured corrosion elements in %	corrosion elements	
ALM S6	DBB-199	surface at end	no	unknown location, Mecklenburg	D	NBA III	DBM	hhXRF	**84.7**	**13.83**	**0.09**	**0.13**	**0.05**	**0.38**	**0.11**	**0.33**	nM	**0.01**	nM	**0.03**	nM	0.4	Ti/Zr	Nørgaard 2015a; Nørgaard 2017
ALM 3139	32752	drill cuttings	no	Vorder Bollhagen, Rostock (LRO)	D	NBA II	Stuttgart	OES	**82.0**	**8.27**	**0.52**	**0.03**	**0.12**	**0.03**	**0.10**	**0.24**	**0.01**	**0.01**	**0.02**	**0.02**	nM	8.6		Krause 2003; Junghans et al. 1974
ALM 2195	DBB-230	surface	no	Weisin, Ludwigslust-Parchim (LUP)	D	NBA III	DBM	hhXRF	**82.8**	**12.68**	nM	**0.14**	**0.13**	**0.06**	nM	**0.08**	nM	nM	nM	nM	nM	4.1		Nørgaard 2015a; Nørgaard 2017
ALM 2197	DBB-229	surface	no	Weisin, Ludwigslust-Parchim (LUP)	D	NBA III	DBM	hhXRF	**60.9**	**27.79**	**0.17**	**1.72**	**0.35**	**0.25**	**0.12**	**0.44**	nM	**0.02**	nM	nM	nM	8.3	Mn/ Ti/V/W	Nørgaard 2015a; Nørgaard 2017
LMN 4390	4390	ground sample	yes	Westerweyhe, Uelzen	D	ZG I-II	DBM	SEM	**84.5**	**9.80**	nM	nM	nM	nM	nM	nM	nM	nM	nM	nM	**0,68**	5.0		Nørgaard 2015b
LMN 12018	12018 K	ground sample	yes	Westerweyhe, Uelzen	D	NBA II (?)	DBM	SEM	**87.1**	**11.79**	nM	nM	nM	nM	nM	**0.65**	nM	nM	nM	nM	**0.47**	0.1		Nørgaard 2015b
Slg. Schmitterlöv	33561	drill cuttings	no	Wolfsdorf, Franzburg	D	NBA II	Stuttgart	OES	**87.2**	**11.70**	**0.07**	**0.14**	**0.14**	**0.36**	**0.10**	**0.21**	**0.03**	**0.01**	**0.01**	**0.04**	nM	0.0		Krause 2003; Junghans et al. 1974
ALM 3374a	DBB-213	surface	no	Wotenitz, Nordwestmecklenburg (NMW)	D	NBA II	DBM	hhXRF	**22.0**	**44.43**	nM	nM	**22.35**	**0.15**	**0.13**	**0.53**	nM	nM	nM	nM	nM	10.4	Mn/Ti	Nørgaard 2015a; Nørgaard 2017
ALM 3374a	DBB-214	surface	no	Wotenitz, Nordwestmecklenburg (NMW)	D	NBA II	DBM	hhXRF	**21.3**	**45.87**	nM	**0.01**	**21.06**	**0.17**	**0.15**	**0.55**	nM	nM	nM	nM	nM	10.9	Mn/ Ti/W/Zr	Nørgaard 2015a; Nørgaard 2017
ALM 3374a	DBB-255	surface inside red patina	no	Wotenitz, Nordwestmecklenburg (NMW)	D	NBA II	DBM	hhXRF	**28.6**	**44.47**	nM	**0.02**	**18.14**	**0.18**	**0.18**	**0.51**	nM	nM	nM	nM	nM	7.9	Mn/Ti	Nørgaard 2015a; Nørgaard 2017
ALM 3374a	DBB-253	surface inside	no	Wotenitz, Nordwestmecklenburg (NMW)	D	NBA II	DBM	hhXRF	**47.2**	**29.98**	nM	nM	**11.12**	**0.22**	**0.21**	**0.39**	nM	nM	nM	nM	nM	10.8	Mn/Ti	Nørgaard 2015a; Nørgaard 2017
ALM 3374	32761	drill cuttings	no	Wotenitz, Nordwestmecklenburg (NMW)	D	NBA II	Stuttgart	OES	**30.0**	**23.86**	**0.07**	**0.02**	**21.50**	**0.27**	**0.10**	**0.56**	**0.02**	**0.01**	**0.02**	**0.02**	nM	23.5		Krause 2003; Junghans et al. 1974
ALM 4124	DBB-217	surface	no	Wozinkel, Ludwigslust-Parchim (LUP)	D	NBA III	DBM	hhXRF	**76.0**	**16.69**	**0.12**	**0.38**	**0.14**	**1.00**	**0.16**	**0.62**	nM	**0.04**	nM	**0.04**	nM	4.9	Ti/V	Nørgaard 2015a; Nørgaard 2017
ALM 4124	DBB-218	surface	no	Wozinkel, Ludwigslust-Parchim (LUP)	D	NBA III	DBM	hhXRF	**75.2**	**16.89**	**0.11**	**0.32**	**0.23**	**0.86**	**0.15**	**0.63**	nM	**0.04**	nM	**0.02**	nM	5.6	Ti/V/Zr	Nørgaard 2015a; Nørgaard 2017
* nM indicates that no measurement was recorded																								

Bronze ornaments of the Nordic Bronze Age (neck collars, belt plates, pins and tutuli) were elaborate objects that served as status symbols to communicate social heirarchy. The magnificent metalwork studied here dates from 1500-1100 BC. An interdisciplinary investigation of the artefacts was adopted to elucidate their manufacture and origin, resulting in new insights into metal craft in northern Europe during the Bronze Age. Based on the *habitus* concept, which situates the craftsmen within their social and technological framework, individual artefact characteristics and metalworking techniques can be used to identify different craft practices, even to identify individual craftsmen. The conclusions drawn from this resulted in new insights into the complex organisation of metalcraft in the production of prestige goods across different workshops. Several kinship-based workshops on Jutland, in the Lüneburg Heath and Mecklenburg, allow us to conclude that the bronze objects were a display of social status and hierarchy controlled by, and produced for, the elite – as is also seen in the workshops on Zealand. Within the two main metalworking regions, Zealand and central Lower Saxony, workshops can be defined as communities of practice that existed with an extended market and relations with the local elite. Attached craft, in the sense that the craftspeople fully depended on a governing institution and produced artefacts as a manifestation of political expression, was only detected on Zealand between 1500-1300 BC.

The investigation presented here showed that overall results could not be achieved when concentrating only on one aspect of metalwork. Highly skilled craft is to be found in every kind of workshop, as well as an intensive labour input. Only when considering skill in relation to labour input and also taking into account signs of apprenticeship and cross-craft techniques, as well as the different categories of mistakes in crafting, can a stable image of craft organisation be created.

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ISBN 978-1-78969-019-4

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Archaeopress Archaeology www.archaeopress.com