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European Mail Armour

RINGED BATTLE SHIRTS FROM THE IRON AGE, ROMAN PERIOD AND EARLY MIDDLE AGES

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European Mail Armour

RINGED BATTLE SHIRTS FROM THE IRON AGE, ROMAN PERIOD AND EARLY MIDDLE AGES

MARTIJN A. WIJNHOVEN

AMSTERDAM UNIVERSITY PRESS

This book meets the requirements of ISO 9706: 1994, Information and documentation – Paper for documents – Requirements for permanence.

Cover illustration: Image top left & bottom right: fragments of mail armour from Bijele Crkve in Serbia dating to the Late Antiquity. Arheološki Muzej u Zagrebu (photograph M.A. Wijnhoven). Image top right: statue of a Gallo-Roman soldier found at Vachères in France. The soldier in this Late Republican sculpture wears a mail coat rendered in a very realistic style. Musée Calvet, Avignon (photograph M.A. Wijnhoven). Image bottom left: the mid-3rd-century Ludovisi sarcophagus depicts a *signifer* clad in mail armour. Palazzo Altemps, Rome (photograph M.A. Wijnhoven).

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To Larissa Mendoza Straffon

1 Introduction

'Beowulf got ready, donned his war-gear, indifferent to death. His mighty, hand-forged, fine webbed mail would soon meet with the menace under water. It would keep the bone-cage of his body safe. No enemy's clasp could crush him in it, no vicious arm lock choke his life out.'
Beowulf (c. 8th century AD)[1]

Mail armour, made of countless interlinked metal rings that protect the body, is a highly successful piece of military equipment. In warfare, where innovation is crucial to stay ahead, the development of weaponry can happen relatively quickly compared to the rate of change in other realms of society. Despite the fast-paced arms race which has been going on since antiquity, mail armour remained basically an Iron Age technology until it fell out of use in the 19th century. This means that it endured more than two thousand years of evolution of military equipment and battle tactics. Its use spread over vast geographical areas including Europe, Asia, North Africa and even the Americas during the Early Colonian period,[2] indicating that it was an extraordinarily effective piece of protective gear in all kinds of battle conditions, places, and periods.

Although mail is no longer worn in combat, it continues to exist. Nowadays, its most common applications are in protective suits for scuba divers against shark bites, and in gloves or mittens to avoid injuries when working with sharp tools, for instance in professional kitchens. As a piece of defensive equipment, it lives in our collective consciousness as the archetypical outfit of military men from the remote past, and has been immortalized by popular culture appearing frequently on television, film, videogames, and literature.

The long lifespan and success of mail armour as a defensive garment is, however, not reflected in scholarship, where there are surprisingly few works that deal with this type of armour in depth. The following section introduces some key publications that outline the state of the field in mail research, leading up to the aims of this study.

1.1 PREVIOUS RESEARCH

Shortly after armour became obsolete on the European battlefields and turned into a historical item, studies of its development started to appear in the late 18th and early 19th centuries.[3] These scholarly volumes looked mainly at the plate armour of the medieval knight and dealt with mail only in passing. One of the few exceptions was the work of Sir Samuel Meyrick in the first half of the 1800s,[4] which due to its pioneering status still contains many misconceptions about mail. Meyrick only had access to historical armour, which is armour that has been passed down from owner to owner through history. These pieces are generally no older than the 14th century AD, so they just provide information of mail from the Late Middle Ages and Early Modern period. In Meyrick's time, archaeology was a new discipline and finds of archaeological mail were rare, so they were largely ignored by him and his contemporaries.

1 *Beowulf*, lines 1142-1148; translation Heaney 2000.

2 E.g. Absolon 2017, 292-296; Arkell 1956; Bivar 1964, 30-38, 59-66; Robinson 1967; Smith 1960a; 1960b; Terry/Terry 1961; Wedel 1975; Wood *et al.* 2013.

3 E.g. Grose 1786; Hewitt 1860; Lacombe 1868.

4 Meyrick 1821; 1824; 1846.

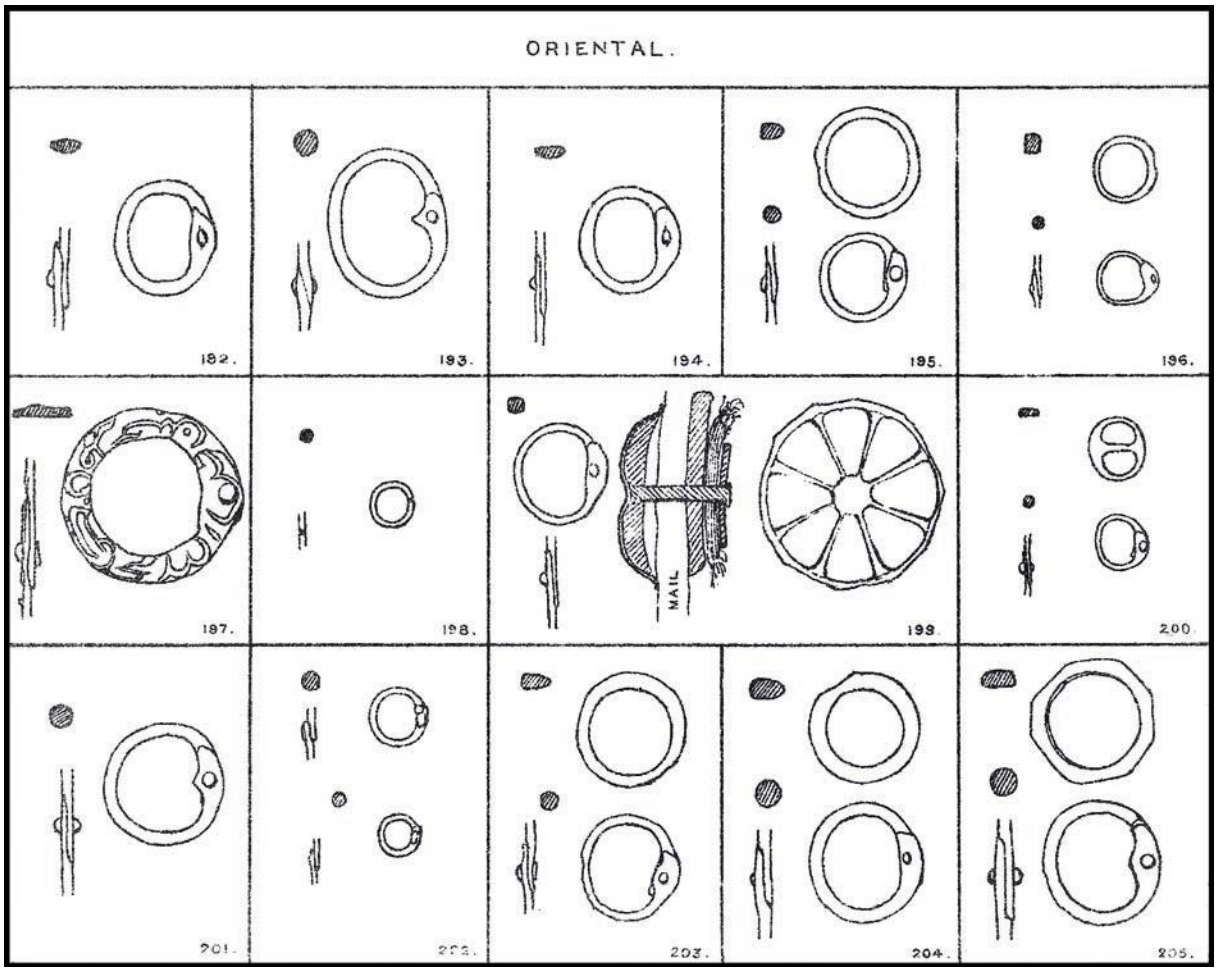


Fig. 1.1. Baron De Cosson and Wiliam Burges's catalogue from 1880 includes detailed drawings of individual rings from historical mail. This illustration shows the variety of characteristics they observed in Oriental mail rings (De Cosson/Burges 1880, pl. 13).

The first study to include passages devoted completely to mail is the *Catalogue of the exhibition of ancient helmets and examples of mail* by the baron De Cosson and William Burges, from 1880.[5] Although the main topic of the volume is helmets, the sections on mail provide detailed and thorough observations of the material available at the time (fig. 1.1). Inevitably this means that the text mostly discusses historical mail from Late Middle Ages and after, but for the first time it goes beyond Europe to include mail from other regions of the world. De Cosson and Burges were aware of archaeological finds, and refer for example to the 'two masses of oxidised iron' stored in the basement of the British Museum, but did not make much of their potential.

Between 1897 and 1929, the German scholar Walther Rose published four articles on mail armour.[6] In these he mainly focuses on the marks found on mail rings, either as decoration in historical Indo-Persian mail or as maker's marks in historical European mail. However, in his 1906 work titled *Römisch-germanische Panzerhemden,* he analyses mail from Antiquity up to the Carolingian period, finally moving away from historical examples and delving into an earlier period. Rose considers written and iconographic sources along with archaeological finds, offering brief descriptions of 14 specimens of archaeological mail known by then. In spite of his limitations, Rose is the first to address the period prior to the Late Middle Ages in some depth and to take into account different sources of information.

5 De Cosson/Burges 1880, 563-570, 574-583, pl. 11-15.

6 Rose 1897; 1902; 1906; 1929.

The most influential scholar in the study of mail armour is probably E. Martin Burgess.[7] Between the 1950s and early 1960s, he published a series of articles dedicated to European historical mail. His *Further research into the construction of mail garments* was a seminal publication that laid the foundation for the systematic analysis of mail garment construction. In it he describes how to record the pattern in which the rings are woven together, and the techniques employed to shape the mail fabric. Most of his subsequent work consisted of case studies, where he applied his newly developed method to well-preserved mail garments. These publications spurred a new line of mail armour research and several studies of historical mail have followed his procedure since.[8]

In 1956 Burgess co-authored an article with H. Russel Robinson on the construction of a 14th century mail coif.[9] The latter author is best known for his 1975 book *The armour of imperial Rome*, a cornerstone of what eventually became Roman military equipment studies (see below).[10] Robinson made wide use of archaeological finds in his research, especially for his typology of helmets and in the reconstruction of segmented body armour, or *lorica segmentata*. However, when dealing with mail armour Robinson primarily resorted to iconography rather than actual specimens. Even though he mentions several finds, he remains unconvinced of how informative these might be:

> *'Actual Roman mail has survived only in rare instances; and when shirts have survived they have been little more than a caked mass of iron oxide from which nothing of their shape and only the most approximate size of the rings can be ascertained.'* [11]

In 1983 the conference 'Roman military equipment' was held in Sheffield. This event was devoted to the material culture of the Roman soldier and it launched the Roman Military Equipment Conference series (ROMEC), which still runs every three years. In addition to the Roman army, the conference covers topics from outside the Roman Empire and a wide timeframe, from the Iron Age to the Byzantine period. ROMEC has resulted in a large body of literature published for the most part in the *Journal of Roman Military Equipment Studies* and comprehensive volumes like *Roman military equipment* by Mike C. Bishop and Jon C. Coulston,[12] *Die Armee der Caesaren* by Thomas Fischer,[13] and *Les armes des romains* by Michel Feugère.[14] Roman military equipment studies has produced numerous articles that touch upon mail armour, and a few that deal with it specifically.[15] Nevertheless, the subject of mail has mostly been anecdotal until now. Consequently, the same small number of finds is repeatedly mentioned in the literature while an extensive analysis of the evidence remains lacking, as Fischer has noted:

> *'The current state of research on Roman body armour is fairly uneven: segmental cuirasses have been published comprehensively in two modern monographs. But the other types of armour, in other words, muscle, mail, scale, and lamellar cuirasses have been summarized on the basis of older research by Robinson. Modern detailed investigations into these types of body armour are not currently available.'* [16]

7 Burgess 1953a; 1953b; 1955; 1957; 1958; 1960; Burgess/Robinson 1956; Reid/Burgess 1960.

8 E.g. Wood *et al.* 2013; Chapman 2004, 43-49; Krogh 2016; Schmid 2003, 4-7; Hellman 1995.

9 Burgess/Robinson 1956.

10 Originally he was a specialist in oriental armour; cf. Robinson 1967.

11 Robinson 1975, 171.

12 Bishop/Coulston 2006.

13 Fischer 2012; 2019.

14 Feugère 1993; 2002.

15 Czarnecka 1996; Juncher 2016; Van der Sanden 1993; Wijnhoven 2016a; 2017.

16 Fischer 2012, 163; 2019, 125. He expresses this lack of a comprehensive study also in Fischer 2011, 107.

Fig. 1.2. The state of preservation of historical and archaeological mail differs greatly. Historical mail, like the 15th century German coat on the left, usually has been passed from person to person and tends to be in good and complete condition, making it relatively easy to examine and understand (photograph Metropolitan Museum of Arts, inv. no. 29.156.68). There is only a handful of examples predating the 14th century. Older specimens come from the archaeological record and are often so heavily corroded that they form a solid block. In such cases, (mechanical) cleaning can sometimes reveal the outlines of the rings, like in the Roman period find on the right from Kalkar, Germany, now in the PUG Collection in Utrecht (photograph M.A. Wijnhoven).

Roman military equipment studies is a field well-known for being inclusive towards the historical re-enactment community. Collaborations between scholars and re-enactors have yielded excellent results for experimental archaeology. For example, Marcus Junkelmann was able to study the practical use of the full Roman army kit by having a group wear it and recreate weeks-long marches across Europe, published in *Die Legionen des Augustus*.[17] The coat of mail does feature in Junkelmann's work, but only as one among the many items of military equipment.[18] In the sphere of experimental archaeology, it is David Sim who has paid particular attention to mail armour. In his article *Roman chain-mail: experiments to reproduce the techniques of manufacture*, he reports using Roman-age technology to reconstruct possible tools for making mail.[19]

Scientific techniques have become increasingly important in the study of archaeological materials. Nonetheless, mail armour has rarely been analysed in this way, except for radiography and metallography. X-rays and CT-scans have proven helpful in identifying mail in what seem shapeless clumps of corroded

[17] Junkelmann 1986. Similar experimental studies are found in Junkelmann 1991; 1992; 1996; 2008; Koepfer *et al.* 2011.

[18] Junkelmann 1986, 164-168.

[19] Sim 1997; Sim/Kaminski 2011, 111-134; Sim/Ridge 2002, 98-103.

[20] E.g. Bruce-Mitford 1978, 232-240; Gilmour 1997, 28-32; 1998, 163-164; Greiner 2008; 99-101; O'Connor 1992b, 1187; Price 1983, 13; Tweddle 1992, 896-902, 1006-1009.

iron and sediment, and in revealing details not evident to the naked eye. Since the 1970s, radiography has increasingly been used to analyse surviving specimens of mail armour, but is not standard practice.[20] Metallography has featured a bit more frequently in mail armour studies. It was first applied in the 1950s by J.R. Vilella (*Examination of mail armour links from the Metropolitan Museum of Art*)[21] and Cyril Stanley Smith (*Methods of making chain mail (14th to 18th centuries) - a metallographic note*),[22] in their examinations of historical mail rings from Europe and Asia. Vilella and Smith were ahead of their time and metallographic studies would not be performed again on mail armour until the 1980s.[23] Because metallography requires the mail rings to be in good condition, the technique has not been applied to archaeological material often, but it can be used successfully in well-preserved specimens as demonstrated by the work of Arne Jouttijärvi, *The manufacture of chain-mail*.[24]

As mentioned, mail research often has an anecdotal character operating on a case-study basis. A notable exception is Leif Hansen's *Die Panzerung der Kelten* from 2003, which assembled from the literature what was the largest inventory of archaeological mail.[25] Despite his focus is on the Late Iron Age, Hansen also included a substantial list of mail specimens from the Roman period.[26]

To recapitulate, over the last one and a half century, the field of mail armour studies has generally pivoted on well-preserved and relatively modern historical examples. To understand mail from earlier times, scholars have had to make do with archaeological mail, which is often badly preserved and incomplete. Therefore, there has been a tendency to deem this material as less- or even uninformative (fig. 1.2). For the same reason, most works that discuss mail from antiquity rely heavily on iconography, occasionally supplemented by a quote from a written source or a passing mention of an archaeological find. As a consequence, a systematic analysis, or meta-analysis, encompassing the collection of available evidence from the period preceding the Late Middle Ages is still lacking.

The current state of research shows that very little is known about mail armour from antiquity, other than the fact that it was worn. For instance, whereas mail artefacts regularly turn up in archaeological excavations, usually there is not much that can be said of or concluded from it; and in the absence of context, as is frequently the case for items in old or private collections, it becomes difficult to even estimate their age.

1.2 RESEARCH QUESTION AND AIMS

The process of archaeological research is constituted by various progressive stages, each contributing to the ultimate aim of reconstructing past societies as accurately as possible. The first stages comprise the collection, organisation, and analysis of archaeological data and their categorization in sets, e.g. chronologies, typologies, models, etc. These, in turn, serve as a basis for inferring and explaining various aspects of social organisation and relations.[27] The present study addresses multiple stages. It first sets out to gather, order and assess the reliability of the information available about mail armour. The results of these stages

[21] Vilella 1958.

[22] His article spurred on a discussion with renowned scholar of mail Martin E. Burgess. Cf. Burgess 1960; Smith 1959; 1960.

[23] Chapman 2004; Edge 2001; Fenn 2009; Fernández Reyes 2014; Fulford *et al.* 2005; Grandin 2008; Pleiner 2012; Tweddle 1992, 1023-1025; Vike 2000; Williams 1980; 2003.

[24] Jouttijärvi 1996.

[25] Hansen 2003. Inventories of mail finds, albeit on a much smaller scale, are also listed in Borangic 2011a; Fredman 1992; O'Connor 1992b; Raddatz 1959/1961b; Waurick 1982.

[26] Hansen's database also served to analyse the 3rd century AD mail armour from Thorsberg in Germany; cf. Matešić 2015.

[27] Bate 1998, 147.

are in large part presented in the database. The study then looks at what can be inferred from this information by combining different sources and, if present, by contrasting their outcome with existing ideas. These aims call for a broad main research question, namely:

What can the combined systematic analysis of archaeological, iconographic and textual sources say about mail armour in the past?

This inquiry is directed at four topics, briefly described below.

ORIGIN AND DISPERSION

This topic addresses the invention of mail armour and its subsequent dispersion throughout the world. It therefore requires a clear definition of mail armour and how it differs from other objects made from interconnected metal rings. It also assesses the extent to which possible precursors of this type of armour can be identified. It further looks into where, when and who invented mail and how it spread over time to become a well-established form of armour. Within this topic, the distribution of the material evidence for mail is essential, for which it is also necessary to understand the taphonomic processes that underlie the preservation of that evidence.

USE AND NAMING

This theme concerns the use of mail garments. It attends to the parts of the body that were protected by mail and the type of garments worn. This topic scrutinises what the mail armour looked like by comparing depictions and actual surviving specimens, and asks whether there were different styles in different places, and how their design evolved through time. It also pays attention to the decoration of mail armour. In addition, this theme examines whether mail was used as a stand-alone armour or if it was employed together with padding to enhance its characteristics. Finally, it investigates what this armour was called in antiquity.

TECHNICAL DETAILS

This subject considers the mail components, i.e. the rings, that make up the armour itself. It focuses on the weaving patterns employed to interconnect the rings into a mesh and the techniques applied to tailor the garments to the human body. Special attention is given to explaining observed differences between time periods. The production process, or *chaîne opératoire* (see below) of the rings, from raw material to finished ring is examined, revealing specific characteristics shaped by the steps taken to complete a single ring. The presence of diagnostic characteristics is subsequently used to try to accurately assign mail armour to a certain time period or region. The latter is especially relevant for the many existing remains in sites or collections that lack context.

SOCIAL CONTEXT

The last issue focusses upon the people that wore mail armour and the role it played within society. It looks at the social accessibility of mail and whether it was available to and attainable by the few or to the

many. This topic also establishes whether this changed through time or across societies by comparing, for example, the Iron Age with the Roman period, seen from the Empire in contrast to the lands beyond its territory. The matter of whether a society produced its own mail armour or obtained it through other processes will also be discussed.

1.3 CHAÎNE OPÉRATOIRE

This study will make ample use of the concept of the *chaîne opératoire* as an analytical tool.[28] This concept, which was originally developed by the ethnologist Marcel Mauss for whom societies were to be understood through their technology,[29] has been widely applied in archaeology.[30] It allows for a reconstruction of technology as a 'total social fact' by tracing back the series of steps involved in transforming raw materials into artefacts. The operational sequences that turn a raw material into a finished product are specific to each society. Consequently, the work process of any craftsperson will be organized according to the internal logic of their particular society.

The *chaîne opératoire*, literally the chain of operations, involves the entire life cycle of an artefact encompassing everything from the manufacturing stages to its social use and its disposal, at which point it often ends up in the archaeological record. The potential of the *chaîne opératoire* as a methodological tool in archaeology has been embraced mainly by studies of prehistoric lithic technologies.[31] It has been applied less frequently in proto-historical and historical archaeology, perhaps due to the relative abundance of other sources. Nonetheless, it holds a lot of potential for revealing novel information while providing a solid interpretive framework.[32]

Chapters 8 to 11 will explore in depth the use of the *chaîne opératoire* to analyse the technical steps of the mail making process in its respective socio-cultural context. As we will see, this concept can bring to light new data regarding the behaviour, the decision making process, and the institutional-cultural contexts of the mail makers from various societies. It can also inform us on the role that mail played in each society and on issues such as the social accessibility and status of this armour. Moreover, by applying a long-term, cross-cultural focus, this study makes it possible to compare different societies (e.g. Roman and non-Roman) over several periods (e.g. Iron Age, Roman period, and Early Middle Ages), inaugurating a sound framework to address the cultural and chronological origin and evolution of mail armour.

1.4 A MULTI-DIMENSIONAL APPROACH TO MATERIAL STUDIES

In order to elucidate the topic of early mail armour and to address the four topics mentioned above, I will use a multi-dimensional approach to the study of material culture. This approach was originally developed by Jan Slofstra as an analytical model to better understand the concept of Romanisation related to the confrontation of (proto-) historical peoples with Roman power and culture.[33] He argued that the process of Romanisation should not be seen as a one-way linear process, but as a series of complex multi-dimensional interactions.

[28] Dobres 1999; 2009.

[29] Mauss 1979 [1934].

[30] The ethnological concept of *chaîne opératoire* was first applied in archaeology by Leroi-Gourhan (1964).

[31] In their edited volume Arntz/Lewis (2020) demonstrate that this approach can be applied easily to many other technologies and also to historical societies.

[32] E.g. Sellet, 1993; Soressi/Geneste 2011.

[33] Slofstra 2002.

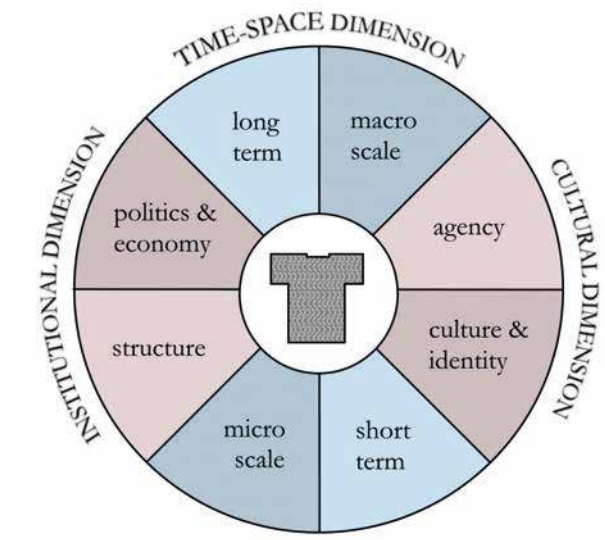


Fig. 1.3. Model of multi-dimensional analysis used here to study mail armour. The model demonstrates the interrelationship of the different dimensions and the need to study them together.

Although Slofstra did not foresee the application of the multi-dimensional approach to the field of material studies, it is highly suitable for this purpose. Like Romanisation, the concept of artefact types is similarly part of dynamic, complex non-linear developments in which various dimensions come into play. Slofstra's model considers three main dimensions: temporal-spatial, institutional, and cultural (fig. 1.3).

The time-space dimension is primarily relevant to archaeological and historical research. Regarding time, the present study looks specifically at mail armour during the Iron Age and Roman periods, which encompasses a long period spanning many centuries. This allows for a *longue durée* approach able to reveal changes through time.[34] In addition, this study will make use of insights from other periods. As discussed above, a lot more is known about mail from the Late Middle Ages and the Early Modern period, as there are more images, written sources and surviving artefacts from those eras. Such epistemic disparity obliges us to use information from these later periods as a means of comparing, supplementing and interpreting the evidence from earlier times.

The same applies to the spatial aspect. Mail was in use across many areas and is found over vast territories, yielding region-wide and cross-cultural data that allow us to compare and complete information between different geographies and (archaeological) traditions. We can, for example, compare data from the Roman Empire and the Barbaricum, leading to a better understanding of both. Furthermore, a cross-cultural approach allows us to incorporate insights from regions beyond the scope of the present study, such as Japan and India.

The institutional and cultural dimensions are interrelated and therefore placed opposite of each other in the model. The former has to do with the standardised practices and organisations that structure society and, as such, contains diverse aspects, e.g. political, economical, social and religious. For instance, in Roman society the influence of these dimensions becomes visible through the institution of the Roman army and the imposition of regulations surrounding the possession of certain pieces of military equipment. The formal and informal institutions of the peoples beyond the Empire's borders or the Iron Age societies differ from those in Roman society. To a great extent, the institutional dimension also determined the scale of armour production as well as the social access to and ownership of armour. These factors relate to the status of an artefact in society and can vary substantially across times and places. Armour was also associated to religious belief systems, as inferred from the fact that it is often found among the burial offerings of different cultures. Another indication is the practice of the ritual deposition of mail armour in various societies. Both examples refer to the place that armour had in the worldview and religious practices of a group.

[34] Braudel (1949) specified three orders of historical time, i.e. *événéments*, *conjonctures* and *longue durée*. This study will mainly focus on the latter two.

[35] Giddens (1979) introduced the paired terms of structure and agency.

[36] For the same reason Roymans and Derks (2011) use it to study Roman villa landscapes.

The intertwining of the institutional and cultural dimensions is illustrated by the interaction of the concepts of structure and agency.[35] Change and development are not only the product of institutions, but also of individual actors or small groups. The interplay between structure and agency is partially revealed in the relationship between mail armour and the identity of the individual that wears it, but it is most visible at the level of the craft. The work process of a craftsperson, every choice made and every tool used at each stage will shape the characteristics of the final object. Concepts such as creativity, standardisation, specialisation, and the regulation of the trade all come into play.

The aim of using the multi-dimensional model in the analysis of mail armour is to have a balanced approach,[36] able to accommodate many more relevant aspects of this armour than mere functionality. The advantage of this method is that it allows the material to be studied from various perspectives and scales. It is like taking a series of photographs of the same object, each from a different angle and distance. Every picture reveals particular details, and the sum of the photographs give a more complete and clearer image of the actual object. This also allows for the predictions generated by information at one dimension to be tested by data obtained at another, making it easier to validate findings.

The source material for this analysis entails all of the available evidence from archaeology, iconography, and textual sources. Each with its own advantages and biases, their combined analysis can provide a much clearer description of the phenomenon of early mail armour. The analytical procedure includes a detailed review of relevant literature, the subsequent collection and systematic categorization of the information cited in the sources, and the direct examination of surviving mail armour and its representations. Within the limitations of this survey, a considerable number of specimens has been inspected directly – as referred in the database (appendix) and the figure captions.[37]

1.5 SCOPE

A multi-dimensional approach has implications for the scope of this research, which in its totality is inevitably wide. It is therefore useful to distinguish between the scope of the subject of the study and the scope of the broader context.

Mail armour, the subject of study, comprises all types of defensive attires made from interconnected metal rings that form a mesh whose function is to protect the body from trauma during armed combat (box 1.1). This includes what I have named 'hybrid armour'. Like regular mail, hybrid armour is built of rings, but these are linked to an outer layer of scales, constituting a merger of mail and scale armour. Other forms of armour (e.g. plate, lamellar, and segmented) or *militaria* are not included here, but will be drawn upon as part of the larger context.

As for the time frame, this study focuses mainly on the period between mail's invention during the Iron Age until approximately the end of the Roman Western Empire, situated in the 5th century AD. The appendix contains a database of archaeological finds of mail armour generated by a systematic literature review and the direct examination of specimens. However, this database also includes finds up to AD 1000. This allows for various aspects of mail from the Iron Age and Roman period to be compared with the Early Middle Ages. The inclusion of this material also makes it easier to understand the transition from Late Antiquity into the Middle Ages. Although the early-medieval period will not be at the core of this study, it will feature frequently throughout various chapters.

Part of the broader context is mail from the Late Middle Ages and Early Modern period. Almost every aspect of mail is better understood from the 14th century onwards, thanks to many surviving historical examples of mail. That knowledge is often applied to contrast and complement data from the period

[37] All objects photographed by M.A. Wijnhoven have been examined directly by the author.

BOX 1.1 CLARIFICATION OF TERMINOLOGY USED

Mail versus mail armour
The two terms do not necessarily denote the same. Mail armour involves an object made of interconnecting metal rings with the explicit function to protect the body against combat trauma. In contrast, mail can refer to a ringed mesh of any purpose, including decorative items such as jewellery. This study focuses on mail armour.

Early and late mail
Early mail denotes here finds dated to the Iron Age and the Roman period. These always come from an archaeological context. The term 'antiquity' is used in the same sense and refers to the same timeframe. Late mail is employed to refer to artefacts from the Late Middle Ages and Early Modern period. Although there are archaeological finds among these, the great majority concerns historical objects that have been passed from owner to owner through time.

Roman and non-Roman finds
In this study the term Roman refers to mail armour finds from the Roman Empire, mostly from its borders, and finds from outside the Empire that are associated with (activities of) its army. The term Roman includes here both citizens and non-citizens, since the army was made up of both. Non-Roman finds concern those that are found outside the Empire and are not associated with the Roman army.

under discussion. To differentiate between the two, this work uses the term *late* for mail armour of the Late Middle Ages and Early Modern period, and *early* for that of the Iron Age and the Roman period (box 1.1).

Geographically, the study includes all regions where mail is found up to the 10th century AD, that is, Europe, North Africa, Asia Minor, the Caucasus, and Russia. The great majority of the evidence for this period will centre around Europe.[38] In part this has to do with the fact that mail is a European technology that later spread to other parts of the world, notably Asia, and later even to the new world, brought by European traders and colonists. Nonetheless, it also has to do with the availability of information. The relative intensity of archaeological research in Europe automatically leads to a greater abundancy of data.

Information of late mail from other geographical areas, notably India and Japan, is still frequently touched upon in this study. Just as late mail from Europe, it forms an important context to contrast and complement the insights for early mail. Moreover, both European and non-European mail from later times are descendants from a common ancestor, early mail armour, the subject of this study.

1.6 MAIL OR CHAIN-MAIL?

Designating an object by its correct term is important, especially when it concerns the research subject. In English both 'mail' and 'chain-mail' are nowadays used to indicate armour made of interconnected metal rings. The word mail is the original phrasing. It was introduced into English before the 1300s

[38] Hence the decision to include the word 'European' in the title of this work.

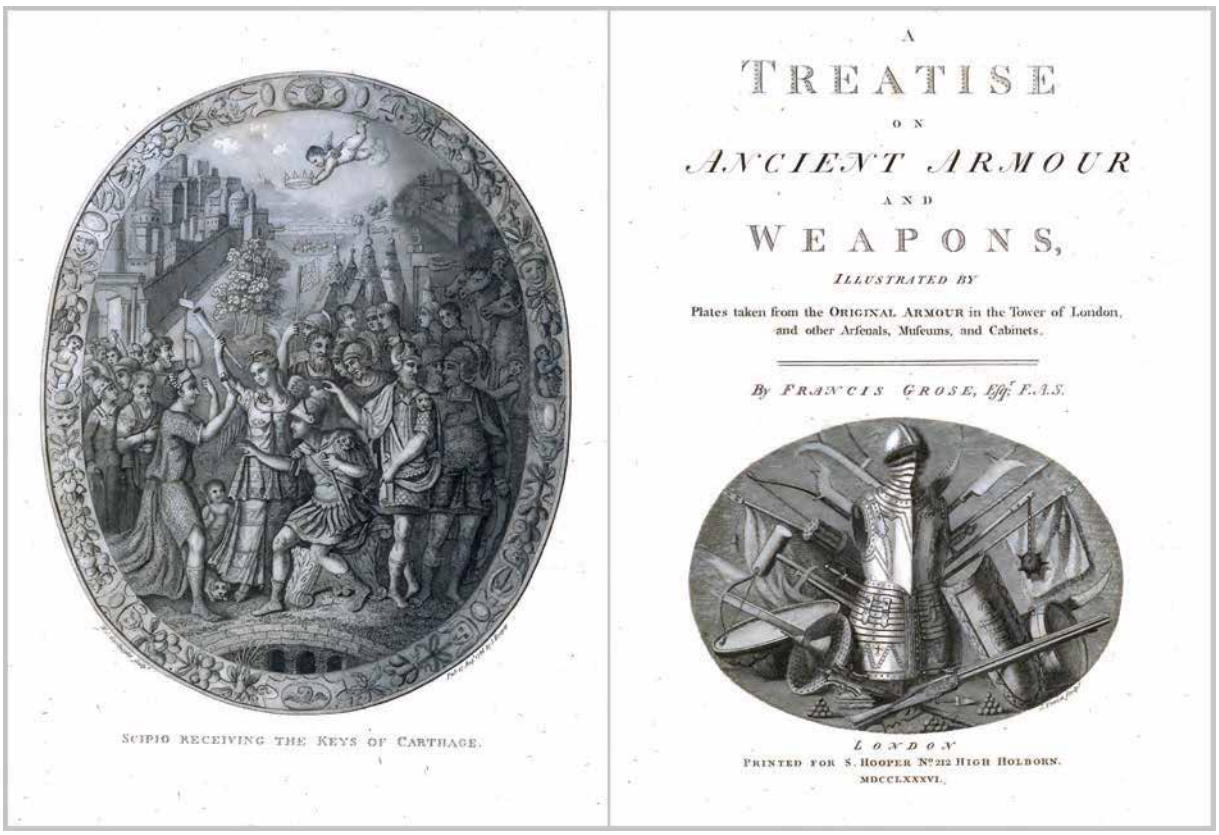


Fig. 1.4. Francis Grose's *A treatise on ancient armour and weapons*, published in 1786, contains one of the earliest references to the term chain-mail. This book has been very influential within the study of arms and armour.

through Anglo-French relationships and derives from the (Old) French word *maille*, which means 'mesh (of a net)'.[39]

The term chain-mail is nowadays probably more embedded into public consciousness and features often in popular culture. It is a relatively recent term, stemming from the late 18th century, when it was erroneously thought that 'mail' was a term that denoted armour in general.[40] The academic community of the time felt it thus necessary to specify the different kinds of armour by adding a descriptive noun indicating their key characteristics. Hence, terms such as 'chain-mail' and 'ring-mail' were forged to denote mail armour (fig. 1.4). In the early 19th century, the influential scholar of arms and armour Sir Samuel Meyrick further subdivided chain-mail into different 'types' (e.g. single, double-chain, trelliced, rustred).[41]

All in all, ring- and chain-mail are modern pleonasms derived from a terminological misunderstanding of the word mail. Likewise, Meyrick's classification is superfluous, based on a misinterpretation of the data available to him at the time. The problematic nature of these terms has long been known and discussed by several scholars, among which none with such rigour and passion as Francis M. Kelly in 1931, whose remarks are worth quoting:

[39] Simpson/Weiner 1989, vol. 9, 212.

[40] The Oxford English Dictionary indicates Sir Walter Scott's *The fortunes of Nigel* (1822, 67) as the first attestation of the word chain-mail. While this might concern its earliest known usage in a novel, older evidence is observed in scholarly works. The earliest phrasing of chain-mail comes from Francis Grose's *A treatise on ancient armour and weapons* (1786, 13-14). The earliest reference to mail understood as a generic term for armour that I encountered, is from John Merchant's *A new complete English dictionary* (1760).

[41] Meyrick 1821; 1824; 1846; 2007 [1842].

'And let me define plainly what I mean by 'mail'. I hold that in the Middle Ages and, indeed, as long as armour continued, so to speak, as 'a going concern', the term applied properly, nay, exclusively, to that type of defence composed -as in a modern lady's steel purse- of interlinked rings. Only through late poetical licence did it come to be extended to armour in general. 'Chain-mail' is a mere piece of modern pleonasm; 'scale-mail' and still more 'plate mail' stark nonsense. As for Meyrick's proposed classification of mail- 'ringed', 'single', 'double-chain', 'rustred', 'trelliced', etc.- it may be dismissed without further ado. His categories, in so far as they were not pure invention, rested wholly on a misconception of the evidence; the passages he cites to support his theories of 'ringed', 'trelliced', 'muscled', etc., all refer to what he calls 'chain' mail; otherwise MAIL pure and simple.' [42]

After such spirited wording, one would almost not dare contradict Mr. Kelly. Fortunately, we agree with him wholeheartedly. This study will therefore avoid the use of such terms and abide by the historical phrasing of 'mail' or 'mail armour', as it was known back when it was still worn in battle.

[42] Kelly 1931, 265. The scholar of medieval arms and armour, Claude Blair, also uses this quote in his book *European armour* (1958, 20).

2 The origins of mail armour

'Whoever may have been the inventors of this armour, the probability seems to be that it came into use gradually: from its costliness and rarity, leaders only could at first obtain it; that, as handicraft improved, and the efficiency of the defence became acknowledged, its adoption was extended, and its costliness diminished.'
John Hewitt[1]

2.1 SUGGESTED PRECURSORS

The history of technology teaches us that very few artefact types appear without any antecedents or influences. Likewise, mail armour probably did not come out of nowhere. Although little research has been done on the possible predecessors of mail, there are a few tentative suggestions involving artefacts with metal rings that form some kind of wearable mesh.[2]

One of the earliest suggested ancestors of mail comes from Brno-Židenice, Czech Republic, where a single grave of the Horákov Culture, dated to Hallstatt C (800-650 BC), contained nearly 15,000 small bronze rings.[3] These rings, however, did not interconnect but were woven onto a textile, with the threads of the warp and weft passing through them (fig. 2.1). The amount of rings suggests that the original garment must have been large and heavy, which probably ignited the idea that it constituted the remains of some sort of body armour.[4] This interpretation is nevertheless unlikely. As the rings were not interconnected, the structural

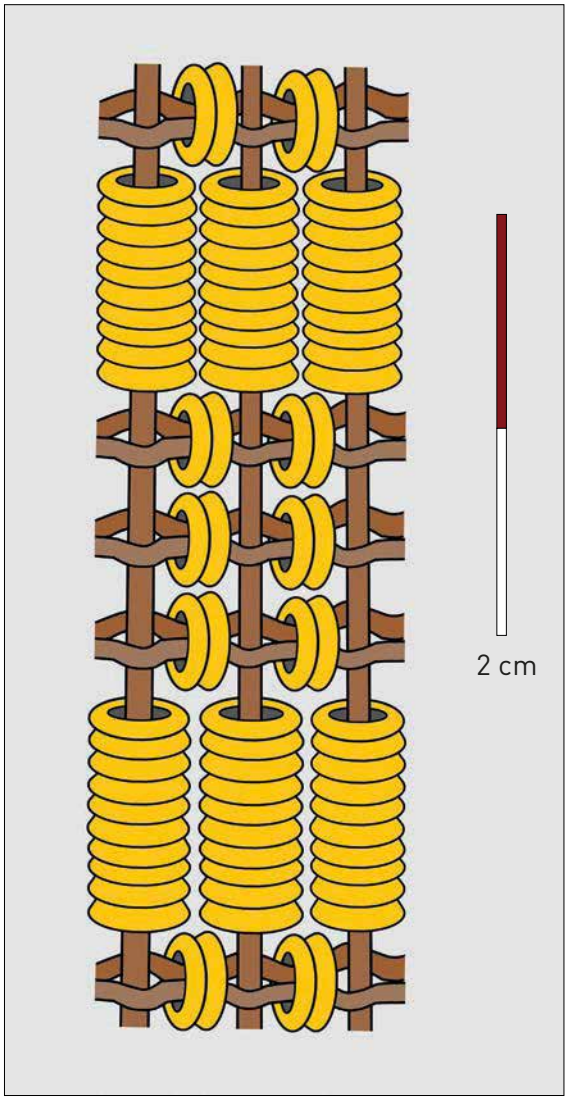


Fig. 2.1. Schematic representation of the bronze rings woven into a textile fabric from Brno-Židenice, Czech Republic, dated to 800-650 BC (drawing M.A. Wijnhoven after Hrubý 1959, pl. 7).

1 Hewitt 1860, 64.

2 E.g. Baril Vicente *et al.* 1998, 76-77; De Cosson/Burges 1880, 566; Rusu 1969, 289; Stone 1961, 427-428.

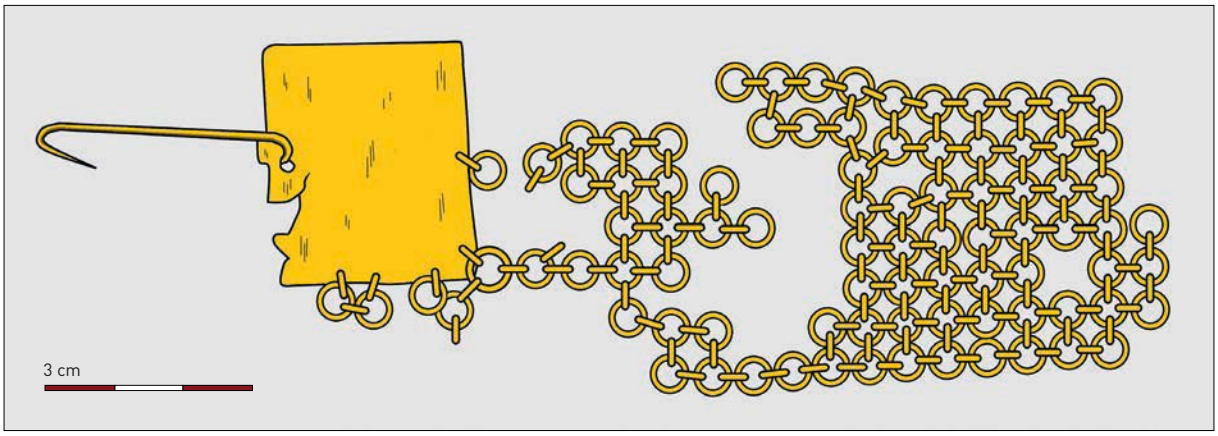


Fig. 2.2. A detail of the ring structure from Almaluez in Spain from the turn of the 5th century BC. Each flat-laying ring is connected to four smaller standing rings (drawing M.A. Wijnhoven after Baril Vicente *et al.* 1998, fig. 3).

strength of the piece would have relied entirely on the textile threads, which in turn were not tightly woven due to the insertion of the metal rings. The resulting fabric would have been easily shredded by any edged weapon, making it unsuitable for the rigours of battle. This makes it more likely that it was worn for personal adornment. The find is not unique and similar textiles with inserted bronze rings have been found in Maiersch (Austria) dating to Hallstatt C and in a high status female grave at Waldalgesheim (Germany) dated around 325 BC.[5]

Another category of mail-like artefacts is meshes of interconnected bronze rings with no textile support. The Spanish cemeteries of Almaluez and Clares, dated to the turn of the 5th century BC, have yielded ten fragments of these meshes,[6] formed by larger flat-laying rings that each connect to four smaller rings placed at an angle (fig. 2.2). Interestingly, this weaving technique reappears much later, and independently, in Japanese mail, but is not found in European mail armour (chapter 9). Some of the fragments are attached to small rectangular pieces of copper alloy plate with the edges perforated to insert the rings. The bronze links are made from wire and have butted ends. Meshes of butted links are structurally weak and can be torn easily which is why it less likely that these remnants served as armour. Furthermore, five of the ten fragments were found in graves that contained mostly female-related goods, while only two were associated to male objects (three fragments had no associated artefacts). In sum, these ring meshes also seem to have been used as a kind of decoration, perhaps as a chest piece.

Ornaments made of bronze rings also appear in Italy between the end of the Bronze Age until the 5th century BC. Generally found in female graves, they include loose rings and chains or meshes of interconnected rings attached to pendants and brooches (fig. 2.3).[7] The bronze rings in these ornaments were mould cast (fig. 2.4), as evidenced by the casting seams, traces of flash, or sprue remnants seen on the links. To connect them, some were cut open, resulting in a weave of half solid and half butted rings.

The objects described above seem to constitute instances of female personal ornaments. An apparent exception is a 4th-century Italic bronze belt that is now housed at the Louvre Museum in Paris (fig. 2.5).[8] Such bronze belts are usually found in graves of adult males in southern Italy and although it is uncertain whether they can be considered armour in their own right, they certainly belong to warrior paraphernalia.[9] What makes the Louvre belt unique is that it has a mesh of bronze rings dangling from it, which seems to have covered the pelvic area like a skirt.

3 Hrubý 1959.

4 Hrubý 1959, 36.

5 Grömer 2010, 185-186.

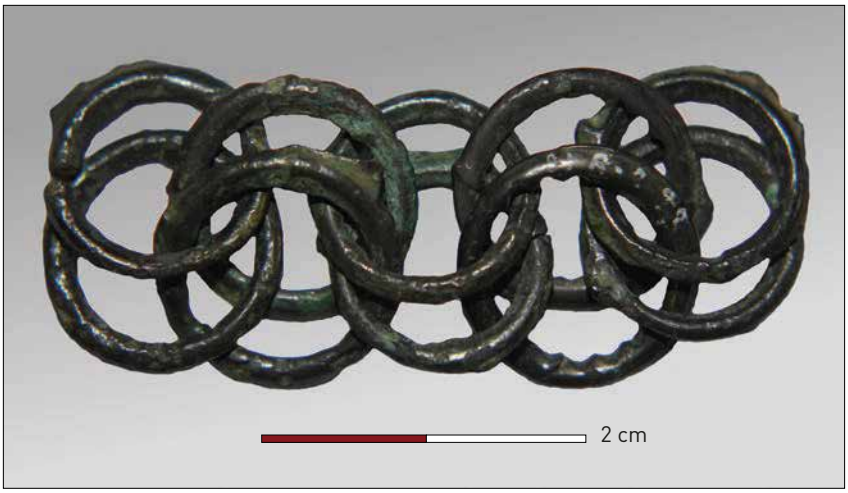
6 Baril Vicente *et al.* 1998.

7 Examples can be found in Bartolini *et al.* 1980; D'Andrea 2014; Frey 1991; Haynes 2000; Hencken 1968; Iaia 2007; MacIntosh 2005; Müller-Karpe 1959; Nizzo 2007.

8 Inv. no. Br 4757.

Fig. 2.3. Brooch with a ring structure from Cumae in Italy, dated to the second half of the 9th century BC. Museo Archeologico Nazionale, Naples (photograph M.A. Wijnhoven).

Fig. 2.4. Small fragment of interconnected rings from an unknown find spot in Greece, now in the British Museum (inv. no. 1881,0802, 98). Remnants of flash indicate that the rings were cast (photograph M.A. Wijnhoven).



A warrior belt with extra protection in the form of a ring skirt makes sense, and it has been suggested that this example may point to the development of ringed meshes from female decorative contexts towards male armour-centred uses.[10] Unfortunately, a close examination of the Louvre piece has revealed that the belt and skirt did not go together originally but were probably assembled as one during the 19th century.[11] Both parts are antiquities, but come from different contexts; the belt from a 4th-century Italic male burial, and the ring skirt probably from a rich 8th- or 7th-century BC female burial in the Italian

9 Burns 2005, 131-146; Robinson 1995; Suano 1986.

10 Barril Vicente *et al.* 1998, 76.

11 Wijnhoven 2019b.

Fig. 2.5. The 4th-century BC bronze belt at the Louvre Museum with a skirt of bronze rings. The belt and ring mesh concern two unrelated archaeological objects that were put together in the 19th century (photograph M.A. Wijnhoven).

region of Basilicata. That area has yielded similar meshes that hang from a bird-headed plaque pendant or form a hip ornament placed below a textile belt covered in beads of glass, amber and bronze (fig. 2.7).[12] Thus, the Louvre ring skirt was probably a female hip ornament. We can therefore discard the idea that this item reflects the evolution of ring meshes into male armoured-centred applications. Moreover, the construction aspects of the Louvre mesh reinforce the fact that it is ornament and not armour. For example, almost a third of the rings does not add to its structural integrity, but is merely decorative (fig. 2.6), like tassels with ring clusters, loose hanging rings, and rings with lentil-shaped pendants.

At some point or another, almost every example mentioned so far has been postulated as a precursor of mail armour; some have even been considered early types of mail, and probably quite wrongly so. Part of the confusion is due to the lack of well-defined terminology. A clear distinction must be made between 'mail', in the general sense of a multi-purpose ringed mesh, and 'mail armour' made for the explicit function of protecting the body against combat trauma. Protective mail that did *function as body armour* differs from these purported predecessors in five key aspects:

1. The raw material of the rings. Mail armour rings are invariably made from iron.[13] Sometimes copper alloy rings are used in addition to iron ones, for decorative purposes (chapter 6).
2. The weave of the rings. Except for a few cases, all European mail armour of all eras is woven in a 4-in-1 pattern (chapter 9). The rings are placed in rows and each ring is connected to four others, two rings in the row above and two in the row below.[14] The examples discussed above all have different weaving patterns.

12 Bianco *et al.* 1998, 215-223; Bottini/Tagliente 1984.

13 Wijnhoven 2017.

14 Burgess 1953b.

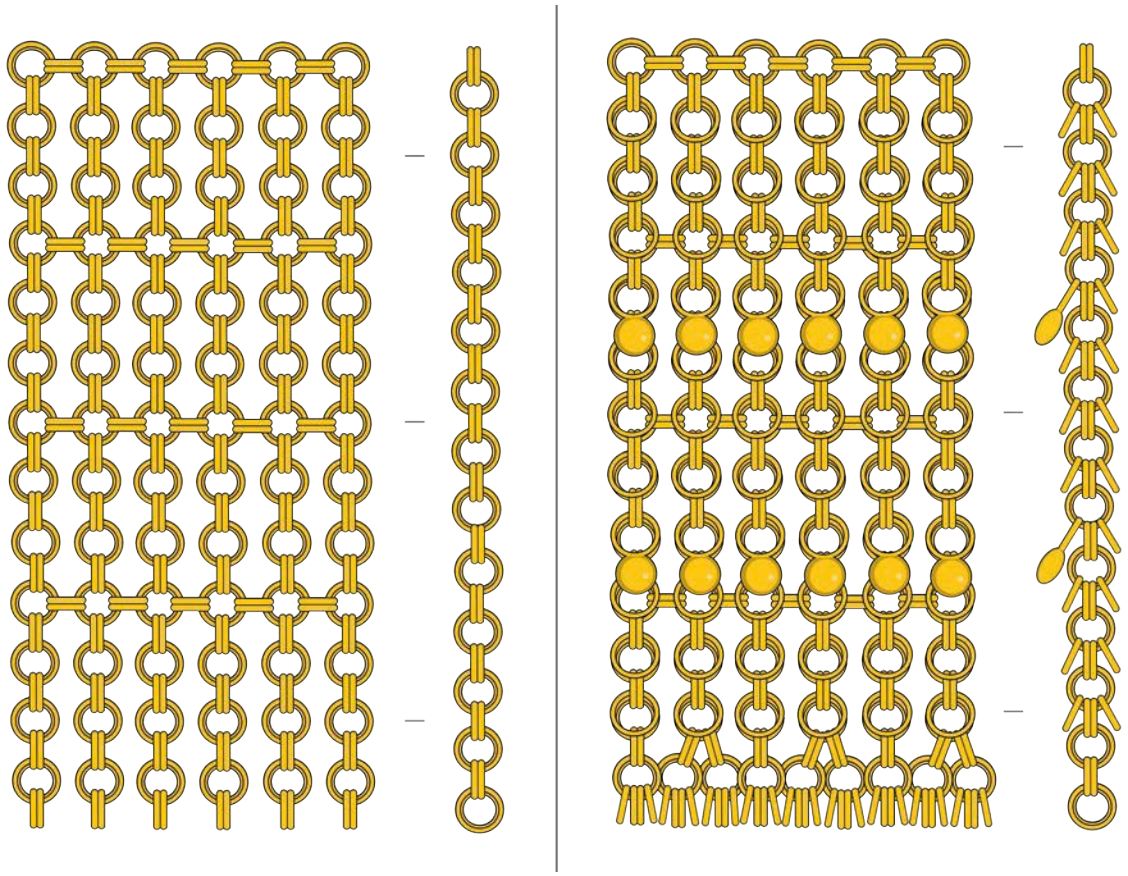


Fig. 2.6. Left: front and side view of the structural basis of the Louvre skirt. Right: front and side view of all the rings in the Louvre skirt, including the decorative ones (drawing M.A. Wijnhoven).

3. Overall function. None of the pieces mentioned above evoke items of military equipment. Instead, they serve as pieces of personal adornment, mainly associated with women. As a consequence, these meshes are unsuitable as armour, which takes us to the following two points.
4. The manner in which the rings are made. Mail armour is either constructed of riveted rings or a combination of riveted and solid rings (chapter 8).[15] The riveted rings are made by shaping metal wire into a circle with overlapping ends that are subsequently pierced and sealed by a small rivet. The solid rings are punched out of sheet metal or made by welding a wire ring shut. The mix of riveted and solid rings ensures the structural integrity of the armour, offering maximum protection against the rigours of battle. In contrast, the examples mentioned above are made of cast rings, many of which are cut open, or of rings made from metal strips with butted ends. Such rings make for a weak structure that would tear with relatively little force and could not withstand the impact of a weapon.
5. Balance. Functional armour always shows a careful balance between weight, protection, and flexibility.[16] The ideal armour offers great protection, while keeping its weight to a minimum and allowing the wearer to have a good range of motion. The objects included in this section do not conform to this principle. Especially the discussed finds from Italy contain many elements that do not increase the structural integrity of the fabric and add a lot of weight without gaining protection, such as tassels or hanging decorative rings.

[15] Burgess 1953a; Sim 1997; Wijnhoven 2015a, 84-85.

[16] Askew *et al.* 2012; Wijnhoven 2015a, 81.

Fig. 2.7. Reconstruction of burials 316 (left) and 324 (right) at Alianello in Italy from the 7th century BC. Female decorative elements including a wide textile belt decorated with many beads. Directly underneath the belt there is a hip ornament made of a ring mesh similar to the Louvre skirt. Burial 316 also contains a bird-headed plaque pendant from which a similar mesh dangles (drawing M.A. Wijnhoven after D'Agostino 1998, fig. 9-10).

Considering these fundamental differences, it is very unlikely that any of the specimens described here may be considered as direct precursors of mail armour, but they do demonstrate that in the centuries preceding the emergence of mail armour there was a great deal of experimentation with ringed meshes. The idea of metal rings applied to body armour may have been 'in the air' and was only a matter of time until it fully materialized.

2.2 CONTESTED ORIGINS

Over the past two centuries, scholars of arms and armour have put forward several archaeological cultures as the 'inventors' of mail (box 2.1). This section will shortly discuss each of these cases.

BOX 2.1 THE COMPLEXITY OF ARCHAEOLOGICAL CULTURES

This study refers to different cultures or peoples in a manner often used in the archaeological literature, grouped together and mainly classified through their material culture. This simplified view may not necessarily correspond to how people perceived themselves. The realities of culture, identity and ethnicity are often far more complicated and organic than what the archaeological record is able to reveal. Especially in the last decades there has been an increasing awareness of the limitations of cultural labels applied to the past (e.g. Hunter *et al.* 2015; Roymans 2004). The cultures or peoples mentioned refer to a geographical-archaeological dimension and serve mainly as a vehicle for understanding the subject of this study.

The East

One of the earliest ideas on the origins of mail was formulated by Sir Samuel Rush Meyrick in the early 19th century. He asserted that 'true mail' was introduced in Europe during the Crusades and had been invented somewhere in the East.[17] Meyrick used mainly historical and iconographical sources in his research, but with the development of archaeology as a scientific discipline during the 19th century his ideas became increasingly criticised.[18] Although finds of mail armour preceding the crusading era disproved its late introduction in Europe, the notion of its Eastern origin survived well into the second half of the 20th century.[19] Nowadays this proposal is no longer considered valid.

The Etruscans

As said in the previous section, the bronze ring meshes from the 8th to 5th centuries BC have often been interpreted as forerunners of, or even as early mail armour.[20] The *Catalogue of the exhibition of ancient helmets and examples of mail* written by Baron C.A. de Cosson and Wiliam Burges in 1880 particularly popularized the idea that mail armour was already in use between 800-500 BC. De Cosson and Burgess describe a mesh of interconnected rings similar to the one found in the Louvre as Etruscan mail.[21] For this reason, every now and again the Etruscans are credited with the invention of mail armour.[22] The mentioned fragment comes from southern Italy and it is in fact another example of a ring mesh that hung from a plaque pendant with bird heads as illustrated in figure 2.7. These are mainly found in female burials from the 8th and 7th centuries BC, and do not concern armour.[23]

17 Meyrick 1821, 336-337; 1824, vol. 1, 101.

18 E.g. Hewitt 1860, 60-64.

19 E.g. Blair 1958, 19.

20 Robinson 1967, 11; Roux/Coffyn 1987, 38; Stone 1961, 427-428.

21 De Cosson/Burges 1880, 566.

22 The Etruscan origin of mail is especially championed on the internet.

23 Wijnhoven 2019b.

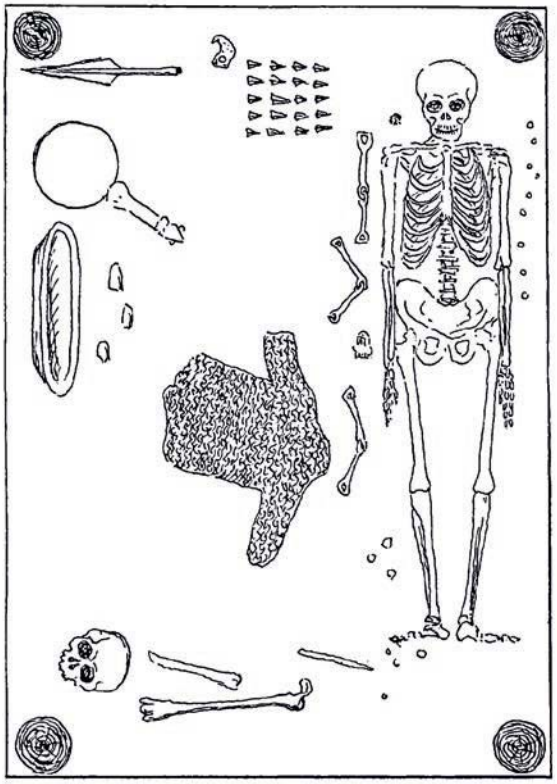


Fig. 2.8. Plan of the burial from Guljaj Gorod in Russia as featured in Ellis H. Minns' *Scythians and Greeks*. Although the armour concerns scale, it is described as mail and also drawn to resemble it (drawing Minns 1913, fig. 70).

The Scythians

Since the early 20th century it has been recurrently suggested that the Scythian tombs from the 5th and 4th century BC in Russia contained mail armour, which would make them the earliest evidence of this defensive equipment.[24]

The book *Scythians and Greeks*, published in 1913 by Ellis H. Minns, proved particularly influential in promoting the idea that mail had been found in the ancient burial mounds of Russia. This was one of the first volumes that made the Scythian world accessible to non-Russian speakers, but Minns's erroneous remarks on mail have lingered in studies of ancient armour up to the present.[25] Minns, for example, states that the burial mounds of Guljaj Gorod and Zhurovka contain an iron coat of mail each,[26] whereas the armour of both sites concerns scale, and not mail.[27] It even includes a burial plan of Guljaj Gorod showing the associated finds, where the armour is drawn as to resemble mail (fig. 2.8).

A burial mound in Russia that did contain mail is Vasjurina Gora. It was tentatively dated to the 4th or 3rd century BC, which would support a Scythian-Sarmatian origin of mail. However, a recent re-assessment of the grave goods has properly dated the burial to circa 180-150 BC.[28] Although this date is still early, it is not as old as the first examples of mail armour, as we will see later in this chapter.

All of the Scythian armour reported as mail in the literature, on inspection, happens to be scale armour.[29] These finds come from old excavations in the 19th and early 20th centuries, a time when the Russian terms for mail and scale armour were used loosely or even interchangeably. In actuality, there is not a single find of mail associated to the Scythians.

The Celts

Archaeologists nowadays seem to agree that the Celts probably conceived mail armour. This assumption is supported by several facts, the most relevant being that, since its emergence and throughout the centuries that follow, mail armour is very often found in Celtic contexts. Additionally, the well-known burial of Ciumeşti is considered by many as the earliest find of mail (see below), and it is generally accepted as Celtic.[30] Every study of early mail refers to this find, which has helped to consolidate the idea that the Celts were the inventors of mail.

[24] Bivar 1972, 276; Davis/Davis 2011, 67; Gilmour 1997, 26; Glad 2009, 60; Kotyhoroshko 2015, 210-211; Minns 1913, 174-176; Müller 2003, 434; Piggott 1965, 240; Robinson 1967, 10; 1975, 164; Wójcikowski 2013, 237.

[25] Almost all references in the previous footnote go back, directly or indirectly, to Minns 1913.

[26] Minns 1913, 274-276.

[27] Černenko 2006, 32, 34-35.

[28] Vlasov 2004, 171.

[29] Černenko 2006, 28; Waurick 1979, 325-326.

[30] Rusu 1969.

Another important fact is that various classical sources mention the mail coat in association to Celtic peoples. In addition to Varro, whose work is invariably cited in modern studies, the Greek historians Diodorus Siculus and Strabo also state its use among the Celts (box 2.2). Varro and Diodorus relate it to the Gauls, while Strabo's narrative refers to the Celtic Lusitanians of the Iberian Peninsula.

Contrary to what is claimed by many modern authors, Varro does not actually say that the Gauls invented mail armour, nor does he mention that the Romans adopted mail from the Celts, although the latter is very plausible.[31] He merely affiliates the Gauls with mail armour, not unlike Polybius who, a century earlier, associated it with the Romans by stating that the mail-clad part of a procession was 'armed after Roman fashion' (box 2.2). Although these sources are unable to shed light on the origin of mail, they do offer an important historical insight that is corroborated by archaeology. During the 1st century BC, when Varro, Diodorus and Strabo wrote their accounts, the only form of metal body armour among Celtic peoples was mail.[32]

BOX 2.2 EARLY CLASSICAL SOURCES THAT MENTION THE CELTS AND ROMANS WEARING MAIL

Varro (1st century BC)
- Cuirass (*lorica*), because they made chest-protectors from thongs (*lora*) of rawhide; afterwards the Gallic cuirass was included under this name, an iron tunic made of rings. (*De lingua Latina* 5.24; translation by the author)

Diodorus Siculus (1st century BC)
- Some of them [the Gauls] have iron cuirasses, chain-wrought, but others are satisfied with the armour which nature has given them and go into battle naked. (*Bibliotheca historica* 5.30.3; translation Oldfather 1939, 176)

Strabo (early 1st century AD)
- Most of them [the Lusitanians] wear linen cuirasses; a few wear chain-wrought cuirasses and helmets with three crests, but the rest wear helmets made of sinews. (*Geographica* 3.3.6; translation Jones 1923, 73)

Polybius (2nd century BC)
- The festival opened with a procession composed as follows: it was headed by 5.000 men in the prime of their life armed after the Roman fashion and wearing chain-wrought cuirasses. (*Historiae* 30.25.2-3; translation adapted from Paton 1960, 142)
- The common soldiers wear in addition a breastplate of brass a span square, which they place in front of the heart and call heart-protector (*pectorale*), this completing their accoutrements; but those who are rated above 10.000 drachmas wear instead of this a coat of mail. (*Historiae* 6.23.14-15; translation Paton 1966, 320)

[31] E.g. Pausch 2003, 201; Torbov 2004, 62; Greiner 2008, 97; Gut 2009, 9.

[32] In earlier centuries, especially during the Late Hallstatt period, the Celts used other forms of body armour. Cf. Hansen 2003, 5-34.

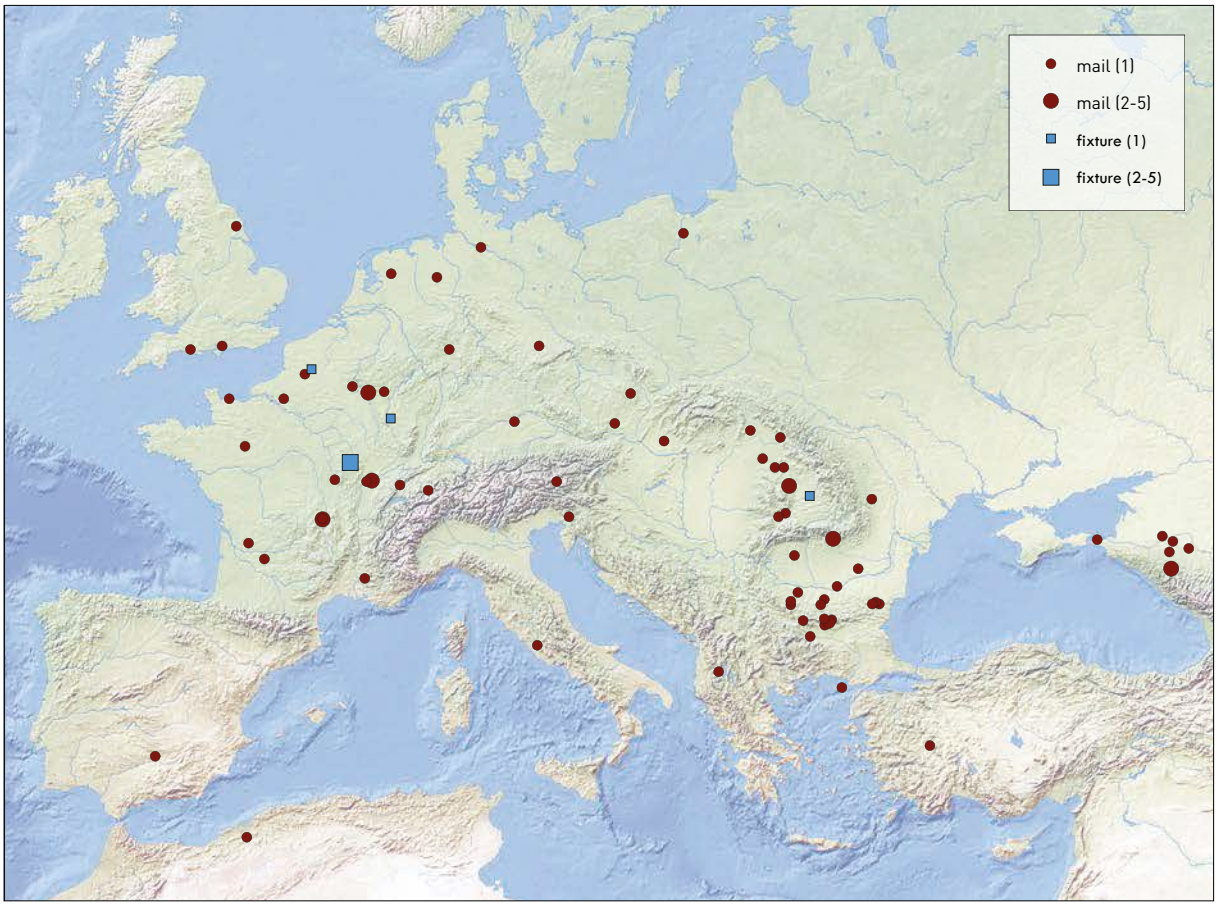


Fig. 2.9. Map of mail finds from its earliest appearance until the reign of Augustus. A large proportion of the early finds of mail comes from Romania and Bulgaria (map M.A. Wijnhoven/B. Brouwenstijn).

The Celts from the Balkans – Romania and Bulgaria

In recent years there have been more and more reports of finds of early mail remains in Eastern Europe, namely Romania and Bulgaria. Some of them, especially the very early ones, actually involve scale armour, but the word (chain-)mail has been misused as a generic term for armour. For example the finds from Bryastovetz, Brunichevo, Kjolmen, Jankovo, Golyamata Mogila and Svetica in Bulgaria are all scale armour.[33] Another supposed early find comes from Rozovets in Bulgaria, which was initially thought to date to the 5th century BC.[34] Whereas the burial chamber is indeed of that age, the objects in it come from 250-150 BC. It seems that the burial chamber was actually reused over time.[35]

Despite these issues, there is still a large corpus of early mail finds from both countries. So large in fact, that various scholars have reconsidered the origin of mail armour, rejecting the idea of a generic Celtic invention to exclude the Western European Celts.[36] They instead suggest an Eastern European origin,

[33] Torbov (2004) presents multiple early finds of mail from Bulgaria in an English article and discusses the origin of mail. While he adds to the wealth of early finds, he also confuses the discussion by presenting finds of mail and scale, which he both calls chain-mail indiscriminately. Agre (2006, 179) speaks of chain armour from the 4th-century BC Golyamata Mogila, but makes it clear in a later publication that it actually is scale (2011, 72-84). Dimitrova (2017, 157) uses the German *Kettenhemd* for scale armour.

[34] Torbov 2004, 61.

[35] Marinov 2008, 148-149.

[36] Borangic 2011a, 192-193; Borangic/Bădescu 2014, 62-63; Borangic/Paliga 2013, 11-13; Poux 2008, 348-349; Rustoiu 2006, 52; 2008, 30; Torbov 2004, 61-64.

specifically the Balkan region, inhabited by the Celts, Thracians and Geto-Dacians, often mentioning the cultural group of the Padea-Panagjurskii Kolonii as responsible for the subsequent dispersal of mail throughout the Balkans and beyond.[37] This archaeological culture was minted in the 1970s to describe a group of burials from Romania and Bulgaria dated to the 2nd and 1st centuries BC, whose inventory combined La Tène and Thracian elements.[38]

The supporters of an eastern Celtic origin of mail point to the great amount of finds from the Balkans. If we look at the map of all the early finds, from the invention of mail until the reign of Augustus in 27 BC (fig. 2.9), it becomes clear that there are plenty of finds in Western Europe, but the highest density is found in the East.

There is one site that has proven difficult to accommodate by the Balkan hypothesis. Hjortspring in Denmark is earlier than any other site in Eastern Europe and thus has the potential to disprove a Balkan origin, but its advocates argue that the objects deposited at Hjortspring were not native and belonged to people that probably came from the Balkans.[39] It is then evident that we need to review the earliest evidence of mail, including Hjortspring.

2.3 EARLIEST EVIDENCE

In the last decades three finds have been mentioned frequently as the earliest evidence of mail armour: Hjortspring from Denmark, Ciumeşti from Romania, and Horný Jatov from Slovakia. Hjortspring, the oldest of the three, is considered a so-called 'war booty sacrifice'. This southern Scandinavian phenomenon entailed the deposition of vast amounts of militaria, supposedly from a defeated army, into a bog as an offering.[40] The Hjortspring find included an entire boat, almost 200 spearheads, fragments of more than 60 shields, 11 swords, and other pieces of military equipment, all deposited in a single moment (fig. 2.10). Wood from the boat and a spear shaft yielded a calibrated radiocarbon date of 350-300 BC, placing it well into the 4th century BC.[41]

Hjortspring is also known for including around a dozen coats of mail. Gustav Rosenberg, who excavated the site in 1921-22, came across a ten to twelve square metre area that contained corrosion products with ring-shaped marks. He assumed that these were the rusted remains of mail coats which were too deteriorated to dig. He estimated one coat per square metre.[42] This means that, except for the odd corroded ring, no actual pieces of mail coats were retrieved.

In fact, other authors point out that what Rosenberg observed may be interpreted in different ways. Arne Jouttijärvi and Flemming Kaul have suggested that the corrosion area may be the result of podzolic precipitation[43], by which oxidised iron (naturally occurring in the ground or originating from nearby iron objects) nestles around roots forming ring-shaped impressions. To solve the controversy, the Nationalmuseet in Copenhagen recently analysed a few of the rings salvaged from the excavation. The results confirmed that the supposed rings did not come from mail, but were actually the result of podzolic

37 E.g. Borangic 2011a, 173-174, 191-193; Borangic/Paliga 2013, 12); Rustoiu 2006, 50.

38 Rustoiu 2005.

39 Borangic 2011a, 172; Borangic/Paliga 2013, 11-12.

40 Cf. Jørgensen *et al.* 2003.

41 Calibrated dates: 2240 BP ± 50; 2290 BP ± 70. Jensen 1989, 533.

42 Rosenberg 1937, 47-48. Kaul (2003, 153) offers an English translation of Rosenberg's writings: 'On closer examination of the mass of peat, saturated with wet, powder-like rust, there could be seen numerous, very delicate and fragile rust flakes from small iron rings, which must doubtless have been joined together to form chain mail coats. The acidic bog water had completely dissolved and leached out the iron from the tin wire rings, as only the initial, coherent rust on the surface of the iron has survived.'

43 Jouttijärvi 1996, 53; Kaul 2003, 153.

Fig. 2.10. Some of the finds from Hjortspring in Denmark, 350-300 BC. Left: iron and bone spearheads. Right: swords of different types and a scabbard (photograph Nationalmuseet).

precipitation.[44] Consequently, one of the earliest and biggest finds of mail has been disproved. At the same time, the Balkan origin hypothesis has been relieved from having to explain the early appearance of mail outside the Balkans.

In contrast to Hjortspring, the find from Ciumeşti did render physical remains of mail armour (fig. 2.11). Although not as old, this site is now seen by many as the earliest example of mail use, and it has become so prominent that one cannot discuss early mail armour without referring to it. The Ciumeşti mail remains were part of a Celtic cremation grave that contained an elaborate helmet whose crest is adorned by a large bronze bird with articulated wings, two bronze greaves, an iron spearhead, belt fragments, an iron brooch, and two ceramic vessels.[45] A bronze fastener decorated with rosettes and a large loose rosette were still attached to the mail coat when discovered.

An issue rarely mentioned in the literature on mail armour is that the age of the Ciumeşti burial and its contents have been disputed, mainly because the initial date assigned to the grave predated the cemetery in which it was found. Based on the ornamentation of the bronze rosettes attached to the mail coat, Mircea Rusu estimated the burial to be from the end of the 4th century BC (La Tène B).[46] This early date has been widely accepted, perhaps because it coincides well with the first incursions of Celtic groups in the area according to historical sources.[47] The age of the cemetery is fairly well established and is nonetheless considerably younger, between 280 and 175 BC (La Tène B2-C1).[48] Given the discrepancy and the fact that the other grave goods, such as the belt, the brooch and the ceramic material all proved

[44] Xenia Pauli Jensen 2014, personal communication.

[45] Németi 1975; Rusu 1969.

[46] Rusu 1969, 288-296.

[47] E.g. Pausanias, *Graeciae descriptio* 10.19.5-23.14.

Fig. 2.11. Left: the coat of mail from Ciumeşti in Romania was corroded into a solid mass, but has been mechanically cleaned resulting in various flexible fragments. Right: the large decorative rosette that was originally attached to the mail coat (photograph MA. Wijnhoven).

younger, many now agree that the 4th century date can no longer be supported for the (entire) burial. Some have suggested that the burial took place in La Tène C1, but that the helmet, greaves, and coat of mail were already old (La Tène B) when deposited.[49]

Recently, two authors have addressed the antiquity of the Ciumeşti mail coat, each arriving at a different conclusion. Leif Hansen, the first of the two, did an assessment of Celtic armour and embraced the early date on stylistic grounds, confirming that this coat should be considered the oldest of all known mail remains.[50] The second, Aurel Rustoiu, re-examined all of the grave goods and concluded that, despite the style of ornamentation of the rosettes, the whole burial must be of a later age given the dates of the remaining inventory. He suggested La Tène B2-C1 (more probably C1), dating the burial to the second half of the 3rd century BC.[51] Rustoiu's holistic approach offers a more compelling argument, meaning that the mail from Ciumeşti may be one of the earliest, but not *the* earliest. The debate on the date of the Ciumeşti burial and its mail coat is, however, probably far from over.

The third of the sites, Horný Jatov in Slovakia, has not received nearly as much attention, but recent insights indicate that the mail remains found there could be the oldest known so far. These are two highly corroded fragments found in grave 460, dated to the first half of the 3rd century BC (fig. 2.12). Although the burial was partly looted, it still contained a rich array of grave goods including a sword and scabbard, a shield, a spear, belt fragments, two brooches, four ceramic vessels, and animal bones.[52]

As this review shows, a reassessment of the earliest finds of mail armour has shifted the conventional date of its origin. Traditionally, Hjortspring and Ciumeşti placed the beginning of mail in the 2nd half

48 E.g. Bader 2000/01, 19; Crişan 1971, 73-74; Horedt 1973, 299-303; Rustoiu 2006, 43.

49 Németi 1975, 243-245; Zirra 1991, 282-283.

50 Hansen 2003, 48-49.

51 Rustoiu 2006, 50, 53; 2012a, 164.

52 Benadík *et al.* 1957, 31-32.

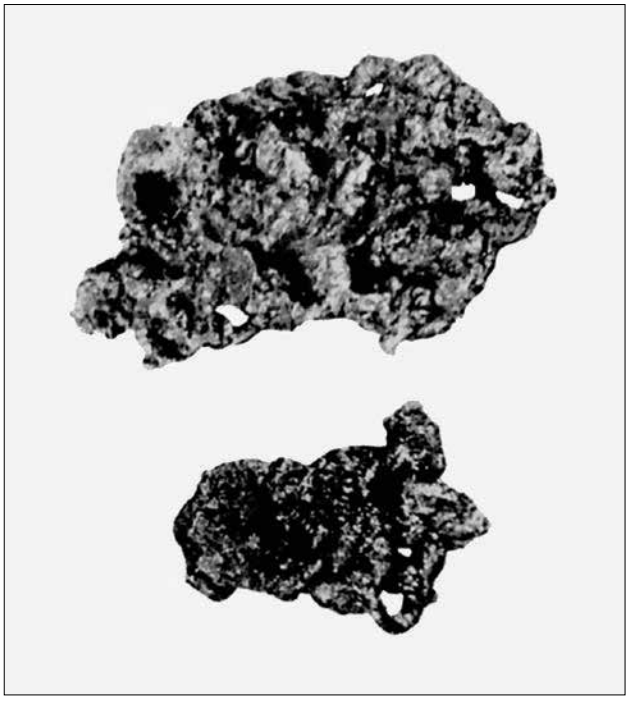


Fig. 2.12. Possibly the oldest mail remains known: the two small (and not very impressive) fragments from Horný Jatov in Slovakia, dated to the first half of the 3rd century BC (photograph Benadík *et al.* 1957, pl. 10.4-5).

of the 4th century BC, which now seems untenable. Currently, the earliest physical evidence of mail with a reliable date puts it at the start of the 3rd century BC. From this date onwards the number of finds increases steadily, as explained below. Considering that it might take time for a new artefact type to make its way into the archaeological record, we may tentatively conclude that mail armour was developed around the turn of the 4th to the 3rd century BC.

2.4 TRACING THE EARLIEST CONTEXTS

The archaeological record offers the best source for establishing the origin and spread of mail armour. Over the past decades the number of finds from the centuries BC has been growing steadily There are now 79 finds of mail and seven isolated fittings, possibly associated to mail, that predate the reign of Augustus (fig. 2.9). Despite the numbers, the intricacy of the archaeological record does not allow to make clear-cut interpretations. The only certainty is that the origin of mail is more complex than so far portrayed in the literature.

Eastern Europe, particularly the Balkans, has rendered many of the early finds, and the amount of specimens from the Iron Age is greater there than in Western Europe. However, this is not necessarily indicative of origin, as quantity may be the result of many factors such as deposition processes, archaeological preservation, or research intensity. To reconstruct the origins of an artefact type it is advisable to restrict the timeframe to the earliest dates, in order to draw up the chronological and geographical boundaries of its first appearances. For this reason we will look at the archaeological evidence of mail during the first half of 3rd century BC.

Figure 2.13 shows the distribution of mail armour from 300 to 250 BC. The methodology used to create the distribution maps in this study is explained in box 2.3. In addition, figure 2.14 sums up the absolute age of each 3rd century find. The map illustrates a total of nine provenanced finds that correspond to the first half of the 3rd century BC. Only finds with a probable date are shown, meaning that Ciumeşti is not included, although it may belong to this period as well.

Contrary to what has been discussed, the distribution of the earliest mail finds does not point to a single area, but shows a scattered dispersal from the very beginning. Finds come from Eastern Europe, but also from Central and Northwestern countries (fig. 2.15 & 16). One of the finds, from Târgu Mureş in Romania, consists of a single button-shaped object with no associated mail remains, but based on its similarity to the rosette button of the Ciumeşti mail coat, it counts as a probable indicator of mail armour.[53]

[53] Berecki 2010.

BOX 2.3 METHODOLOGY OF THE DISTRIBUTION MAPS

Archaeological finds can rarely be pinpointed to a single moment in time and more often they are assigned a date range, which can vary in length. Since the present discussion focuses on origins, the first date of each range has been plotted on the distribution map of the earliest period (300-250 BC). If the date range of a find covers a longer period of time corresponding to various distribution maps, it has been represented in all of them.

Some finds have a very wide range, for example belonging to the pre-Roman period. In such cases, they have been excluded for lack of precision. As a general rule, ranges exceeding 200 years are omitted. Whenever the distribution map spans a longer period, such as in figure 2.9, all finds that date to that period are included.

A date range is sometimes constituted by a probable date and a possible date. For example, the find from Ciumeşti probably dates to the second half of the 3rd century BC, but as seen in the discussion above, may also date to half a century earlier. In the creation of the maps only probable dates were used.

The following finds have thus been excluded from the distribution maps of 3rd century BC finds: Slavchova (pre-Roman), Tzviatkova (pre-Roman), Popeşti 4 (Iron Age?), Zimnicea (Iron Age), Kovačevše (300-27 BC), Champdivers (La Tène or Roman) and Wartberg (La Tène?). A find from Oberleisterberg (250-150 BC) is speculated to concern a fastener for a mail coat (Karwowski 2014), but this is unlikely given that its shape could not have fulfilled that function. Vasjurina Gora and Samothrace originally had a very early date, but have both been reassigned a more recent date (respectively 180-150 BC instead of 400-200 BC and 15 BC-AD 200 instead of 600 BC-AD 500). Evidently, unprovenanced finds cannot be included in the maps, but there are two that may date to the 3rd century BC. First, a bronze button, possibly from the lower Danube region, dated to the 3rd century BC based on its decorative similarities with buttons present at Ciumeşti (Müller 2011), although its association with a mail coat is uncertain. Second, a section of mail with associated fixtures that turned up at the Archaeological Museum at Veliko in Bulgaria. It was attached to a medieval helmet (Dimitrov 2009-2010), but the characteristics of the fixtures point to the Iron Age, possibly c. 250-150 BC.

The distribution map does not support the idea of an Eastern European origin, but neither does it indicate a Western European one. Mail seems to have been widely spread over several regions from the beginning. However, the finds do strongly suggest that the invention of mail armour must be sought among the Celtic peoples, i.e. in La Tène material culture. All early finds of mail armour come from La Tène contexts, except for the find from Fluitenberg in The Netherlands (fig. 2.18). Such a recurrent association implies that the Celts should be considered the cultural matrix from which mail armour emerged.

While the distribution of the earliest mail may appear random at first sight, it actually aligns more or less to the Rhine-Danube corridor. In archaeology this is a well-known route along the valleys of the Danube and Rhine rivers which for millennia has served as a contact 'highway' between Asia Minor, Northwestern Europe and the areas in-between. The dispersal of mail armour during the earliest phase points to a well-developed and wide-ranging cultural network during the 3rd century BC. This is supported by the extensive dissemination of other La Tène militaria throughout Europe around the same time, such as helmets, swords and spearheads.[54]

[54] Rustoiu 2013, 215.

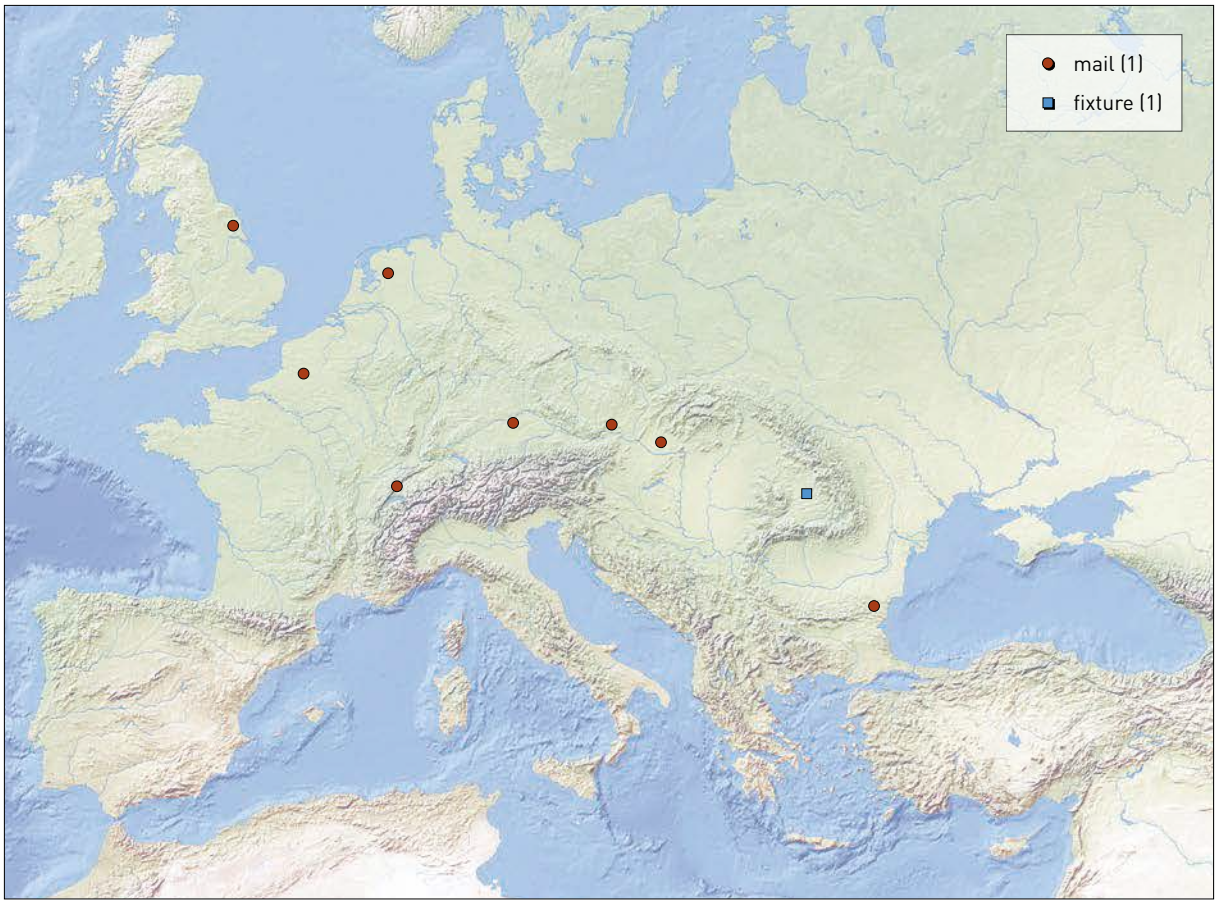


Fig. 2.13. Distribution of mail during the first half of the 3rd century BC. The distribution is not centred in a particular region, but spread out from Western to Eastern Europe (map M.A. Wijnhoven/B. Brouwenstijn).

The distribution pattern of early mail fits well with the renowned high mobility of the Celtic culture, corroborated by archaeological and historical sources,[55] which indicate two periods of great expansion of the La Tène culture: from the beginning of the 4th century BC towards the Southern Alps and Italy and from the beginning of the 3rd century towards South-Eastern Europe and the Balkans.[56] The latter expansion period coincides with the appearance of mail armour, but mail is not the only change in the warrior's panoply at this time.[57] There are also significant modifications to the shield, which becomes large, oval-shaped and has a wooden boss protected by a large metal band positioned horizontally (fig. 2.17 right).[58] The start of the 3rd century also sees the introduction of the sword chain, which is intimately associated to Celtic culture (fig. 2.17 left). This involves a suspension system that secures the scabbard and sword hanging down vertically and keeps them in place even when running or moving fast on foot.[59] The sword chain consists of two metal chains, one long and one short, each connected on one end to the leather belt and on the other to the scabbard. It has been suggested that these changes to the Celtic panoply represent steps towards a heavier and better protected infantry, and could have been the result of contact with Mediterranean cultures that had a Greek hoplite fighting style.[60]

55 E.g. Pausanias, *Graeciae descriptio* 10.19.5-23.14; and Polybius, *Historiae* 2.19-20.

56 Ginoux/Ramsl 2014, 284; Rostiou 2012; 2013, 215-216

57 Lejars 2007, 159-170; 2011, 138-144; Rapin 1999, 54-58.

58 Buchenschutz *et al.* 2012, 196; Stead 1991b, 22.

59 Mathieu 2005; Pérez Rubio 2017, 375-380; Rapin 1999, 510-519.

60 Pérez Rubio 2012, 15-17.

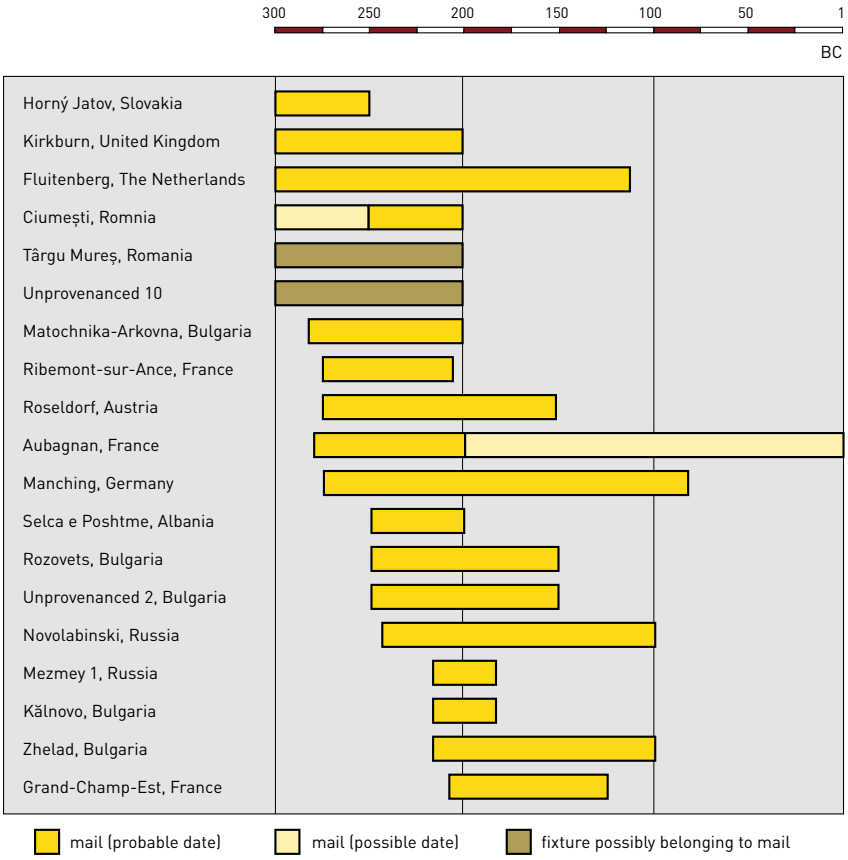


Fig. 2.14. Absolute age of mail armour that (partially) dates to the 3rd century BC. For the first half of the century there are nine mail finds and one isolated find of a fixture that may have belonged to a mail coat. For the entire century there are 19 finds.

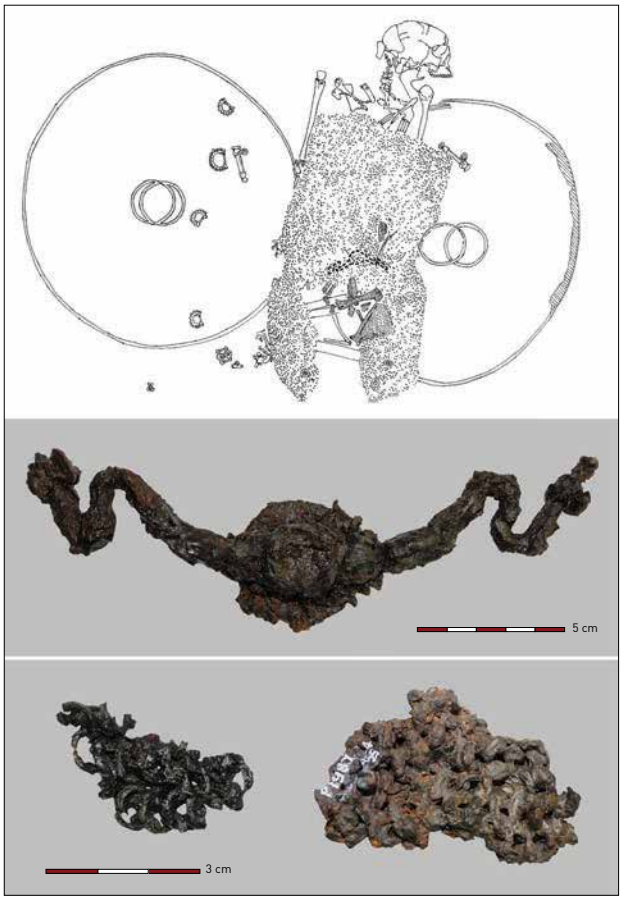


Fig. 2.15. The 3rd-century BC chariot-burial with a mail coat from Kirkburn in the United Kingdom. Top: plan of the burial which shows that a complete coat of mail was deposited on top of the deceased. The coat has been placed upside down into the grave with the shoulder guards turned towards the lower body (drawing M.A. Wijnhoven after Stead 1991a, fig. 45e). Middle: the iron fastener that ensured that the shoulder guards of the mail coat remained in place. Bottom: two of the better preserved fragments of the mail mesh. British Museum, London (photographs M.A. Wijnhoven).

Fig. 2.16. One of the larger fragments of mail from Roseldorf in Austria (270-150 BC). The fragment has been treated with wax in order to protect it against further corrosion. Naturhistorisches Museum, Vienna (photograph M.A. Wijnhoven).

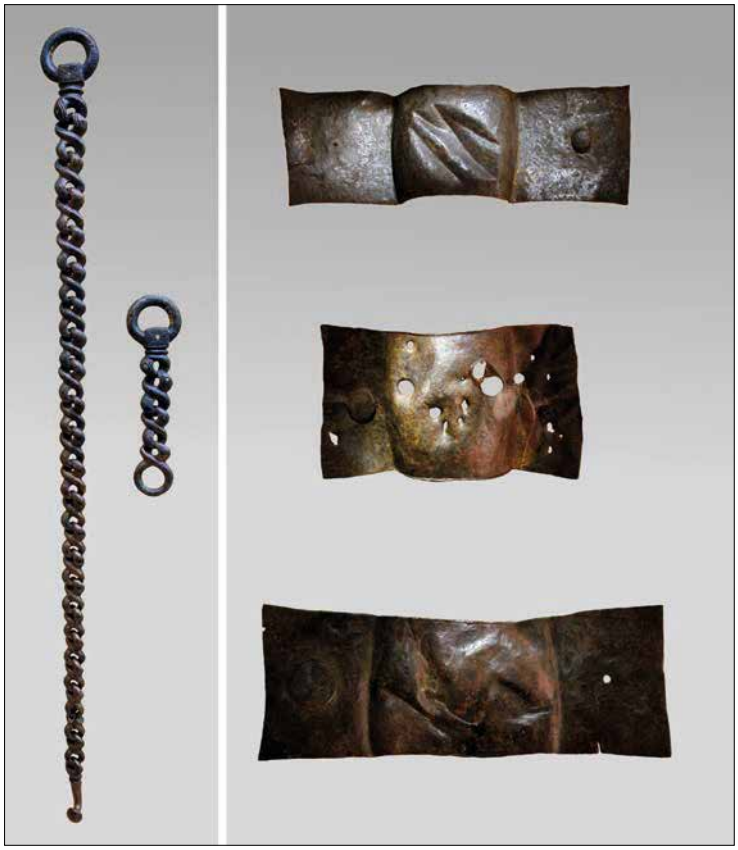


Fig. 2.17. Left: the two parts of a sword chain from 3rd century Bussy-le-Château in France. Right: three metal plates that protected the wooden shield bosses from the sanctuary of Gournay-sur-Aronde in France. Musée d'Archéologie Nationale, Saint-Germain-en-Laye, inv. no. MAN 20933, GSA 118, GSA 214 & GSA 1980 (photograph M.A. Wijnhoven).

Not only do the archaeological and historical sources attest to the high mobility of Celtic culture at the time that mail made its appearance, but also they confirm the increased standardisation of the La Tène material culture across long distances, which before the 4th century had a much more regional character.[61] Contact over large areas allowed new cultural elements to disperse very rapidly throughout the La Tène network, so they appear in the archaeological record of different parts of Europe rather simultaneously. This applies to artefact types as well as to art and decoration, for example the elaborate Celtic plastic style, which uses three dimensional effects in ornamental design implementing human and animal imagery, also appears and spreads around the start of the 3rd century.[62]

Over the last decades it has become increasingly clear that one of the most important arteries of this close-contact network runs through the Danubian corridor, also known as the Middle European corridor, that connects Western and Eastern Europe.[63] Several key players have been identified in the rapid diffusion of new cultural elements within Celtic society during the 4th and 3rd centuries BC. These include the so-called warrior elite, mercenaries and craftsmen, which are all highly mobile.[64] The first group constitutes high-status members of society with a martial association, who had not only the means to travel, but also maintained an extensive network of peers. The evidence for mercenaries comes especially from the 3rd century onwards, when La Tène warriors were active as mercenaries in the Mediterranean. Lastly, the craftsmen appear to have had a symbiotic relationship with the high status members of society. The art and the objects they made were employed to enhance and emphasise the social position of certain groups. Possibly some craftsmen had ties of clientship and their skill may have even been offered as a gift to other members of the warrior elite. The latter would promote the quick expansion of new elements over large distances. There is also ample archaeological and some historical[65] evidence that craftsmen themselves needed to travel around in search of clients that would acquire the exclusive items they made.

To conclude, mail makes its appearance alongside other changes in the warrior panoply during a period characterised by military expeditions and the expansion of Celtic peoples. This turbulent environment, paired with a well-developed network and several highly mobile key players, allowed for innovations to rapidly disperse over long distances. This makes it impossible to pinpoint the invention of mail either in West or East Europe, even when focusing on the short timeframe of 50 years. The distribution pattern of mail in its first 50 years of existence aligns well to the Danube-Rhine corridor and this pattern is not an anomaly, but typical for this period.[66] Given the great speed at which new technology and innovations of Celtic society spread over large distances at this time, the pursuit to pinpoint the origin of mail to a restricted area seems futile. We can however say that mail armour sprouted from La Tène society and that it was absorbed into a well-developed network that caused it to disperse very rapidly from the beginning. As we will see in chapter 3, despite its fast expansion, this new defensive technology was initially only available to a relatively few high-status members of society.

61 Buchenschutz *et al.* 2012, 192-198; Lejars 2007, 170-182; Rapin 1999, 54.

62 E.g. Rapin 1999, 58.

63 Ginoux/Ramsl 2014; Ginoux *et al.* 2014; Ramsl 2010.

64 Lejars 2011, 141-142; Rustoiu 2006, 53-66; 2012b, 367-369; 2013; Rustoiu/Berecki 2014.

65 Pliny the Elder, for example, mentions a blacksmith Helico of the Helvetii who worked in the 4th century BC for some time in Rome before returning to his home with several Roman agricultural products (figs, grapes, oil, wine). These products spoke so much to the imagination of the Helvetii that they decided to invade Italy (*Naturalis historia* 12.2). The story is mostly apocryphal, but does attest to the migrant nature of metal craftsmen.

66 Buchenschutz *et al.* 2012, 193; Ginoux/Ramsl 2014, 293.

Fig. 2.18. The mail fragments from Fluitenberg in The Netherlands, dating to the 3rd or 2nd century BC. Among the remains there is a buckle that is riveted to the mail mesh (top left) and a hook-like implement. It is uncertain whether the hook is part of the mail armour, although it has been speculated that it could be some kind of fastener. Drents Museum, Assen (photograph M.A. Wijnhoven).

2.5 FURTHER DISPERSAL

The fast expansion of mail over large distances continues into the second half of the 3rd century (fig. 2.14). An example is the complete coat of mail from Mezmay 1 in Russia, dated to the late 3rd or early 2nd century.[67] It is interesting to note that the material culture of this region, located by the Sea of Azov, points to a strong La Tène influence.

The mail find of Fluitenberg in The Netherlands is another indication of this long-ranging network. One of the 25 surviving fragments found there still has a small buckle attached to the mail rings (fig. 2.18). The introduction of buckles in Northwestern Europe is however significantly later, more or less around the start of the Roman period,[68] than the age of the Fluitenberg mail which dates to the 3rd or 2nd century BC.[69] Buckles do occur earlier in other areas in Europe around this time. The presence of this small object attached to the Fluitenberg mail implies that this was not a product of local manufacture but came from far away.[70]

67 Mordvintseva *et al.* 2012.

68 Siegmund 1999, 168.

69 The associated cremation remains, partially adhering to the mail of the Fluitenberg find, have been ^{14}C dated to 2170±35 BP and 2145±45 BP. This gives a calibrated age of 355-115 BC (1σ). Cf. Van der Sanden 2003/2004, 368. Since the oldest mail finds belong to the first half of the 3rd century, Fluitenberg is given a probable date of 300-115 BC.

It is also during the second half of the 3rd century BC that the use of mail becomes firmly established in the Balkan peninsula. By this time, it is not only found in Latènian contexts, such as Matochnika-Arkovka and Kălnovo in Bulgaria, but it is also present at sites thought to belong to the Illyrian and Thracian cultures, such as Selca e Poshtme in Albania and Rozovets in Bulgaria. On the basis of the many finds of mail from the Balkans in the succeeding two centuries, we can assume that this innovation fell on fertile soil in Eastern Europe, where it was adopted by local cultures.

2.6 WHEN, WHERE AND BY WHOM

Over the course of two centuries of arms and armour studies there have been many suggestions concerning the predecessors of mail armour. The suggested forerunners have in common that they are made from (interwoven) metal rings. However, as it turns out, the suggested forerunners and mail armour differ in many key aspects. Therefore, the supposed predecessors have been called into question.

Similarly, the invention of mail has been attributed to various cultures and three finds have particularly been credited as the earliest: Hjortspring, Ciumeşti and Horný Jatov. An assessment of the three demonstrates that this ascription is more problematic than usually acknowledged. It also showed that the invention of mail should no longer be set in the 4th century BC, but at the turn of the 4th to 3rd centuries, i.e. around 300 BC.

By taking a closer look at the distribution of the collective evidence of the earliest mail during the 3rd century, it has become clear that its invention cannot be pinpointed to a particular area. Instead it is observed scattered over long distances, attesting to the mobility of the peoples associated with this new armour type. These earliest finds of mail are almost exclusively related to the La Tène culture, which is most likely responsible for its invention and early dispersal throughout Europe.

[70] Lanting/Van der Plicht 2005/2006, 332. Mail armour with a buckle attached is also known from Matochnika – Arkovna (280-200 BC), Mezdra (150-25 BC), Boé (50-25 BC), and Lexden (c. 17-10 BC).

3 Distribution and archaeological context

'It ought to be simple enough: artefacts survive in the archaeological record, they are re-covered in some way, and then we study them. Unfortunately, nothing is ever that simple.'
Mike C. Bishop & Jon C.N. Coulston[1]

The archaeological record is an important source for making sense of the past, but like all sources, it cannot be taken at face value. To properly interpret archaeological data, we need to understand the depositional and taphonomic processes that form the record and make the presence of some objects more apparent than others. A basic model of the use life and deposition of an artefact is visualised in figure 3.1. First, the artefact is made, then it is used or consumed, and finally it is discarded or deposited in the ground where it may be preserved, and finally retrieved as an archaeological artefact in the present.

There are three phases that summarize the cycle from production to archaeological retrieval of mail armour. The first starts with the manufacturing process, followed by circulation and use. During its active use life, mail could be passed on from owner to owner, which could have occurred through several channels, such as inheritance, trade, exchange, or war booty, to mention a few. For the Roman army there is also the practice of selling military equipment back to the army. As many objects, mail would have been repaired when damaged and recycled.

The second phase concerns the deposition. The processes involved in this phase can be inferred using the archaeological context as the main anchoring point. In broad terms, the following general depositional contexts are defined in this study:

- settlement (civilian, military)
- funerary
- sanctuary
- aquatic context (river, lake, bog)
- countryside

These categories are to a certain extent arbitrary and not mutually exclusive, meaning that there can be an overlap. For example, a grave can also be located inside a settlement. In this chapter, contexts have been classified according to the highest level of specification.

The third phase in the mail cycle involves post-depositional processes. The archaeological detection of objects will depend on their preservation, which hinges on factors like the environment, the raw material of the artefacts, and their accessibility to researchers. Likewise, the local regulations (if and how archaeological research is carried out) can greatly affect awareness about the artefacts. The sum of all these processes defines the actual pattern of the archaeological distribution of mail armour.

3.1 BATTLEFIELDS AND ACCIDENTAL LOSS

The main function of any type of armour is protecting the wearer, and it is on the battlefield that this comes into play. For this reason, we would expect armour to be found most frequently on past combat locations. Nevertheless, archaeological digs at battlefields show a notorious absence of armour and of

[1] Bishop/Coulston 2006, 23.

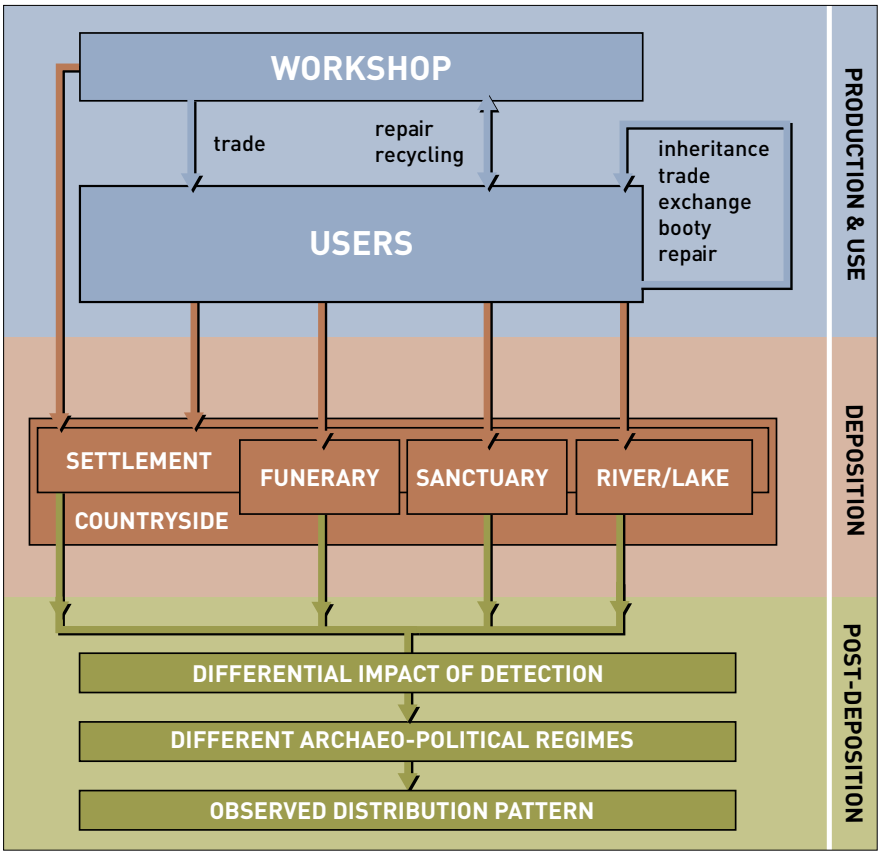


Fig. 3.1. The lifecycle of mail armour, from production to its visibility in the archaeological record (drawing M.A. Wijnhoven).

military equipment in general.[2] The explanation is that all valuables, particularly armour, were usually scavenged as soon as the battle was over. Even broken, damaged and small objects of weaponry had some value as raw material. Metal was a precious commodity in the pre-industrialised world and war booty was an important by-product of warfare. Taking the armour off fallen warriors is documented, for example, in the Bayeux Tapestry which illustrates the conflict between the Anglo-Saxon King Harold Godwinson and William The Conqueror in AD 1066 (fig. 3.2).

Often, only the smallest objects were left behind on the site of the battle, unnoticed, covered up, or not valuable enough to take away. The most commonly found objects are small missiles, such as arrowheads and slingshots, which got buried in the ground on impact. The presence of slingshots on Roman battlefields can be so abundant that it allows for landscape distribution analyses to infer the different stages of the battle.[3]

In some exceptional cases, coats of mail have been recovered *in situ* at the combat site. A good example is the find from Dura-Europos in Syria, where a tunnel collapsed over mail-clad soldiers during a conflict between Romans and Sassanians in the mid-3rd century AD (fig. 6.6).[4] Another find related to the same series of Roman-Sassanian conflicts comes from Zeugma in Turkey. This city was protected by Legio IIII Scythica, but was sacked by the Sassanid king Shapur I. Some of the houses that burned down in the rampage apparently accommodated Roman soldiers. Excavations at these locations have yielded several items of military equipment, including multiple mail coats.[5] In these two examples, the mail armour became inaccessible and ended up intact in archaeological record.

2 Geschwinde *et al.* 2013, 296-297; Meller 2009.

3 E.g. Burns 2015; Laharnar 2011.

4 James 2004, 33-39.

5 Dieudonné-Glad *et al.* 2013, 247-261; Feugère 2006.

Fig. 3.2. The Bayeux Tapestry narrates the conflict between Harold and William over the English Crown in AD 1066. The primary scene depicts the battle, but the lower border shows the situation post-battle. One soldier gathers swords, the other shields, while a central figure strips a fallen warrior from his mail coat (photograph Wikimedia Commons, Myrabella).

Inaccessibility also explains the find of a mail coat at the Roman fort of Arbeia in the United Kingdom (fig. 3.25).[6] During the late 3rd or early 4th century AD, a barrack at the fort burned down and the walls collapsed encapsulating the mail coat stored inside.

Lack of visibility and access can account for other instances in which armour has been excavated in battlefield contexts. For example, at Alésia in France many items of weaponry were found at the site where Caesar's army fought the Gallic tribes under Vincingetorix in 52 BC. Most of the *militaria*, including swords, spearheads, shields and helmets, were found inside the trenches dug by the Romans.[7] Some of these were filled with water prior to the battle, concealing the items that fell in and making them hard to retrieve afterwards.

The battlefields of Kalkriese and Harzhorn in Germany have also rendered large quantities of military equipment, including mail. About 5,000 objects have been recovered at Kalkriese, the probable site of the Teutoburg Forest battle in AD 9 (fig. 3.3). Out of this amount, only a few items were complete with the great majority comprising small fragmented and damaged pieces. The most likely interpretation is that these were left over from post-battle processing.[8] Fallen soldiers would have been stripped off their equipment, not always carefully as suggested by evidence that valuable metals were ripped out of the objects and cut into manageable pieces for reuse. The few mail remains found consist of small fragments

6 Croom 1998.

7 Duval/Lyon-Caen 1994, 267-290; Von Schnurbein 2009, 61, 64-65.

8 Rost/Wilbers-Rost, 2010; 2016.

Fig. 3.3. Modern reconstruction of the rampart at Kalkriese, thought to have collapsed during the battle, although its age and function are under discussion. Whatever the case, many of the retrieved objects show signs of plundering, including the famous face mask of a helmet, which was stripped of its top silver layer, leaving only the iron base. The mail remains are also small and likely the product of post-battle processing. Museum und Park Kalkriese (photograph M.A. Wijnhoven).

and several loose fasteners, which must have undergone a similar treatment. The site of Harzhorn, where the Romans fought Germanic tribes around AD 235, offers a comparable situation with abundant military finds.[9] A large number of the excavated weaponry includes long range weapons, which would have been difficult to spot and recover after combat. The other objects show clear evidence of plundering, and the mail found concerns merely fragments.

A well-known exception of a battlefield excavation that did render high quantities of complete armour, including several mail garments, is the site of the Battle of Wisby.[10] This took place in Gotland, Sweden, in AD 1361, and left some 1,200 casualties. Many of the bodies were placed in mass graves, among which at least 20 victims were buried wearing full armour (fig. 3.4). The head excavator Bengt Thordeman has suggested that despite the evidence of post-battle plundering, it seems that a few bodies

[9] Geschwinde 2013, 313; Geschwinde *et al.* 2013, 309-310.

[10] Thordeman 1939, 93-95.

Fig. 3.4. Casualties from the Battle of Wisby that were buried in their armour. They still wear the mail coifs that protected their heads. Historika Museet, Stockholm (photograph M.A. Wijnhoven).

remained inaccessible for some time. Since the conflict happened at the height of summer, these corpses must have decomposed rapidly, discouraging the retrieval of the armour.

In sum, battlefields are where the main function of mail armour is actually realized, but also where it is mostly absent archaeologically, due to post-battle activities and the scavenging of all valuable materials.

In addition to conflict situations, accidental loss has been suggested as another usual event through which military objects end up in the archaeological record.[11] However, this process seems more common for smaller objects, such as coins or jewellery,[12] and less likely for larger artefacts. Therefore, the relevance of this factor has been questioned in finds of Roman military equipment,[13] and continues to be discussed.[14] The current consensus is that although accidental loss probably occurred at times, it cannot account for the observed find patterns. Other processes that involve intentional deposition must have played a bigger role.

Coats of mail in particular are too big and heavy to be regularly lost by accident, and whenever this happened, they probably were more often recovered than left to become part of the archaeological record. Even the small mail fragments that are frequently recovered archaeologically cannot be attributed to accidental loss. Mail is made so as to keep its structural integrity and not get detached from the body of the garment.[15] In contrast, Roman segmented body armour, or *lorica segmentata*, is made up by smaller components such as the copper alloy fixtures that connect it. These could easily become loose, fall off, and get lost, which may be why the segmented armour seems to be overrepresented in the archaeological record.[16]

Similarly, the fasteners that secured the shoulder guards of the coat of mail (fig. 3.3, 14 & 18) were the most vulnerable elements of mail armour and the most prone to accidental detachment and loss. These fasteners are observed frequently in Roman contexts from the late 1st century BC until the end of the 1st century AD. For this period there are many more finds of isolated fasteners than there are of

[11] E.g. Garbsch 1984, 253; Klumbach 1974, 35; Künzl 2001; Robinson 1975, 58.

mail. Over 50 examples of mail in the database belong to this period. The number of contemporaneous fasteners is around three times as high. This means that, whereas accidental loss apparently played a minor role in the deposition of mail rings, it was a more important factor in the archaeological accumulation of mail fasteners.

To recapitulate, while battlefields and accidental loss may at first glance seem the main circumstances by which mail ended up in the archaeological record, on closer inspection these only played a small part. Conversely, as will be discussed below, the deposition of mail was more often the result of intentional action.

3.2 IRON AGE MAIL

As discussed in the previous chapter, mail was invented around the turn of the 4th to 3rd century BC and rapidly spread over Europe and beyond in the following hundred years. This section focuses on the period between 300 and 27 BC, which marks the beginning of the reign of Augustus.

The dispersion and adoption of mail armour continued during the 2nd and 1st centuries BC, as illustrated on the distribution map in figure 3.5. There is a steady increase in the number of finds from this time. Likewise, from the second half of the 2nd century BC, the presence of mail armour fans out from its core-region along the Rhine-Danube corridor and spreads towards Asia Minor, Northern Europe, Southern Russia and even Northern Africa.

In the 2nd century BC mail truly became the main form of metal armour in most parts of Europe, replacing other types of metal armour, which by then are found less frequently. The success of mail is indicated not only by its rapid expansion into new territories, but also by its growing frequency in areas where it had been known for some time. For example in Bulgaria, where mail was usually placed alongside other grave goods of combined La Tène and Thracian elements in tumuli from the so-called Padea-Panagjurskii Kolonii archaeological culture.

Compared to Bulgaria, the number of finds in Romania is limited until the 1st century BC, but increases tremendously since then, indicating that mail became solidly embedded in Dacian society at that time. A similar increase is observed in Western Europe (e.g. France), where the number of finds grows considerably since then. The frequency of mail in this area, alongside the intensity of the Roman-Gaul interaction during the 1st century BC, may explain why writers like Varro and Diodorus Siculus associate mail armour with the Gauls. In the United Kingdom, all Iron Age finds come from the coastal region facing the continent. Since the quantity is small so far, any new finds can easily alter the distribution pattern on the British isles, but for now the pattern argues for the import of mail from the continent.

During the Iron Age mail armour was deposited in a variety of contexts (fig. 3.5), the most common being funerary, i.e. burial mounds, flat graves, and cremation graves. Burial mounds that include mail among the grave goods occur particularly often in Bulgaria and Russia, whereas in Northern Europe mail usually comes from cremation graves.[17]

Interestingly, in Central and Western Europe, particularly in France, mail is seldom found in funerary contexts at this time. In contrast, in the Balkans and Russia mail comes almost exclusively from graves, like the one from Radovanu in Romania (fig. 3.6). The traditions and processes of deposition clearly

[12] Even the accidental loss of coins, especially of precious metals, has been criticised. Roymans (2004, 47, 95) has shown that archaeologists often overstate accidental loss while dismissing alternatives intentional depositional practices.

[13] Aurrecoechea Fernández 2006, 330-331; Bishop 1985, 8; 1986, 717-719; 1989d; 1991, 21; Bishop/Coulston 2006, 24-34; Deschieter 2016, 61; Nicolay 2007, 183-184; Thiel/Zanier 1994, 66-68.

[14] Künzl 2001. This was one of the main discussion topics at the 20th Roman Military Equipment Conference in 2019, dedicated to weapons in ritual context.

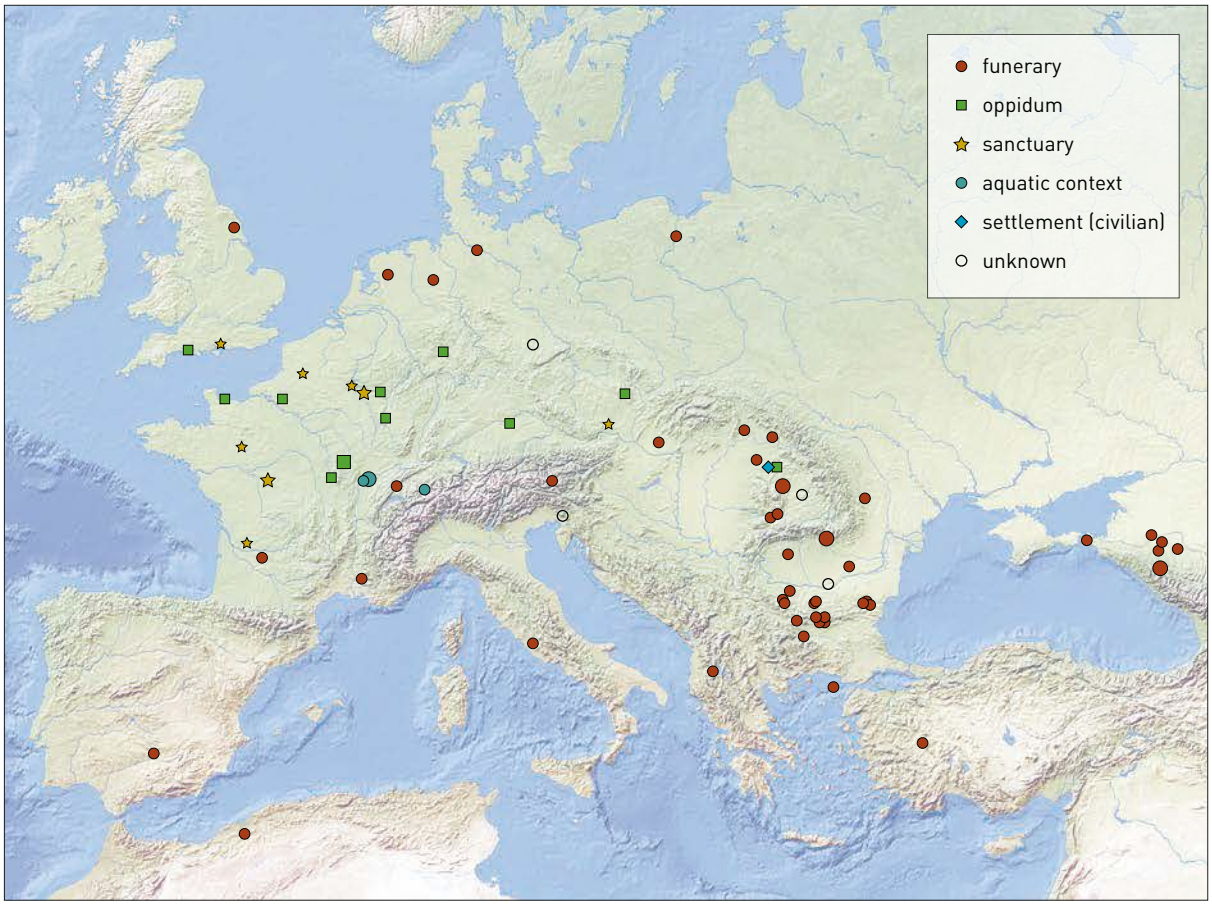


Fig. 3.5. Distribution and context of mail armour from 300 to 27 BC (map M.A. Wijnhoven/B. Brouwenstijn).

differ between these regions, which hinders a quantitative comparison to determine the frequency of mail armour in these societies.

In Central and Western Europe mail is more frequently found in the context of an *oppidum*, a large fortified Iron Age settlement. Most mail finds in France come from *oppida* dating to the 1st century BC. Another usual context for this region are sanctuaries. Again, the highest number of finds is from France, with single occurrences in the United Kingdom, at Hayling Island, and Roseldorf, in Austria.[18] The purpose of depositing mail in these places is unknown, but anthropological analogy and historical sources offer an array of options, from apotropaic uses, to the fulfilment of a vow (*ex-voto*) or the symbol of a larger wish (*pars pro toto*).

Mail has been only sporadically retrieved from aquatic contexts. Moreover, all the finds are restricted to one area across eastern France and Switzerland. The presence of weaponry in rivers, lakes and bogs has sometimes been explained as accidental loss when crossing a bridge or being on a boat or ferry.[19] Undoubtedly this must have happened at times, but cannot solely account for the large amounts of military equipment (other than mail) found in aquatic contexts.[20] The ritual deposition of objects, particu-

15 Bishop 1989d, 1-2; 1991, 21.

16 Bishop/Coulston 2006, 27.

17 About two thirds of the Iron Age burials with mail concern cremation graves and one third regards inhumation graves. The latter are mainly from Russia and Eastern Europe.

18 Gilmour 1997, 31; 1999, 163; Holzer 2008, 127, 129.

19 E.g. Klumbach 1974, 35; Künzl 2001.

20 Bishop/Coulston 2006, 30-31; Goldsworthy 2003, 110-111; Oldenstein 1990, 36.

Fig. 3.6. The coat of mail from Radovanu in Romania, 1st century BC, comes from a cremation grave in a tumulus. It is particularly well preserved, despite being now torn and incomplete. Muzeul Militair National, Bucharest (photograph M. Gui).

larly of weapons, is a well-established fact in Iron Age contexts.[21] The fact that all mail finds from aquatic contexts come from a small region is a strong indication of deliberate deposition, possibly as a votive act.

There is only one find of mail from a civilian settlement, at Şimleu Silvaniei in Romania.[22] Unfortunately this is a surface find and cannot be dated with precision. However its location coincides with a Dacian settlement known for its metalwork activity during the 1st century BC and the 1st century AD. It could be that the find derives from mail production activities, although no mail workshops from the Iron Age are known thus far.

Funerary contexts can shed light on the accessibility of mail armour during the Iron Age. As mentioned before, in the 3rd century BC mail was an elite item circulating mainly in the highest layers of society, accessible to a select few. The analysis of the grave goods found alongside mail armour in Iron Age burials confirms its exclusive character during this period.

There is a total of 36 Iron Age burials containing mail armour and other grave goods which provide additional information.[23] The majority of them (n=26) are graves that included a complete mail

21 E.g. Bradley 1990; Roymans 1996, 17-20, 28-37; Thorbrügge 1970/1971.

22 Borangic 2011a, 189-190, 225.

23 This includes burials with an incomplete inventory (e.g. disturbed graves) where the remaining grave goods still prove informative. The numbers given in this section should be interpreted as a minimum; the actual figures must have been higher. The single Roman funerary find from the Republican period has been excluded.

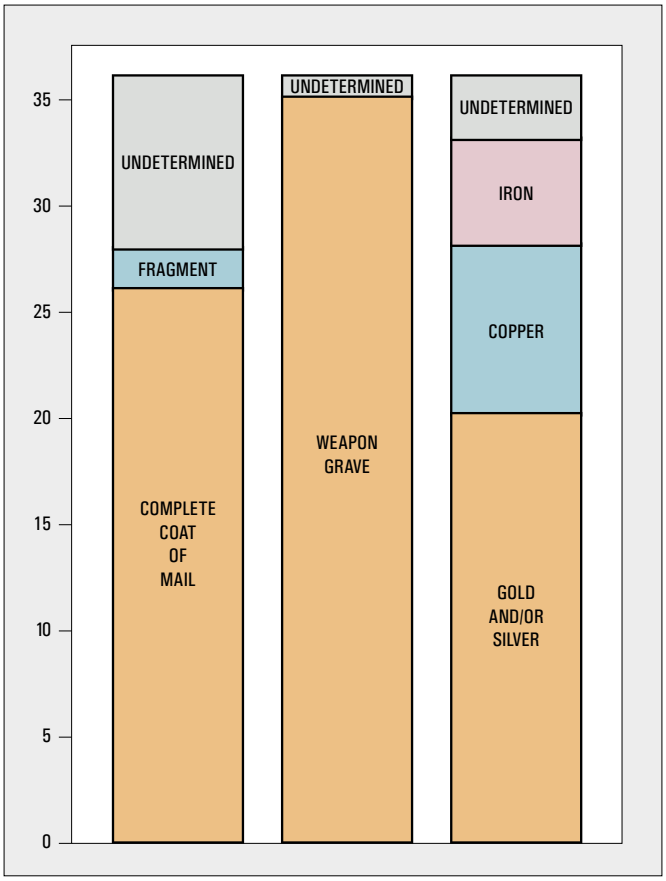


Fig. 3.7. Iron Age burials with mail armour usually contain a complete mail garment. These are weapon graves characterised by the opulence and quantity of the material used in the grave goods.

coat.[24] In eight cases it could not be determined whether the mail garments had been complete, and in the other two cases only fragments were deposited.[25] These figures indicate that the offering of entire mail coats as a grave good was customary during the Iron Age, and rarely involved incomplete mail items or fragments.

At times, complete mail coats were deliberately damaged prior to deposition. For example, in a cremation burial from Hunedoara in Romania (1st century BC),[26] an entire garment was intentionally cut into pieces before placing it in the grave. The practice of purposefully destroying weaponry for a burial or as an offering is well documented in this period,[27] and continues until the 1st century AD. Late examples where mail was torn to pieces upon disposal come from Lexden (17-10 BC) and Baldock 1 (AD 20-35) in the United Kingdom, and the sanctuary of Gurzuf Saddle Pass in the Crimean Peninsula (30 BC-AD 50).[28]

[24] The criteria for counting a mail garment as complete are: 1) it has been described as a complete or very large piece of mail; 2) its current weight surpasses 2 kg; 3) it consists of more than five fragments; 4) fasteners are present among the mail remains.

[25] These are Varbeshnitza in Bulgaria and Cetăţeni 2 in Romania. Torbov 2004, 57, fig. 6b; Borangic 2011a, 175, 182, 191, 205.

[26] Sîrbu *et al.* 2007a, 158-160, fig. 5-6, 12; 2007b, 48-49, 72, 75, 81-82, 196, fig. 42-44.

[27] Buchwald 2005, 121; Măndescu 2012; Rapin 1993.

[28] Foster 1986, 83; Gilmour 1997, 30; 1999, 186; Laver 1927, 248; Novichenkova 2009; 2011.

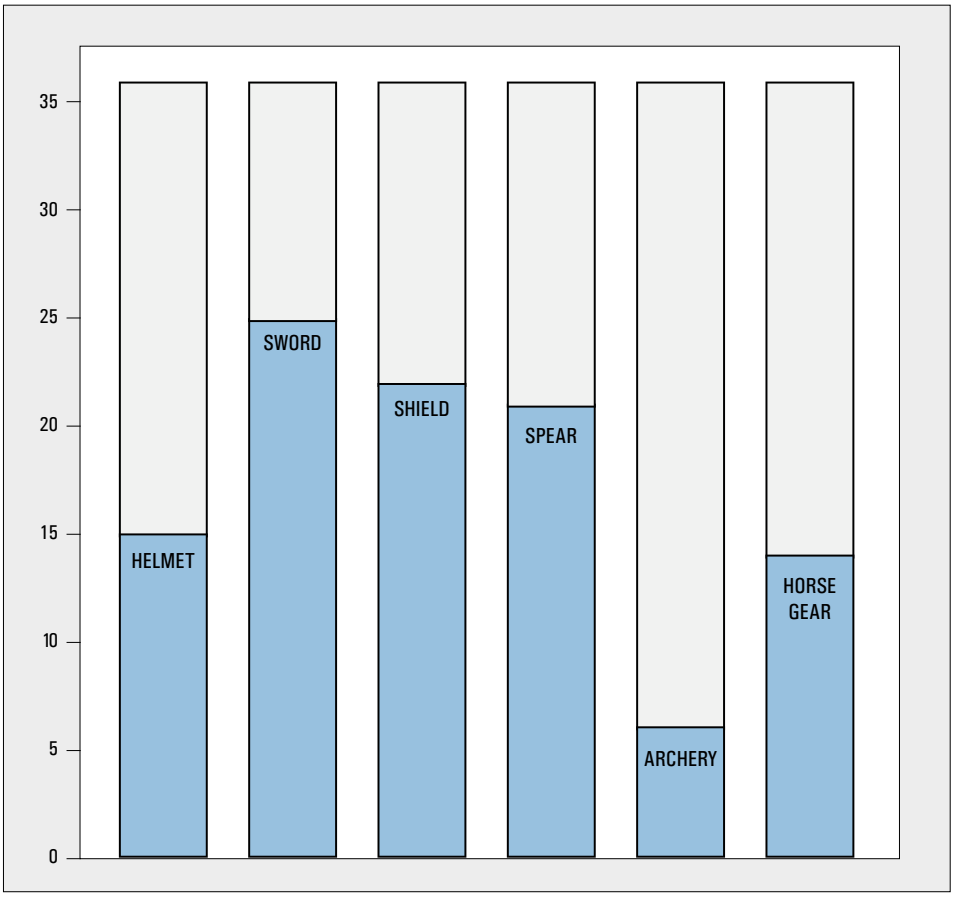


Fig. 3.8. The occurrence of weaponry in Iron Age burials with mail armour. The high status of these graves is confirmed by the relative high frequency of helmets and swords.

All of the 36 burials stand out for the riches of their grave goods, which are both plentiful and of high quality (fig. 3.7). Over half of the graves contain gold or silver items, and almost a quarter include copper alloy objects. These were expensive metals that represented considerable wealth. Only five of the burials lack precious metals, having just iron artefacts. One of these, Horný Jatov in the Czech Republic, is from the 3rd century BC.[29] This concerns a partially looted grave, so it is plausible that any precious metal objects were removed before the archaeological excavation. The four others with only iron artefacts all date to the 1st century BC.[30] These examples alongside the large number of mail finds from the 1st century BC suggest that mail became increasingly accessible, although it remained exclusive to the upper classes as indicated by the fact that even the 'iron only' burials were richly furnished with grave goods.

Another characteristic of Iron Age burials containing mail is their highly martial nature (fig. 3.8). Out of the 36 graves 34 include other weaponry, ranging from a single artefact to a complete warrior's panoply. Only two graves do not have any other military items. The first, Tumulus C at Karalar in Turkey (ca. 160-30 BC), was disturbed by grave robbers so the previous presence of other *militaria* cannot be excluded.[31] The second is the burial at Kirkburn in the United Kingdom '(3rd century BC; fig. 2.15), which in addition to a mail coat includes a chariot and horse equipment, but no weaponry. It must be noted that the Kirkburn burial is in the Yorkshire area, where weapon graves from this period typically

[29] Benadík *et al.* 1957, 31-32.

[30] Cetăţeni 2, Hunedoara, Radovanu and Putensen. The latter again concerns a disturbed grave.

[31] Arik/Coupri 1935, 140; Picard 1935, 44.

Fig. 3.9. The 3rd-century BC burial from Ciumeşti, Romania, contains a rich array of weapon paraphernalia (not to scale). It includes a spectacular helmet with a bird of prey and movable wings. There are also a pair of greaves, a separate cheek guard and a spearhead. The coat of mail has a copper alloy fastener decorated with rosettes in a triskele pattern. A separate button, in the same style and of unknown function, also features on the coat of mail. Both are now detached from the mail fabric. Among other small items in this burial is the ceramic vessel shown here (photographs M.A. Wijnhoven).

contain just one item of weaponry and not a larger set of military objects,[32] which is why it is still considered a weapon grave. We may then conclude that (nearly) all Iron Age burials that have mail armour constitute weapon graves.

The variety of the weapons present in the remaining 34 mail burials is ample. An astonishing 42% contain a metal helmet (fig. 3.9). This is a quite large percentage even for weapon graves, given the rarity of metal helmets which feature only in very high status burials.[33] The presence of swords is extraordinar-

[32] Stead 1992, 33.

[33] For Iron Age weaponry, cf. Brunaux/Lambot 1987; Pernet 2010; Rapin 1996; 1999.

ily frequent as well, in 70% of the graves. Shields and spears, commonly found in more modest weapon graves, occur in about 60% of the cases. Archery equipment is less prominent, at 17%. A full battle panoply, made up of several exclusive items (i.e. mail coat, helmet, sword, shield and spear), is present in 14% of the burials. This strongly suggests that those buried with mail in the Iron Age likely constituted a warrior elite for whom military paraphernalia was an important part of their identity.

Horse gear is found in 39% of the Iron Age graves with mail armour. A third of these include not only a horse harness, but a whole chariot or wagon. The number of horse gear burials increases over time. Whereas there is a single case from the 3rd century BC, the following century has three, and the next, ten. This increment may be related to the intensification of cavalry in warfare by the 1st century BC.[34]

Iron Age burials with mail are found in Western and Central Europe, but are most common in Eastern Europe (fig. 3.5). Despite this imbalance in geographic distribution, it is noticeable that in all regions mail armour is found alongside a similar complex of grave goods that exude opulence and are intimately associated with the martial sphere.

It has become clear that during the Iron Age, the practice of depositing mail in burials was not for everyone, but exclusive to an elite. Mail armour was part of a set of high status grave goods that identified a deceased individual as a warrior from the top social strata. The fact these items were quite uniform across Europe reinforces ideas of long distance networks and high mobility among the upper layers of society.

3.3 THE ROMAN REPUBLIC

The popular image of the Roman army involves that of well-equipped soldiers. However, the archaeological record does not corroborate that image, at least not during the Roman Republic. Whereas mail finds in Iron Age societies increase from the 3rd to the 1st centuries BC, the physical evidence of Roman mail at that time is scant at best (fig. 3.10).

The earliest possible find of Roman mail concerns several small fragments from the tomb of the Scipios in Rome.[35] It could date back to the 2nd century BC, although a later date is also possible. The other few finds of Republican mail (eight in total) are equally problematic. Several have a wide date range, meaning that in fact they may also come from the Early Imperial period. All are from a Gallo-Roman context, making it hard to say whether they should be considered Roman, Gallic or a mix of both. Three were found in sanctuaries. The first are several mail fragments from the Gallo-Roman sanctuary of Flaviers à Mouzon, dated around 50 BC-AD 50/70.[36] Another comes from a Gallo-Roman temple located in the *vicus* of Baâlons-Bouvellement, dated between the second half of the 1st century BC and the first half of the 1st century AD.[37] The third is a mail fragment from Allonnes, retrieved from a sanctuary dedicated to Mars Mullu, c. 50 BC-AD 14.[38] Leaving mail in temples likely is a continuation of the earlier Iron Age tradition of offering weaponry and horse gear in sanctuaries. Such practices did not stop with the Roman arrival but were incorporated into Gallo-Roman military culture since the second half of the 1st century BC and flourished during the subsequent century.[39]

Other few finds come from *oppida*. One from Titelberg 1 in Luxembourg was found in a museum depot box next to Roman ceramics from the Late Iron Age and the Roman Republic; unfortunately its exact date and context remain unknown. This site also yielded two isolated buttons perhaps from a mail coat (Titelberg 2-3), broadly dated to the 1st century BC - 1st century AD. Another copper alloy

[34] Cf. Perez Rubio 2012; 2015, 182-184.

[35] Liberati 1997, 29, fig. 17.

[36] Caumont 2011, 195-200.

[37] Neiss 1985, 360.

[38] Reddé/Gruel 2004, 298, 306-307.

[39] E.g. Nicolay 2007, 177-179, 240-244; Roymans 1996, 18-21, 28-34; 2004, 13-14, 108-112.

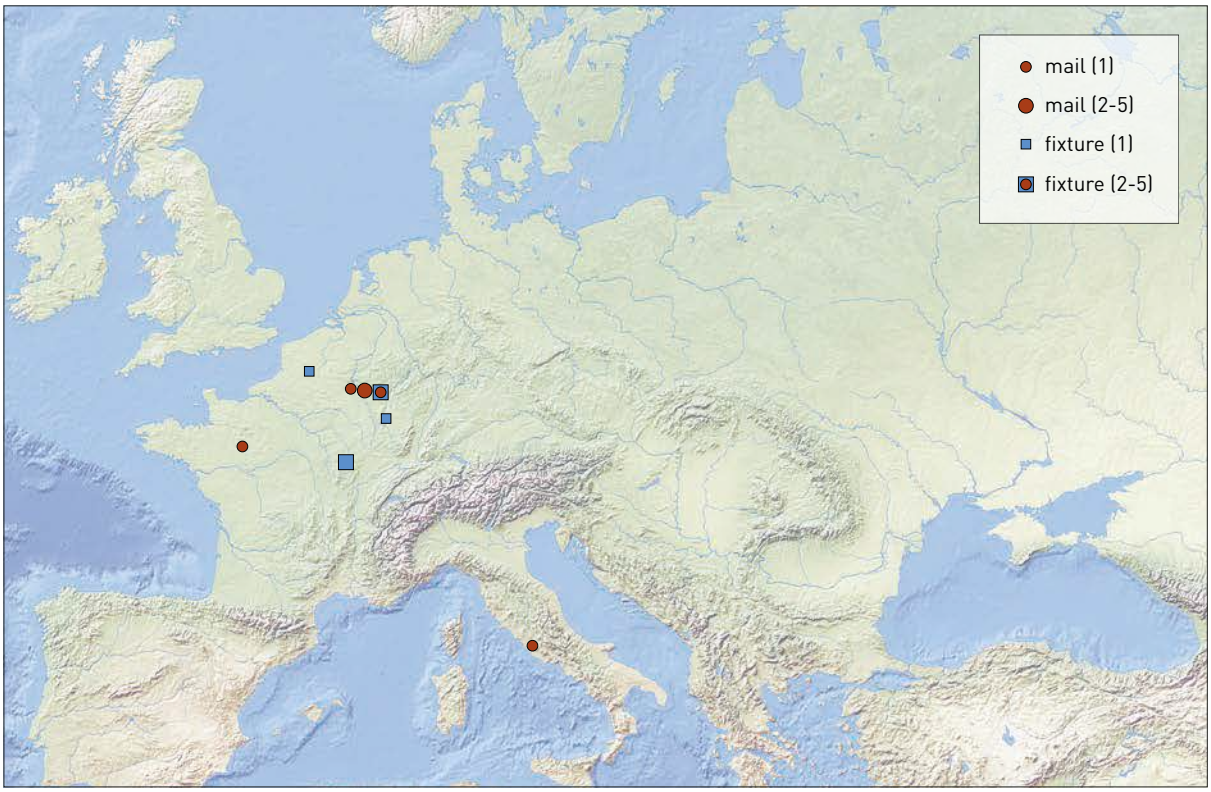


Fig. 3.10. Distribution map of mail armour during the Roman Republic, including fittings no longer attached to mail (map M.A. Wijnhoven/B. Brouwenstijn).

button possibly associated to mail armour was found at the *oppidum* of Essey-lès-Nancy (fig. 3.11a).[40] Three similar buttons from the *oppidum* of Alésia 1 probably relate to the confrontation between Caesar and the Gauls (fig. 3.11c-e).[41] The main caveat of identifying isolated button finds is that similar shaped buttons can be used for other purposes than mail, such as copper alloy lock-pins.[42] Also from the trenches of Alésia 2 come three fragments that may or may not be from mail fasteners.[43] Finally, a partial fastener with several mail rings was found at a Roman military base in a Gaul settlement in modern Arras 2, from ca. 50 BC-AD 50 (fig. 3.11b).[44]

Overall, the archaeological record gives the impression that mail was not common among Roman soldiers during the Republic. The material evidence is scarce and what little there is could be from a later date or non-Roman in origin. However, when the deposition processes are considered, together with the information offered by other sources, this impression alters significantly.

The earliest texts that discuss the use of mail during the Roman Republic go back to the 2nd century BC. It is by then that the Romans probably adopted mail armour from the Celtic peoples they came in contact with. The Romans were known for rapidly embracing effective weaponry used by their enemies, such as the military dagger (*pugio*) and the short sword (*gladius*). Polybius,[45] for instance, says that 'no people are so ready to adopt new fashions and imitate what they see is better in others'. He also offers the first two mentions of the use of mail armour by the Romans. In one, he asserts that the Seleucid king Antiochus IV organised a large parade during the festivities of 165 BC in which he had 5,000 men dressed in mail coats, 'after Roman fashion'. The remarkably large number of men clad in mail that early

40 Dechezleprêtre 2008, 100-101, fig. 5.6.

41 Poux 2008, 350, fig. 34.

42 Birley 1997, 30-34, figs. 11-12.

43 Duval/Lyon-Caen 1994, 273-274, 288, figs. 222-223.

44 Jacques/Prilaux 2008, 57-58, fig. 10.12.

45 Polybius, *Historiae* 6.23.14-15; 6.35.11; 30.25.2-3; (adapted) translation Paton 1966, 142, 320, 327.

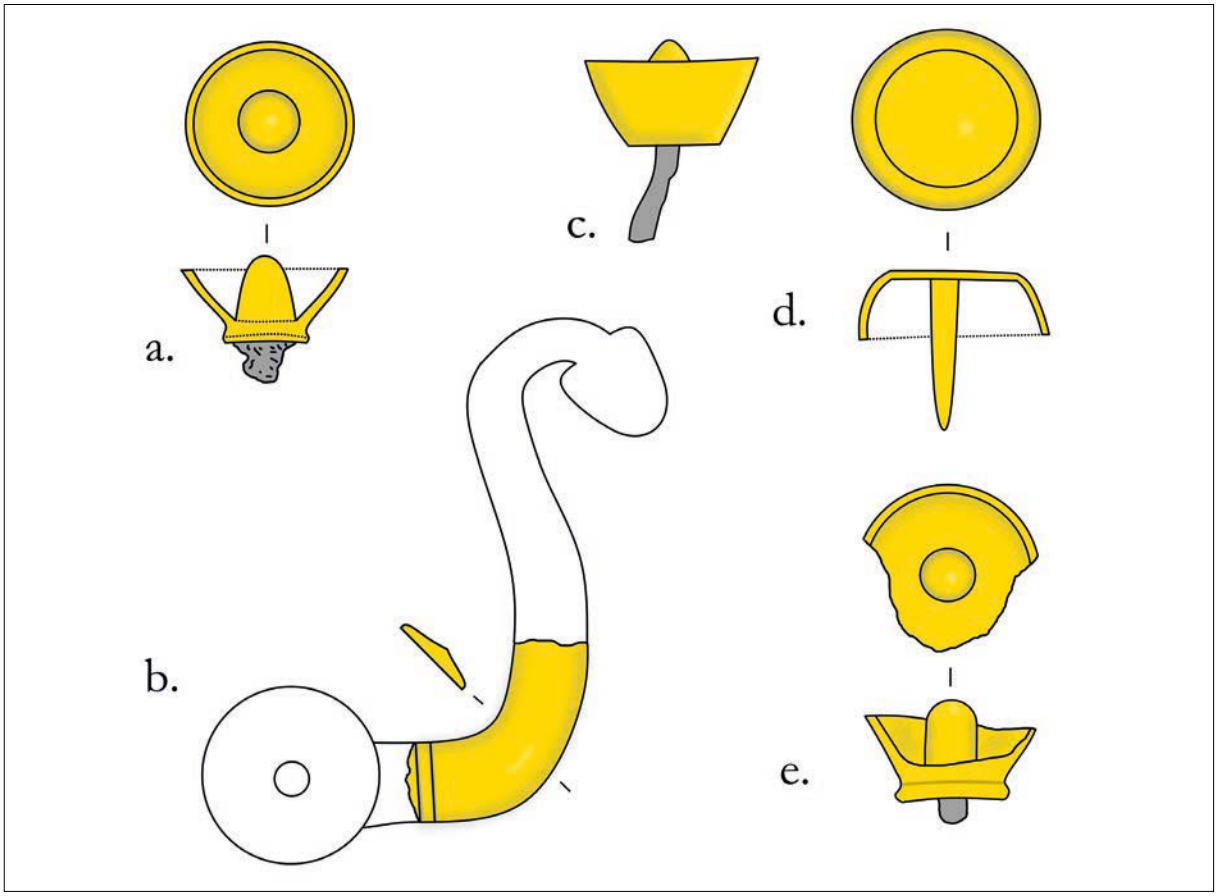


Fig. 3.11. Isolated fixtures that may belong to mail armour, from the Roman Republican period (not to scale). (A) copper alloy button with an iron shank from 1st-century BC Essey-lès-Nancy. (B) partial S-shaped fastener from Arras 2, that either belongs to the Roman Republican or the Early Imperial period. (C-E) three buttons, two of which are damaged, from Alésia 1 (drawing M.A. Wijnhoven).

makes the veracity of the description doubtful. Nonetheless, Polybius' statement confirms that by the 2nd century BC the Romans were already intimately associated with mail armour, so much so that it was considered 'after Roman fashion'. Polybius further describes the Roman soldier's equipment. He points out that common soldiers wore a relatively small metal plate as chest-protection and only those rating above 10,000 drachmas wore a coat of mail. This proves that at the time, mail armour was still exclusive to the Roman elite.

The oldest iconographic evidence of the Roman use of mail armour is from the 2nd century BC as well, reaffirming the statements by Polybius. It is found in a victory frieze depicting a battle between Romans and Macedonians (figs. 3.12 & 5.11),[46] which was part of a building erected by Aemilius Paullus in Delphi, around 168 BC. In it, several Roman soldiers from infantry and cavalry wear coats of mail. Depictions of Roman weaponry, especially of mail, are also rare during the 1st century BC, but become increasingly common since then. The so-called Altar of Domitius Ahenobarbus, from the first half of the 1st century, depicts legionaries and cavalrymen wearing mail shirts (fig. 5.14).[47] A contemporary sculpture from Osuna in Spain features two infantrymen protected by helmets, large curved shields and greaves; one of them also wears a mail coat (fig. 5.15).[48] Lastly, there is the well-known statue of a Romanised Gaul found at Vachères in France, which may still date to the Republican era (fig. 5.16).[49]

[46] Taylor 2013b; 2016.

[47] Hansen 2003, 90-91, fig. 32.4.

Fig. 3.12. The Delphi victory frieze erected by Aemilius Paullus around 168 BC depicts Roman soldiers, both infantry and cavalry, wearing mail armour. Delphi Archaeological Museum (photograph V. Verschoor).

Although the collective evidence from the Roman Republic is not extensive, it is enough to recognise that mail was likely adopted into the Roman warrior panoply by the 2nd century BC, albeit at first only by those who could afford it. The organisation of the Roman army changed profoundly during the last two centuries BC, when it went from a citizen-based organisation to a state-funded, fulltime professional army.[50] Mail soon lost its exclusivity and became increasingly common. By the time of Caesar's armies it probably was a usual item in the military equipment of the Roman soldier.

Despite that, very few mail items from the Republic have been preserved. The explanation may be found in the specific processes of artefact deposition. In general the Republican period has rendered relatively few finds of *militaria*, compared to the Empire.[51] Only a handful of examples of Roman body armour from the last three centuries of the Republic are known, other than mail. These include a (possible) round breastplate from Numantia in Spain and a scale armour at the Royal Ontario Museum, said to come from Lake Trasimene.[52] The scarcity of mail finds from the Roman Republic is therefore not an exception, but consistent with the general pattern of body armour and larger pieces of *militaria* from that period.

48 Robinson 1975, 164, fig. 175.

49 Barruol 1996.

50 Erdkamp 2007; Goldsworthy 2003; Nicolay 2007, 11.

51 Bishop/Coulston 2006, 48. Notwithstanding, the body of knowledge on weaponry from the Roman Republic has been growing rapidly over the last decades, e.g. Feugère 1997; Poux 2008.

We can identify three main factors of why Republican mail armour did not survive in great quantities. First is Roman funerary traditions, which differed from those observed beyond the borders. Depositing *militaria* in graves was not a generalized practice among the Romans,[53] even if it sometimes occurs,[54] like at the tomb of the Scipios. This is a stark contrast with Iron Age mail, where the burial deposition of mail armour is the main process that allowed it to survive to this day.

The second factor is that the Romans rarely used *militaria* as a (votive) offering in sanctuaries or in lakes and rivers, despite being familiar with the practice. Weaponry did have an important place at a Roman worldview and tradition, as exemplified by the Roman triumph or the erection of a *tropaeum* in the battlefield.[55] However, the votive deposition of mail armour did not play a significant role during the Roman Republic. The few instances that we do find from Roman Gaul are likely a continuation of pre-Roman traditions, where the practice of offering weaponry had been well established since the Late Iron Age.

The third factor why Republican mail has not survived frequently is the location where it was produced, repaired and recycled. In contrast to the Roman Principate, these activities did not take place at Roman forts and their neighbouring settlements. The temporary military forts and camps of the Republic did not attend to the production or recycling of military equipment, which means that repeated annual campaigning left little trace of military equipment.[56] The production and recycling of mail at this time must have happened within Roman territory, possibly in city-based workshops.[57] Since the occupation of cities can continue for centuries, such workshops and their products are more easily lost to archaeology, through a continued process of reuse and recycling.

The combination of these three factors can largely explain why finds of mail armour, and Roman *militaria* in general, are so scarce during the Roman Republic. The low number of finds should not be taken for an absence of mail armour, but rather the absence of the deposition practices that would have allowed it to become more visible in the archaeological record.

3.4 THE ROMAN PRINCIPATE

From the Early Principate onwards the archaeological evidence of mail suddenly becomes very abundant (fig. 3.13). While the Republican era rendered no more than a handful of possible finds, the Principate, from 27 BC to AD 285, has 212 entries in the database. Another 44 cases are only broadly dated to the Roman period, but a substantial part of them probably belong to the Principate.

In addition to mail armour, there are two mail-related find categories that together demonstrate the abundance of finds during this period. The first is hybrid armour, a combination of mail and scale armour, of which there are 20 examples described in the following section. The second find category is S-shaped fasteners, which were an integral part of the mail coat with shoulder guards (fig. 3.14). Very few mail coats have been found with their fasteners still attached. The overwhelming majority of S-shaped fasteners is found isolated from the rest of the armour.

The database includes 153 isolated fasteners from the Roman Principate. Fasteners were not exclusive to mail and could have been used in hybrid or scale armour, as illustrated by iconographic and archaeological sources. Because they are found detached, it is impossible to determine the type of armour they

[52] Robinson 1975, 175; Schulten 1927, pls. 44.19, 50. Several ringed remains were also discovered at Numantia dating to the 2nd century BC. These have been suggested to concern mail, but are most likely pieces of regular chain.

[53] Bishop 1989d, 2.

[54] Sanader *et al.* 2013.

[55] Beard 2007; Hölscher 2009, 29-34; Östenberg 2009; Schmuhl 2013.

[56] Bishop/Coulston 2006, 28.

[57] Aurrecoechea Fernández 2006, 309-310; Bishop 1985; Bishop/Coulston 2006, 233-240.

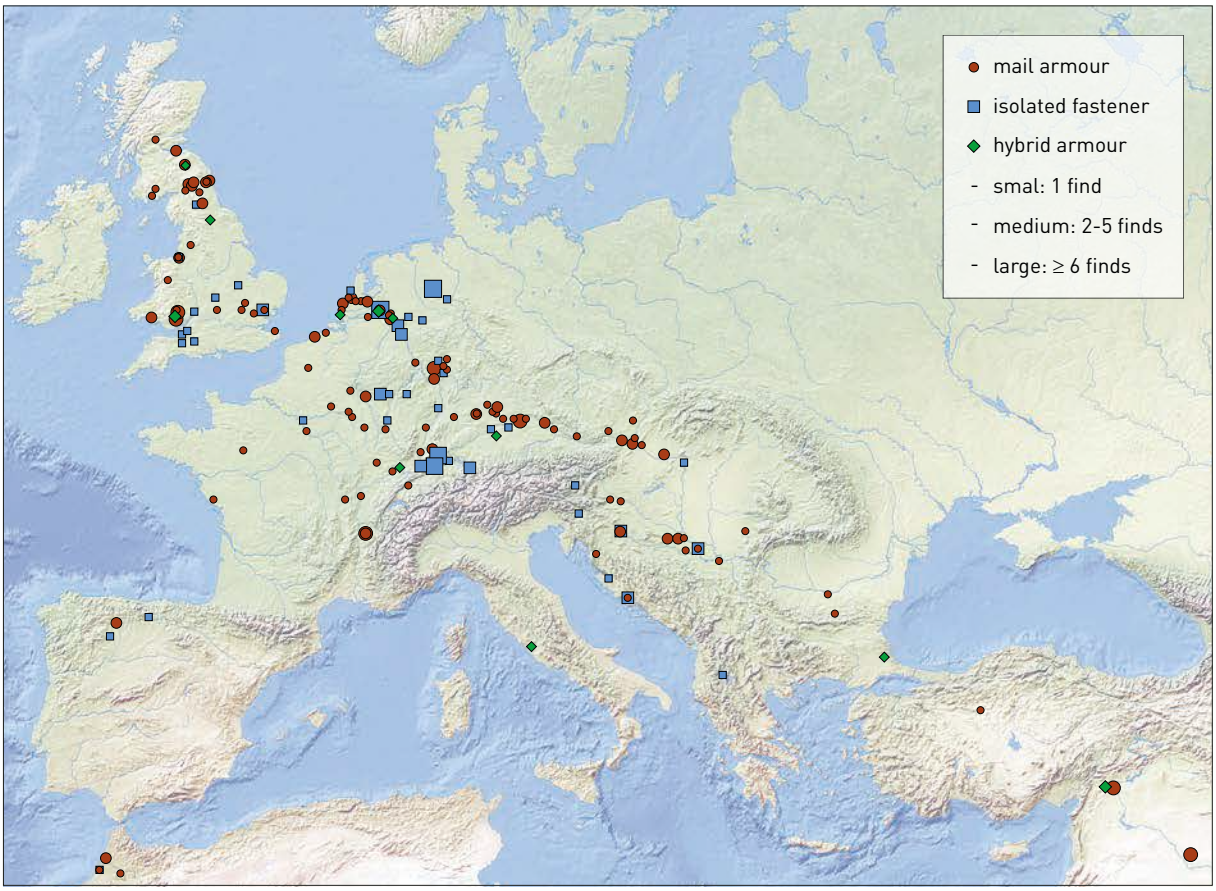


Fig. 3.13. Distribution of mail-related artefacts during the Roman Principate. The map includes mail, isolated finds of fasteners and hybrid armour (map M.A. Wijnhoven/B. Brouwenstijn).

once belonged to, but given the frequent occurrence of mail in the archaeological record of this period, a substantial amount must have come from mail coats. Fasteners fell out of use during the Flavian period and did not continue into the 2nd century, meaning that all 153 examples are from the Early Principate.

Taken together, these categories (i.e. mail, fasteners, hybrid armour, and finds broadly dated to the Roman period) make up no less than 429 possible finds from this time. This abundance is a stark contrast with the scarcity of the Roman Republic and it demonstrates that mail had become very common during this period. Mail was definitely no longer restricted to the upper classes of the Roman army, as Polybius had said for the 2nd century BC. Written sources including classical works, like Tacitus,[58] as well as mundane correspondence documenting the payments and wills[59] corroborate that the Roman soldiers from the Principate owned their military equipment. Each soldier received his kit at the start of his career, which he paid for through salary deductions over his years of service. The equipment then became his property and he could upgrade it, take it home after service, or sell it back to the army to be reused.[60] Epigraphic evidence of ownership inscriptions on military equipment supports such practices.

[58] Tacitus, *Annals* 1.17, asserts: 'Indeed a soldier's life was hard and unrewarding, he said. Body and soul, he was worth ten asses a day, and from that his clothing, weapons, and tents were to be purchased, and bribes found to avoid the brutality of the centurions and gain exemption from chores.' Translation Yardley 2008, 14.

[59] Bishop/Coulston 2006, 262-263; MacMullen 1960, 24-25; Nicolay 2007, 166-167.

[60] The so-called *castrense peculium* meant that anything belonging to a man's military service was property of the man himself instead of his father, as was customary in Roman law.

Fig. 3.14. Four examples of S-shaped fasteners. Top left: Nijmegen 17, The Netherlands, Flavian. The top of the fastener contains a graffito that reads in dotted lines: >SVPERI. This means that the fastener belonged to an infantryman who served under the command of a *centurio* Superi. Top right: Sisak 5, Croatia, 1st century AD. At the base are two rivets with decorative insets, now missing. Bottom left: Usk 11, United Kingdom, Neronian. Bottom right: Nijmegen 23, late 1st century BC-1st century AD (photograph M.A. Wijnhoven).

Cases where more than one name is found indicate that one piece of equipment could pass from owner to owner. Although mail rings cannot bear inscriptions, S-shaped fasteners sometimes feature ownership marks, like Nijmegen 17 from The Netherlands (fig. 3.14), or Neuss 1 from Germany which has even more than one inscription.[61]

The system of providing equipment at the start of a soldier's career and paying installments throughout his service, means that metal body armour became available to all Roman soldiers when it befitted their tactical deployment in the army. However, it does not say which ranks wore mail armour. Stereotypically, legionaries wore segmented body armour, or the *lorica segmentata*, and auxiliaries, mail or scale armour. The columns of Trajan and Marcus Aurelius (chapter 4.4) are partly to blame for this popular image of the Roman army and the division between legionaries and auxiliaries. Nevertheless, these columns did not necessarily aim at representing reality closely, but at conveying a message to the spectator. The artistic

[61] Klein 1891, 37. The fasteners from Kalkriese 3 also have multiple inscriptions.

attribution of an armour type to each army rank facilitates identification and makes the narrative of the columns more comprehensible.

Archaeology suggests that the reality was more complex. Although auxiliary troops certainly wore different, i.e. their native, equipment during the Late Republic and at the start of the Imperial period, this changed during the Early Imperial period, when both legionaries and auxiliaries were equipped by the army.[62] In fact, the range of military equipment found at legionary forts does not differ much from that found at auxiliary forts.[63] This means that mail and scale armour are found at legionary forts as well.

Whereas there is no absolute difference between legionaries and auxiliaries, there is a marked distinction between the gear of infantry and cavalry,[64] each with equipment specialized for their military tasks. The large curved shield, or *scutum*, for instance, was useful to heavy infantry troops but unsuitable when riding and therefore not used by cavalry. As for body armour, there is no evidence that the segmented plate armour was ever worn on horseback.[65] Not only had it been cumbersome, but segmented armour was also relatively short, leaving the hips and legs unprotected. This style of coverage was adequate for infantry, especially when paired with a large curved shield, but would have left part of a cavalryman vulnerable, particularly when facing infantry troops. Moreover, a cavalryman had much less opportunity to actively shield himself against attacks than an infantryman, which made him more reliant on the passive protection of his body armour. The short *lorica segmentata* did not suffice the needs of the cavalry. Conversely, mail armour was very appropriate as it can be made long to cover vulnerable parts of the body without impeding movement when riding a horse.

This does not mean that mail was not used by infantrymen during the Principate. Epigraphy provides good evidence for infantry using mail. Ownership *graffiti* found on fasteners can feature a *centurio* mark indicating that the armour belonged to an infantryman.[66] Moreover, the suitability of mail for infantry was already attested during the Late Roman Republic, when mail was the armour of choice for the legionary. Since mail can be adapted to any length and weight, it can be customized to suit the needs of almost any tactical deployment, from light to heavily armoured and from infantry to cavalry. This means that it could have been worn by a wide range of soldiers in the Roman army during the Principate.

Figure 3.13 shows the distribution of mail finds, isolated fasteners and hybrid armour from the Principate. They are largely located alongside the northern border of the Roman Empire. The same pattern is observed in most, if not all, Roman *militaria* from this period. The presence of the Roman army along the borders is, however, not enough to explain the emerging distribution pattern. Other borders of the Empire, notably Northern Africa, have rendered surprisingly few finds. The entire southern border, including Asia Minor, only has 11 sites in the database. Such difference cannot be solely attributed to variations in equipment among Roman soldiers stationed in different locations, since finds of military equipment are generally rare along this border.[67] Exceptions, such as Dura-Europos and Zeugma, in fact indicate a remarkable homogeneity in the equipment of the Roman army across the Empire.[68]

Research biases can explain a small part of the observed geographical disparity. The intensity of archaeological investigations along the northern border is much higher than in other areas. Nevertheless, the key reasons of the contrast are found in divergent depositional processes during the Principate. As illustrated in figure 3.15, the majority of the mail finds from the northern border of the Roman Empire come from military contexts, either border forts (*castella*) or their extramural settlements (*vici*). The wealth

62 Nicolay 2006, 60-61; Pernet 2010; Waurick 1994.

63 Fischer 2019, 58-61.

64 Bishop 1986, 119-121; Fischer 2019, 58-61.

65 Dixon/Southern 1992, 36-38; Junkelmann 1992, 176; Stephenson/Dixon 2003, 43-50.

66 Kalkriese 3, Neuss 1, Nijmegen 6 and 17.

67 Bishop/Coulston 2006, 28.

68 Dieudonné-Glad *et al.* 2013; James 2004, 251-254. The homogeneity of Roman military equipment should not be mistaken for uniformity. There was not such a thing as a military uniform, which is a relatively new phenomenon. Cf. Fischer 2019, 75-76.

of archaeological finds of military equipment on such locations during the Principate is due to the combination of location, production and recycling processes, and the final abandonment of forts and *vici*.

The professionalization of the Roman army that had started during the Republic was completed under emperor Augustus. Paired with the expansion of Roman territory into new areas, this meant that the full-time army of the Principate was now stationed in permanent forts.[69] As a result, extramural settlements sprouted along the forts, especially in (previously) sparsely populated areas far from larger cities. Military presence often ignited the start of larger civilian settlements, like at Nijmegen.

Traditional production centres of military equipment for the Roman army were probably in cities within Roman territory.[70] Such centres predominantly served the Republican army, which restocked and replenished its equipment after each campaign. In contrast, the new remote military forts on the northern border could not rely on external supplies, so the Roman army at these locations took the production of equipment upon themselves.[71]

The border forts, their extramural settlements, and possibly even the nearby civilian settlements that were heavily dictated by military life became important places of production. Manufacture activities could be carried out by veterans, civilians, and even active soldiers. Written sources in fact mention that the Roman soldiers of the Principate did more than patrolling and fighting, and provided a substantial labour force involved in the production of military objects.

Paternus, who served in the army as a praetorian prefect in late 2nd century AD, lists the soldiers who were exempt of regular fatigues due to the nature of their work, or *immunes*.[72] Among them, he mentions helmet makers, arrow smiths, sword smiths, bow makers and blacksmiths. In the same section he also lists the function of *optio fabricae*, presumably the head of a military workshop. Other documents suggest that regular soldiers or units were assigned the production of specific military equipment.[73] These were presumably placed under the guidance of skilled craftsmen such as the *immunes* or *optio fabricae* mentioned by Paternus. In this manner, the army could upscale production to large quantities using a limited number of skilled army craftsmen and a lot of unskilled soldiers. A 2nd or 3rd century AD papyrus from Egypt, for instance, mentions the activities of a military workshop where at least 100 people were labouring.[74] The document demonstrates that legionary soldiers, auxiliary soldiers, camps servants and even civilians were involved in the production of equipment. Another example is a 2nd century tablet from Vindolanda that alludes to over 343 men working at the military workshops on one day.[75]

The written evidence is corroborated by archaeology. Although mail making workshops are difficult to identify, several are known (chapter 8.5), for example the workshops inside the legionary forts at Caerleon and Hauarra. In León, there is a repair workshop for armour, including mail, associated with the Seventh Legion. And Woerden has evidence of mail making activities at the *vicus*.

The production of Roman army equipment thus changed substantially from the Republic to the Principate. In addition to the city-based, presumably civilian, workshops of the Republic, there now were army-run workshops at the frontiers, usually in places where there had been no production prior to the presence of the Roman army. Being logistically removed from city-based production centres, the frontier army had to become an autonomous producer of military equipment.

69 Gilliver 2007; Goldsworthy 2003, 50-79.

70 Bishop 1985; Bishop/Coulston 2006, 233.

71 Aurrecoechea Fernández 2006, 309-315; Bishop/Coulston 2006, 233-238; Hanel 2006; Scott 1985.

72 *Digesta seu Pandectae* 50.6-7.

73 The written evidence is discussed in Bishop 1985; Bishop/Coulston 2006, 236-238.

74 Papyrus 6765, Staatliche Museen, Berlin. Bruckner/Marichal 1979, 6-7 (ChLA 10 409).

75 Vindolanda Tablet II 155 VI. Bowman/Thomas 1983, 77-79.

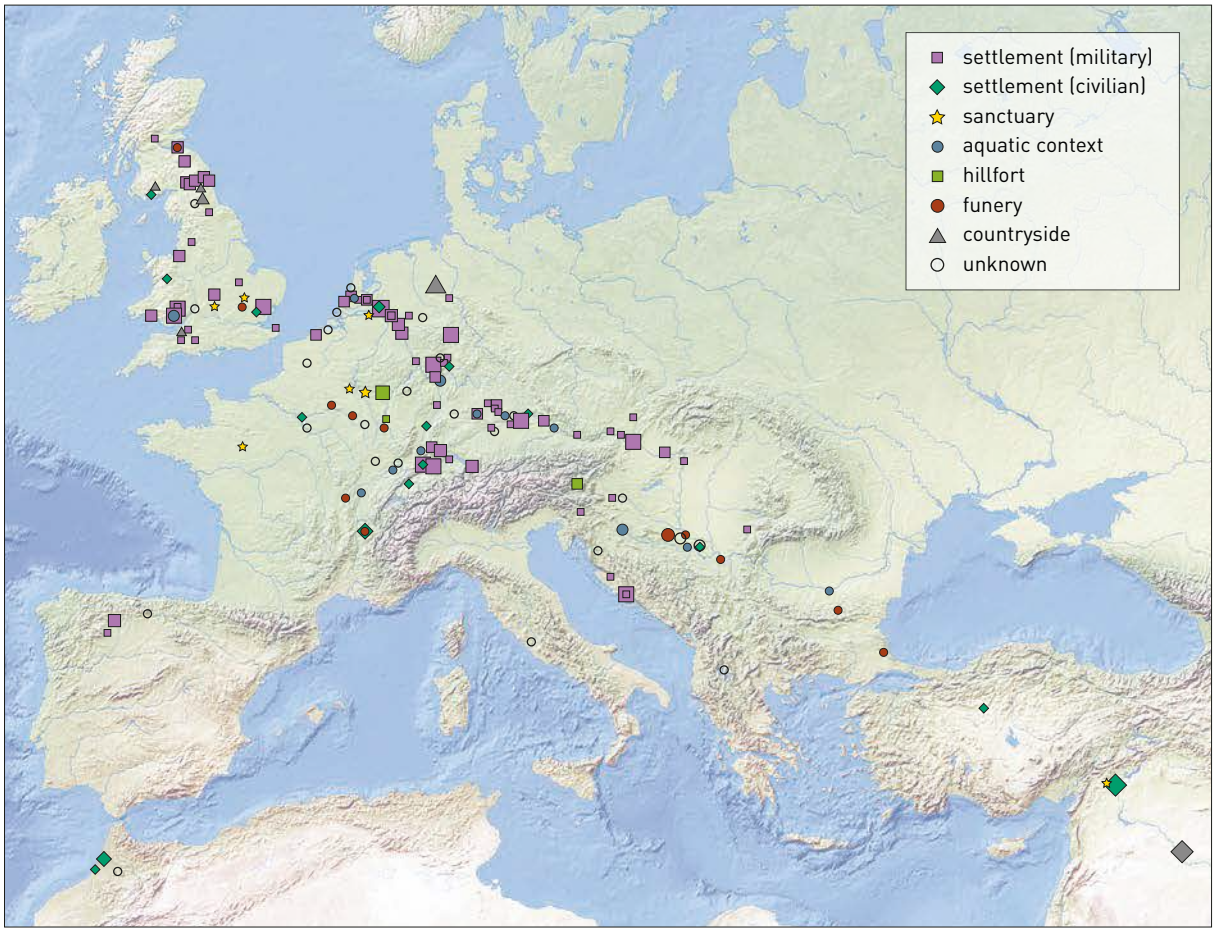


Fig. 3.15. Archaeological context of mail armour, isolated finds of fasteners and hybrid armour during the Principate (map M.A. Wijnhoven/B. Brouwenstijn).

Army workshops were in charge of the production, repair, and recycling of military equipment.[76] Scrap metal had a substantial value, and failing to recycle meant that new metal had to be mined and processed. Recycling thus helped to keep the demand for resources down. As for mail, it could be easily repaired or remade, either by taking out or adding sections. When a garment was no longer serviceable, parts could be salvaged and made into 'new' composite garments, a practice observed in surviving items of historical mail. At the end of its life cycle, the several kilograms of iron in a coat of mail could be reused as raw material.

The final abandonment of *castela* and *vici* by the Roman army is the last factor influencing the distribution of Roman mail during the Principate. Amounting evidence indicates that the Roman army was actively involved in clearing and dismantling army sites before leaving.[77] Scrap metal that could not be taken away was often left in ditches, pits, wells, or holes, ensuring that it did not fall into foreign hands.

The unique combination of the location of military forts along the northern Roman border, the involvement of the frontier army in the production and recycling of *militaria*, and the disposal of scrap metal upon abandonment, all account for the observed abundance of military equipment in the archaeological record. The fact that very few mail finds from the Principate concern complete mail coats suggests that mail was part of these processes (fig. 3.16). Most fragmented pieces were likely scrap awaiting recycling. Some of the better preserved specimens had been cut into manageable rectangular pieces suitable for re-use or recycling, such as the mail remains from Künzing 4 (fig. 3.17) and Inveresk 3.

[76] Bishop 1985, 7-9; Bishop/Coulston 2006, 27; Oldenstein 1977, 68-85.

[77] Bishop 1986, 721-722; Bishop/Coulston 2006, 27.

Fig. 3.16. Many of the mail finds from the Roman Principate are fragments. Top left: two fragments from a Roman fort at Loughor, United Kingdom, c. AD 260-310. Top right: detector find from the Roman fort located at Gnotzheim, Germany, 2nd-3rd century AD. Bottom left: a formerly solid fragment of mail made flexible through treatment and now in three parts. It was found in pit 1 at the Roman fort of Newstead, UK, AD 140-180. Bottom right: a flexible fragment of mail from Sisak 2, Croatia, broadly dated to the Roman Principate. The fragment has one straight line, which could be an original hem of a mail garment or the result of a garment being cut into pieces for easy recycling (photographs M.A. Wijnhoven).

These processes also explain the scarcity of military equipment along the south-eastern frontier. On the one hand, a large part constituted a natural border that needed little active military control. On the other hand, especially in Asia Minor, there already existed city-based workshops that remained active throughout the Principate.

Mail is sometimes found in civilian settlements during the Principate (fig. 3.15), for which there are various explanations.[78] One option is that settlements played an important role in the recycling of scrap metal, including military equipment.[79] Just as finds from military contexts, these also involve mostly fragments, supporting such an interpretation. In the case of the Strasbourg mail, it was found in the cellar of a house alongside an assemblage of scrap material.[80] Likewise, the mail found at Steinheim was retrieved among other scrap metal including various pieces of military equipment and iron objects.[81] A final example

78 Fischer 2001; Nicolay 2007.

79 Pfahl/Reuter 1996.

80 Hatt 1953, 235-236.

81 Hansen 2003, 167.

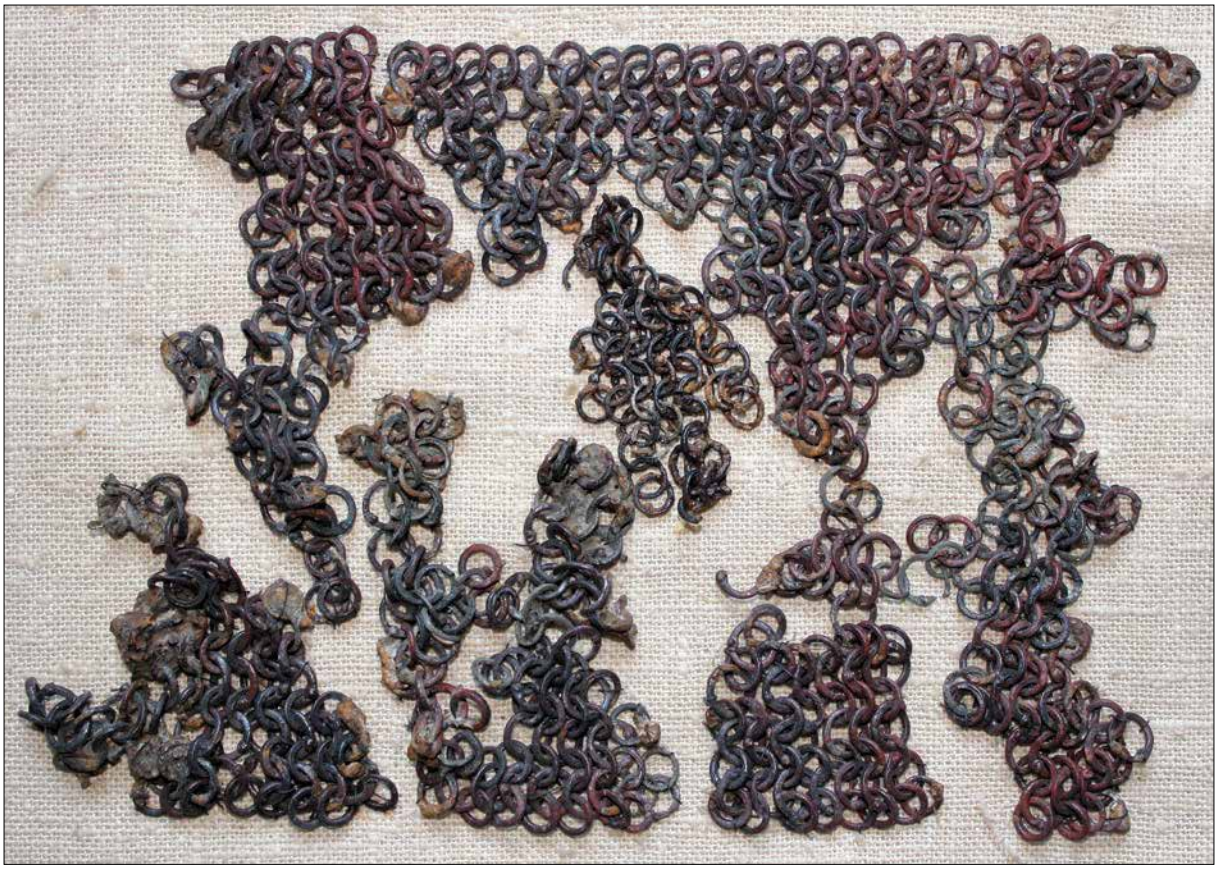


Fig. 3.17. One of several rectangular fragments of mail from Künzing 4 in Germany, dating to the abandonment of the Roman fort around the mid-3rd century AD. They most likely represent pieces of scrap metal intended for recycling (photograph M.A. Wijnhoven).

of a recycling context comes from Lyon 1.[82] Interestingly, these remains are not fragments, but a complete mail coat. There are other reasons for finding mail in civilian settlements. In Dura-Europos and Zeugma, for instance, conflict created exceptional circumstances that impeded the retrieval of mail coats.

The ritual deposition of weaponry is well-known for the Iron Age and has been increasingly recognised in the Roman Empire over recent decades.[83] Not only was it a widespread pre-Roman practice that likely had continuity into the Roman period, but it also explains the presence of mail at sanctuaries, particularly in Gallo-Roman and Romano-British contexts dating to the Early Imperial period. The incidence of mail in aquatic contexts can be interpreted in a similar manner although, as mentioned above, complementary processes such as washout material from army camps and accidental loss may have contributed as well. Mail is sometimes found in Roman baths,[84] which due to its association with water and springs may equally indicate acts of ritual deposition.

Lastly, some mail from the Principate has been retrieved among grave goods in burials. Most of these cases are associated with foreign influences,[85] which is not rare as the Roman army relied heavily on non-Roman soldiers. This is why weapon graves, especially those located near the borders, are often attributed to auxiliaries, or non-Roman indigenous traditions embedded within a Roman context,[86] such as the burials with mail from Chassenard (fig. 3.18) and St. Albans.[87]

82 Guillaud 2019, 80.

83 E.g. Nicolay 2007, 177-189; Thiel/Zanier 1994, 66-68.

84 Badenweiler, Banasa 1, Caerleon 4 & 7.

85 Bishop/Coulston 2006, 33.

86 Nicolay 2007, 199-200.

87 Beck/Chew 1991 105-106; Gilmour 1997, 26-30

Fig. 3.18. The mail coat from Chassenard in France was discovered in a burial together with a face helmet and a bronze torc (not to scale). This grave from the 1st-century AD is thought to belong to a native Gaul that served as an officer in the *auxilia* of the Roman army. The burial contained many other items, for example a *gladius* with scabbard, coin minting tools, and an elaborate belt. The face mask was deposited on top of the mail coat, which is still partially adhered to its back and survives in several pieces. It also included two sets of fasteners, a detached one is depicted here. Musée d'Archéologie Nationale, Saint-Germain-en-Laye (photograph M.A. Wijnhoven).

3.5 HYBRID FEATHERED ARMOUR

Hybrid armour is a combination of mail and scale, where the mail mesh forms the structural backing of the armour and a layer of scales covers the exterior (figs. 3.19 & 20).[88] Perhaps the most striking characteristic of hybrid armour is the minute size of all its components. The mail rings that serve as backing are no larger than a few millimetres in diameter. The scales are equally small, rarely exceeding 11 mm in length. For this reason, it is estimated that the construction of a single hybrid cuirass required some 30,000 scales and 350,000 rings![89]

Another prominent feature of hybrid armour is the vertical mid-rib of its scales, that gives them a featherlike appearance, which is why it has often been identified as the *lorica plumata*, or 'feathered armour',[90] mentioned in classical sources. However, the term feathered armour could refer to any type of scaled armour with a central rib, which is what gives it the feathery look. Therefore, here we will speak of hybrid armour only.

Finds of hybrid armour are few and far between and the current total amounts to just 20 examples.[91] The fairly low quantity of specimens may in part be attributed to the difficulty of identifying hybrid armour in the archaeological record and in collections. For instance, it was not until meticulous X-ray analyses were applied to encapsulated vestiges of metal that hybrid armour fragments were recognized at

88 Wijnhoven 2009a-b; 2016a.

89 Driehaus 1968, 15.

90 E.g. Robinson 1975, 173.

91 There are reports of possible hybrid armour from Mount Hebron and Zeugma 2. Both cases have rendered the archaeological remains of mail and of scale armour. However, neither show evidence that mail and scale were physically connected and are more likely two separate pieces of armour deposited together. Cf. Feugère 2006, 93; Weinberg 1979, 85.

Fig. 3.19. A large fragment of hybrid feathered armour from Ouddorp, The Netherlands, AD 70-200. The backing of this armour is made from mail rings, while the top layer consists of small scales. Rijksmuseum van Oudheden, Leiden (photograph M.A. Wijnhoven).

Usk 7-10 in the United Kingdom, which otherwise would have remained unnoticed.[92] Likewise, a fragment from Nijmegen 3 of what appeared to be regular mail with very small rings was identified as hybrid only upon closer inspection, in this case, partial remnants of some of the scales were found embedded around the riveted rings, while the remainder of the scales was no longer present.

So far, all finds with a known provenance come from a Roman context, except for a Thracian find from Vize, Turkey, dating probably from before Thrace's annexation to the Roman Empire. Three specimens are from private collections and have no accurate recorded location, but allegedly two of them come from the Balkans and the other from Bulgaria. Most examples of hybrid armour have been found in the periphery of the Roman Empire with the exception of one, found near Rome (fig. 3.13). As discussed above, this distribution pattern is similar for Roman military equipment during the Principate.

Unfortunately not all hybrid armour finds have a clear archaeological context; in some cases the provenance was not recorded and in others the information has been lost. Nonetheless, the majority of finds with a known context come from (the vicinity of) a Roman fort. Even a specimen found at the temple of Jupiter Dolichenus in Dülük Baba Tepesi, Turkey,[93] may have a military connection since this cult is often associated with the Roman military,[94] an interpretation that is reinforced by the abundant pieces of *militaria* discovered at the sanctuary. Only the context of the Vize find is markedly different, as it was found in a tumulus probably built for a member of the Thracian royal family. It is thought that it might have been the resting place of Rhoemetalces III, the last king of Thrace, who died in AD 45/46.[95]

Despite the low number of finds, it is possible to establish a time range for the use of hybrid armour. The earliest well-dated example is from the tumulus at Vize, which can be assigned to *c.* AD 35-50, based

92 Price 1983, 12-13.

93 Fischer 2011.

94 Collar 2011, 218.

95 Driehaus 1968, 15-16.

Fig. 3.20. Hybrid feathered armour from Nijmegen 5 dating either to 19-9 BC or AD 70-125. The later date is the more plausible of the two. Although many scales are damaged, it can still be seen that the scales end in a triangular shape, which is exclusive to this find and Newstead 4, from the UK. Gelders Archeologisch Centrum Museum G.M. Kam (photograph M.A. Wijnhoven).

on the associated grave goods.[96] Two finds from Nijmegen 4 & 5 (fig. 3.20) point to a possible earlier occurrence for hybrid armour. Both lack an accurate date, but the Roman military activity at the find spots points to either a later presence in AD 70-125, or 19-9 BC. Given the age of other finds of hybrid armour, the earlier date is the less likely of the two, but cannot be excluded. The majority of hybrid finds originate from the 1st century AD, although the statistics of small numbers may shift easily with future finds. Hybrid armour certainly persists into the 2nd century, but probably disappears from then on. Only one find hints at the 3rd century, from Dülük Baba Tepesi.[97] It has a *terminus ante quem* of AD 256, related to a destruction layer from the time of the Sassanian arrival. However, the associated material is not contemporary with this event and seems to be much earlier. Moreover, the armour probably had some age to it at the time of deposition. It had been originally left at the sanctuary but, like other objects, was cleared out at a later date to make room. Added up, the finds indicate that the phenomenon of hybrid feathered armour spanned between AD 35 and the 2nd century AD.

Hybrid armour is scarce in the archaeological record. Its apparent uniqueness and sophistication might point to a high status piece of equipment and the possible royal connection of the Vize specimen seems to corroborate this idea. However, the entire body of evidence does not support such a straightforward conclusion. Apart from Vize, the general archaeological context of hybrid armour is no different from more common *militaria*. Evidently, the production of hybrid armour, with its large number of components, took considerably longer than other armour types, but it should not be overestimated. Like regular mail, the production of hybrid armour could be done by unskilled labourers under the guidance of a skilled craftsman, e.g. soldiers, veterans or civilians, including slaves and children. In the Roman era, time-investment did not influence status and exclusivity as it does in modern society. The information so far available is too scarce to conclude whether hybrid armour pertained solely to the elite, to the rank and file, or was accessible to both.

While the social status of hybrid armour remains momentarily undetermined, functionally, its weight suggests that it might have been suitable for cavalry. Despite its small components, hybrid armour is heavy, e.g. in finished condition the Vize armour is thought to have weighed about 18 kg.[98] This seems more in tune with the equipment of horsemen, who can carry a heavier kit than infantrymen.[99]

96 Driehaus 1968, 15; Mansel 1939, 177-182.

97 Fischer 2011.

98 Driehaus *et al.* 2012, 384.

99 Wijnhoven 2016a, 84.

3.6 HYBRID ARMOUR BEYOND THE ROMAN EMPIRE

In addition to the type of hybrid armour described above, there are other references to hybrid or combined armour from outside the Roman Empire, particularly from the Krasnodar Krai region in southern Russia, associated with the Sarmatians.[100] Finds of combined armour, made from mail and scale, mainly come from burial mounds, or kurgans, built between the 1st century BC and the 2nd century AD. Despite the fact that many were disturbed by grave robbers,[101] at the turn of the 20th century the archaeologist Nikolay Veselovsky was able to recover several pieces of armour from the burial mounds.[102] They were found in a bad state of preservation, heavily corroded and damaged by the grave robbers. In addition, Veselovsky's Victorian approach was aimed at recovering top quality objects, so he paid little attention to the corroded armour fragments.[103]

Consequently, the interpretation of these armour remains has been challenging and several ideas have been put forward regarding their reconstruction. Notably, the mail rings are woven in a 4-in-1 pattern, which is the standard weave since the invention of mail (chapter 9). The scales take on various shapes; some have a mid-rib, some end in a triangular shape, and others are slightly domed or embossed at the tips. Veselovsky did not attempt to reconstruct the armour and did not remark whether the mail and scale elements were connected, but he did speculate that the scales had been worn on the most exposed parts of the body, like the shoulders.[104]

Building on that assumption, Antoly Khazanov has suggested two possible reconstructions (fig. 3.21).[105] One involves two separate pieces of armour worn on top of each another, with the mail shirt worn underneath the scale armour. The second is a single piece of armour combining mail and scale. These do two not superimpose, as in Roman hybrid armour. Instead, the scales are fixed around the shoulders and upper chest, transitioning into mail on the rest of the suit.

Aleksej Simonenko further developed the idea of combined armour, based on the finds from Vozdviženskaja Staniča and Zubov dating to the 1st century BC (fig. 3.22).[106] The armour from these sites have scales with a medial rib, like those of Roman hybrid feathered armour. This is probably why he has proposed that they belonged to a single piece of armour that combined scale and mail, similar to the Roman examples. In his view, the armour from Vozdviženskaja Staniča and Zubov consisted of a continuous mail backing covered by an additional layer of scales around the most vulnerable body areas, like the chest.

Even though the finds from the Krasnodar Krai region have been often interpreted as combined or hybrid armour, the evidence is slim at best. The fact that remnants of mail and scale have been discovered alongside each other does not necessarily mean that they belonged to the same piece of armour. For instance in the excavation of Tbilisskaya Staniča 1, published in 1902 by E. Lenz, mail and scales were fused by corrosion, which is a common occurrence.[107] The inside of the scales still showed the original leather lining, a usual feature of regular scale armour, which uses a backing of leather or textile. For their part, the mail rings were not on the inside of the scales, but on the outside, excluding any connection between mail and scale, other than corrosion. Clearly, the two were part of separate pieces of armour, one of scale and one of mail, deposited together in the burial mound. The same applies to the armour from Zubov, which was reassessed by I. Gushchina and P. Zatetskaia.[108] Their description makes it evident that

[100] Bârcă 2006, 214; Bârcă/Symonenko 2009, 299-301; Černenko 2006, 30; Gushchina/Zasetskaia 1989, 73; Hansen 2003, 57-58; Nefedkin 2006, 435; Negin 1998, 69; Simonenko 2001, 271-276; 2010, 111-119; Waurick 1979, 325-326; Wójcikowski 2013, 239-240.

[101] Simonenko 2010, 117.

[102] Veselovsky 1905.

[103] Miller 1956, 30; Negin 1998, 69.

[104] Veselovsky 1905, 353.

[105] Khazanov 1971, 60-61.

[106] Simonenko 2001, 271-277, fig. 40.9-11; 2010, 111–120.

[107] Lenz 1902.

[108] Gushchina/Zasetskaia 1989, 116.

Fig. 3.21. According to Khazanov the combined armour could be constructed in two ways. The first consists of a mail shirt covered by a separate piece of scale armour. The second entails a single piece of armour that combines mail and scale (drawing M.A. Wijnhoven, after Khazanov 1971).

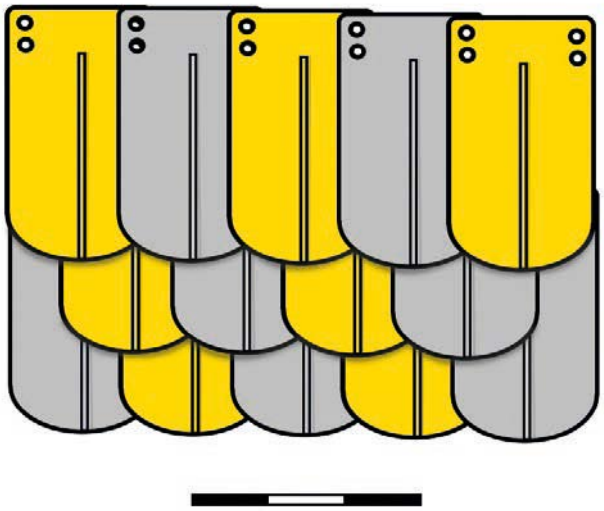


Fig. 3.22. Several of the scales found at Vozdviženskaja Staniča in Russia. The scales are made from iron and copper alloy. All have a medial rib and a double set of holes at the top (drawing M.A. Wijnhoven, after Simonenko 2001, fig. 40).

the scales still have remnants of leather backing. This corresponds with regular scale armour rather than the type of hybrid armour observed in the Roman Empire.

In sum, no finds from the Krasnodar Krai region have rendered actual physical evidence of having mail and scale linked into a single suit of armour. It therefore is unlikely that the Krasnodar Krai finds constitute hybrid or combined armour. Instead, the data indicates that different pieces of armour were regularly deposited together in one burial. It is uncertain whether they were worn over each other, as has been previously suggested, or if they respectively protected different parts of the body (e.g. one for the trunk and another for the limbs). The grave inventories of the burial mounds included many battle-related items and the deceased were richly accompanied by military equipment well suited for mounted warfare. The use of more than one protective piece of armour would befit such warrior panoply.

3.7 LATE ANTIQUITY

The traditional view is that the heavily armoured infantrymen of the Principate were replaced by lightly armoured foot soldiers in Late Antiquity. The latter might have worn a helmet, but did not wear body armour frequently.[109] The writings in the military manual of Flavius Vegetius Renatus, from the late 4th century AD, have been very influential in the creation of this image:

> *'The manner of arming the troops comes next under consideration. But the method of the ancients no longer is followed. For though after the example of the Goths, the Alans and the Huns, we have made some improvements in the arms of the cavalry, yet it is plain the infantry are entirely defenceless. From the foundation of the city till the reign of the Emperor Gratian, the foot wore cuirasses [i.e. armour] and helmets. But negligence and sloth having by degrees introduced a total relaxation of discipline, the soldiers began to think their armour too heavy, as they seldom put it on. They first requested leave from the emperor to lay aside the cuirass and afterwards the helmet. In consequence of this, our troops in the engagement with the Goths were often overwhelmed with their showers of arrows. Nor was the necessity of obliging the infantry to resume their cuirasses and helmets discovered, notwithstanding such repeated defeats, which brought on the destruction of so many great cities.*
>
> *Troops, defenceless and exposed to all the weapons of the enemy, are more disposed to fly than fight. What can be expected from a foot-archer without cuirass or helmet, who cannot hold at once his bow and shield; or from the ensigns whose bodies are naked, and who cannot at the same time carry a shield and the colours? The foot soldier finds the weight of a cuirass and even of a helmet intolerable. This because he is so seldom exercised and rarely puts them on.' [110]*

Vegetius paints a worrisome picture that fits the stereotype of the Roman decline during Late Antiquity. However, his text is not a regular military manual, as it may appear. Rather, it is a piece of propaganda to push the idea of a better, glorious past and to support military reforms that, in his view, would solve Rome's problems. Moreover, his comments of lazy soldiers and the lack of grit among the men was a common discourse all throughout Roman history, since at least the 1st century BC.[111] Vegetius should then be taken with a grain of salt.

Among others, Jon Coulston has worked on body armour from Late Antiquity.[112] He concluded that despite there being little archaeological and iconographic evidence for body armour during this period, Vegetius' description is flawed. The lack of evidence is not due to the disuse of armour, but the result of several other factors.

For one, the style of funerary stelae changed (chapter 4.5). After the 3rd century, Roman soldiers rarely invested in figurative funerary monuments anymore, and if they did, they chose to be portrayed not in 'battle dress' but in the so-called 'camp dress',[113] which still identified them as Roman soldiers, particularly through the belt.

Another factor was a shift in the production centres of military equipment in Late Antiquity. This affected the processes leading to the deposition of military equipment in the archaeological record. During the Principate a substantial part of the military equipment was produced and recycled at the Roman frontier, especially along the northern limes. In Late Antiquity large centralised state factories (*fabricae*)

[109] E.g. Garlan 1972, 103; Sirago 1961, 369.

[110] Vegetius, *De re militari* 1.19; translation Clarke 2013 [1767], 20-21.

[111] Coulston 2002, 8.

[112] Charles 2003; Coulston 1990; 2002; 2013; Elton 1996, 110-114; Glad 2009.

[113] Speidel 2011.

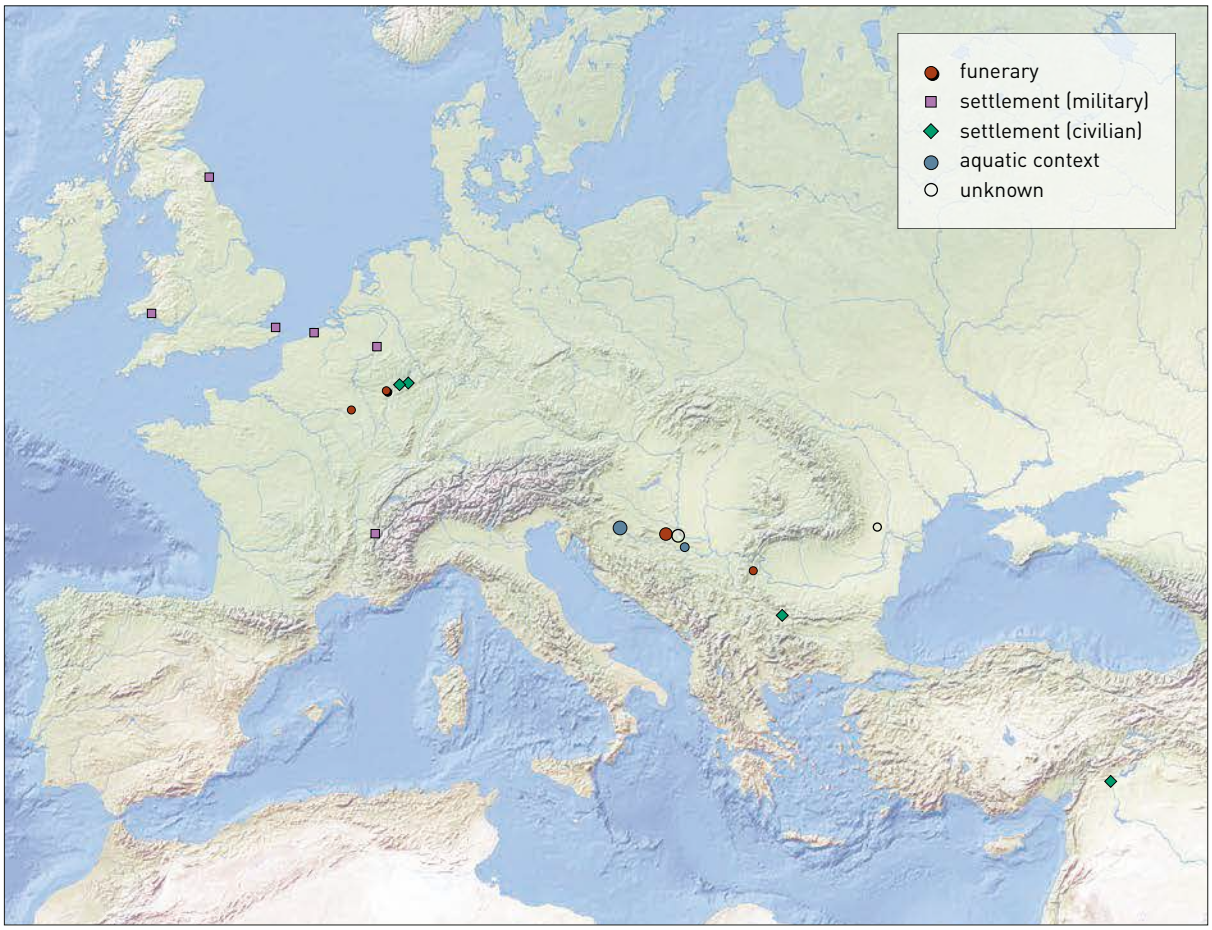


Fig. 3.23. Distribution and context of Roman mail armour from AD 260 to the 5th century AD. Finds with a date range larger than 200 years are excluded, because of lack of accuracy. Likewise, mail with a start-date earlier than AD 260 is excluded since it does not add to the discussion of late Roman armour, as it could also be attributed to a previous period (map M.A. Wijnhoven/B. Brouwenstijn).

were introduced.[114] These were located in or near cities that remained populated for centuries, meaning that most material was used, reused, and recycled to exhaustion, leaving little to be deposited.

The Late Roman period also introduced new strategies for defending the Empire, which altered the presence and activities of the Roman army along the borders. The active, forward-moving defence of the Roman frontier that had predominated during the Principate is thought to have changed into a more inward defence, also known as defence-in-depth.[115] This meant that instead of eliminating threats at or before reaching the border, these were allowed to make incursions into Roman territory and were neutralised on Roman soil.

The last two factors completely revoked the main mechanisms that had been responsible for the abundance of artefact deposition during the Principate. So, although the small number of armour finds from the Late Roman period may appear to support Vegetius' remarks, the reasons for the lack of presence are different. The current evidence does not point to the decline of body armour, but to the diversification of the troops. This in turn brought about not only light infantry, that indeed wore less body armour, but also an ever more heavily armoured close-order infantry,[116] and heavily armoured cavalry.[117]

[114] James 1988.

[115] Luttwak 1976, 127-190. Luttwak's influential work has been criticised, but the consensus is that the nature of the Roman defence at the borders changed significantly during the Late Roman period.

[116] Coulston 1990.

[117] Elton 1996, 105-107; Mielczarek 1993; Negin 1998.

Fig. 3.24. One of two fragments of mail armour from a villa in Mehring in Germany. It was found together with other items of military equipment. Rheinisches Landesmuseum, Trier (photograph M.A. Wijnhoven).

Figure 3.23 sums up the archaeological evidence for Late Roman mail, i.e. from AD 260 to the 5th century AD. The map includes fewer finds compared to the Principate, but shows that body armour was certainly not abandoned in Late Antiquity, although the find contexts did change. Mail finds from military contexts only persevere in the western part of the Empire, and in smaller quantities than in the previous centuries. Yet, the persistence of production demonstrates that even if the introduction of the centralised state *fabricae* affected the scale at which military equipment was produced, it did not completely substitute local production at the northern border.

Mail is still found in civilian settlements from the East and the West of the Empire (fig. 3.24). As discussed earlier, some may be the result of recycling military equipment in towns.[118] The 4th-century mail find from Trier certainly belonged to an assemblage of scrap metal that was ready to be recycled.[119] Of course, there may be other explanations for the presence of military items in settlements.[120]

Mail is also found in rivers, for example at Sisak 1 & 3 in Croatia and Bijele Crkve in Serbia, in both cases the remains are of substantial size.[121] Unfortunately, little is known about their exact location and context. They may well represent votive offerings, but could also be washout material.

Lastly, five finds come from burials. Weiler-la-Tour in Luxembourg and Sarry in France concern large fragments that may have been complete upon dis-

Fig. 3.25. A complete coat of mail from South Shields 1 - Arbeia, UK, dating to the late 3rd or early 4th century AD. It was excavated at a soldiers' barracks that burnt down. Arbeia Roman Fort and Museum (photograph M.A. Wijnhoven).

[118] Pfahl/Reuter 1996.

[119] Miks 2008, 14, fig. 21.

[120] Fischer 2001.

posal in the grave.[122] Gamizgrad in Serbia only has minor fragments, but likely was also a complete coat of mail at the time of deposition.[123] The other two, from Štrbinci 1 & 2, concern small pieces wrapped in textile, left in children's graves.[124] The practice of putting mail in female and child burials will be discussed in more detail below.

All in all, the distribution and contexts of Late Roman mail suggest that the processes behind the deposition differed substantially from previous centuries. These changes also explain the marked decline in the number of finds.

3.8 THE BARBARICUM AND BEYOND

It is conventionally assumed that the Roman army was better equipped than many of its adversaries, particularly the peoples from the Barbaricum. This is a designation for the regions beyond the Roman Empire mainly occupied by Germanic peoples and includes broadly the regions North of the Danube and East of the Rhine up to the Vistula (i.e. North-East Germany, Scandinavia, Poland, the Czech Republic and Slovakia). The notion of the superiority of Roman military equipment goes back to the classical sources. A good example are the writings of Tacitus, who says about the Germanic peoples:

> *'Even iron is not plentiful, as is inferred from the way they are armed. Only a few use swords or large lances. They carry spears, or as they call them in their own language,* frameae*, with a short and narrow iron point, which are, however, so sharp and easy to handle that they fight with the same weapon at close quarters or long range, as required. Even their horsemen are content with just shield and spear. The infantry also hurl javelins, of which each man has several, and they throw them a vast distance. They are either naked or lightly clad in short cloaks. Their weapons have no ostentatious decoration – only the shields are marked out in very bright colours. A few have a breastplate [i.e. armour], one or two at most a metal helmet or a leather cap.'* [125]

Such texts should be read critically. In this particular quote, Tacitus may be giving factual information, or instead, he may be simply be offering an antithesis of Roman civilisation as a means of highlighting the otherness of the peoples beyond Rome's frontiers.[126] Moreover, the naked warrior described by Tacitus is an ancient archetypal theme in Greek literature and art, adopted by the Romans.[127] Its twofold imagery refers, on the one hand, to the Greco-Roman 'heroic warrior', whose nudity in combat is associated with the gods and bodily perfection. On the other, it alludes to the foreign 'fearless warrior', whose unarmoured nakedness accentuates his oddness and bravery in combat.[128] Classical authors often exploited such themes in their narrative.

The general absence of human representations in the Barbaricum during the Roman period adds to the difficulty of understanding the use of body armour in that region. The few depictions that do exist are so stylized that it is hard to make out whether textile or armour is being shown. Therefore, in order to get a broad idea of what warriors from the Barbaricum looked like, scholars have to rely on Roman artworks which, in most cases, oppose well-equipped Roman soldiers with unarmoured or bear-chested

[121] Hoffiller 1912, 43-45, fig.19-20; Radman-Livaja 2004, 78-79, 130, fig. 18-19.

[122] Chew 1993, 313, pl. 3.3, 4.3; Waurick 1982.

[123] Vujović 2017.

[124] Migotti 2008.

[125] Tacitus, *Germania* 6; translation Birley 1999, 40.

[126] The latter is a well-known phenomenon in history and anthropology, and can for example be seen in the descriptions of the New World by European discoverers and conquerors.

[127] Cunliffe 2018, 222; Quesada-Sanz 2011, 151-152; Speidel 2004, 53-61.

[128] Glassman 2017, 1237-1238.

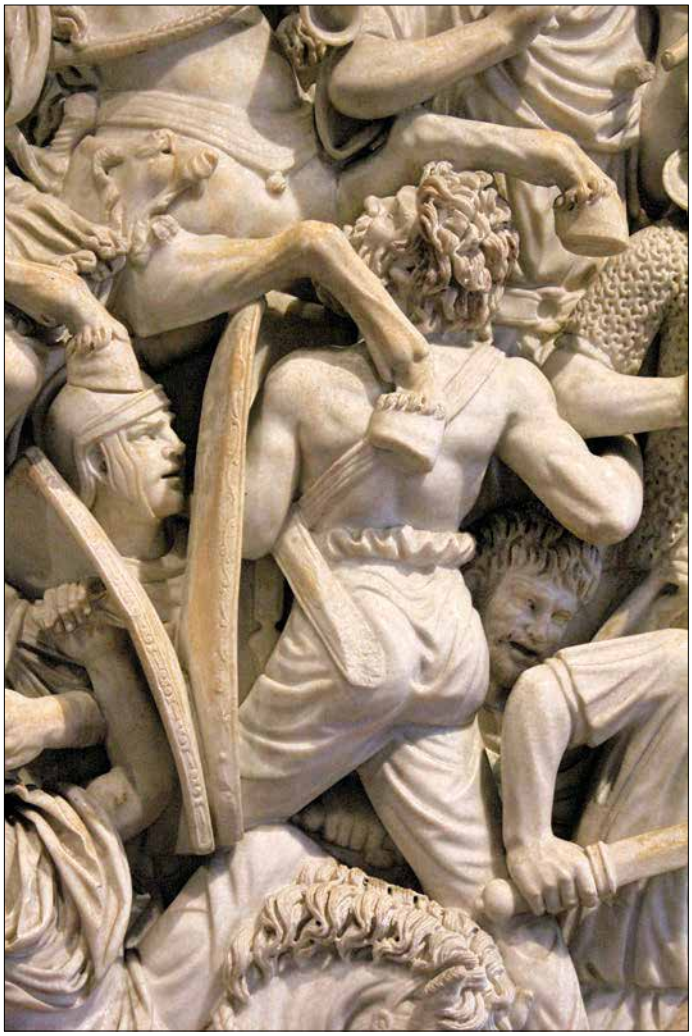


Fig. 3.26. The central panel of the Ludovisi sarcophagus (3rd-century AD) displays a battle between Roman soldiers and Germanic warriors. Most of the Romans wear armour, or at least a helmet, whereas the Germanic men are all without armour, and many are bare chested, like the warrior shown here. Palazzo Altemps, Rome (photograph M.A. Wijnhoven).

men. Examples include the columns of Trajan and Marcus Aurelius, the Tropaeum Traiani, and the Ludovisi sarcophagus (fig. 3.26).[129] However, as with the texts, it is difficult to say the extent to which these representations reflect the reality or constitute artistic conventions to emphasize Roman superiority.

Given the portrayal of peoples from the Barbaricum in Roman literature and art, whenever mail is found in this region it is often presumed to be of Roman provenance.[130]

The first study of the distribution of mail in the Barbaricum, by Klaus Raddatz, was based on a small number of finds.[131] Raddatz noted a gap in the archaeological record between the centuries BC and the 2nd century AD without mail finds. He therefore assumed that the presence of mail from then onward had to be of Roman production. Raddatz was convinced that the Romans would not have sold weaponry to their enemies, thus he concluded that the presence of mail beyond Rome's borders could not be attributed to trade. Likewise, he thought that the finds were too abundant to be gifts used in diplomatic exchange. Finally, the dates of many of the finds and their distribution led him to believe that their presence was linked to the Marcomannic wars of the second half of the 2nd century AD, and attributed the presence of mail to war booty taken from the Romans.

The attribution of the Marcomannic wars as the sole reason for the presence of mail in the Barbaricum has been disproven. In a broader study, Götz Waurick showed that mail finds occur both before and after the timeframe of the wars.[132] Nonetheless, he still assigned them a Roman provenance, excluding local manufacture. His argument was that most mail in the Barbaricum came from funerary contexts, and that finds of complete coats of mail were often accompanied by items of Roman origin. He also reasoned that small pieces of mail found in non-weapon graves actually served as jewellery, worn as a luxury Roman import. Waurick's interpretation of mail in the Barbaricum was not so much related to body armour, but to a product that signalled high status.

[129] Burandt 2017; Coulston 1988; 1989; Ferris 2008; Pogorzelski 2014; Richmond 1967; Richter 2010; Taylor 2011; 2013a.

[130] E.g. Hansen 2003, 82; Kaczanowski 1994, 216-219; Müller 2003, 437-438; Waurick 1982, 114-116.

[131] Raddatz 1959-1961b, 52-55.

[132] Waurick 1982, 114-116. And confirmed by other studies, e.g. Hansen 2003, 81-82; Kaczanowski 1994.

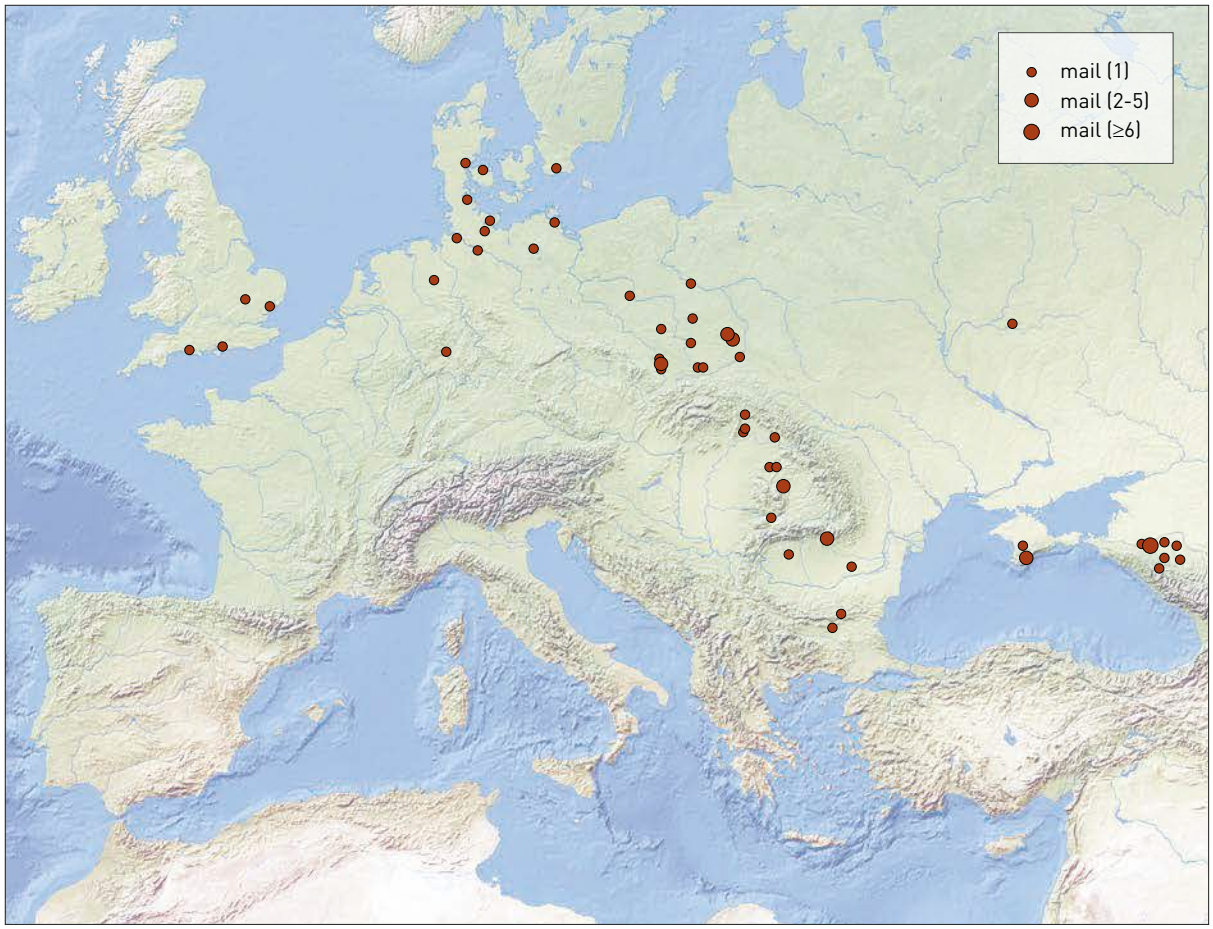


Fig. 3.27. Mail armour finds outside the Roman Empire dating between the reign of Augustus and the 1st century AD (map M.A. Wijnhoven/B. Brouwenstijn).

The idea that all mail from the Barbaricum is Roman has long predominated,[133] and many explanations as to how mail, and Roman military equipment in general, ended up there exist. War booty, as suggested by Raddatz, is one. Another is legal trade.[134] The supposed Roman ban on the export of weapons has been shown to be more likely a misinterpretation of Roman legal sources. Boris Rankov demonstrated that, at least during the Principate, it did not apply.[135] It has also been suggested that Roman military kits were brought back to the Barbaricum by Germanic warriors returning home after having served as auxiliaries in the Roman army.[136] Lastly, it has been argued that mail could have been used as a diplomatic gift for local leaders by the Romans.[137] Nowadays, most scholars agree that probably a combination of all these processes accounts for the presence of Roman *militaria* in the Barbaricum.

Only recently has the Roman origin of mail in the Barbaricum been questioned, and the possibility of native Germanic manufacture been reconsidered. For instance, using the grave inventories of 16 burials containing mail, Kirstine Juncher has determined that mail was likely made by both Roman and Germanic craftsmen.[138] Suzana Matešić has arrived at a similar conclusion based on a larger sample of some 90 well-dated mail finds from inside and outside the Roman Empire.[139] But perhaps the strongest evidence in favour of the native manufacture of mail, so far, is Arne Jouttijärvi's analysis of the mail coat

133 Hansen 2003, 78, 81-82.

134 Erdrich 1994; Kaczanowski 1994.

135 Rankov 1999.

136 Grane 2007; 2015; 2017.

137 Erdrich 1994; Grane 2007; 2015; 2017.

138 Juncher 2016.

139 Matešić 2015, 214-218.

from Hedegård, Denmark.[140] It showed that the chemical composition of the slag inclusions in the rings match northern Germany or western Jutland as the source of the iron.

Figure 3.27 includes all finds from the database of this study that are located outside the Roman Empire, including the Barbaricum, between the reign of Augustus and the 1st century AD. Contrary to what Raddatz suggested, there was no gap in the occurrence of mail armour between the centuries BC and the 2nd century AD. There are enough examples of mail from Germany, Scandinavia, Poland and Slovakia to support the continuous use of mail in the Barbaricum throughout this period.

The map shows concentrations of finds in different regions. As discussed, Bulgaria and Romania have a high density from the centuries BC up to the 1st century AD, but cease once they become part of the Roman Empire. Their incorporation into Roman society meant the end of the practice of depositing mail in rich funerary mounds. The Bosporan Kingdom, a client state of the Roman Empire, is another area of high concentration. Since the last centuries BC and well into the early 3rd century AD this region also counted with burials containing mail. After that, finds become scarcer there as well.

The continuity of mail in the archaeological record and the results of the Hedegård mail analysis strongly point towards an indigenous mail production in the Barbaricum. The detailed study of ring characteristics in chapter 11 further demonstrates that there in fact was an autonomous production of mail native to the Barbaricum.

Figure 3.28 includes the long-term distribution of mail beyond the Roman Empire, from Augustus to the 5th century AD. The archaeological contexts of mail within and outside the Roman Empire diverge a lot, implying that different deposition processes were at work. Out of Rome, most finds come from funerary contexts, whereas Roman finds are mainly from military settlements such as forts, camps, and *vici*, especially during the Principate. The great majority of the graves with mail concern cremation burials, although this changes around the end of the 3rd century AD in favour of inhumation.

Another important find context in the Barbaricum are the so-called 'war booty sacrifices',[141] which involved offering large quantities of military items in wet areas during a single event. It is hypothesised that large part of the defeated party's equipment was sacrificed after the conflict, possibly to thank the gods for the victory.

Over thirty bogs with weapon offerings are known so far. Only three of them have yielded mail: Vimose in Denmark, Thorsberg in Germany, and Czaszkowo in Poland.[142] Mail and mail-related items like fasteners are numerous in Thorsberg. Conrad Engelhardt, who excavated both Vimose and Thorsberg in the 19th century, noted that the latter site produced at least five complete coats of mail.[143] Vimose retains evidence of at least seven mail garments, but the number could have been as high as eleven (fig. 3.29).[144] The finds at Czaszkowo, are not as abundant and have rendered just small and corroded mail fragments. The fact that only a small proportion of all the weapon sacrifices contains mail must be the consequence of intentional selection. The differential treatment of certain artefacts resulted in some being over and others being underrepresented in the deposits, with some perhaps being completely left out.[145] Unfortunately, we can only speculate as to why mail was only incidentally selected during this process.

Also outside the Roman Empire some finds come from civilian settlements. The possible reasons for this have been discussed above. No mail making workshops have been identified outside the Roman Empire until now, although these are notably difficult to recognise (chapter 8.5). The presence of mail in civilian settlements could be an indicator of mail making activities. It could also be the result of other processes, as evidenced for example by the find from Dortmund-Oespel which was among discarded items prepared for recycling.[146]

[140] Jouttijärvi 1996, 57-59.

[141] Jørgensen *et al.* 2003. This interpretive term is not unproblematic; cf. Pauli Jensen 2009, 56-59; 2011, 39-40.

[142] Matešić 2015, 208-224, 512-521, pl. 104-109; Nowakiewicz/Rzeszotarska-Nowakiewicz 2012, 62-63, 128-129; Pauli Jensen 2008, 217-218.

[143] Engelhardt 1866, 46.

[144] Personal examination of the Vimose remains.

[145] Blankenfeldt 2015, 22-24; Möller-Wiering 2011, 133-134.

[146] Brink-Kloke 1999, 47.

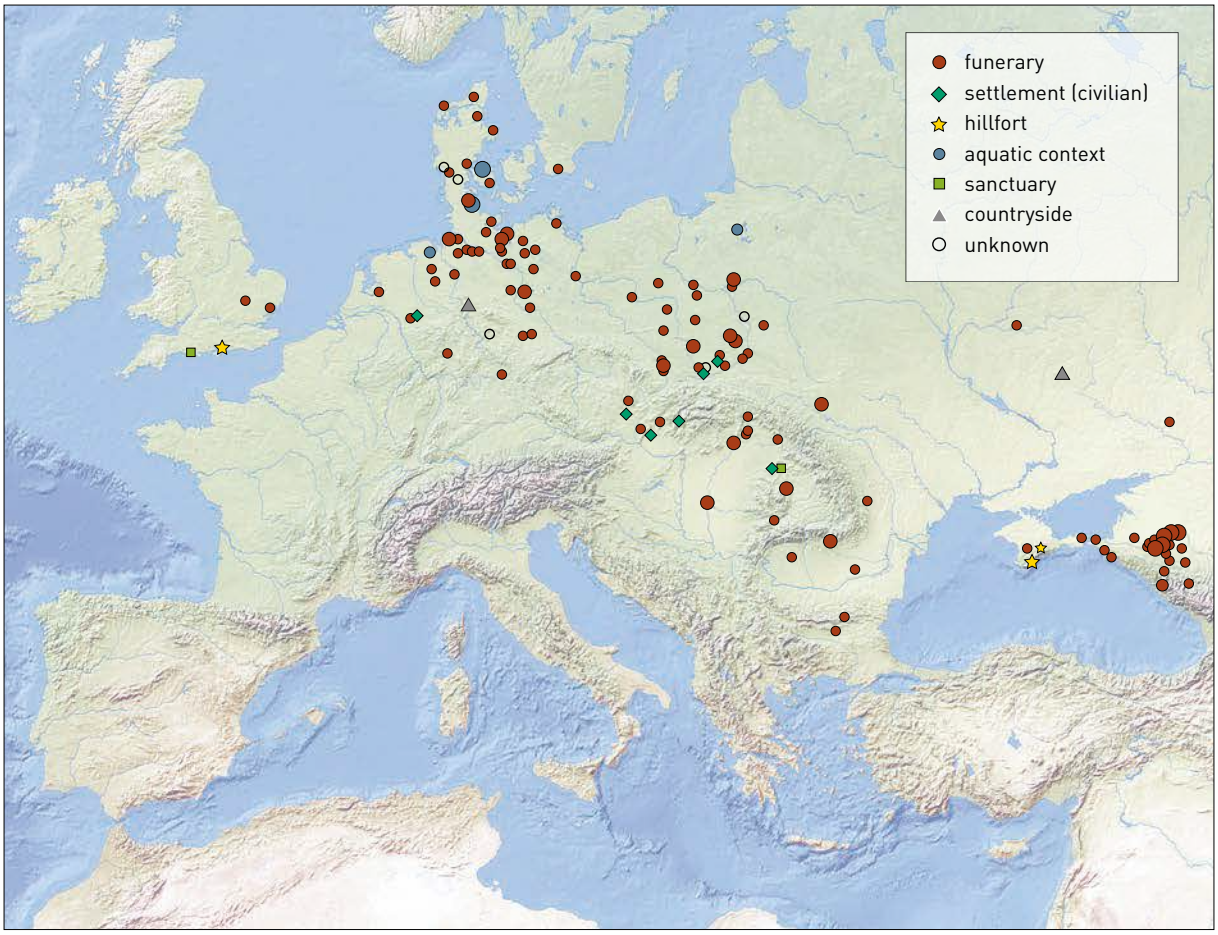


Fig. 3.28. Archaeological context of mail armour outside the Roman Empire between the reign of Augustus and the 5th century AD (map M.A. Wijnhoven/B. Brouwenstijn).

Three mail finds come from sanctuaries, Eklizí-Burún (Roman period) and Gurzuf Saddle Pass (30 BC-AD 50) located in the Crimean Peninsula and Hayling Island (50 BC-AD 25) in the United Kingdom.[147] The dates of these finds suggest that the offering of mail in sanctuaries was foremost an Iron Age tradition, not observed after the 1st century AD. The same applies to the deposition of mail in hillforts, like at Maiden Castle in the United Kingdom and Dünsberg in Germany.[148]

3.9 MAIL FOR MEN, WOMEN AND CHILDREN

As an item of military equipment, mail armour is commonly associated with men. Nevertheless, the archaeological record offers many examples where mail is found in burials of women or children. Suggesting that this armament also played some role in the (after)lives of other members of society. The nature and meaning of this phenomenon is the subject of this section.

The attribution of age and gender through the physical examination of skeletal remains is not always straightforward. This study follows the data presented in the literature, which is collectively sound although in individual cases may be ambiguous.

147 Gilmour 1997, 31; Lysenko 2013, 279; Novichenkova 2009; 2011.

148 MacGregor 1962, 28; Schultze-Forster 2002, 80, pl. 49.

Fig. 3.29. Some of the finds from the war booty sacrifice of Vimose in Denmark. There was more than one deposition event at thsi site, so the objects differ in date. Top left: partial fastener with a piece of mail still attached, from the 1st century AD. Top right: a pair of roundels that were originally attached to a mail coat, but have been separated post-excavation. The style of the roundels puts them in the second half of the 3rd century AD. Bottom: copper alloy hinge with strips of mail attached. This is probably a mail belt and similar hinges date this find to the 2nd century AD. Nationalmuseet, Copenhagen (photographs M.A. Wijnhoven).

The practice of depositing mail in a female or infant graves is entirely absent during the Iron Age. The earliest evidence for this phenomenon dates back to the start of our calendar. A woman at Mezmey 2, in Russia, was then buried with many grave goods, including a large quantity of mail.[149] This tradition becomes more common from *c.* AD 70 onwards, and has a long duration. It spans over the Roman period and continues well into the Middle Ages, to finally fade out in the 9th century AD.

The map in figure 3.30 illustrates all mail finds from funerary contexts between the 1st and 9th centuries AD. The database includes 344 burials with mail found among the grave goods.[150] 75 of them can be attributed to females and 19 to infants. In some instances the grave contained more than one body, usually an adult female with an infant, for example at Opatów 3 in Poland and Dessau-Grosskühnau 3 in Germany.[151] Over a quarter of all mail from funerary contexts from this period correspond to women or children.

Figure 3.31 shows the number of mail finds and their respective assignation to male/undetermined or female/infant burials in three periods. [152] During the first five centuries AD, the majority of mail is observed in male or undetermined graves. This begins to change in the 6th century and female and child

[149] Dedyulkin/Shevchenko 2017.

[150] Many publications lack information on the gender and age of the deceased. When information is lacking, the deceased is considered a male adult in this analysis.

[151] Articus 2004, 96; Opreanu 2011, 221-222, fig. 5.1.

[152] Burial rites can vary significantly through time and space. Up to the end of the 3rd century the great majority of burials with mail are cremations, whereas from this time onwards they mainly concern inhumations. The exception is Scandinavia during the Early Middle Ages where mail is frequently found in cremation graves.

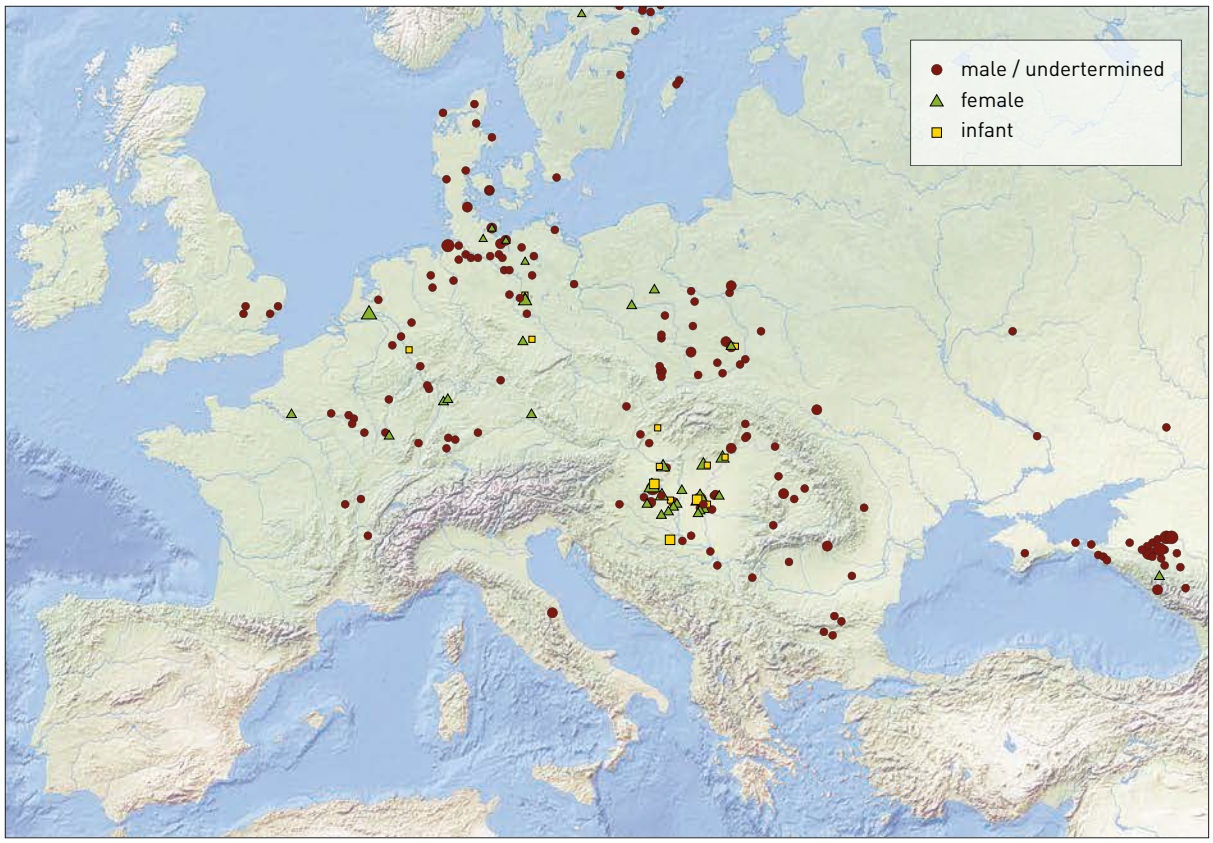


Fig. 3.30. Graves containing mail armour between the 1st and 9th centuries AD. The majority belongs to males, but over a quarter are of women and children (map M.A. Wijnhoven/B. Brouwenstijn).

burials now make up a substantial part of all funerary finds. Between the 7th and 9th centuries, the number of female/child graves greatly surpasses the amount of male graves. Notably, most examples from the last period come from Hungary, where this phenomenon truly flourished during the Early Middle Ages.

In the Roman period the majority of graves with mail come from outside the Roman Empire (188 *vs.* 16). Three of the 16 finds from the Empire are associated with female or infant remains. Two are from Štrbinci 1 & 2 in Croatia, and date to the second half of the 4th or first half of the 5th century AD. Both comprise only a small piece of mail carefully wrapped in fabric.[153] The other find is an urn with the cremated remains of a woman from Birdoswald in the United Kingdom, from the 2nd century AD.[154] The urn contains various small objects including a fragment of mail. All three examples have been interpreted as a custom introduced by foreign influences into the provincial Roman milieu.[155]

Over time, the geographical distribution of mail in female or children's graves changes. Between AD 70 and the start of the 4th century it is almost exclusively observed in northern Germany, Poland and Slovakia. Clearly, this is a well-established practice in the Barbaricum at the time. From the mid-4th to the 5th century there is little evidence for mail armour from this region. However, in the 6th and 7th centuries the phenomenon is again observed among Germanic graves in France (fig. 3.32), Germany, and The Netherlands.[156]

[153] Migotti 2008.

[154] Unpublished. Pers. comm. R. Collins, 2018.

[155] Migotti 2008, 210-211.

[156] France: Chaouilley. The Netherlands: Rhenen 2-4; Germany: Cologne; Mannheim-Seckenheim; Pfingstberg. There is even a 7th century find from Straubing 2 in Germany.

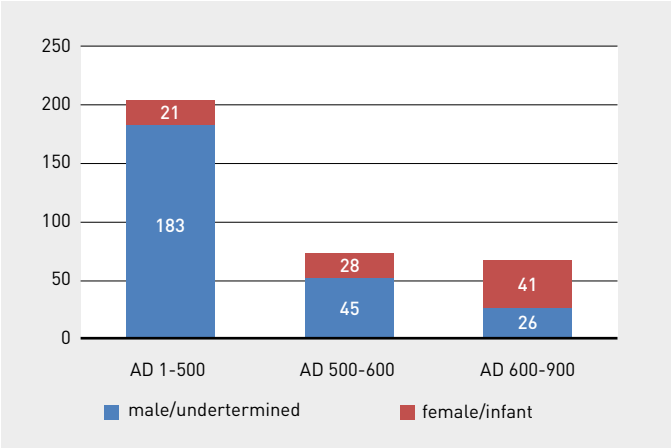


Fig. 3.31. Number of male/undetermined and female/infant graves containing mail.

During Late Antiquity the practice turns up in Croatia, Hungary and Georgia. In the 5th century, mail is found only in six female/infant graves from this area. But by the 6th century it is seen in 19 graves, all from Hungary, and the period that follows counts as many as 39. The origin of this tradition in a country like Hungary is uncertain. Given its earlier occurrence in the Barbaricum, it may have been introduced through contact. However, Hungary is heavily influenced by semi-nomadic steppe peoples some of whom settled in the region at the same time that this phenomenon appears, suggesting its emergence with them. Between the 7th and 9th centuries peoples like the Gepids and the Avars are largely representative of this practice in Hungary.[157]

All this raises the question of what the presence of mail armour among the grave goods actually means. Is its occurrence in female graves indicative of an Amazonian tradition of female warriors? Should we then assume that children also partook in warfare? Are there alternative explanations? If so, do these apply to male burials as well? Traditionally, the presence of mail in a man's grave is immediately taken as the mark of a warrior. Is such an interpretation correct?

Raddatz was the first to address these issues.[158] He noticed that male graves from the Barbaricum with ring-pommel swords could contain a complete mail coat. Conversely, smaller mail fragments were often found in women's graves, which he thought were curios or souvenirs from the Roman Empire. Leif Hansen arrived at similar conclusions by comparing the archaeological record of known finds from the Barbaricum with skeletal gender attributions. Full shirts were associated with male graves, and smaller patches of mail were more common in female burials.[159]

The present study corroborates these associations for the entire period under discussion. Out of all the women and children's graves with mail, only one seems to contain enough mail to represent a complete coat. Incidentally, it also is the earliest occurrence of this phenomenon, at Mezmay 2, which is a very richly furnished burial including numerous gold ornaments, two horses, glass bowls, a mirror and various ceramic vessels, among other items.[160] A large lump of mail, now weighing some 16 kg, was deposited next to the deceased. In all the other cases the mail remains are small and unlikely constitute a complete garment. Most female and infant graves contain one or two small mail fragments, seldom exceeding a handful. This suggests that complete mail garments were not (usually) deposited in women or children graves, and instead minor pieces were purposefully offered. Moreover, many fragments show textile adhesions, which indicates that they were either wrapped in fabric or placed adjacent to items of clothing (fig. 3.33). In the Przeworsk culture, an archaeological complex from the (Roman) Iron Age occupying parts of Poland and Slovakia, these pieces of mail sometimes have miniature tools attached to them as pendants (fig. 3.34).

These small wrapped or ornamented mail pieces do not signal a martial character. This is confirmed by the grave inventory as a whole. The great majority of female and infant graves with mail do not

[157] Csallány 1972; Glad 2009; Petér 2014.

[158] Raddatz 1959/1961a, 24; 1959/1961b, 52.

[159] Hansen 2003, 78-79, table 6.

[160] Dedyulkin/Shevchenko 2017.

Fig. 3.32. Grave goods of a 6th-century woman buried at Chaouilley in France. They include various pieces of jewellery made of precious materials and a gold Byzantine coin dating to AD 527-565. Two small mail fragments, almost corroded beyond recognition, were part of the inventory. Musée Nationale d'Archéologie, Saint-Germain-en-Laye (photograph M.A. Wijnhoven).

contain any other items related to warfare. A possible exception is again Mezmay 2, which includes two horses, although even here other clearly military objects are lacking. Three of the medieval Hungarian graves from Gátér (7, 12, and 16) have one or a few plates of a lamellar armour among the grave goods.[161] As with mail, these are only a fraction of a much larger piece of armour, and do not seem to allude to warlike activities, but probably served the same function as the small pieces of mail in burials.

So far, the only grave with an evident martial character belongs to a boy from Cologne. The burial dates to the first quarter of the 6th century and contains a full warrior's outfit with helmet and mail aventail (fig. 3.35), a sword, a throwing axe, a spear and a knife.[162] Although we cannot exclude the possibility that the child would have actually participated in armed conflict, the the presence of weaponry can be interpreted in another way. In the Early Modern period, for example, children would be given weaponry, especially plate armour,[163] not for martial purposes but as a mark of their position and status in society. A somewhat similar case from the Roman period is the young son of the general Germani-

[161] Csallány 1972, 31, 35, 43, fig. 10.

[162] Vogt 2006, 38, 297.

Fig. 3.33. The 6th-century burial of a woman at Rhenen 4 in The Netherlands contained two small fragments of mail with textile adhered to them. The inventory consisted of a rich array of artefacts including silver brooches, amber beads and a glass cup. Rijksmuseum van Oudheden, Leiden (photograph M.A. Wijnhoven).

cus, who went with his father on campaign dressed in a miniature soldier's outfit. The army men affectionately called him Caligula, 'little soldier's boots'.[164] So, an alternative interpretation of the Cologne grave is that the military items served either as status markers or attempted to imitate an adult ensemble.

There are several proposals regarding the significance of the small pieces of mail in female and infant graves in the Barbaricum, particularly from the Przeworsk culture. Following Raddatz, one suggestion is that these pieces may have been personal ornaments.[165] Sections of mail could be worn as bracelets, pendants, or sewn onto items of clothing, also to signal high status or as a symbol of prominence.[166] Another interpretation relates to the concept of *pars pro toto*, where a fraction of an object stands for the whole.[167] In such case, the deceased would be accompanied in the afterlife by a fragment that represented a mail coat rather than by the actual complete, and expensive, garment. Since women and children's graves usually lack other military items, it is possible that the mail fragments were not intended as warrior markers but instead functioned as protective symbols. This leads to a third explanation, which is that the mail pieces served an apotropaic purpose, as amulets meant to deter harm or evil.[168] As such, they could have been worn in life, perhaps equally as pieces of jewellery,[169] or could have been prepared especially for the funerary ritual.

Several facts seem to support the protective function of the mail fragments found in the graves of women and children. For instance, in the Przeworsk culture there are shields among the miniature tools found with mail (e.g. at Opatów 1), which also appear to have a symbolic protective character. Many of the fragments show evidence of having been wrapped in fabric upon deposition. Although the exact function of the textile covering remains unclear,[170] the anthropological notions of 'making special' and 'safeguarding' come to mind. Lastly, the three female graves from Gátér, mentioned above, also contain a section of lamellar armour. A lamellar armour plate can hardly be worn as a personal ornament. It is

163 Daehnhardt 1988; Smith 2004; Willemsen 2016.

164 Suetonius, *De vita caesarum - Caligula* 9.

165 Godłowski 1980, 99; Raddatz 1969, 16.

166 Czarnecka 1994, 251-252.

167 Laser/Leineweber 1991, 207.

168 Beilke-Voigt 1992; 1994; Czarnecka 1994, 251; Kiernan 2009, 108; Migotti 2007, 205.

169 Beilke-Voigt 1994, 606.

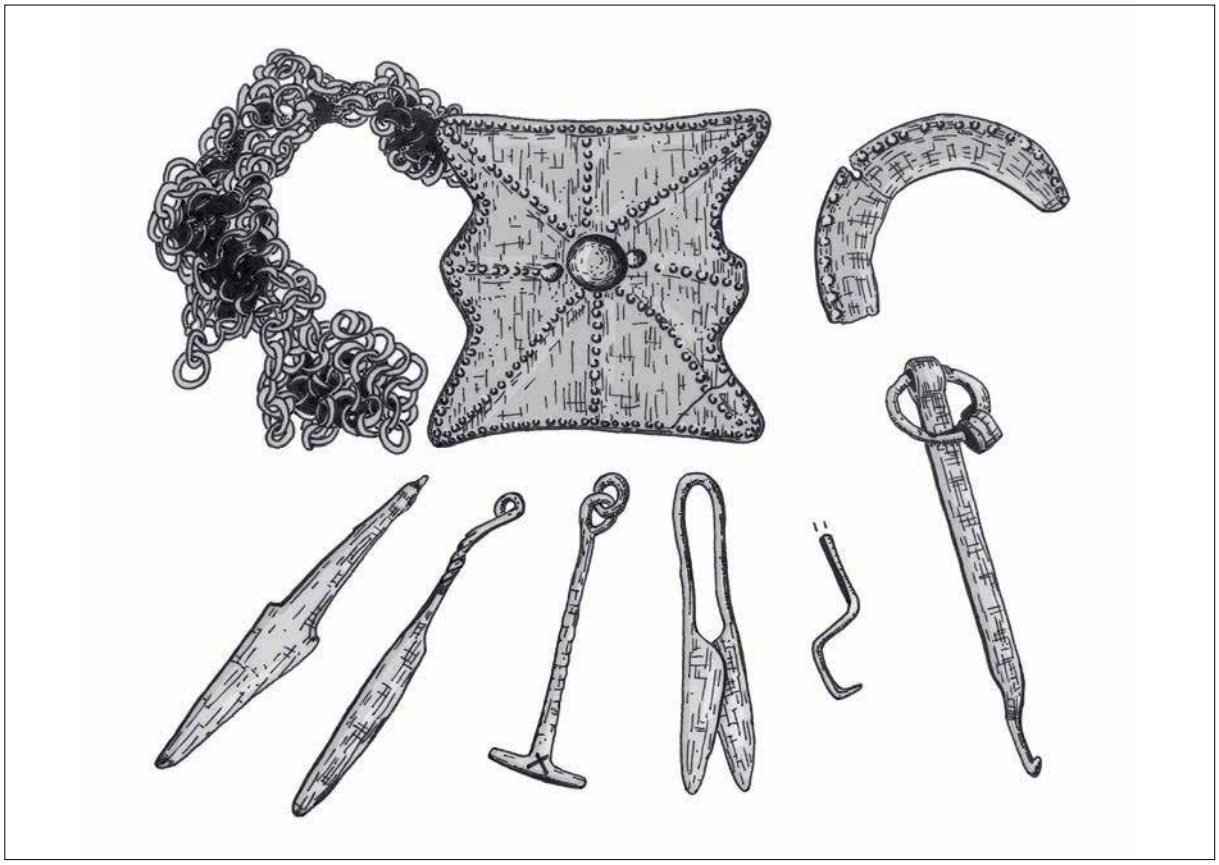


Fig. 3.34. Urn grave 49 from Opatów 1 in Poland. It contains a strip of mail still attached to a miniature shield. Miniature tools of knives, a hammer, shears, and keys were originally also attached to this strip. The mail with tool-pendants was probably worn on the body as an ornament. The gender and age of the deceased are undetermined (drawing M.A. Wijnhoven, after Czarnecka 1994, fig. 1).

more likely that, just like mail fragments, its presence was intended as a symbol or amulet to protect the departed in (the journey towards) the afterlife.

The practice of putting fragments of mail into the graves of women and children spans such a long time and vast geographic range that probably more than one explanation applies. Furthermore, some accounts are not mutually exclusive, for example an amulet can be simultaneously worn as a piece of jewellery, a signal of status, a protective symbol in life and death, and as a representation of an object.[171]

The case of the female and infant graves clearly shows that the presence of mail should not be interpreted directly as martial in character, even in men's burials. It is probable that the practice found among women and children also applied to men who belonged to the same culture.

This assumption seems corroborated by the nature of the mail remains in combination with the other grave goods of 163 entries of male/undetermined graves from the 1st to the 9th centuries AD (fig. 3.36).[172] Half of the graves (n=83) do not contain any other objects that could be assigned a military function, such as weapons or even horse gear. Moreover, almost none of the 83 include a complete mail garment

[170] The act of wrapping items in cloth prior to desposition is well-known among Iron Age graves; cf. Grömer 2010, 273. It is also observed during the Roman Iron Age in the so-called war booty sacrifices; Möller-Wiering 2011, 26-28, 38, 87-90, 99, 105-106.

[171] Sociology and anthropology can offer many additional possibilities in relation to grave goods in early-medieval burials, as discussed by Härke (2014).

Fig. 3.35. The grave of a boy from Cologne in Germany (first quarter of the 6th century) contained a complete martial inventory, consisting of a sword, a throwing axe, a spear and a knife. The helmet is made from iron and gilded bronze with horn plates. The mail neck guard, or aventail, shown here is a modern reconstruction. Cologne Cathedral Treasury (photograph M.A. Wijnhoven).

(n=3), whereas the overwhelming majority have one or several small fragments of mail. In contrast, complete mail garments usually appear in graves that contain other items of *militaria* (n=72 out of 80).[173]

Some of the 83 burials of undetermined gender/age that do not contain other *militaria* may in fact belong to women or children. Considering that the presence of spindle whorls among the grave goods usually correspond to women, eight of these burials could be female. However, it is unlikely that all 'weaponless' graves are of women. In fact, a few positively identified male remains also lack military items other than the piece of mail. Therefore, part of the unidentified mail graves must be of men.

In brief, it can be concluded that the deposition of mail in the graves of men has two manifestations. In the first, the body is accompanied by various military objects, often forming a complete warrior's panoply. These grave goods portray the deceased as a military man and the mail garment is almost always complete when placed in the grave. The second manifestation resembles the burials of women and infants, and involves graves of a non-martial character. These normally contain only one or a handful of small mail fragments.

The distribution of the weaponless male burials follows that of women and children's graves (fig. 3.37). They are found in the Barbaricum throughout the Roman period, mainly in northern Germany

[172] Male/undetermined graves without (enough) information on the grave goods have been excluded.

[173] It is not always evident if a the grave contained a complete mail garment. Here items have been considered complete when: 1) they are described as such in literature (e.g. a coat of mail or a mail aventail of a helmet); 2) the grave contained more than 5 fragments of mail; 3) the weight of the surviving mail exceeded 2 kg. A complicating factor is the bias caused by the type of burial practice. Due to their nature, cremation graves will preserve less often a complete mail coat than inhumation burials. While this affects the absolute number of complete mail coats observed in the archaeological record, it does not influence the outcome of the analyses done in this section. In the comparison of male/undetermined burials with female/infant burials with mail (or weapon- *versus* weaponless graves) both categories are affected equally by this bias. Therefore the observed difference between the two can not be accredited to divergent burial practices.

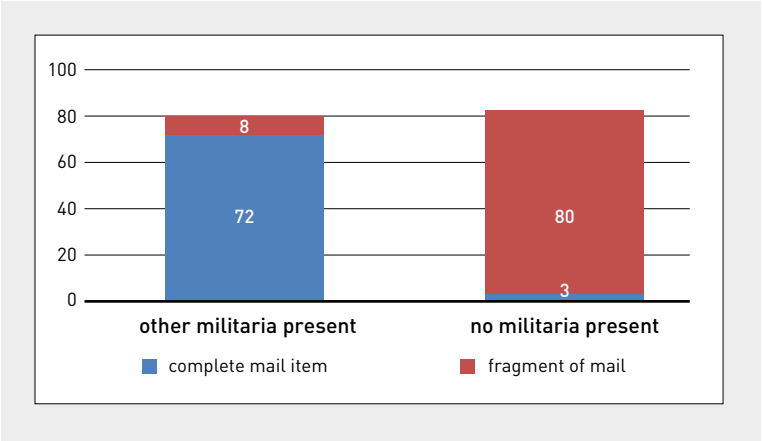


Fig. 3.36. Number of male/undetermined graves with and without the presence of other *militaria* among the grave goods and with a complete mail garment or a fragment.

and Poland. In Late Antiquity and the Early Middle Ages these are mostly confined to Hungary. The exception is parts of Germany, France and The Netherlands during the 6th and 7th centuries AD, where Germanic graves with mail fragments and no weapons belong exclusively to women. All of the men's graves from this time and area, including the boy from Cologne, are furnished with weaponry and contain a complete mail garment.

The data in this section suggest that it is possible to detect different practices related to the burial deposition of mail. In addition to being part of the warrior paraphernalia, mail also played an important role in the (after)life of people who did not bear a martial identity, including women, children, and adult men. It then seems that mail armour had transcended its status as an actual protective object and took on a symbolic protective function in the social and ritual spheres as well.

3.10 SOCIAL ACCESS TO MAIL OUTSIDE THE ROMAN EMPIRE

Grave goods are highly informative on the exclusivity or ordinariness of mail armour outside the Roman Empire during the first five centuries AD, the only caveat being that funerary behaviour does not always reflect everyday practices. As the previous section has shown, we can distinguish two sets of grave goods: those that include military items, or weapon graves, and those that do not, the weaponless graves. We will first discuss the former.

The assessment of the weapon burials can be aided by a framework to guide their interpretation and elucidate possible indicators of socio-economic status. The literature on war booty deposits – the phenomenon of large-scale weapon disposal in wet areas in southern Scandinavia – can provide such an interpretative framework. [174] We will take the material from the well-documented site of Illerup Ådal in Denmark as a guideline. Over 15,000 weapons and other objects have been retrieved at this location. Deposition A counts some 10,000 artefacts that were disposed of in one single event. They comprise the weaponry and personal equipment of an army, including shields, swords, sword belts, and horse harnesses. The range of items clearly shows a three-tier social hierarchy consisting of high, middle and low levels. Objects pertaining to the top-tier are (partially) made of gold and silver, or contain decorative elements of embossed precious metals (*Preßblech*). These constitute only 2% of the finds at Illerup Ådal. The mid-lev-

[174] Von Carnap-Bornheim/Ilkjær 1996, 483-485; Ilkjær 2000, 100-114, 124-135; 2001; Ilkjær/Iversen 2009, 140-141.

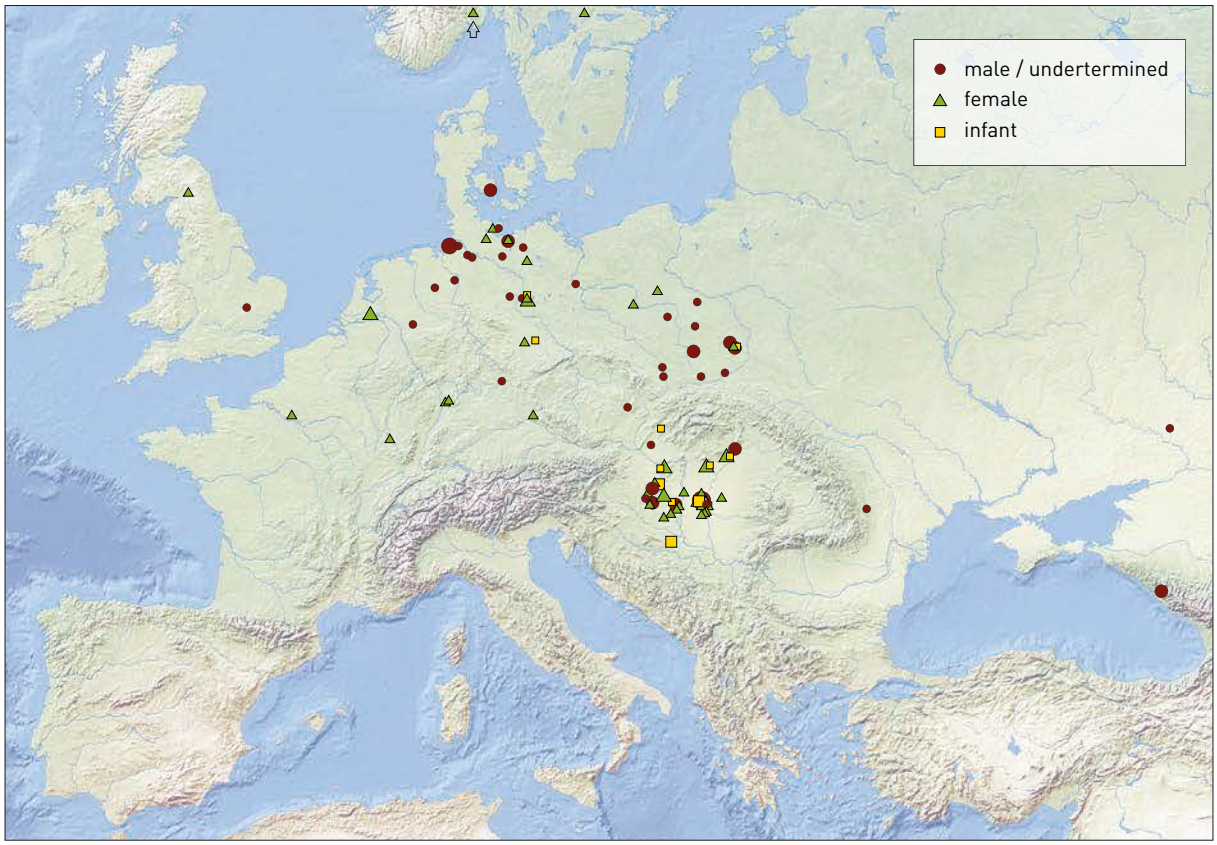


Fig. 3.37. Distribution of 1st-9th century burials with enough information on the grave goods to indicate that there were no military objects among them, other than mail (map M.A. Wijnhoven/B. Brouwenstijn).

el equipment is made of bronze or involves *Preßblech* with a bronze or iron base. These are 9% of the retrieved objects. At the lowest level are objects made only from iron, which form the bulk of the finds, at 89%. While not every member of the army carried a sword, they all carried a shield. Therefore, the ratio of the shields corresponding to each level is particularly indicative of the makeup of the army. This closely matches the ratio of the metals used in *militaria,* at 2%, 10% and 88% respectively. The finds from Illerup Ådal suggest that out of every 50 men, one came from the highest level, five were at mid-level, and 44 formed the lowest level. They also can inform us about army hierarchy. Since all the horse harnesses are made either of bronze, silver or gold, cavalry must have belonged to the top-tier. In contrast, infantry must have pertained to the bottom level.

The same three-level hierarchy can be recognised in other war booty sites, such as Nydam and Ejsbøl, as well as in the weapon burials from Denmark, Norway and Sweden.[175] This three-tier stratification applied to the whole of Scandinavia and probably extended over adjacent continental regions, especially from the 2nd to 4th centuries AD.[176] Although our period of interest is longer, and our region larger, the three level framework currently provides the best model for interpreting the grave goods under study.

The database includes 37 Roman period weapon graves with complete inventory from outside the Roman Empire (fig. 3.38). Within our framework, the majority of them (62%) belong to the top level, as they contain gold and silver objects. 30% fit at mid-level with bronze or copper alloy items, and only

[175] Ilkjær 2000, 114; 2001, 87-90; Ilkjær/Iversen 2009, 141.

[176] Ilkjær 2000, 96, 124.

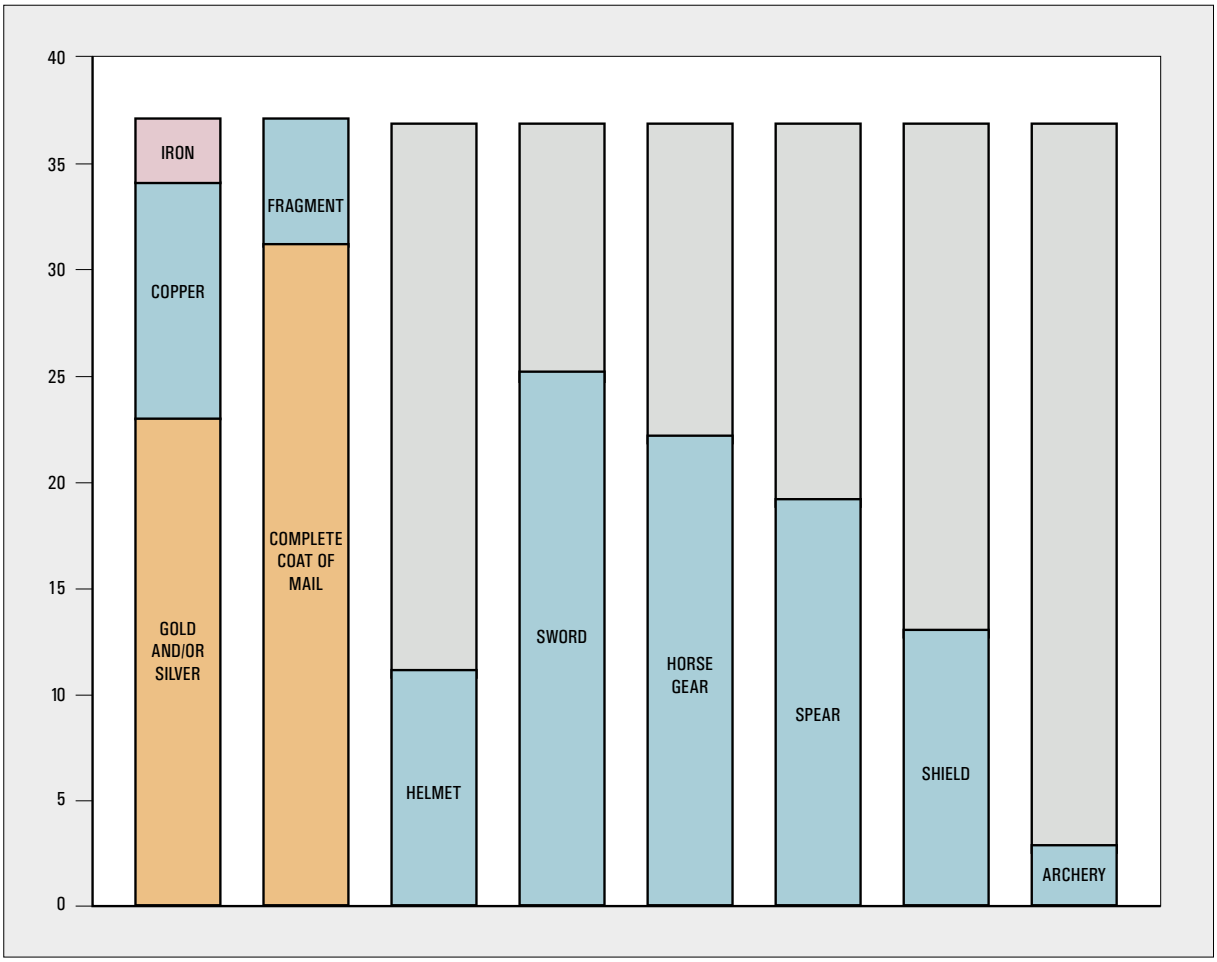


Fig. 3.38. Weapon graves with mail from outside the Roman Empire in the 1st-5th century AD. The majority contains objects made from precious metals or copper. Likewise, most include a complete mail garment. The graves stand out for their opulence and often include rare items such as helmets and swords. Since some graves were disturbed and some have not been published in their entirety, the actual occurrence of these items may be higher.

8% of the weapon graves with mail have grave goods made only of iron. However, even the latter include high-quality grave goods and should by no means be considered modest.

All of the 37 weapon graves are richly furnished, often both the quantity and the quality of the objects accompanying the body are very high (fig. 3.39). Swords, which are usually considered high-value items that were not available to every warrior, are a common feature in these graves.[177] 25 of the 37 weapon graves with mail also had one or more swords. Even two out of three of the bottom tier weapon graves with mail included a sword among the grave goods. In contrast, in the war booty sacrifice of Ejsbøl in Denmark, spears outnumber swords three times in a single deposition.[178] A systematic study of the weapon graves from the German Barbaricum similarly concluded that approximately one in four weapon graves contained a sword.[179]

Helmets and horse gear are absent from the grave goods of the lowest level, but are well represented in the other two levels. Horse gear is found in approximately two thirds of them. This is in line with the prior observation that at Illerup Ådal cavalry is associated with the top levels of army hierarchy. Helmets

[177] Thompson 2008.

[178] Todd 2004, 42.

[179] Adler 1993, 141.

Fig. 3.39. Some of the grave goods from Hagenow 3 (burial 9/1995) in Germany, AD 100-110. A cauldron was used as an urn and contained a complete coat of mail. The other military items involve a sword and scabbard, two spearheads, shield fragments, and four pairs of spurs with silver inlay (photograph Wikimedia Commons, J. Steakley).

are less frequent than horse gear but their percentage is still high, being present in a third of the 37 burials, whereas, helmets rarely occur in regular weapon graves.[180]

This brief summary shows that mail was not accessible to the majority of military men outside the Roman Empire. Weapon graves with mail are defined by their great material wealth. The overall impression is that mail armour must have been a considerably valuable and costly piece of military equipment that pertained mainly to the higher levels of the army.

Illerup Ådal offers an additional insight that could prove relevant for the understanding of mail outside the Roman Empire. Among the swords and baldrics deposited at the site, some are of Roman and others of Germanic origin. The richest baldrics and sword hilts, belonging to the top tier, are all of native production, while the Roman ones belong to the lower levels.[181] This suggests that the military elite used locally manufactured military equipment to emphasise their status, and deemed Roman imports as less suitable for this purpose. This elite was also the social group that made most use of mail armour so that their affinity with native equipment could further support the case for the local production of mail.

The second type of mail graves do not have any other military items, i.e. these are weaponless graves. Outside the Empire, 73 of these burials from the Roman period have information on their grave goods.

[180] Adler 1993, 105; Weski 1982, 39.

[181] Ilkjær 2000, 134; 2001, 92.

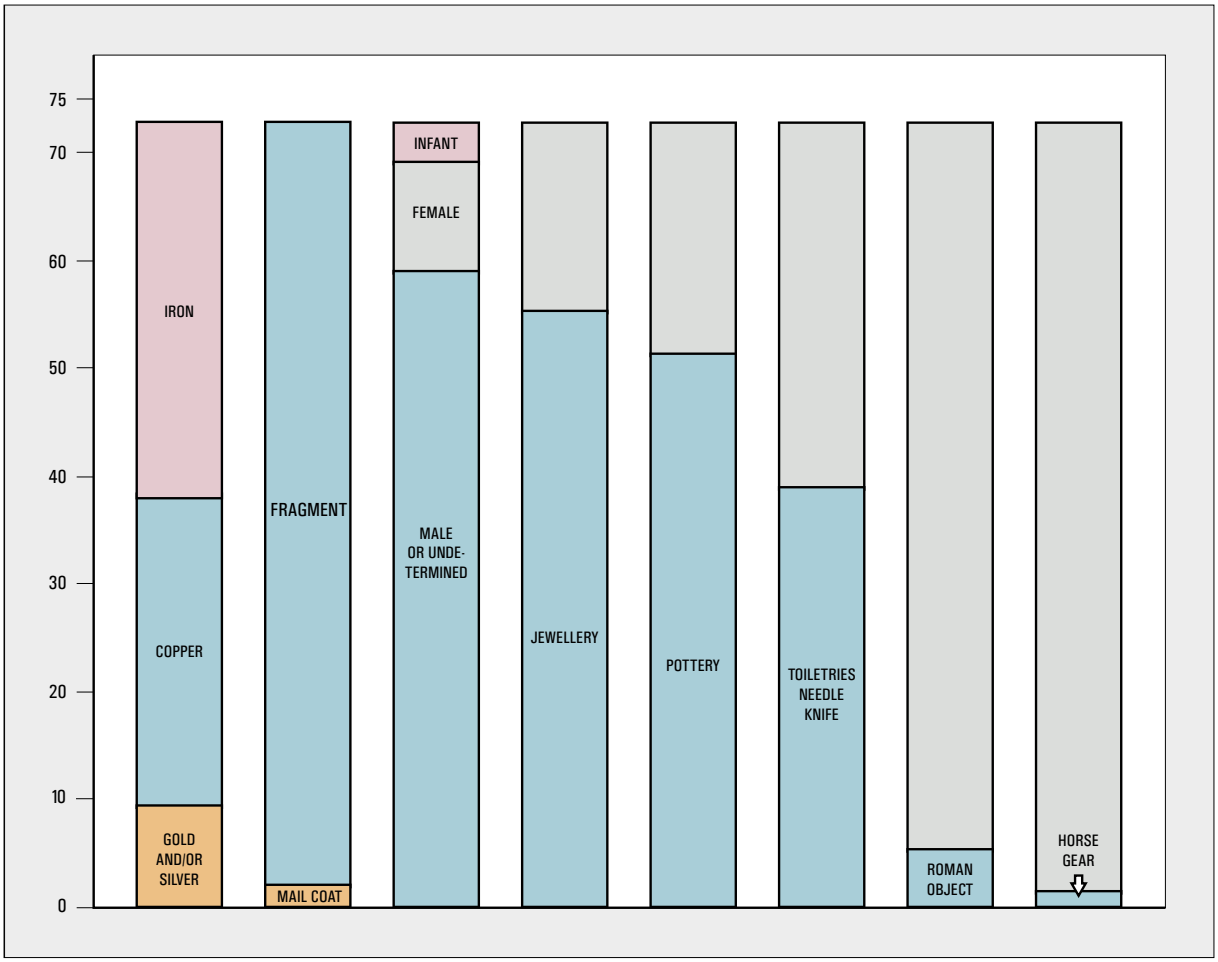


Fig. 3.40. Weaponless graves with mail outside the Roman Empire from the 1st-5th century AD. These belong to a wider social range than the weapon graves with mail. The majority does not contain precious metal objects or a complete mail garment and only has one or a few fragments of mail. Disturbed and partly published graves suggest that the frequency of the artefacts should be considered a minimum.

The majority concern male or undetermined remains, while only 20% can be attributed to female or infant individuals.

Although the three level framework was developed for military artefacts, it can also be used to analyse these burials. As it turns out, the level ratio differs greatly between weapon and weaponless graves (fig. 3.40). While all of the weapon graves with mail belong to the top social strata, this is not so for the weaponless graves with mail. Only a small proportion (12%) corresponds to the top level. 40% fit the middle level, and the majority (48%) belongs to the bottom level.

There are other obvious differences between the inventories of the weapon graves and the weaponless burials. First, as already mentioned, weaponless graves rarely contain complete mail garments. Only two of the 73 weaponless graves have a full mail coat. Second, horses and horse gear are equally absent, with only one grave containing a horse-related artefact. Finally, the grave goods in weaponless graves are often utilitarian and more mundane in character. Typical objects include brooches and buckles for clothing, objects of personal ornamentation, toiletries such as combs or tweezers, and items of everyday use, like spindle whorls, needles or a small knife. Most graves also include one or several items of pottery.

The most common objects in the weaponless graves are pieces of jewellery, such as necklaces, bracelets, pendants or finger rings, which can be found in 75% of them. Jewellery made of beads (glass, or amber,

bone or some other material) is the most prevalent kind of jewellery and is found in 38% of the weaponless graves. The presence of beads in general is widespread in graves outside the Empire during the Roman period. They are seen in both male and female graves, although they occur more often and in greater numbers in female graves.[182] The same pattern is observed among the weaponless graves with mail.

Over half of the weaponless graves contain toiletries, needles and/or a small knife. All occur slightly more often in burials of women and children. Only 7% of the graves has Roman products such as *terra sigilata* or Roman coins, and these are exclusively associated with male graves.

We can generally conclude that the socio-economic status of the weaponless graves with mail is lower than for the weapon graves. Taken together, the grave goods can still represent a considerable value, even in cases where no precious metals are present, but they do not reach the levels of the average weapon grave. The practice of accompanying the deceased with one or several fragments of mail in weaponless graves is aimed at a different social stratum than weapon graves. The individuals buried in the bottom tier weaponless graves would not have had the means to afford a complete mail garment, but more importantly, they probably did not need it. In these burials, mail did not have a military connotation, but fulfilled another function, one for which small pieces sufficed. The economic value of these pieces would have been literally a fraction of a complete coat of mail. Unfortunately, it is unclear whether these small fragments represent finished products or were repurposed from older or damaged mail coats.

3.11 CENTURIES OF ARCHAEOLOGICAL EVIDENCE

The archaeological record can prove very informative on the subject of mail, especially when seen from a long-term perspective. A better understanding of the changing depositional processes through time and place is essential to explain what is preserved in archaeology and what this means.

Mail has played an important role in different societies over the centuries. The nature of this role varied from a highly exclusive object in Iron Age society to a common piece of military equipment for the Roman soldier between the Late Republic and Late Antiquity. During the Roman period the purpose of mail outside the Empire was not unlike that observed in the centuries BC. Mail belonged to the upper layers of society. This probably went hand in hand with the scale of production, discussed in chapters 8 and 11. While mail was mass-produced for the Roman army, this was not the case outside the Empire.

Mail armour is also a good indicator of how people saw themselves and of their social identities. For the Roman soldier, it was an important visual mark that set him apart as a member of a specialised professional army. In Iron Age society it was a symbol of the power and status of the ruling class. Similarly, during the Roman period outside the Empire, it was an membership indicator for the warrior elite. There, however, mail also acquired an important meaning as symbolic protection among the wider social strata. Small fragments of mail served possibly in life, but certainly in death as a means of protecting others and oneself in the afterlife.

[182] Tempelmann-Maczyńska 1985.

4 The iconography of early mail armour

'On these stelae, all the required details of lorica hamata of the type under discussion are shown except for the rings that form the fabric of the garment itself. Anyone who has tried to draw, let alone carve in stone, the detail of a mail shirt will know how time consuming such a task can be.'
H. Russell Robinson[1]

4.1 THE ICONOGRAPHIC EVIDENCE

Excavated mail remains are often in poor condition, being fragmentary or corroded, which makes it difficult to make out their original shape and appearance. As will be seen in chapter 10, there are some exceptions that prove very informative, but these are still few and far between. Therefore, iconographic evidence is key to reconstructing the development of the mail coat's look and design throughout the centuries. This type of evidence includes military tombstones, state monuments and frescoes, among other imagery.

Nevertheless, iconography must be approached with caution, as what has been depicted is not always clear or reliable. Interpreting representations of mail is challenging. Even when realistically portrayed, images of mail are always simplified or stylised. Many artistic conventions were used to represent mail, from realistic to highly figurative. During the 19th century the phenomenon of artistic conventions was less well understood. Scholars of that period tended to interpret each variation as a separate type of armour, which they gave descriptive names such as 'ringed' or 'mascled' armour, and 'single', 'banded' or 'double chain-mail'. In the early 20th century, J. Green Waller and later F.M. Kelly proved that these types were not real, but all comprised different conventions to indicate 'regular' mail.[2]

Realistic renderings of mail can show individual interconnected rings, although much larger than their actual size. In many cases the weave is not properly illustrated (i.e. the 4-in-1 pattern with rows positioned horizontally; see chapter 9), and simply shown as a mesh. The more stylised images may include a number of possibilities, like circular or crescent shapes, horizontal or vertical squiggly lines, dots, circular holes, and crosshatching.

Due to so many conventions and the fact that they were not used systematically, it is not always clear whether the artist indeed intended to depict mail. For example, the tombstone of the centurion Titus Calidius Severus found at Carnuntum (fig. 4.1) displays part of his panoply including a shirt-like garment marked by crosshatching. This could be either interpreted as mail, as scale armour, or as a plaited or padded textile garment.

To complicate things, the majority of the images on tombstones, sculptures and monuments was originally covered by a layer of gesso and/or paint, now lost.[3] Gesso and paint allowed the artists to include details that could not be carved on the stone, such as the intricate mail weave.[4] The fact that none of the Roman military tombstones from the 1st century AD show the mail texture on the stone, even when the characters are shown in full battle gear, led past scholars to believe that the represented armour must have been made of leather (fig. 4.2). H. Russel Robinson convincingly argued in 1975 that this was very unlikely. Rather,

1 Robinson 1975, 169.
2 Kelly 1931; 1934; Waller 1904.
3 E.g. Brinkmann/Brijder 2006; Pogorzelski 2014.
4 Coulston 1988, 224.

Fig. 4.1. The funerary stele of Titus Calidius Severus from Carnuntum (1st century AD) demonstrates the difficulty of interpreting iconography. His tombstone shows pieces of defensive weaponry: a crested helmet, a pair of greaves, and a shirt. It is uncertain what to make of the crosshatching on the shirt. It may represent a kind of armour (mail, scale or padded garments?), or it could just indicate armour in general, without specifying the type. Kunsthistorisches Museum, Vienna (photograph M.A. Wijnhoven).

Fig. 4.2. 19th-century life-size reconstruction of a Roman soldier based on the tombstone of Gaius Valerius Crispus. Traditionally, shirts on Roman funerary stelae had been interpreted as leather garments due to their smooth surface. Nowadays it is recognized that they are meant to represent mail armour on which the rings were originally painted. The painted surface of almost all Roman tombstones is no longer present. Museum der Stadt, Worms (photograph M.A. Wijnhoven).

the tombstones depict all the details of the mail coat (such the shoulder guards, fasteners and splits) except for the actual rings,[5] suggesting that they must have been rendered in paint that has faded away. Robinson's interpretation is now widely accepted in the field of armour studies.[6]

It is crucial to remember that the representational record was not created with the prime aim to depict items as realistically as possible,[7] but to convey a certain message. A lack of likeness may be due to the artist being unfamiliar with the subject, resorting to artistic licence, or sticking to particular conventions. Götz Waurick demonstrated that historicism in art is the main reason for which Roman armour in iconography often differs from the actual artefacts found archaeologically.[8] Roman artists usually incorporated ancient Hellenistic elements into depictions of armour at the expense of contemporary military gear, especially in allegorical and symbolic images such as representations of gods, mythological scenes, and portraits of the hero-emperor. Because such themes were intended to evoke ideas of indefectibility or antiquity in the observer, portraying them in a Hellenistic style would have made sense. Similarly, state monuments show a much greater degree of Hellenization in armour than provincial art; the latter being deemed more true-to-life.[9] For example, the Rhineland

5 Robinson 1975, 169.

6 Some scholars insist that a leather shirt remains a possibility. E.g. D'Amato 2009, 68, pl. 3; Mattern 1999, 66-86; Selzer 1988, 155.

7 The reliability of depictions of military equipment has been discussed by several scholars; cf. Blair 1996; Coulston 1983; 1988; 1989; Richter 2010; Waurick 1983.

8 Waurick 1983.

9 E.g. Coulston 1983, 24-25; Feugère 2002, 20-24. Waurick 1983, 291-298.

Fig. 4.3. The funerary monument from Sidon in Lebanon contains one of the earliest depictions of mail armour (3rd-2nd century BC). The presence of mail is indicated by the grey colour and black crescent shapes. İstanbul Arkeoloji Müzeleri (photograph A. Kyrychenko).

tombstones from the 1st century AD are thought to be fairly truthful representations of the paraphernalia of Roman soldiers. The gravestone sculptors seem to have been very familiar with military equipment and may have been soldiers or veterans themselves.[10]

The challenges posed by interpreting the image record do not mean, however, that the armour depicted in works of art is necessarily fictitious. In fact, as long as one bears in mind the limitations of the source material valuable information can be gained.

4.2 THE 3RD CENTURY BC TO THE END OF THE ROMAN REPUBLIC

The earliest representations of mail coats come from Celtic contexts. Extraordinarily, all the sources - classical literature, archaeology and iconography - point to the same direction. Chapter 2 already covered that the earliest archaeological evidence of mail is associated with the La Tène culture. Likewise, several classical authors link the mail coat to the Celtic peoples, such as Varro, Strabo and Diodorus Siculus.[11] Iconography corroborates the indications from both sources.

One of the earliest representations of mail armour is the so-called Galatian mercenary, depicted on a funerary stele at Sidon, thought to date from the 3rd or 2nd century BC (fig. 4.3). The stele features an armed warrior with a bronze coloured helmet, a shield with *spina* and *umbo*, typical of the age, and a spear. His sleeveless mail shirt reaches slightly over the hips. The shirt is painted grey and the metal rings are simulated by black crescent shapes. The opening for the head consists of a simple slit made in the mail fabric; a feature also present on actual surviving mail examples (chapter 10.3). Remarkably, the painting lacks one crucial element observed in almost every other early depiction of mail: the shoulder guards.

Also known as extensions or doublers, shoulder guards were part of the mail shirt until the late 1st century AD. They constituted an extension of the back of the garment, that split at the nape into two sections which covered the shoulders down to the upper chest. They were fixed at the front by a system of fasteners and buttons. The mail shirt with shoulder guards is very akin in design to the tube-and-yoke

[10] Bishop/Coulston 2006, 10.

[11] Cf. box 2.2.

[12] There has been much debate on the true nature of this type of cuirass since it is primarily known from iconography; e.g. Everson 2004, 145-159; Jarva 1995, 33-44.

Fig. 4.4. Greek vase with an armoured man wearing a tube-and-yoke cuirass. The design of the early mail coat with shoulder guards is probably derived from this organic armour, which was still popular at the time of the invention of mail. Museum voor Kunst en Geschiedenis, Brussel (photograph M.A. Wijnhoven).

cuirass, often referred to as *linothorax* (fig. 4.4),[12] which was made of organic material, possibly leather or textile. Around the time when mail was invented, at the turn of the 4th to 3rd century BC, the tube-and-yoke cuirass was one of the most popular forms of armour. The design of the early mail coat must have derived from it.

The representational evidence for mail coats with shoulder guards predating the 1st century AD shows that there was a variety of shapes, but two main types predominated. The first mirrored the tube-and-yoke cuirass closely, with fairly narrow shoulder guards that covered only the upper part of the shoulder and part of the chest. The second variant had very large guards, resembling a cape, to protect the shoulder, the upper torso and even part of the upper arms.

The 'cape' style mail coat is well represented in a series of five life-sized sculptures from the site of Entremont (fig. 4.5), near Aix-en-Provence, dated to the 3rd or 2nd century BC. The recovered statues are in fragmented condition and only the most complete specimen has the texture of mail fabric reproduced by holes drilled into the stone. The armour on the other sculptures is left smooth.[13] The shoulder guards on every sculpture are of the cape type but each differ in shape and portray different kinds of fasteners. Two of them show fasteners that consist of three aligned rosettes, the middle one slightly larger than the others. These bring to mind the plate-like fastener with decorated rosettes found at Ciumeşti, Rumania (fig. 4.6a).[14] Two other sculptures have eight-shaped fasteners that do not look like any known archaeological example. The fastener on the fifth statue has the form of a head between two swirls reminiscent of La Tène (fig. 4.6d) and Roman S-shaped fasteners, of which many examples are known.

The Musée d'Archéologie Méditerranéenne in Marseille houses the torso of another fragmented limestone warrior from the site of Fox-Amphoux (fig. 4.7). Although this piece cannot be dated with certainty, based on its similarities with the Entremont statues, it may be attributed to the 3rd or 2nd century BC.[15] On this sculpture, the texture of mail is recreated by small round holes and circles. The figure is wearing a belt and holds a shield in his left hand, now much damaged. While the shoulders have also broken off, a line indicating the lower outline of the doublers can be clearly distinguished under the fastener, which is shaped like a spoked wheel with a lug on each side, through which it probably connected

[13] Hansen (2003, 91) and Robinson (1975, 169) interpret these garments as mail, while Benoit (1981, 71) considers them leather.

[14] Rusu 1969, fig. 146.

[15] Hansen 2003, 92-93.

Fig. 4.5. The five sculptures from Entremont featuring a coat with shoulder guards (3rd-2nd century BC). The guards differ in shape, but are all large and cover part of the upper arms and torso. Only on the most complete figure is the coat texture suggested by small holes throughout the garment. The absence of texture on the other four makes it slightly harder to assure that they are mail, however the large shoulder guards and fasteners are strong indicators of a mail coat. Musée Granet, Aix-en-Provence (photographs M.A. Wijnhoven).

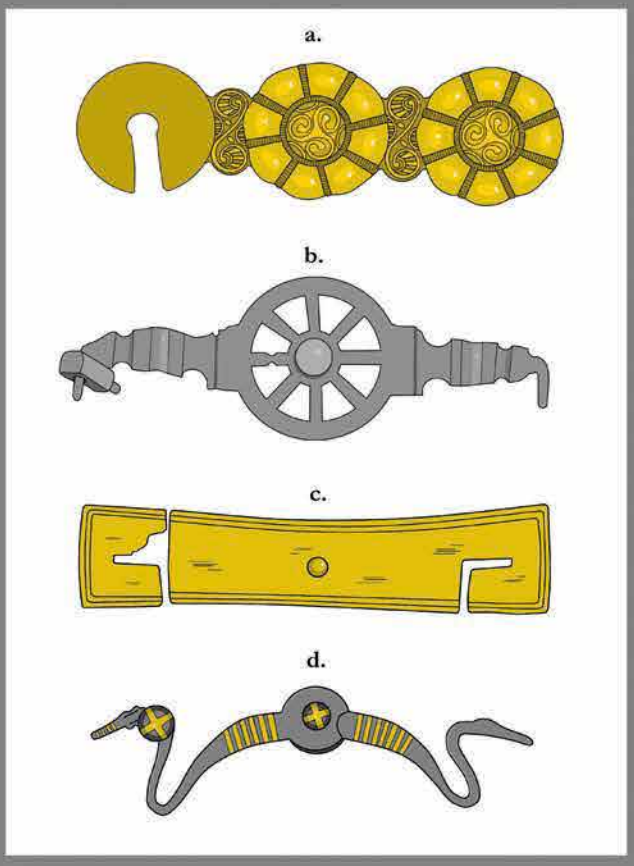


Fig. 4.6. In the Iron Age, mail coat fasteners could vary substantially in shape and design. Their diversity is attested by both representations and surviving specimens, many of which correspond. The most common archaeological examples are shown here: a) plate-like fastener with rosettes affixed to the left or right on the chest of the mail coat (Ciumeşti, Romania, 3rd century BC); b) wheel-shaped fastener attached to the sides of the coat of mail (Bulgaria, 250-150 BC); c) plate-like fastener affixed to the centre on the chest of the coat (Tărnava, Bulgaria, 150-25 BC); d) S-shaped fastener consisting of two parts attached to the chest of the coat (Doyrentsi, Bulgaria, 2nd-1st century BC) (drawing M.A. Wijnhoven).

Fig. 4.7. Despite the damage, the statue from Fox-Amphoux is exceptional in that the texture of mail is created by circles around small holes. A wheel-shaped fastener, not unlike the archaeological specimen in fig. 4.6b, holds the shoulder guards in place. Musée d'Archéologie Méditerranéenne, Marseille (after photograph D. Giancatarina).

Fig. 4.8. The weapon reliefs from Pergamon (c. 180 BC) contain three images of mail coats. The detailed stone carving shows individual interconnecting rings. A plate-like fastener features on the chest of the coat and holds the two shoulder extensions in place. The fastener resembles archaeological examples, e.g. Tărnava, shown in fig. 4.6c. Pergamonmuseum, Berlin (photograph M.A. Wijnhoven).

Fig. 4.9. The remains of a sculpture of a warrior wearing a mail coat with a plate-like fastener from the oppidum at De la Cloche, early 3rd or late 2nd century BC. Like the Entremont figures, it has a mail coat with large shoulder guards that cover his upper arms. Musée d'Histoire de Marseille (photograph M.A. Wijnhoven).

with buttons on the shoulder extensions. This fastener is very similar to one from Bulgaria which is still attached to a section of mail and thought to date between 250 and 150 BC (fig. 4.6b), although its provenance is unknown.[16] The wheel is a well-known Celtic motif that represents the sun god; a powerful symbol to protect the wearer.[17]

The weapon reliefs at the sanctuary of Athena Polias Nikephoros from Pergamon show three mail coats with narrow shoulder guards (fig. 4.8).[18] The reliefs are thought to show the spoils of the victory over the Galatians during the 180s BC. The mail texture is represented realistically through individual interconnecting rings carved on the stone, although of much larger size and disregarding the actual mail weaving pattern. The shoulder extensions are held together by a plate-like fastener that has a button at its centre to fix it firmly to the body of the mail coat. A diagonal slit on each end of the fastener receives the buttons from the shoulder guards. Next to each button there is another one that does not connect to the central fastener but was probably used to affix the shoulder guard to the body of the mail shirt. The fastener kept the guards positioned tightly along the neck to avoid gaping. Plate-like fasteners, very similar to those depicted at Pergamon, have been found in Bulgaria at Tărnava and Doyrentsi, dating between the 3rd and 1st centuries BC (fig. 4.6c).[19]

Plate-like fasteners were also employed in mail coats with wide shoulder guards, such as the one featured on a statue from the oppidum at De la Cloche in France (fig. 4.9).[20] The statue was smashed to pieces and was not found in its original location. It has been given a tentative date of the 3rd or 2nd century BC. Despite the damage, enough of the sculpture has been preserved to conclude that it must have resembled those from Entremont.

Another example of a plate-like fastener is found on a warrior statuette from the Este-Baratella sanctuary in Italy (fig. 4.10).[21] The figurine dates from the 2nd or 1st century BC.[22] This fastener is not

16 Dimitrov 2009-2010. Wheel-shaped fasteners very much like the one from Fox-Amphoux are also illustrated on a Late Augustan relief, now located at the Palazzo Ducale in Mantua (fig. 4.17).

17 Green 1992, 116.

18 Bohn 1885, pl. 44, 46, 49.

19 Torbov 2004, 61, fig. 4.

Fig. 4.10. A warrior statuette from the sanctuary at Este-Baratella, 2nd or 1st century BC. The mail coat has relatively large shoulder guards and a plate-like fastener. The mail texture is indicated by semi-circles. Museo Nazionale Atestino, Este (drawing Montelius 1895, pl. 61.4).

as detailed as those from the Pergamon frieze, therefore elements such as the slits and buttons are omitted. The shoulder guards are large, but they do not cover the arms like those from Entremont. Another warrior statue from the same sanctuary, which seems to have represented a horseman originally, has a similar coat as the first, with semi-circles indicating the mail texture and a plate-like fastener on the chest. However, in this case the shoulder guards are missing altogether.

What might be the earliest Roman depiction of mail comes from a victory frieze at Delphi (fig. 4.11).[23] The building to which this frieze belonged was erected by Aemilius Paullus in 168 BC. It shows a battle between Romans and Macedonians in which infantry and cavalrymen are all donned in mail. The coats reach just over the hips and are worn with a belt to relieve some of the weight of the armour from the shoulders. The shoulder extensions are narrow and some have square cut-outs at their ends, which appear frequently in depictions of mail and were often present in depictions of tube-and-yoke cuirass in an earlier period. A cavalryman has a mail shirt with short splits at the sides to facilitate horse riding. Unusually, one of the characters is portrayed from the back, showing that the shoulder guards were an extension of the mail shirt, and not separate. Unfortunately, the frieze does not contain any details of fasteners or buttons, which were possibly painted on and no longer survive.

A recent addition to the limited inventory of early mail representations is a warrior sculpture from Las Atalayuelas in Spain (fig. 4.12).[24] It is thought to date from between 175 and 70 BC and seems to have been made in an Iberian workshop. The fractured piece was re-used as building material, preserving only the torso, a small part of a knee, and a round shield. Nonetheless, enough remains to make out the armour. The texture of mail is clearly represented by chiselled marks repeated diagonally and in a stepped fashion. The sculpture portrays a horseman meant to be seen from the side or the back, which is more detailed than the front. The mail coat reaches down to the hips where the side splits to aid riding are located. The warrior from Las Atalayuelas is another exceptional case where the back is shown, confirming again that the shoulder guards were not separate panels of mail connected to the body of the coat, but a true continuation of the back extending to the shoulders and chest. The shoulder guards are of the large variant, held together by a fastener of unknown type which seems unnaturally placed, perhaps due to the uncommon perspective from which this sculpture was shown.

An Etruscan cinerary urn from Volterra, dated to the period between Marius and Augustus (fig. 4.13), depicts a soldier wearing a mail shirt with slim shoulder guards.[25] A fabric waistband, also known as a *fascia ventralis*, can be discerned around the waist. The guards end high on the chest and have no central

[20] Chabot 1983, 73-75.

[21] Montelius 1895, 309-314, pl. 61.4.

[22] Hansen 2003, 94.

[23] Fischer 2012, 33-35; Taylor 2013.

[24] Quesada Sanz/Rueda Galán 2017.

[25] D'Amato 2009, 51, fig. 38; Sumner 2009, fig. 10.

Fig. 4.11. The Delphi victory frieze, c. 168 BC, has possibly the earliest depiction of Roman mail. The cavalryman has a coat of mail with small side splits to aid riding. The infantryman wears a similar coat without splits. The narrow shoulder guards have cut-outs. Delphi Archaeological Museum (photograph V. Verschoor).

Fig. 4.12. Side and back view of the sculpture of a mounted warrior from Las Atalayuelas, c. 175-70 BC. Chisel marks give the mail its texture. The mail coat has splits to facilitate horse riding. Museo Arqueológico, Seville (photographs J.P. Bellón/ F. Quesada Sanz).

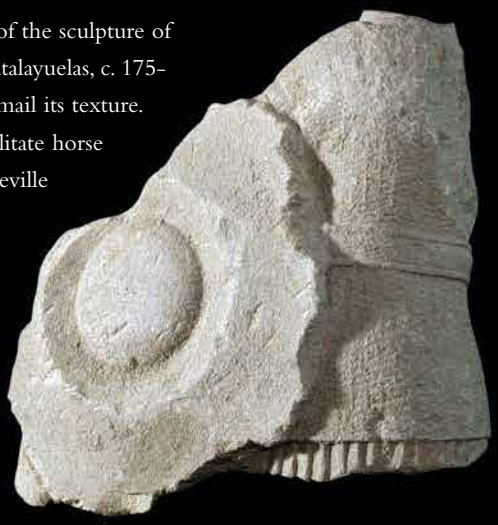


Fig. 4.13. Side panel of an Etruscan urn from Volterra depicting a soldier wearing a mail coat. The shoulder extensions are edged, indicating leather tubing, a lining, or padding sewn into the mail coat. The shoulder guards are held in place by rings and thongs, a very common closing method in earlier tube-and-yoke cuirasses. Late Republican period, Museo Etrusco Guarnacci, Volterra (photograph F. Casprini).

Fig. 4.14. Altar of Domitius Ahenobarbus, first half of the 1st century BC. It depicts several Roman legionary soldiers wearing mail coats with differently shaped guards, including cape-like and narrow examples. The fasteners seem of the plate-like variety.

↑ The figure above has shoulder guards of a distinctive texture, suggesting according to some that they may be made of a material other than mail. Louvre, Paris (photographs M.A. Wijnhoven).

← Fig. 4.15. Sculpture of two infantrymen from Osuna, 1st century BC. One man is wearing mail, indicated by the rectangular indentations that cover the protective garment. The coat is missing the shoulder extensions, which may have been omitted due to lack of space. Museo Arqueológico, Seville (photograph M.A. Wijnhoven).

fastener, instead the shoulder guards are attached to the chest by small rings placed at each extreme, which hold a thong that goes through the body of the mail shirt fastening the guards into place. The use of thongs to fix the shoulder guards, with or without rings, is often seen in the organic tube-and-yoke cuirass, and in armour portrayed on Hellenised sculpture from the Imperial period.[26] In the latter, it is uncertain whether this was the actual manner of fastening the mail coat or is a case of historicism, although some archaeological evidence suggests that thongs and rings may have still been used in armour during the 1st century BC.[27] The shoulder guards in the Volterra urn are edged, which could represent leather tubing or may indicate that the entire shoulder extensions were lined with leather or textile. Alternatively, this could be depicting integral padding stitched to the armour (chapter 7), which is common in Turkish and early-modern Indo-Persian mail.[28]

The so-called Altar of Domitius Ahenobarbus, from the first half of the 1st century BC, displays various legionaries and cavalrymen wearing mail shirts (fig. 4.14). The men are equipped with horsehair tailed helmets and oval *scuta*. Repeated horizontal wiggly lines sculpted into the stone indicate the texture of the mail fabric. One figure has a particularly narrow set of shoulder guards where the lines go in different directions. This has led some to conclude that the guards were made of a different material, i.e. leather embossed with decorative patterns.[29] But, although body armour combining mail with leather shoulder extensions is possible, a likelier explanation is that the sculptor was unable to carve horizontal lines within the restricted space of the narrow shoulder guards and opted to illustrate the mail texture differently. The Altar of Domitius also features mail coats with broad cape-like shoulder guards, indicating that both variants were used simultaneously in the Roman army. The fasteners are not very detailed, indicated only by a horizontal band connecting the shoulder guards. Given their plate-like appearance, it is likely that the artist intended to represent metal fasteners not unlike those found at Tărnava and Doyrentsi (fig. 4.6c). Others have speculated that such general horizontal bands found in sculpture correspond to a leather strap with similar function as the metal fasteners.[30] Even though this is plausible, there is no actual evidence for this practice.

A 1st-century BC sculpture from Osuna, Spain, features two infantrymen protected by helmets, large curved shields and greaves (fig. 4.15).[31] Despite the Roman subject, it is considered the work of an Iberian sculptor.[32] One of the depicted men seems to wear a mail cuirass, as indicated by rectangular indentations carved in the stone.[33] A belt relieves some of the armour's weight. Like the painting on the funerary stele of Sidon (fig. 4.3), this mail shirt lacks shoulder guards. This could be interpreted in various ways. The absence of guards may simply be an omission by the artist, which is feasible since much of the coat is obscured by a large shield and the presence of the rectangular indentation. This was enough to imply that the legionary was wearing mail. However it may also be that in addition to the coat of mail with shoulder guards, a variant with no guards was already in use.

[26] Tube-and-yoke examples: Aldrete *et al.* 2013, 32-35, fig. 2.2-2.8, pl. 2, 4; Everson 2004, fig. 50; Jarva 1995, fig. 13-14. Hellenised examples from the Imperial period: cf. D'Amato/Sumner 2009, fig. 163, 312; Fischer 2012, fig. 202; Waurick 1983, pl. 54.2. Cf. also fig. 4.17.

[27] From an oppidum in Vernon, France, come various fragments of mail containing two fixtures: a button and a sort of hook. Viand (2008) speculates that the hook fixture may have been placed on the inside of the shoulder guard and tied with a thong to a ring placed on the body of the armour.

[28] Bottomley/Bowstead Stallybrass 2000, 136-137; Robinson 1969, 41-42, 64, 98-99.

[29] D'Amato 2009, pl. 1c; Sumner 2009, pl. 10; Oorthuys 2012, 6.

[30] E.g. Demierre 2012, 166; Sumner 2009, fig. 10; Junkelmann 1986, 165.

[31] Robinson 1975, 164, fig. 175.

[32] Quesada Sanz/Rueda Galán 2017, 28.

[33] A similar technique to indicate mail can be found on a Gallo-Roman funerary monument from Saint-Julien-lès-Martigues in France, dating between Caesar and Augustus. Cf. Benoit 1948; Leveau 2016, 229; Picard 1943.

Fig. 4.16. Statue of a Gallo-Roman soldier from Vachères, Late Roman Republic. The statue and mail coat are rendered realistically. The coat of mail has shoulder guards, which as a second layer protect the shoulders, and contain cut-outs. It closes with S-shaped fasteners that connect to buttons on the shoulder guards and chest. Musée Calvet, Avignon (photograph M.A. Wijnhoven).

One of the most detailed images of a mail coat with shoulder guards is found in a statue of a Romanised Gaul, from Vachères in France, dating back to the second half of the 1st century BC (fig. 4.16).[34] The warrior is displayed in a casual fashion, his hand resting lightly upon the rim of his shield. The sword belt, worn over the mail coat, hangs loosely on the hips. The texture of his mail shirt is realistically recreated through carved crescent shapes. The shoulder extensions reach down mid-chest and contain cut-outs. Underneath the shoulder guards a second layer of mail covering the shoulders and part of upper arms can be seen. It would seem that this sublayer of mail has short sleeves, but these are more likely the protruding fabric of a rectangular coat that falls over the arms. This is a phenomenon also observed in Roman tunics from this period, and is known as 'false sleeves'. These are created by broadening the tunic and having the surplus material cover the shoulders down to the upper arms, creating the impression of sleeves.[35] The statue of Vachères is also one of the earlier clear depictions of a mail coat with an S-shaped fastener, which connects a button on the shoulder guards to the chest. Archaeological examples of S-shaped fasteners are known since the Iron Age, notably in Kirkburn (fig. 2.15) and Doyrentsi (fig. 4.6d), but become very prominent during the Early Roman Empire.[36]

This survey of the pictorial record prior to the reign of Augustus has highlighted some of the key features of the mail coat at that time. It usually included shoulder guards, which vary in size from narrow to very large. There is also the possibility of a sleeveless mail shirt without guards, although the interpretation of the evidence is ambiguous. The shoulder extensions are sometimes depicted with a border, which may indicate tubing, a lining of leather or possibly even the presence of integrated padding sewn into the armour. The mail coat from this period was not very long and reached down to the hips or upper legs. At times, it had splits at the sides of the hem to facilitate movement during activities such as horse riding. Often, the mail coat is shown worn with a large and sturdy belt which would have relieved

[34] Barruol 1996.

[35] Pausch 2003, 84-86, fig. 119, 121-122.

[36] Deschler-Erb 1991, 19-21, 140; Hansen 2003, 72-75, 209-211; Stead 1991, 54-55; Torbov 2004, fig. 5.

the shoulders from the weight of the armour. Finally, the portrayed fasteners bear a striking similarity to those found archaeologically. Furthermore, the collection of fastener representations includes almost every archaeological type known to date. Some of the depictions are so detailed that they even show the buttons located on the shoulder extensions that connected to the central fastener.

4.3 EARLY EMPIRE UNTIL THE END OF THE IST CENTURY AD

During the Early Empire the artistic evidence for the mail coat increases considerably, perhaps due to the creation of a fulltime professional army stationed more or less permanently along the Empire's borders.[37] This was a very important development for the Roman army. Whether legionaries or auxiliaries, the military men invested in showing off their identity: in life, through the military equipment they wore, and in death through the stone funerary stelae erected in their memory. In fact, the tombstones of soldiers portray a wholly military identity, often stating where they served, in what rank and for how long. Many of them were represented in battle gear, which offers a rich resource for this study. Britain and the Rhineland area of Germany, in particular, have yielded a large number of military tombstones.

Consequently, the evidence from this period comes primarily from funerary contexts, except for a few cases. For example, a Late Augustan relief that depicts a battle between Romans and Gauls, now in the Palazzo Ducale in Mantua (fig. 4.17),[38] includes a cavalryman wearing a mail coat with large shoulder guards and a wheel-shaped fastener. Another example is the triumphal Arch of Orange in France, which shows various soldiers wearing mail (fig. 4.18).[39] There is also an image of Mars donned in a mail coat, depicted on a votive pillar at Mavilly (fig. 4.19).[40] And lastly, there is a relief carved into the four sides of a column base, thought to have belonged to the *praetorium* of a fort in Mainz.[41] It includes the image of a soldier wearing a mail shirt, holding a large shield in one hand and possibly a sling in the other (fig. 4.20). Unlike the other examples mentioned above, the texture of the mail in the Mainz relief was not carved in the stone, but was probably painted, now appearing smooth.

Funerary stelae do not represent mail by carving its texture in the stone. For this reason, scholars in the past have been led to believe that leather, not mail armour, was being represented. Other details such as fasteners or the buttons that connected them to the shoulder guards are also often missing on tombstones. In all likelihood, these were applied in paint and gesso as well. So, on funerary stelae mail coats can only be identified using morphologic criteria, e.g. garment shape or details like the folds indicating the heaviness of the garment, or the presence of splits. The most recognisable feature are the shoulder guards, although these are not exclusive to mail and could be present on scale armour too.[42]

At the periphery of the Empire, the tombstones are generally considered fairly accurate.[43] Nonetheless, their purpose was not to be an actual portrait of the deceased but to convey a message about their life, which was more easily accomplished if the artwork followed a well-established iconographic 'vocabulary' of conventions and recognisable themes. One of these conventional themes, for instance, is the triumphant rider (see below). The use of a well-established iconographic code produced some degree

37 Gilliver 2007.

38 Robinson 1975, pl. 472 or Junkelmann 1992, fig. 157.

39 D'Amato/Sumner 2009, fig. 6, 315; Robinson 1975: 169, fig. 31-32.

40 Thevenot 1955.

41 Bishop 2018; Riemer 2017, 30-35.

42 Scales were sometimes carved into stone, such as in the tombstones of Vonatorix (Germany), Licaus, Dazas and Liccaius (Algeria), and Longinus (United Kingdom); cf. Schleiermacher (1984, 79, 155, 157, 159, 189).

43 E.g. Coulston 1983, 24-25; Feugère 2002, 20-24. Waurick 1983, 291-298.

44 On stylistic grounds and the resemblance of many tombstones within a certain theme, some scholars speak of a workshop tradition; e.g. Anderson 1984, 27; Gabelmann 1973; Schleiermacher 1984, 37-50.

Fig. 4.17. Relief of a battle between Romans and Gauls that probably dates to the Augustan reign. The horseman wears a belted coat of mail with large shoulder guards with cut-outs. The guards are held in place by a wheel-shaped fastener and rings with thongs. Both elements originated in an earlier period, but are not seen on other representations from the Early Empire. Small chisel marks give the appearance of mail rings. Palazzo Ducale, Mantua (photograph S. Manning).

Fig. 4.18. The date of the reliefs on the Arch of Orange is debated between its construction, during the reign of Augustus, and its reconstruction under Tiberius, in AD 27. The reliefs show cavalrymen and infantry wearing mail armour. The coats are covered in rectangular holes giving the appearance of mail rings, except for the narrow shoulder guards which are smooth. Some of the coats have splits and they all feature S-shaped fasteners (photographs M.A. Wijnhoven).

Fig. 4.19. Votive pillar from Mavilly, 1st century AD. The god Mars wears a coat of mail with large shoulder extensions. The guards are folded back, like lapels in a modern jacket. This is the only example of such feature outside of Germany. The texture of mail is implied by crescent carvings. Musée Archéologique, Dijon (drawing M.A. Wijnhoven, after Robinson 1975, fig. 176).

Fig. 4.20. Base of a column probably from the *praetorium* of a fort in Mainz, c. AD 70-80. Each side has military scenes, among which there is this soldier in full battle kit, including a helmet, shield, sword and possibly a sling. His coat is smooth with no signs of mail texture. However, a fully equipped soldier would have certainly worn a mail coat. In addition, the splits at the bottom hem and on the sleeve are highly indicative of mail. Landesmuseum Mainz (photograph M.A. Wijnhoven).

of standardisation, to the extent that one workshop or craftsman would turn out tombstone prototypes that only differed in the details.[44]

The representational evidence from this time, especially the second half of the 1st century AD, indicates that this was a very dynamic period in which the mail coat design underwent drastic changes. As a result, there is more diversity in mail coat imagery at this time than any other. While some of these depictions do have an actual armour design counterpart, others are difficult to interpret.

The mail coat with large, cape-like shoulder guards is still depicted frequently and is observed until the end of the Flavian period. It is especially prevalent on the triumphant rider tombstones from Germany, which show the deceased mounting a horse in battle. The horse often stands on its hind legs, with the front legs suspended in the air. Usually, an enemy warrior is being trampled down by the horse and at times a servant, or *calo*, is standing in the back holding reserve spears. The riders commonly have an oval or hexagonal shield in their left hand, while the right holds a spear overhand ready to stab.[45] At their waist a sword dangles from a belt, and a helmet adorns the head.

The coat of mail with large shoulder guards on the triumphant rider stelae differs from those seen previously. The inner edges of the guards are folded over at the breast, resembling modern lapels.[46] This feature is almost exclusively found in Germany and can be observed on the cavalry tombstones of Togitio (Mainz-Gustavsburg), Reburrus (Bonn), Gaius Romanius Capito (Mainz), Andes (Mainz), Annauso (Mainz), and on three tombstones of anonymous cavalrymen from Worms (1 and 2) and Cologne (fig. 4.20-26).[47] The only example of large guards with folded inner edges outside of Germany comes from the aforementioned image of the god Mars from Mavilly in France (fig. 4.19). The shoulder guard shape varies, the most common being the cape-like type covering most of the upper arms, as seen on the

[45] The tombstone of Insus from Lancaster indicates that these could diverge, at least outside Germany. Insus is portrayed without a spear, but holds a sword in his right hand, ready to strike; cf. Bull 2007.

[46] This is a clear indication that these shirts must have been made from mail, since such a construction would have been impossible in scale armour; cf. Schleiermacher 1984, 23-24.

[47] Bauchhenß 1978, 37-38, pl. 21; Boppert 1998, 86-88, 90-91, pl. 50, 52; 1992, 133-137, 139-144, pl. 29-30, 32-33; Junkelmann 1991, fig. 44, 55; 1992, fig. 117; Robinson 1975, 164, pl. 298, 302; Schleiermacher 1984, 73-74, 93-94, 97-100, 110-112, 122-123, 151-152.

← Fig. 4.21. Funerary stele of Togitio, son of Solimarus, mid-1st century AD. It shows the deceased as a triumphant rider wearing full battle gear, including a hexagonal shield, spear, sword, helmet, and a coat of mail. The coat has a split at the hem for movement. The shoulder guards are cape-like, albeit not very wide. The inner edges of the guards are turned over, like modern lapels, held together by an S-shaped fastener. His *calo* stands in the background wearing a helmet. Reiss-Engelhorn Museen, Mannheim (photograph M.A. Wijnhoven).

→ Fig. 4.22. Funerary relief of Gaius Romanius Capito, c. AD 60-70, with triumphant rider motif rendered in great detail, including even the decoration of his helmet's cheek guards. He wears full battle gear with the same equipment as Togitio (fig. 4.21). The shoulder guards of his mail coat are also turned over and attached with an S-shaped fastener. The split at the hem for unrestricted movement is clearly observed. Cast from the Kelten Römer Museum, Manching (photograph M.A. Wijnhoven).

← Fig. 4.23. Tombstone of cavalryman Andes from the Ala Claudia, AD 70-75. He is shown on horseback trampling over a long-haired enemy who is raising a sword. Andes wears full armour and all the kit common to the triumphant rider theme. Some details have worn away, but the split at the hem can still be recognised. The faint outlines of his shoulder extensions can also be observed. Landesmuseum Mainz (photograph M.A. Wijnhoven).

→ Fig. 4.24. Damaged funerary stele from Worms (1). It clearly depicts a triumphant rider but is missing the name of the owner. Stylistically it has been dated to AD 40-60. Like on the other examples, the deceased is dressed in full battle gear including a mail coat. The cape-like shoulder extensions are turned over on their inner side. The fastener cannot be made out due to damage, nor the split at the bottom hem because its usual location is occupied by his sword. Museum der Stadt, Worms (photograph M.A. Wijnhoven).

← Fig. 4.25. Second funerary stele from Worms (2) belonging to an anonymous cavalryman. Less damaged, this tombstone preserves the image of the *calo* behind the rider. It closely resembles the previous example and has been given a similar date of AD 40-60. The shoulder guards on this one are exceptionally large, reminiscent of a cape. The finely executed S-shaped fastener holds together the turned over edges of the guards. A split at the bottom hem peeks out from under his scabbard which hangs at the hip. Museum der Stadt, Worms (photograph M.A. Wijnhoven).

→ Fig. 4.26. Tombstone of an anonymous triumphant rider from Cologne, probably second half of the 1st century AD. Like the others, this rider is fully equipped and shown in action, ready to stab his trampled opponent with his spear. The mail coat also has large shoulder guards that are turned over to form a sort of lapel, but their shape is much more rectangular and covers only a small part of the upper arms. Römisch-Germanisches Museum, Cologne (photograph M.A. Wijnhoven).

Fig. 4.27. Funerary stele of Genialis, *imaginifer* of the 7th cohort of the Raetians, second half of the 1st century AD. Like the triumphant rider tombstones from Germany, the stele shows Genialis in full battle dress. His helmet, covered in an animal skin, hangs over his shoulder. His coat of mail has exceptionally large shoulder guards that resemble a cape, covering the entire upper body. The inner edges of the guards are folded over and held together by an S-shaped fastener. The hem of his armour has a split for easy movement. Landesmuseum Mainz (photograph M.A. Wijnhoven).

Fig. 4.28. Tombstone of *signifer* Gaius Valerius Secundus of the Legio XIV Gemina Martia Vixtrix, second half of the 1st century AD. It is similar to Genialis's stele, and nearly identical to that of Quintus Luccius Faustus. The coat of mail has not only splits at the bottom hem, but also on the shoulder extensions. This feature may have made movement of the arms easier), while still offering good protection. Underneath the mail coat, our *signifer* wears a garment with rows of *pteruges* that cover his arms and upper legs. Landesmuseum Mainz (photograph M.A. Wijnhoven).

tombstone of an anonymous cavalryman from Worms (2) (fig. 4.25). Other cases, like the tombstones of the anonymous cavalryman from Cologne (fig. 4.26), leave most of the upper arms unprotected. Some tombstones have the fasteners carved in stone, resembling the S-shaped fasteners well-known in the archaeological record. These are normally connected to the outside of the lapel-like shoulder guard, but are frequently depicted on the inside as well.

In the 1st century AD, infantrymen are rarely depicted wearing mail armour with large shoulder extensions anymore. The only three exceptions are not regular infantrymen, but all concern standard bearers. The most realistic of these is the tombstone of *imaginifer* Genialis (Mainz, Germany; fig. 4.27).[48] His armour follows the design described above, containing large guards with lapels held together by a

[48] Bull 2007, 42; Junkelmann 1996, fig. 31; Schleiermacher 1984, 187-188.

Fig. 4.29. Funerary stele of Dolanus, c. AD 35-50. It is one of the earliest depictions of the triumphant rider in Rhineland, Germany. The relief shows him wearing a mail coat with fairly slim shoulder extensions held together by a fastener, and short sleeves. The state of preservation makes it difficult to determine whether the sleeves belong to the mail coat or a separate garment worn beneath, for example a tunic. Cast from Heidenmauer, Wiesbaden (photograph M.A. Wijnhoven).

Fig. 4.30. Tombstone of Sextus Valerius Genialis, second half of the 1st century AD. It is the only example of a triumphant rider wearing a mail coat with shoulder guards from the United Kingdom. The guards have large cut-outs and on the chest the coat has what seems a Medusa's head, instead of a central fastener. A similar feature is seen on the Arch of Orange, where the Medusa's head is combined with an S-shaped fastener (fig. 4.18). Corinium Museum, Cirencester (photograph M.C. Bishop).

finely carved S-shaped fastener attached to the outside of the guards. On his chest he sports his helmet, seen from the underside, covered in an animal skin. The other two representations are the tombstones of Quintus Luccius Faustus and Gaius Valerius Secundus (fig. 4.28) from Mainz, Germany.[49] Both men were *signiferi* in the XIV Legion and their tombstones are almost identical. They are depicted standing upright, holding a small shield in one hand and a standard in the other. A helmet, possibly covered with animal skin, is displayed in the background. The large shoulder guards of the mail armour cover part of the upper arms and are turned over at the chest. The rest of the upper arms are covered almost up to the elbow by three rows of *pteruges* that protrude from beneath the mail guards. Both have an additional split on each shoulder guard, a unique feature not seen anywhere else. This would have facilitated the movement of the arms, especially upwards, which is particularly useful for a standard bearer.

The apparent exclusivity of mail armour with large guards among ordinary cavalrymen as well as standard bearers is hard to explain. Probably it is a false impression created by the overrepresentation of these two types of Roman soldiers in tombstones featuring armour. However, there is one practical argument that indicates that this might also reflect actual practice. Both cavalrymen and standard bearers used smaller shields than the large legionary shield. Moreover, since both hands were already occupied, they

[49] Boppert 1992, 100-103, pl. 8-9; Junkelmann 1996, fig. 29; Selzer 1988, 131-132.

Fig. 4.31. Funerary stele of Gaius Valerius Crispus, legionary of the Legio VIII Augusta, second half of the 1st century AD. This tombstone served as inspiration for the 19th-century reconstruction of a Roman soldier in figure 4.2. The deceased wears a mail coat with narrow shoulder guards, his upper arms and legs are protected by an undergarment that ends in rows of *pteruges*. He also wears a wide military belt that includes an apron decorated with metal studs. Copy from Heidenmauer, Wiesbaden (photograph M.A. Wijnhoven).

Fig. 4.32. Tombstone of the *centurio* Marcus Favonius Facilis, mid-1st century AD. He wears a mail coat with slim shoulder extensions that have tubing along their edges. The armour is fairly wide at the shoulders and droops over the upper arms creating the impression of short sleeves. Atypically, the hem of his mail has a curve that follows the abdomen. Colchester Museum (drawing from Price 1880).

relied less on the active use of the shield to ward off opponents. The reduced protection offered by the shield could have been compensated by wearing armour that protected larger portions of the body. This argument is by no means watertight, since the iconography also shows standard bearers and cavalrymen in armour that does not cover the upper arms.

The mail coat with slim shoulder guards is still present during this period as well, and depictions of it prevail until the end of the 1st century. Examples of cavalrymen wearing this model of mail armour are found on the tombstones of Dolanus (Wiesbaden), Sextus Valerius Genialis (Cirencester),[50] Niger

[50] Interestingly, this is the only of many triumphant rider tombstones from the United Kingdom that displays shoulder guards. This could point to them already becoming less common for the cavalry by the time of the Roman conquest of Britain. Cf. Bull 2007 for an overview of Roman cavalry tombstones found in the United Kingdom.

Fig. 4.33. Tombstone of Titus Flavius Bassus, soldier of the Ala Noricorum, c. AD 80-95. He is portrayed as a triumphant rider in full battle dress, which usually includes a coat of mail, and in this case has no shoulder guards or sleeves. Römisch-Germanisches Museum, Cologne (photograph M.A. Wijnhoven).

Fig. 4.34. Tombstone of Quintus Carminius Ingenuus, *signifer* of the Ala Hispanorum, mid-1st century AD. He is shown as triumphant rider in battle dress. His outer garment is probably a coat of mail, indicated by the large splits at the hem of his garment. The coat does not have shoulder guards and seems to be sleeveless, worn with a short-sleeved textile garment underneath. Museum der Stadt, Worms (photograph M.A. Wijnhoven).

Fig. 4.35. Funerary stele of Leubius, son of Claupus, veteran of the Ala Sebosiana, aged 81, mid-1st century AD. He appears to wear a mail coat without shoulder extensions that is either sleeveless or has very short sleeves. Museum der Stadt, Worms (photograph M.A. Wijnhoven).

Fig. 4.36. Tombstone of Vellaunus, son of Nonnius and *signifer* of the Ala Longiniana, mid-1st century AD. He is portrayed on horseback with a standard in his hand. His coat of mail has short sleeves covering half of his upper arms and has splits at the hem. A long sword hangs from a belt, which may have helped to distribute the weight of the body armour. Copy from Johanneskreuz, Bonn (photograph Wikimedia Commons).

Fig. 4.37. Tombstone of Gaius Castricius Victor of the Legio II Adiutrix, second half 1st century AD. He holds two throwing spears in one hand and a shield in the other. He wears a helmet, what appears to be a short-sleeved mail coat, and a baldric with a sword. Aquincum Museum, Budapest (photograph M.C. Bishop).

→ Fig. 4.38. Tombstone of Flavinus, standard bearer of the Ala Petriana, second half 1st century AD. He has a helmet with three large feathers and holds a standard in his hand. He seems to wear a coat of mail with fairly long sleeves that come down to the elbows and a scarf around the neck tucked underneath the armour to prevent chafing. A sword hangs from his waist. Hexham Abbey (photograph M.A. Wijnhoven).

← Fig. 4.39. Funerary stele of an anonymous infantryman found between Bonn and Bad Godesberg, AD 50-70. The mail coat has short sleeves with splits on their underside, which may be a transitional type from false sleeves that droop over the shoulder to true sleeves. The bottom hem also has two splits to facilitate movement. Landesmuseum Bonn (photograph M.C. Bishop).

(Bonn), and an anonymous rider from Koblenz (fig. 4.29-30).[51] They are also found on funerary monuments from Arlon (Luxemburg) and Liège (Belgium), which originally depicted entire battle scenes with multiple cavalrymen in the style of the triumphant rider.[52] The narrow shoulder guards are regularly shown with cut-out corners, just as observed previously on the Arch of Orange (fig. 4.18). Mail armour with narrow shoulder extensions can also be found on the funerary stelae of infantrymen, such as Gaius Valerius Crispus (Wiesbaden), of standard-bearer Tiberius Iulius Pancuius (Neuss), and of *centurio* Marcus Favonius Facilis (Colchester) (fig. 4.31-32).[53]

During the same period, there are also representations of sleeveless mail coats with no shoulder guards at all. Although they could have been painted on, it is unlikely. The emergence of the sleeveless coat without guards coincides with an overall change in mail armour design towards the end of the 1st century AD, when the traditional model is abandoned and others gain popularity. This process is evident not only in iconography but also in the fact that fasteners, an essential element of the shoulder guards, disappear from the archaeological record.

Representations of the sleeveless mail coat without shoulder guards come from funerary stelae, but because the mail texture is not carved in the stone, it is not always entirely clear whether mail is being portrayed. A way to identify it is by a split on their lower hem, as in the tombstones of the cavalrymen Titus Flavius Bassus (Cologne), Quintus Carminius Ingenuus (Worms), Leubius (Worms) and Insus (Lancaster) (fig. 4.33-35).[54] These splits are not unique to mail and are also seen on textile tunics. However the presence of a mail coat fits the iconographic theme of the above tombstones, which show the deceased as triumphant riderswearing full battle gear including helmets, shields and swords. A mail shirt would have been part of this panoply.

In the second half of the 1st century AD we see the first representations of a short sleeved mail coat without shoulder guards. They are observed on the tombstones of cavalry *signifer* Vellaunus (Bonn), infantryman Gaius Castricius Victor (Budapest) and the cavalry *signifer* Flavinus (Hexham), an anonymous rider from Ribchester, and an anonymous infantryman from Bonn (fig. 4.36-38).[55] Often, these shirts also contain splits at the sides of the hem, a feature that strengthens their identification as mail. Two representations, from the column base in Mainz and that the anonymous infantryman from Bonn (fig. 4.20 & 39), have not only splits at the hem, but also on the sleeves. The function of these splits is unclear. The grave stele of Dolanus (Wiesbaden) is also very interesting since it may represent a mixed design (fig. 4.29).[56] It has short sleeves, but at the same time still contains a set of shoulder guards.

Tombstones with the banquet theme may provide further possible evidence for the short sleeved mail coat. A specific group of these contain two scenes: one of the deceased at a banquet and another of his servant reining a horse. The servant is frequently depicted wearing a helmet and a sleeved garment which, given the presence of a helmet, may well be a mail coat. Examples of these are found on the funerary stelae of Marcus Sacrius Primigenius, Lucius Romanus, Longinus Biarta (all from Cologne), Marcus Aemilius Durises (Bonn), and Silius (Mainz) (fig. 4.40-43). The last of these still retained some paint when it was found in 1834. In a watercolour copy made by Johann Lindenschmit, the garment is coloured green, which seems less befitting a coat of mail than grey.[57]

[51] Bauchhenß 1978, 35-36, pl. 19; Bull 2007, 42; Gabelmann 1973, 167, fig. 29; Junkelmann 1996, fig. 31; Mattern 1999, 69-70, pl. 6; Robinson 1975, 169, pl. 300, 304; Schleiermacher 1984, 71-72, 131-132, 187-188; Walter 2003, pl. 12.

[52] Gabelmann 1973, 148, 151-153, fig. 15, 18.

[53] Mattern 1999: 66-68, pl. 4; Robinson 1975, 169, pl. 467, 469; Sumner 2009, pl. 12; 2010.

[54] Boppert 1998, 83-86, 88-90, pl. 52, 56; Gabelmann 1973, 172, fig. 30; Schleiermacher 1984, 90-92, 136-139; Sumner 2003, 12; 2009, fig. 80.

[55] Anderson 1984, 32; Bull 2007, 31; Bauchhenß 1978, 28-29, 32-33, pl. 12, 15; Robinson 1975, 169, pl. 470.

[56] Mattern 1999, 69-70, pl. 6; Schleiermacher 1984, 131-132.

[57] Riemer 2017, 23. It is possible that the original colour shifted to green. The servant on the triumphant rider tombstone of Togitio also wears a helmet and could be wearing mail (fig. 4.21).

↑ Fig. 4.40. Two-panel tombstone of Marcus Aemilius Durises, cavalryman of the Ala Sulpicia, who died at the age of 36 after 16 years of military service, c. AD 80. The top (not included here) depicts the deceased at his funerary banquet. The bottom panel shows a servant reining a horse with one hand and carrying a spear in the other. A shield is fastened to the horse. The servant wears a helmet and an indeterminate garment with a clear straight slit for the neck opening, which is a feature of textile garments, but also of mail coats with sleeves (see chapter 10.3). The military theme favours a mail coat. Landesmuseum Bonn (photograph M.A. Wijnhoven).

↑ Fig. 4.41. Funerary stele of Longinus Biarta, AD 80-90. It depicts a servant wearing a helmet and possibly a sleeved coat of mail. Römisch-Germanisches Museum, Cologne (photograph M.A. Wijnhoven).

← Fig. 4.42. Tombstone of Lucius Romanus of the Illyrian Dardani tribe, who died at the age of 30 while serving in the Ala Afrorum, AD 80-90. Only the lower half has been preserved, which shows a servant reining a horse. The servant wears a helmet and carries two spears. It is not clear whether he is wearing a coat of mail with short sleeves, but it would fit the martial theme of the relief. Moreover, he has a neck scarf which was usually used to prevent chafing when wearing mail. Römisch-Germanisches Museum, Cologne (photograph M.A. Wijnhoven).

→ Fig. 4.43. Tombstone of cavalryman Silius of the Ala Picentiana, second half 1st century AD. He is depicted at a banquet (not included), while his servant guides a horse. The servant wears a helmet with cheek pieces and carries a spear in his hand. In contrast to the other tombstones, his garment is wider and has fringes. When it was excavated, this tombstone still had some original paint, and the garment had a green colour. Landesmuseum Mainz (photograph M.A. Wijnhoven).

Fig. 4.44. Tombstone of *centurio* Marcus Caelius of the Legio XVIII, who died in Varus's disaster in AD 9. He is shown wearing his military awards, including various *phalerae* and two torques on leather straps over his armour. His head is adorned with a *corona civica* and in his hand he has a *vitis*, or centurion staff. His armour may be a mail coat wide enough to droop over the shoulders and cover part of the upper arms. Rarely seen, the curved shape of the bottom hem resembles the outline of the Hellenistic muscle cuirass of earlier times. Landesmuseum Bonn (photograph M.A. Wijnhoven).

Fig. 4.45. Funerary stele of standard bearer Gnaeus Musius of the Legio XIV Gemina, first half of the 1st century AD. It is somewhat similar to the previous (fig. 4.44). The deceased is also seen decorated with several military awards on top of his armour. A row of *pteruges* from an undergarment peek out beneath the armour, which droops over the shoulders, a feature that mail, but not many other types of armour can accomplish. The hem of his coat is obscured by the belt, but is likely straight. Landesmuseum Mainz (photograph C. Raddato).

Several funerary stelae depict a type of body armour that droops over the shoulder onto the upper arm. The tombstone of *centurio* Marcus Caelius at Bonn (fig. 4.44) is a good example. H. Russel Robinson used that type of shirt to argue against the interpretation of leather armour.[58] He reasoned that protective leather would have needed to be so thick that the wearer would not have been able to move the arms, rendering the armour useless. Only mail can have this shape and allow the wearer to move freely. Similar coats appear on the stelae of *aquilifer* Gnaeus Musius (Mainz), standard-bearer Tiberius Iulius Pancuius (Neuss), and *centurio* M. Favonius Facilis (Colchester) (fig. 4.32 & 5.45).[59] The latter two have shoulder guards, while the former two do not. The most plausible interpretation of these drooping shoulders is as

[58] Robinson 1975, 169.

[59] Bauchhenß 1978, 18-22, pl. 1-4; Boppert 1992, 87-90, pl. 1; Junkelmann 1986, fig. 24; Robinson 1975, 169, pl. 468.

↑ Fig. 4.46. Left: tombstone of *signifer* Pintaius, 1st century AD. Middle: traditional interpretation showing a tunic (red), a mail coat indicated by the crescent lines (grey), and an over-garment (green). Right: suggested interpretation showing a tunic (red), a padded garment with fringes (green) and a mail coat (grey). Landesmuseum Bonn (photograph M.A. Wijnhoven).

→ Fig. 4.47. Left: tombstone of an anonymous soldier from Andernach, 1st century AD.

↑ Right: suggested interpretation of the different layers of equipment, including a tunic (green), a padded garment with fringes (brown), a sleeveless mail coat (grey) and a cloak (red). Landesmuseum Bonn (photograph M.C. Bishop, reworked by M.A. Wijnhoven).

← Fig. 4.48. Left: funerary stele of Firmus, 1st century AD. Right: suggested interpretation with a tunic (green), a padded garment with fringes (brown), a mail coat (grey), and a hooded cloak thrown over the shoulders (red). Landesmuseum Bonn (photograph M.A. Wijnhoven).

Fig. 4.49. Fragment of a funerary monument from Arlon, 1st century AD. It depicts a battle scene with several cavalrymen wearing indeterminate armour. The arrangement at the shoulders could be regular mail armour shoulder guards badly executed. The fabric on the men's torso also resembles mail. A combination of a mail shirt with the shoulder plates of segmented armour has also been suggested. Cast from Jubelparkmuseum, Brussel (photograph M.A. Wijnhoven).

Fig. 4.50. Right: tombstone of cavalryman Rufus of the Ala Hispanorum, c. AD 15-40. Left: museum interpretation. Rufus's armour is difficult to understand. He has a possible fastener on the upper chest, which befits mail armour. The vertical line running over his chest from neck to hem suggests a garment constructed like a modern coat. It is likely, although not certain, that he is wearing mail. Reiss-Engelhorn Museen, Mannheim (photograph M.A. Wijnhoven).

Fig. 4.51. Damaged tombstone of an anonymous cavalryman, late 1st century AD. The horseman wears an unidentified garment, which may be a mail coat. The three circular objects on his chest resemble the buttons and fasteners of a mail coat with shoulder guards, but the guards are missing. A vertical line runs from neck to hem. Musée Archéologique, Strasbourg (photograph M.A. Wijnhoven).

'false sleeves' created by the excess material of the rectangular mail coat. They are therefore the same as the 'regular designs' discussed before.

The armour of *centurio* Marcus Caelius and *centurio* M. Favonius Facilis have hems unlike others. Instead of being straight, they curve graciously and protect the lower abdomen while leaving the hips completely uncovered. This shape is reminiscent of the Hellenistic muscled plate cuirass. It is unclear how we should interpret these hemlines.[60] Mail can be made into almost any shape, so a curved outline is feasible. However, it could be also a case of historicism, in which ancient traits were applied to depictions of contemporary armour. In fact, the armour of Marcus Caelius appears to contain a belly button, typical of the muscled plate cuirass, but the indentation may also be damage.

Several grave stelae display sculpted crescent lines that peek out underneath an outer garment. The tombstones of *signifer* Pintaius (Bonn), infantryman Firmus (Bonn), an anonymous soldier (Andernach), and *aquilifer* Gnaeus Musius (Mainz) all display this feature (fig. 4.46-48).[61] At times, these crescent lines have been interpreted as a convention to replicate the texture of mail,[62] but this is probably incorrect. The tombstone of Gnaius Musius demonstrates that the lines are the fringes of *pteruges*, which were part of an undergarment. The coat of mail is actually the outer garment. The layers of clothing on these characters thus consist of a tunic, a padded undergarment with fringes, and a mail coat on top. When interpreted in this manner, the grave stelae provide further evidence for the new mail armour design in the 1st century AD, without shoulder guards and with (false) short sleeves.

Some other depictions of armour are very ambiguous. For example, a funeral monument from Arlon in Luxembourg shows a battle scene with several riders (fig. 4.49). They wear armour with an unusual arrangement on the shoulders. It has been suggested that this might be a hybrid form of armour combining a mail body with segmented shoulder plate pieces borrowed from a *lorica segmentata*.[63] This is a very literal interpretation of the iconography. Most likely the monument simply portrays regular mail armour with shoulder guards, which the sculptor failed to represent realistically.

The tombstones of Rufus, Argiotalus (Worms), Cantaber (Mainz) and an anonymous cavalryman (Strasbourg) are other examples of ambiguous armour depictions (fig. 4.50-51). In all cases, the armour has a central line running from the neck, over the chest, and down to the hem, which has been interpreted as an indication of segmented armour.[64] However, *lorica segmentata* is not associated with cavalry, given its unsuitability for use on horseback. Moreover, the monuments show a pectoral ornament unheard of in segmented armour. A more likely although uncertain interpretation is that they represent mail armour. The line could refer to the shape of a modern coat. Mail coats of similar construction are known from early-modern times.

The period under discussion proves to be very dynamic. We can conclude that the iconographic record shows the presence of three different mail coat designs. First, the mail armour with shoulder guards, which can be either wide and cape-like, or slim. This model is dominant during the reign of Augustus and large part of the 1st century, but starts to wane from the second half of the 1st century. It is steadily replaced by two types without guards; one sleeveless and one with short sleeves. This may explain why relatively few funerary stelae from the United Kingdom display shoulder guards.[65] British tombstones postdate the conquest of AD 43, a time when the guards begin to disappear. Regardless of the design, all mail coats are shown to reach down over the hips and can be worn with a belt to relieve some of the weight. The use of splits to allow movement is also observed in all variants. The artistic record

[60] It has also been suggested that the tombstone of M. Favonius Facilis represents linen armour; cf. Sumner 2010.

[61] Bauchhenß 1978, 26-27, pl. 10; Hoss 2011, fig. 4.1-2; Robinson 1975, 169, pl. 243-244.

[62] E.g. Boppert 1992, 89; Robinson 1975, 169.

[63] Bishop 2002, 72-73, fig. 8.6-8.8.

[64] Schleiermacher 1984, 23-24.

[65] Alternatively it can be the result of local workshops or craftsmen working in a different stylistic tradition than their counterparts from the continent.

also includes depictions which are more difficult to interpret. A closer look nevertheless demonstrates that many (but not all) fit into one of the three mentioned designs.

It is remarkable that the funerary stelae mainly depict three types of soldier from the Roman army wearing mail. The great majority of the depictions involves cavalrymen, usually belonging to the *auxilia* of the army. This may have a practical reason, as mail is indeed better suited for use on horseback than for example segmented armour, but it is more than that. It was these cavalrymen who mostly invested in tombstones where they chose to be depicted wearing full armour in battle. These cavalrymen identified as battle-hardened soldiers who, with great prowess, eliminated their opponents. The tombstones can be understood as a direct reflection of their self image, strongly embedded in martial culture. The second type of soldier frequently depicted wearing mail armour are standard bearers. A very flexible, but protective armour as mail also befits their task in the army. This is probably not the main reason, and just as the cavalrymen the standard bearers are overrepresented in funerary stelae including armour. They too frequently choose to be represented wearing full battle gear, albeit not in action. The third type of soldier are centurions, which sometimes wear mail on their tombstones, although less frequent than the former two. Interestingly, the tombstones of regular legionary soldiers rarely show them wearing any type of armour, be it mail, scale or segmented armour. They chose to be depicted differently.

Despite the bias in the representational record towards certain types of soldiers being depicted wearing armour, the general impression is that the use of armour was the norm for most soldiers of the Roman army. This applies to the legionaries that make up the heavy infantry, the cavalry, and the standard bearers. The exception is probably the light infantry and light artillery that are part of the *auxilia*. Within the Roman army of the Early Principate mail armour is clearly no longer an exclusive item, as it was in Iron Age society, but common stock.

4.4 THE 2ND CENTURY AD

During the 2nd century, the iconographic evidence for mail stays abundant even though its context changes, with state monuments replacing funerary stelae as the main source of information. To legitimise and reinforce their position, the emperors from this period made ample use of war imagery in commemorative state monuments celebrating the military achievements of Rome and her imperial power.[66]

The monuments erected under Trajan, with their visual narrative of war, such as his column and the Great Trajanic Frieze, became highly influential in Rome throughout the entire 2nd century AD. Their impact is observed, for example, on the base of the Column of Antoninus Pius, the Column of Marcus Aurelius and the Arch of Septimius Severus. For this reason, scholars like H. Russell Robinson have questioned whether 2nd century state monuments offer a reliable picture of military equipment, or whether they should be considered as replicas of Trajan's works that throughout the century become increasingly inaccurate.[67]

The monumental architecture that worked in the Trajanic tradition made use of iconographic convention for the sake of narrative. This means that legionaries were consistently depicted in segmented armour, while the auxiliaries were portrayed in mail and scale. This convention makes it easy for a spectator to recognise the different army troops in the narrative. For the convention to work it must contain some truth. And indeed, segmented armour is suited for heavy infantry, to which most legionaries belonged. It is not well-adapted for use on horseback. Cavalrymen rather use mail or scale armour, and large part of the auxiliaries were cavalrymen. Archaeology has demonstrated that reality was more complex. Legionary forts have rendered finds of mail and scale armour, and auxiliary forts of *lorica segmentata*.

[66] For information on the role of war imagery within Roman society: Dillon/Welch 2009.

[67] Robinson 1975, 170-171.

Fig. 4.52. On Trajan's Column, the texture of mail was replicated by close-set zigzag patterns, which can still be observed in some places. This particular cast shows one of the better preserved examples. Museum für Antike Schiffahrt, Mainz (photograph M.A. Wijnhoven).

It is important to remember that mail and scale are certainly also suitable for heavy infantry and have been used by legionaries over a long period of time. Moreover, the *auxilia* consisted not only of cavalry, but also of infantry, just as the legion included cavalrymen besides infantry.

In the Trajanic tradition, the mail coat is represented as a short-sleeved garment, a model that emerged in the previous century, but with some stylistic innovations. The garment is now tight-fitting and fairly short, extending just above the hips. Its most salient features are dagged hems and sleeves which, though protective, were probably mainly decorative. So far, there are no conclusive archaeological examples of Roman mail with vandyked hems (chapter 6.10), but there are many well-known examples among late-medieval and early-modern coats of mail.[68]

One of the earliest depictions of this new style of mail coat is found on Trajan's Column (fig. 4.52-57).[69] Completed in AD 113, this monument celebrates the victories of two military campaigns against the Dacians. Its iconography breaks with earlier artistic traditions, featuring for the first time a linear narrative with explicit violence and repetitive images of battle scenes on a continuous frieze. The soldiers are often depicted in full armour, with the legionaries wearing segmented body armour and the auxiliaries and standard bearers wearing mail or scale. At a first glance, the mail cuirasses seem to have a smooth surface, but close examination reveals that the mail texture was created by chiselling close-set zigzag patterns in the stone (fig. 4.52). Unfortunately, most of these details have eroded over time. In contrast, the base of the column contains two mail coats of similar design but with finely carved interconnecting rings (fig. 4.57). In fact, all mail on Trajan's column is depicted without much variation. The

[68] E.g. the mail shirt from Sinigaglia; Burgess 1957.

[69] Coulston 1988; 1989; Pogorzelski 2014; Richter 2010.

Fig. 4.53. This plaster cast of Trajan's Column shows two auxiliary soldiers in the foreground wearing mail. The design of the mail coat is similar throughout the monument and consists of a relatively tight-fitting garment with short sleeves. The coat is not very long, ending above the hips. One of the most salient characteristics is the vandyked hems. Rijksmuseum van Oudheden, Leiden (photograph M.A. Wijnhoven).

Fig. 4.54. The Syrian archers on Trajan's Column wear a mail coat of the same design as all the others, except longer, extending down to the upper legs. Also, their helmets are very conical, distinguishing them from the auxiliaries, and they wear a baldric for their swords in addition to their bows, quiver and arrows. Rijksmuseum van Oudheden, Leiden (photograph M.A. Wijnhoven).

Fig. 4.55. All the coats of mail depicted on Trajan's Column have vandyked hems and sleeves, but there are subtle differences among them. Some have a circle placed inside each dag, shown on this picture. It is uncertain what these are meant to represent and there are no archaeological finds to match them. The soldier on this scene is being treated for a leg wound. Interestingly his tunic, protruding under the armour, also has dags or fringes. Plaster cast, Rijksmuseum van Oudheden, Leiden (photograph M.A. Wijnhoven).

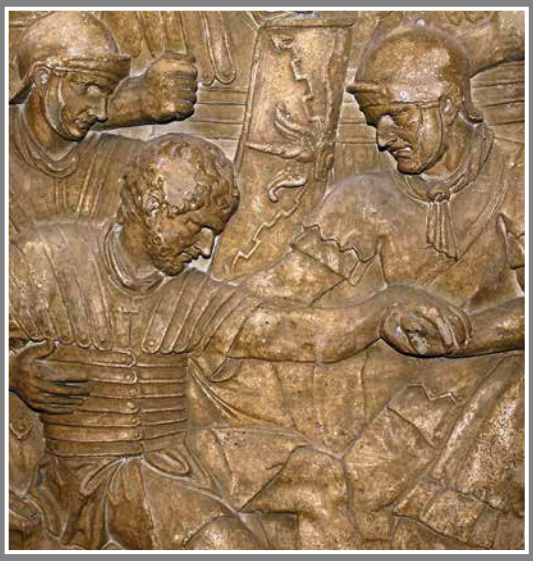


Fig. 4.56. Detail of Trajan's Column. Some coats of mail have a line running closely along the edges of the dags. One can be seen on the sleeves and bottom hem of the mail coat of the auxiliary soldier tending to the injured legionary. These lines are puzzling but they might represent the edge of a lining or a decorative trim. Plaster cast, Rijksmuseum van Oudheden, Leiden (photograph M.A. Wijnhoven).

most distinctive model is that worn by the Syrian archers, which is the same but longer, extending to mid-thigh length (fig. 4.54).

The vandyked hems are present throughout the column but represented in different manners. For example, in some coats all the dags contain a circle (fig. 4.55-56) of uncertain function, which may be purely ornamental. Other coats have a horizontal line separating the main body of the cuirass from the dags themselves. It has been suggested that in these cases the sculptors perhaps intended to depict a mail shirt with a straight hem worn on top of a dagged undergarment.[70] Textile garments with dags or fringes are certainly known from the iconography of this century,[71] and are also seen on Trajan's Column worn underneath the mail armour, resulting in a 'double scalloped' line (fig. 4.55). Still other coats of mail have a line that runs closely parallel to the edge of the dags (fig. 4.56). This could be a decorative trim of copper alloy rings contrasting with the iron mail coat. Unfortunately, not enough paint survives on Trajan's Column to know if these were indeed painted in a different colour, but there is ample archaeological evidence for copper alloy trimmings in mail during the 2nd century (chapter 6.5). Alternatively, the parallel lines could represent some form of edging, lining, or integrated padding.

These subtle variations are difficult to interpret. However, if the armour shown on the Great Trajanic Frieze is any indication, these could all be different representations of regular vandyked mail hems (fig. 4.58). This frieze, dated around AD 111-114, consists now of only four panels that were re-used in the Arch of Constantine.[72] It features various cavalry and infantrymen wearing the same type of mail coat. The interconnected rings have been carefully reproduced throughout the entire coat, including the vandyked hems.

The mail coat of 'Trajanic design' is present during the whole of the 2nd century. The surviving base of the Column of Antoninus Pius is an example (fig. 4.59). It dates from AD 161 and includes two scenes of a *decursio* showing infantry and cavalry. Some of the cavalrymen wear dagged garments with apparently a smooth surface resembling fabric, which makes it dubious to say whether mail is being depicted.[73] The Column of Marcus Aurelius, finished shortly before AD 192 by his son Commodus (fig. 4.60), is better-defined.[74] It portrays numerous soldiers wearing Trajanic mail armour, indicated by small circular holes. In most cases, the holes also appear inside the vandyked hems, which occasionally are left smooth. The Arch of Septimius Severus, dedicated in AD 203, is the last of the state monuments in the Trajanic visual tradition.[75] It features several Roman soldiers dressed in mail coats with vandyked hems (fig. 4.61).

The mail coat of Trajanic design is also featured on the richly decorated Portonaccio sarcophagus, found in Rome (fig. 4.62).[76] It was made for a Roman general who participated in the campaigns of Marcus Aurelius between AD 180-200. The front depicts a battle between Germanic tribes and Romans soldiers wearing different types of armour (segmented, scale and mail). The surface of the mail coats has been left smooth.

There are few representations of Trajanic mail outside of the Roman capital. The British Museum holds the statuette of a soldier which, based on the attire, has been attributed to the middle of the 2nd century (fig. 4.63).[77] The character wears a pair of trousers, known as *bracae*, and has a vandyked tunic beneath his mail coat. A relief from the Temple of the Gaddé at Dura-Europos (AD 159) (fig. 4.64)[78] pictures the god Gad flanked on one side by King Seleucus I Nicator portrayed as a soldier wearing a tight-fitting vandyked garment, probably a mail coat. Unlike the other coats, this one is sleeveless and a

70 Coulston 1988, 227.

71 Pausch 2003, 79-81.

72 Elsner 2000.

73 Vogel (1973, 57) interprets these as leather armour with fringed sleeves and hems. The use of leather body armour is however very unlikely; cf. Fischer 2012, 163-164.

74 Burandt 2017; Ferris 2008; Taylor 2013a.

75 Brilliant 1967.

76 Kebric 2015.

77 Robinson 1975, 170, pl. 474.

78 Downey 2006, fig. 12.

Fig. 4.57. The coats of mail at the base of Trajan's Column have more detail than the rest, with the rings individually carved. The overall design is however the same for all the mail coats portrayed on the monument. Plaster cast, Victoria and Albert Museum, London (photograph M.A. Wijnhoven).

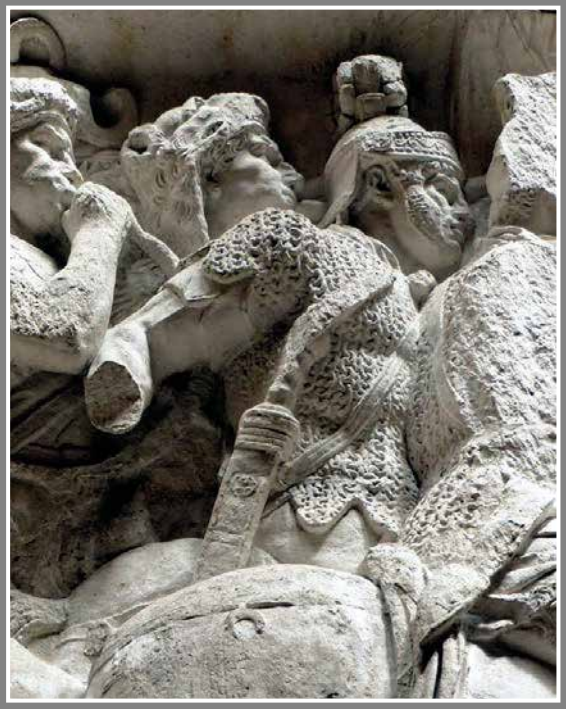


Fig. 4.58. Great Trajanic Frieze, c. AD 111-11, re-used in the Arch of Constantine. The cavalrymen seen here wear the same mail armour design as on Trajan's Column. The dags are evidently part of the mail coat, a detail which is not always clear on the column. Plaster cast, Museo della Civilità Romana (photograph M.C. Bishop).

Fig. 4.59. Base of the Column of Antoninus Pius, AD 161. Several cavalrymen wear garments in the Trajanic tradition, but they seem to be made of textile instead of mail (photograph Wikimedia Commons, Sailko).

Fig. 4.60. Section of the Column of Marcus Aurelius in Rome, AD 192. In the manner of Trajan's Column, the depicted mail coats have vandyked hems, but here the texture of mail is indicated by small holes spread over the coats (photograph M.A. Wijnhoven).

Fig. 4.61. Close-up of the Arch of Septimius Severus in Rome, AD 203. This is the last of the state monuments to represent the coat of mail in the Trajanic fashion of a short close-fitting garment with vandyked hems. Several figures on the arch, including these two soldiers, display the texture of mail through hollowed circles (photograph M.A. Wijnhoven).

Fig. 4.62. Close up of a Roman soldier on the Portonaccio sarcophagus, late 2nd century AD. The soldier wears a mail coat of Trajanic style with short vandyked sleeves. The mail texture is not indicated and the stone surface is smooth. Museo Nazionale Romano, Rome (photograph M.A. Wijnhoven).

Fig. 4.63. Bronze statuette of a Roman soldier, probably mid-2nd century AD. One of the few examples of a Trajanic mail coat outside of Rome. The figure wears a dagged garment underneath his mail coat, which has the appearance of rings. British Museum, London (photograph M.A. Wijnhoven).

Fig. 4.64. Relief from the Temple of the Gaddé at Dura-Europos, AD 159. King Seleucus I Nicator, on the right, is wearing armour with a vandyked hem, which could be a mail coat. Unlike other representations of Trajanic mail, this one is sleeveless. Yale University Art Gallery, New Haven (photograph Yale University Art Gallery).

Fig. 4.65. Left: figure of a soldier from Mithraeum I at Stockstadt in Germany, 3rd century AD. Right: colour interpretation specifying the soldier's equipment. He holds a staffed weapon or military standard in one hand, and rests the other on his shield. He wears a cap on his head and a mantle on top of his mail coat of Trajanic style. Römerkastell Saalburg (photograph M.A. Wijnhoven).

row of *pteruges* from an undergarment protects the arms. Another double row of *pteruges* protrude from underneath the hem covering the upper legs. The latest depiction in the Trajanic tradition is possibly the stone sculpture of a soldier from the Mithraeum at Stockstadt, dated to the early 3rd century (fig. 4.65). This may be a transitional piece as it shows the soldier already wearing a cap, but still dressed in a vandyked mail coat of Trajanic style with unusually large dags.

The periphery of the Roman Empire provides a much more diverse view of the mail coat than is suggested by the 2nd century monuments from Rome. Moreover, the depiction of armour on the outskirts of the Empire is generally considered more realistic and less prone to historicism.[79] One reason may be that the artists there were in closer contact with soldiers or may have even been (former) members of the army themselves.

The Tropaeum Traiani in Adamklissi, Romania, is contemporaneous with Trajan's Column and commemorates the same victory over the Dacians, but it offers a different view of the Roman army and their equipment (fig. 4.66).[80] For instance, there are no depictions of *lorica segmentata*, instead all soldiers are clad in either mail or scale,[81] and some wear a segmented arm protection, or *manica*, which is never

[79] Bishop/Coulston 2006, 10; Coulston 1983, 24-25; Feugère 2002, 20-24; Waurick 1983, 291-298.

[80] Richmond 1967; Taylor 2011.

[81] The use of mail together with additional protection for the arms (*manicae*), legs (greaves) and the placement of reinforcing bars onto the helmet has often been understood as a Roman adaptation to the Dacian falx, a heavy curved sword (e.g. Richmond 1967, 34-35; Robinson 1975, 170). Since all these elements were already in use during the 1st century AD (D'Amato 2011, 18), this

Fig. 4.66. Tropaeum Traiani at Adamklissi in Romania, 2nd century AD. It is contemporary to Trajan's Column and narrates the same victory over the Dacians, but it portrays the soldiers of the Roman army in a different manner than the capital's monuments. Here, segmented armour is absent and all soldiers wear only mail or scale. The design of the coat of mail also varies, it is longer and protects the upper arms down to the elbows but does not have the typical vandyked hems of mail coats in Rome (photographs M. Thomas).

Fig. 4.67. Standard bearer wearing mail, wall paintings from Panticapaeum on the Crimean Peninsula, AD 90-150. These murals are an exceptional example of non-Roman mail depictions from the first centuries of our era. They show mail coats that resemble those of the Tropaeum Traiani, except for a large split at the front, and presumably the back, to aid horseback riding on account of the length (drawing M.A. Wijnhoven).

Fig. 4.68. Decoration of the Nawa helmet, 2nd century AD, representing a battle scene between Parthians and Romans. The mail coats appear sleeveless and one has shoulder guards. This is an archaic style, which makes it a likely case of historicism (drawing M.A. Wijnhoven, after D'Amato/Sumner 2009, fig. 129).

seen on Rome's state monuments. Infantry, cavalry, *signiferi* and *cornicines* are all portrayed in mail with no vandyked sleeves or hems, like in Rome, but with simple straight edges. Most soldiers, with the exception of the cavalrymen, have two or more rows of *pteruges* sticking out from under the hem of their armour. Some also have a row of *pteruges* covering the arms, as in the relief from Dura-Europos. The mail shirt depicted on the Tropaeum Traiani covers up more of the body than those seen on the state monuments of Rome. The sleeves, while short, protect the upper arms down to the elbows, the coats are substantially longer, reaching well over the hips, although no apparent splits are present, and none are shown with a belt, which had been a common feature in previous times.

A bronze statuette of a cavalryman from Saalburg, dating to the 2nd century,[82] bears a mail shirt similar to those on the Tropaeum Traiani; it has straight hems and is longer than those seen in Roman monuments from the same period.

There are very few representations of mail armour from this time beyond the Roman Empire. One exception is the wall paintings in the crypts of Panticapaeum (modern Kerch) in the Bosporan Kingdom (fig. 4.67).[83] Discovered in the 19th century, these paintings date between AD 90 and 150 and show cavalrymen with conical helmets wielding a very long spear with two hands. They are probably cataphract riders with *kontos* spears. Their armour is painted grey and the texture of mail is indicated by curvy black lines. The mail coats resemble those depicted on the Tropaeum Traiani, with similar straight hems and sleeves that almost reach the elbows, but they are much longer, extending down above the knees and they do have a large split to facilitate movement, which is essential for riding. The horsemen are painted in a naïve style that makes it hard to determine whether the splits are located on the sides or at the front and back. Several infantrymen are depicted wearing the same protective gear of a conical helmet and a

seems implausible. Moreover, this does not explain the observed differences in the representations of armour between the Tropaeum and Trajan's Column.

[82] Robinson 1975, fig. 122.

[83] Logdacheva *et al.* 2001; Minns 2013, fig. 224, 227, 230.

→ Fig. 4.69. Carved ivory box, 2nd century AD. Attributed to the reign of Trajan, this box depicts a mail coat with shoulders guards in great detail. It even recreates the puckering of the fabric caused by the belt. The texture of mail is replicated by lines filled in by cross-hatching. The shoulder guards have no cross-hatching, just like the representations of mail on the Altar of Domitius Ahenobarbus and the Arch of Orange (figs. 4.14 & 4.18). The cross-hatching might have been omitted due to lack of space, or to indicate a different material. Efes Müzesi, Turkey (photograph C. Raddato).

↓ Fig. 4.70. The base of Trajan's Column shows the spoils of the Dacian Wars. Among the booty of weaponry there are, for the first time in Roman art, helmets with aventails. The inside of the aventails has been left smooth, indicating that they were lined. Archaeological examples of mail aventails, albeit from later centuries, confirm that they could be lined. Interestingly, these helmets, thought to be Sarmatian, resemble those depicted at Panticapaeum. Plaster casts, Victoria and Albert Museum, London (photographs M.A. Wijnhoven).

mail shirt, but wield shorter spears and a shield instead of the *kontos*. There is also a mail-clad standard bearer carrying a *vexillum*. The mail coats of the infantrymen clearly have a split at the front and back.

It is interesting to note that the armour illustrated at Adamklissi, Saalburg, and Kerch corresponds with an actual example of surviving mail from that time, the coat of Vimose in Denmark (chapter 10.3).[84] This is a uniquely well-preserved specimen which is complete and flexible, and where the garment design can be fully appreciated. It dates from the 2nd or early 3rd century and is fairly long, covering most of the upper legs, has splits at the sides and short sleeves that reach down the elbows. This coat then attests to the realism of the depictions discussed above.

A helmet from Nawa in Syria bears a representation of mail that differs from the previous descriptions (fig. 4.68). Particularly during the 2nd and first half of the 3rd century AD armour and helmets used in the Roman army could be lavishly decorated, often featuring gods and symbols to endow protection and strength to the wearer.[85] The characters portrayed in these decorations sometimes wear armour, but

[84] Wijnhoven 2015b.

[85] These pieces of ornamented armour are known in German as *Paraderüstungen*. Cf. Garbsch 1978; Junkelmann 1996; Schamper 2015.

usually of an unrealistic, Hellenised style. This also applies to the Nawa helmet that is embossed with a battle scene between the Parthians and the Romans. The latter wear Attic helmets and sleeveless mail coats that protect the trunk, in the fashion of a muscled cuirass.[86] In fact, the only indication that the armour is not a muscled cuirass is the curved lines and circles that denote the mail texture.

The mail shirt with shoulder guards, popular in previous centuries, still appears occasionally in 2nd century art. Fragments of a decorated ivory box, now held in the Efes Müzesi in Turkey, show a figure dressed in mail with very narrow guards (fig. 4.69). The box's context is unknown but it probably dates from the reign of Trajan.[87] Also, a relief from the Villa Albani in Rome portrays a soldier seen from the back,[88] wearing the typical mail coat of Trajanic design. Oddly, the coat has very slim shoulder guards, each bearing a ring through which a thong affixes them to the main corselet. Such feature is usually seen on the front of the garment, not on the back. Moreover, the use of rings and thongs is an archaic manner of closing the guards. This suggests that the image depicts a contemporary coat of mail mixed with historical elements.

The iconography of the 2nd century also introduces a completely novel mail garment especially designed to protect the neck, called an aventail. It basically consists of a protective veil made of mail or scale which attaches to the rim of a helmet. The frieze at the base of Trajan's column shows the spoils of war of Dacian and Sarmatian weaponry, which include several conical helmets with aventails of both scale and mail (fig. 4.70). The inside of the helmets appear smooth perhaps indicating a lining. The presence of mail aventails on Trajan's column significantly predates the archaeological evidence. The earliest aventail find is the Sassanid helmet from Dura-Europos dated to the mid-3rd century, almost a century and a half later.[89] In fact, archaeological remains of mail aventails from the Roman period are scarce. Some exceptions are a helmet from Biberwier in Austria and a helmet fragment with an associated piece of mail from Trier.[90] It is only with the introduction of a particular type of helmet, called *Spangenhelm*, in the 5th century that archaeological finds of aventails become more frequent.[91]

The survey of the iconographic evidence from the 2nd century indicates that the mail coat underwent important changes at this time. The design with shoulder guards was abandoned altogether at the end of the Flavian period. Not only do its representations wane, but also since the start of the Trajanic period fasteners disappear from the archaeological record. The mail coat with short sleeves, an innovation from the previous century, now becomes the norm. Trajanic state monuments in Rome and others in its tradition display a particular variant of the half-sleeved mail coat which is fairly short and has vandyked sleeves and hems. It is unlikely that the vandyked variant was used by the Roman army to the extent suggested by the state monuments in Rome. Representations from other regions and beyond the Empire indeed demonstrate more variety. These include a coat of mail that by the early 2nd century had become much longer, protecting most of the body and upper arms. The archaeological specimen from Vimose attests to the existence of this type of coat, which became the blueprint for mail armour in centuries to come. Finally, it is also during the 2nd century that we find the first evidence of helmets with mail aventails to protect the neck.

[86] D'Amato/Sumner 2009, fig. 129.

[87] Dahm 2012; D'Amato/Sumner 2009, fig. 121.

[88] D'Amato/Sumner 2009, fig. 98. They date the relief to the Flavian period, possibly based upon the presence of shoulder guards. I think that the Trajanic design of the mail coat makes an early 2nd century date more likely.

[89] James 2004, 104-105.

[90] Both helmets date to the 4th century. Miks 2008, 12-14, fig. 20-21; 2014, 218, 223, pl. 51, 70-72.

[91] Böhner 1994; Vogt 2006.

4.5 THE 3RD TO 5TH CENTURY AD

From the 3rd century AD onwards, armour becomes less common in the representational record, especially in relation to the two previous centuries. The decline of armour in iconography has led scholars to believe that its popularity decreased among Roman infantry and that body armour was gradually abandoned.[92] The 5th century texts on military matters by Vegetius have probably reinforced this idea. This author compares the Roman soldiers of his time to those of Rome's heyday asserting that since the time of Gratianus (AD 367-383) infantry rarely wore helmets and cuirasses anymore, due to the loss of discipline among the soldiers, who considered the armour too heavy.[93] The accurateness of this statement has been rightfully questioned (chapter 3.7), particularly because Vegetius' intention was to prove that the Roman Empire had lost the shine of the centuries past.[94]

The lack of armour images from the 3rd century onwards must be understood as a change in artistic topics and not as the actual waning of armour. Since the start of the 3rd century there are no more state monuments in the Trajanic tradition, with explicit war and battle-laden iconography. The Arch of Septimius Severus is the last vestige in this style. Change is also observed in military tombstones, the other major source of armour representations. During the Late Roman period there are less tombstones that include the depiction of the deceased soldier. Those that do, usually no longer show them in full battle gear, but in a belted tunic. Although to us armour may seem the clearest mark of a soldier, written evidence suggests that army identity could be equally displayed by other paraphernalia such as the military cloak, hobnailed shoes, the bearing of arms, and especially the use of a military belt, all of which appear in military tombstones at this time.[95]

Despite there being fewer depictions of mail from this period, these are enough to get a general idea of its development during Late Antiquity. For example, a column dedicated to Jupiter in Wiesbaden, Germany, from AD 221 (fig. 4.71),[96] shows a horseman trampling down a man in the style of the triumphant rider. His coat of mail seems longer and more voluminous than in the previous century, covering a greater part of the body. The mail shirt comes down to the knees in length, but lacks splits, and the sleeves are also extended, reaching above the elbows.

A rock carving of similar age (i.e. AD 227) comes from Firuzabad in Iran, outside the Roman Empire,[97] and portrays the Sassanian king Ardashir I as a *clibanarius* in three stages of battle against the Parthian king Artabanus V (fig. 4.72). Ardashir is shown wearing a voluminous mail coat realistically rendered with carved individual rings, and a short sleeveless garment on top of his armour. Remarkably, his mail coat has long sleeves down to the wrists, making this the earliest depiction of a long-sleeved mail armour.

A coat of mail of the same design with long sleeves is probably depicted on the military stele of a horseback standard bearer from Chester (fig. 4.73).[98] He carries a *draco* standard consisting of a metal dragon's head attached to a brightly coloured wind sock. Because the *draco* was introduced in the Roman army by the Sarmatians, this tombstone is sometimes attributed to a man of Sarmatian origin. Another tombstone from Chester dated to the late 3rd century (fig. 4.74)[99] shows a triumphant rider trampling a barbarian who lies face down yielding a shield. The mail armour of the cavalryman ends at the knees and has no splits. The length of the sleeves is difficult to determine due to damage, but appears to extend to the elbows.

Several depictions of infantrymen wearing mail from the 3rd century exist. An exceptional example comes from the Ludovisi sarcophagus (circa AD 250), housed at Palazzo Altemps in Rome, which rep-

92 E.g. Garlan 1972, 103; Sirago 1961, 369.

93 Vegetius, *De re militari* 1.20.

94 Charles 2003; Coulston 1990; 2002.

95 Hoss 2011; James 2004, 60, 64-66; Speidel 2011, 8-9.

96 Florschütz 1890; Mattern 1999, 75-76, pl. 13.

97 Ciafaloni/Della Rocca de Candal 2011, 114, fig. 5; Grotowski 2010, fig. 53.

98 Coulston 1991a, 102, fig. 7.

99 Bull 2007, 41; Robinson 1975, 171; Schleiermacher 1984, 183-184.

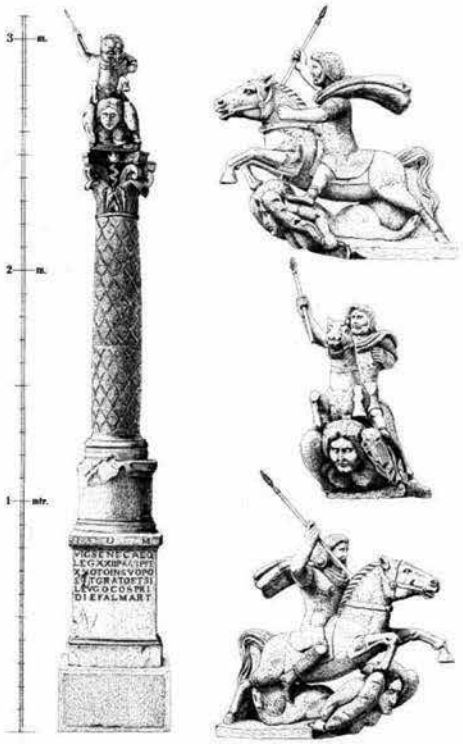


Fig. 4.71. Small Jupiter Column from Wiesbaden in Germany, AD 221. The horseman on top appears to wear a coat of mail. Compared to 2nd century specimens, this coat is relatively long and voluminous, which must be to enable movement when horse riding in the absence of splits at the bottom hem (drawing from Florschütz 1890).

Fig. 4.72. Rock carving from Firuzabad in Iran, AD 227. This frieze offers another example of mail in artwork from outside the Roman Empire. It depicts the Sassanian king Ardashir I in three stages of combat. His mail coat is covered in crescent shapes that give the appearance of rings, and it does not have splits in spite of being of mid-thigh length. This is the earliest depiction of a mail coat with long sleeves (drawing Wikimedia Commons).

resents a battle between Roman soldiers and Germans in great detail (fig. 4.75).[100] One Roman *signifer* shows a finely carved mail coat with a round neck-opening and sleeves that end just above the elbows. A fold in the mail fabric around the waist indicates that it was worn with a belt. Despite its realistic appearance, the sarcophagus also includes some fantastic elements such as fictional helmets.

A 3rd-century synagogue in Dura-Europos, Syria, has frescoes representing the Battle of Ebenezer, with several infantrymen and two cavalrymen wearing protective gear (fig. 4.76).[101] The texture of the armour coats is indicated by wavy horizontal lines making it hard to say whether they are meant to be of mail or scale, but they all seem voluminous and fairly loose fitting, of knee length, and lacking splits. Some of them are worn with a thin belt and the sleeves vary from long to half long.

[100] Künzl 2010.

[101] James 2004, 29, 41-44, 111, pl. 4; Macdowall 1995, 5; Stephenson 2006, 27, fig. 22.

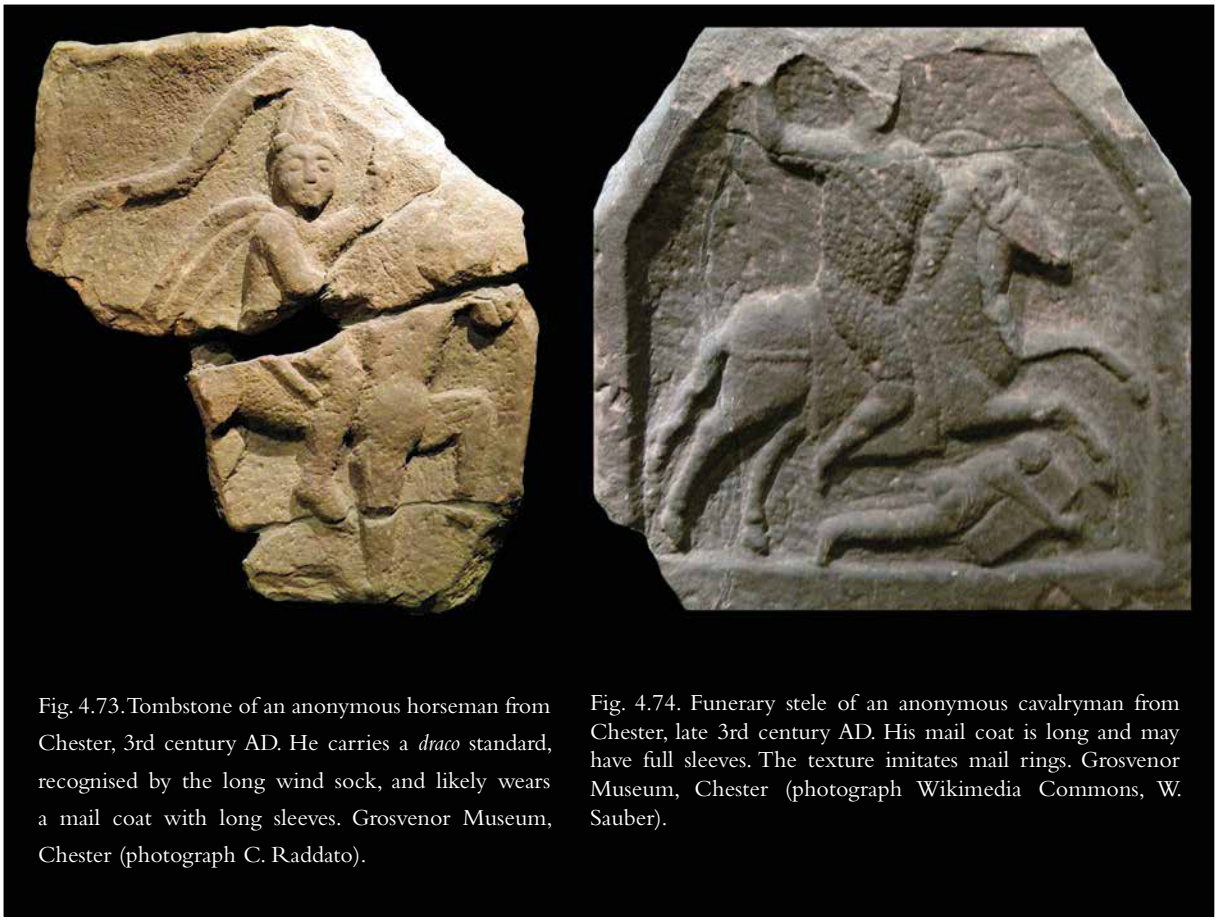


Fig. 4.73. Tombstone of an anonymous horseman from Chester, 3rd century AD. He carries a *draco* standard, recognised by the long wind sock, and likely wears a mail coat with long sleeves. Grosvenor Museum, Chester (photograph C. Raddato).

Fig. 4.74. Funerary stele of an anonymous cavalryman from Chester, late 3rd century AD. His mail coat is long and may have full sleeves. The texture imitates mail rings. Grosvenor Museum, Chester (photograph Wikimedia Commons, W. Sauber).

In addition, this fresco introduces an interesting new piece of equipment. Never portrayed before, three figures wear an armoured coif made of the same material as the body armour, either scale or mail.[102] Best described as a flexible hood, the coif is a piece of armour that protects the head, throat, neck and shoulders, leaving only the face bare. Mail coifs are well known from the 11th century AD onwards and are often assumed to be a medieval invention,[103] perhaps due to the frequency with which they are depicted in that period and the lack of actual pre-medieval examples. Nevertheless, the iconographic evidence from the Late Roman period (see also below) indicates that the mail coif is much older. This is also suggested in the late-classical text *Strategikon* by Maurice. This 6th-century military manual includes the following description of a soldier's equipment: 'They should have hooded coats of mail [armour] reaching to their ankles, which can be caught up by thongs and rings, along with their carrying cases.'[104] Maurice's comment clarifies that to enhance movement, a long armoured coat could be lifted up and fixed with thongs and rings. Moreover he confirms the presence of the armoured coif, as possibly integrated into the body armour.

[102] Scale coifs are archaeologically unknown, but a modern reconstruction following the Dura-Europos frescos has been successfully made; c.f. Sumner 1997, 50-51.

[103] Ffoulkes 1909, 25. Almost none of the standard works on medieval armour mention the existence of the mail coif from before the Middle Ages. They usually indicate the 11th century Bayeaux Tapestry as one of the earliest depictions of a mail coif.

[104] Maurice, *Strategikon* 1.2.10. Maurice uses the word ζάβας, which is a generic term for armour. Dennis (1984, 12) translates it as mail armour.

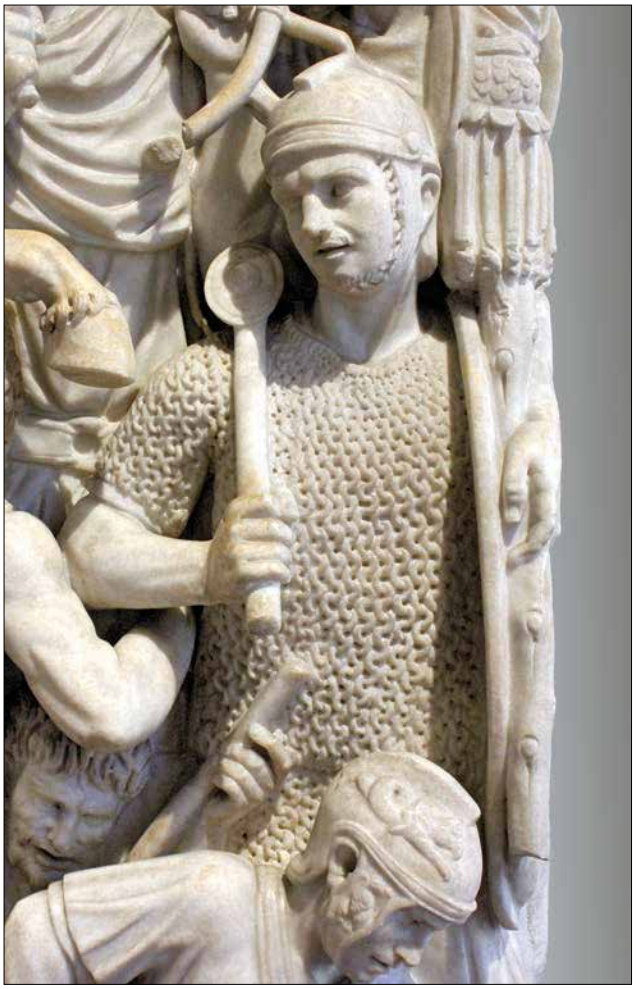


Fig. 4.75. Ludovisi sarcophagus, mid-3rd century AD. This piece depicts a battle between Romans and Germans. A *signifer* wears a realistically rendered mail coat with carved interconnecting rings. The exact length of the coat cannot be observed, but it is minimally of mid-thigh length. The coat is worn with a belt to relieve some of its weight, as indicated by the puckering of the mail fabric around the waist. Palazzo Altemps, Rome (photograph M.A. Wijnhoven).

After the 3rd century the evidence for mail armour in the representational record becomes even scarcer, but what little is left follows the same pattern as before. A 3rd - early 4th-century relief housed at Museo Chiaramonti in Rome (fig. 4.77)[105] contains two armoured legionaries wearing helmets and carrying large round shields, one wears scale and the other mail. The mail coat is very similar to those discussed above, it has long sleeves and covers a large part of the body, ending by the knees. A fold in the mail fabric seems to indicate the use of a belt. A mail shirt of similar design, albeit with three-quarter sleeves is seen on a military gravestone at Linz (fig. 4.78). It has been suggested to come from the 4th century AD, but recent insights place it more likely in the 3rd century.[106] The deceased is shown wearing a helmet with cheek guards and rests his hand upon a shield that stands before him. He does not wear a belt, but a baldric with a sword.

The Late Roman period includes several colour representations of the mail coat. There is, for instance, a 4th-century painting of a Pharaonic warrior at the Via Latina Catacomb in Rome.[107] It depicts a soldier in a long-sleeved shirt of a brown-reddish colour covered by small black dots to simulate the texture of mail. Likewise, the *Vergilius Vaticanus* manuscript, created around AD 400, contains an illumination with soldiers dressed in full armour (fig. 4.79).[108] Although it is supposed to illustrate the Iliad's Trojan council, the men wear the armour of Vergil's time, with short-sleeved mail coats indicated by their grey colour covered in black dots. Interestingly, their heads are protected by armoured coifs covered in the same dots thus implying that they were made of mail.[109]

[105] Coulston 1990, 142, 145, fig. 4; Stephenson 2006, 51.

[106] Eckhart 1967; Fischer 2002; Ruprechtsberger 2004.

[107] Coulston 1990, 145, fig. 8; Ferrua 1960, 81, pl. 84.1.

[108] Coulston 1990, 145, fig. 7; Nicolle 1992, 15.

[109] There are possibly two other depictions of mail coifs from Roman times. The first concerns a now headless sculpture from Alba Iulia in Romania. The figure wears a *lorica segmentata* that has circle-like shapes at the shoulders. This has been interpreted as a combination of segmented and scale armour; cf. Bishop 2002, 62-65. Alternatively it could also represent a mail coif worn on top of the segmented armour; cf. Stephenson 2006, 27. The second depiction is that of a 3rd-century graffito from Dura-Europos of a heavily armoured cavalryman carrying a long spear; cf. James 2004, 42, fig. 23. He has a helmet and mail covering his neck and shoulders. This could be either an aventail or a coif worn underneath the helmet.

Fig. 4.76. Two frescoes from the synagogue of Dura-Europos, 3rd century AD. Both cavalrymen and infantrymen wear armour of either mail or scale. The coats of armour are voluminous, with long or short sleeves. Three of the soldiers in the bottom image wear an armoured coif, an entirely new piece of protective headgear which covers most of the head and neck, leaving only a small opening for the face. (photographs Gill/Gillerman slides collection - Yale).

Fig. 4.77. Fragmented relief of two infantrymen, late 3rd or early 4th century AD. Of unknown provenance, it has been suggested the relief may come from the Arch of Diocletian in Rome. One of the soldiers wears mail armour as indicated by the crescent shapes that cover his shirt with long sleeves. Museo Chiaramonti, Rome (photograph M.A. Wijnhoven).

Fig. 4.78. Gravestone of an anonymous soldier from Linz in Austria. Different dates have been suggested including the 4th century. Most likely the gravestones dates to the 3rd century AD. The soldier has a voluminous coat of mail with three-quarter length sleeves. Schlossmuseum Linz, Austria (photograph Wikimedia Commons, W. Sauber).

The only other known depiction of mail armour from the 5th century concerns an intricate wood carving from Egypt (fig. 4.80).[110] It portrays Roman garrison troops defending a town against raiders. Several soldiers wear mail as denoted through a convention of crescent shapes placed in horizontal rows. The shirts are similar to those already described, with long sleeves reaching to the mid-arm and worn with a belt.

[110] Macdowall 1994, 48; 195, 57.

Fig. 4.79. Illumination from the *Vergilius Vaticanus* manuscript, c. AD 400. It is another rare example of a mail coif depiction. Here, the coif is worn with a short-sleeved mail coat. The illumination is not detailed enough to see whether the coif was integrated to the mail coat or a separate piece of defensive equipment. Vatican, Biblioteca Apostolica (MS Vat. lat. 3225- folio 73v).

Fig. 4.80. Wood carving from Egypt, 5th century AD. It portrays a Roman garrison defending a town. Several soldiers are wearing mail with sleeves that span mid-arm and is worn with a belt. Museum für Spätantike und Byzantinische Kunst, Berlin (photograph L. Mendoza Straffon).

Summarising, from the 3rd to the 5th centuries AD, the general design of the mail coat seems to remain more or less unchanged. However, the images of mail from this period, although less common, indicate some developments in relation to previous centuries. By this time, the coat of mail covers more of the body, being long with sleeves that protect the upper arms, or even the entire arms. The overall appearance of the mail coat is of a voluminous garment, especially when compared to earlier designs. Perhaps for this reason it is often, though not always, accompanied by a belt that gathers the armour and relieves some of its weight. All the known representations of mail from this period are missing the splits at the bottom hem. The problem of freedom of movement could be solved, Maurice's *Strategikon* tells us, by simply pulling up the coat when more mobility was required. Alternatively, the lack of splits could be understood in response to the mail coat becoming more loose fitting, making them obsolete.

The Late Roman period also saw the introduction of a new item of mail, the coif. While no archaeological examples are known, the imagery indicates that it had already made its appearance by the 3rd century AD. This postdates the aventail which is first observed in the iconography of the 2nd century. Given this timeframe it is likely that the coif evolved from the mail aventail.

4.6 DEVELOPMENT OF MAIL ARMOUR DESIGN IN ICONOGRAPHY

Despite its limitations, the artistic record allows us to reconstruct some important developments in the design and use of mail armour throughout the centuries. Until the reign of Augustus a substantial part of the examples comes from Latènian contexts, but from the start of the Empire the bulk of the evidence belongs to the Roman sphere. The iconographic sources show that the design of the early mail coat resembled that of the tube-and-yoke cuirass, with two shoulder guards that were an extension of the back and fastened to the chest. During the 1st century AD, especially the second half, the shoulder guards were increasingly abandoned in favour of a sleeveless or short sleeved mail garment. According to state monuments of the 2nd century, the short sleeved mail coat became relatively short and tight fitting, and had decorative vandyked hems. Imagery from outside Rome shows greater diversity and indicates that the mail coat could be longer and have straight hems as well. It is also during this period that we find the first representations of mail aventails attached to helmets. From the 3rd century onwards the coat of mail protects more of the body by becoming longer, more loose fitting and can now have full sleeves. With the introduction of the mail coif even more of the wearer is protected by mail. Between the 3rd and 5th centuries, the design for the mail coat remains more or less unchanged.

5 The naming of mail armour

> *'The dewy earth produced me from its frozen inwards. I am not made from the bristling fleece of [sheep's] wool; no yarn is drawn [tight on the loom], no humming threads leap about [the spindle]; nor do Chinese silk-worms weave me from their yellow floss; I am not gathered from spinning wheels, nor am I beaten by the stiff carding comb; and yet, nevertheless, note that I am called 'clothing' in common parlance. I have no fear of arrows drawn from long quivers.'*
> 7th century Anglo-Latin riddle for the word *lorica*[1]

Many works on the weapons of the Roman army will attest that the segmented cuirass of the heavy infantry is called *lorica segmentata*, scale armour is known as *lorica squamata*, and the correct term for mail is *lorica hamata*. All three terms are well-accepted and can be considered common knowledge in scholarly and popular publications. While many do indicate that *lorica segmentata* is a modern Latinised term without an ancient counterpart, it is usually taken for a fact that the Romans referred to a coat of mail as a *lorica hamata*. However, when we look in more detail at the available evidence, the term loses much of its assumed infallibility. One may even say that establishing the Roman term for mail is like stepping on quicksand,[2] seemingly safe on the surface, but shaky and treacherous deep down.

5.1 CLASSICAL LITERATURE ON ARMOUR

While many classical sources make mention of armour, often using the word *thoraca* (cuirass) or *lorica* (armour), they usually do so only in a general sense. The great majority of the written sources does not specify the type of armour that was involved, what it looked like or was constructed. For example, although historical works often involve narrations of conflict, it is the description of events and not of objects that gets the emphasis. For the narrative it is simply not necessary to go into the elaborate description of objects such as armour. Moreover, what armour looked like was probably self-evident to most readers and did not need to be explained in the texts.

Still several sources that do offer a more detailed description of armament. It is important to remember that there is a survival bias for the classical texts available to us today. Texts needed to be considered interesting or important enough to be copied throughout the ages. The majority of descriptions of armour that has survived actually comes from works of poetry. Due to their lyrical nature, poems are often more descriptive. However, the language they use may not be representative of colloquial speech. This means that the armour terms found in this literary genre may not correspond to their common denomination or to military terminology.

Geographical works can also include descriptions of armour, especially when explaining what foreign armour looked like. These descriptions are often more detailed than accounts of native armour, maybe because it seemed necessary to explain unfamiliar sights. In addition, narratives of 'strange' armour, garments, customs, environments, etc., were used to accentuate the otherness of the peoples described.

[1] Aldhelm, *Enigmata* 33; translation Lapidge/Rosier 1985, 76. Cf. also Cavell 2016, 54-61.

Fig. 5.1. Illumination from the Psalter of Eleanor of Aquitaine circa AD 1185. David and Goliath are depicted wearing 12th century gear, disregarding the actual period in which the confrontation took place. Goliath wears a mail hauberk including a coif and mittens. Additional protection is provided by a helmet with a nasal, a kite-shaped shield and mail leggings. It is a common iconographic practice to place an older narrative in a contemporary setting. At times, this can result in a mix of new and (stereotypical) historical elements. Koninklijke Bibliotheek, Den Haag (MS 76 F 13 – folio 29r).

For this reason, these sources must be used carefully, as the reports may not be accurate but exaggerated to stress the exoticism of far-away regions and peoples.[3] Such descriptions usually tell us more about how the culture that produced the texts saw themselves than about the reality of foreign groups.

A third type of source is etymological encyclopaedias, which because of their very nature, clarify the subject of armour and its background. Lastly, military treatises can sometimes contain descriptions of military equipment, although in relation to the subject of armour they seldom do. Most military treatises are much more concerned with tactical considerations than with the description of armour, which was probably considered common knowledge to all army men.

5.2 LORICA HAMATA

Over the past hundred years several Latin terms found in classical literature have been put forward as the possible original term for mail armour. None has been so widely accepted as *lorica hamata*. Unlike the other possible designations, the term *lorica hamata* is featured in the 4th century Latin translation of the Bible (Vulgate). The influence of the Bible on Western culture is probably the main reason for the popularisation and the modern hegemony of *lorica hamata* over others.

It is mentioned in the passage that describes Goliath's armour as he is about to confront David (see St. Jerome in box 5.1), often translated as 'and he had a helmet of brass upon his head, and was clothed in a coat of mail, and the weight of the coat was five thousand shekels of brass'. The presence of a coat of mail in the age of David and Goliath is, of course, an anachronism. Mail armour was yet to be invented and the passage must have originally referred to scale armour.[4] Nevertheless, this does not mean that

[2] A discussion of the difficulties of determining the proper Latin name for Roman military artefacts is found in Bishop 1989.

[3] This practice was frequent in Roman sources describing the peoples or geography outside the Roman Empire. Lendering 2009; Lendering/Bosman 2012, 5-8, 22.

Fig. 5.2. Hook-shaped fasteners were used in pairs to attach the shoulder guards to the chest of the mail coat. Their shape and hook-like qualities have sometimes been used to justify the term *lorica hamata* for mail armour. These particular fasteners were found at Kops Plateau, Nijmegen, in The Netherlands, and are now held at the Gelders Archeologisch Centrum Museum G.M. Kam. Top: set of fasteners with decorative rivets filled with red coral (Nijmegen 29). Bottom left: right half of a set of fasteners (Nijmegen 37). Bottom right: fastener with decorative rivets, one still containing blue glass (Nijmegen 28) (photograph M.A. Wijnhoven).

lorica hamata cannot refer to a coat of mail.[5] It is very common for biblical scenes to be envisioned in a familiar historical context, like in medieval illuminations which show biblical characters dressed or armed in the fashion of the artist's time (fig. 5.1). When translating the Bible into Latin, it is conceivable that St. Jerome described an armour contemporaneous to him in Late Antiquity, such as mail.

Since the end of the 16th century scholars have generally accepted the term *lorica hamata* to mean mail armour. For example, in Kiel's *Etymologicum Teutonicae linguae* the term is equated to *malien-koller* and *ring-koller*, i.e. the Dutch phrasing for a coat of mail.[6] It was probably the landmark volume *L'antiquité expliquée* by the Benedictine monk Bernard de Montfoucon, from 1722, which solidly established this term in the scholarly community as equivalent to mail.[7]

Despite its favourable reception, the term is problematic. Although several classical sources do include (some variation of) the name *lorica hamata*, they are surprisingly few, especially considering the popularity of mail throughout the Roman period, as attested by the archaeological and iconographic records. Box 5.1 sums up the collected evidence, which amounts to four or possibly five Latin sources and one similar in Greek.[8] The sources in Latin all concern poetical works, except for the Bible. These are possibly not the most adequate sources to inform us about the correct term for mail armour.

4 Hulit 2002, 56-62.

5 The story of David and Goliath also appears in Titus Flavius Josephus' *Antiquitates Iudaicae*, written in Greek in the late 1st century AD. In this version Goliath is wearing armour described as a 'chain cuirass' (box 5.2). In later classical Persian and Ottoman literature David is even considered the first person to create mail armour after god bestowed him with the power to soften iron; cf. Péri 2019.

6 Kiel 1632 [1599].

7 Montfaucon 1722a, 42; 1722b. 27.

8 Pausanius, *Graeciae descriptio* 9.26.8. This section speaks of armour and mentions hooks, but the actual nature of what is being described remains unclear. For this reason, translations can seem odd. E.g. Jones 1935, 285: 'He had made a bronze breastplate, with a fish-hook, the point turned outwards, upon each of its plates'.

BOX 5.1 EVIDENCE FOR LORICA HAMATA IN CLASSICAL SOURCES

Virgil (epic poem, late 1st century BC)
- *loricam consertam hamis auroque trilicem (Aeneid 3.467)*
- *hamis consertam auroque trilicem / loricam (Aeneid 5.259-260)*
- *clipeumque auroque trilicem / loricam induitur (Aeneid 7.639-640)*

Silius Italicus (epic poem, late 1st century AD)
- *loricam induitur; tortos huic nexilis hamos / ferro squama rudi permixtoque asperat auro (Punica 5.140-141)*

St. Jerome (Latin translation of the Bible, late 4th century AD)
- *lorica hamata induebatur porro pondus loricae eius quinque milia siclorum aeris (Biblia Sacra Vulgata, Samuel 1.17.5)*

Sidonius Apollinaris (panegyric poem, mid-5th century AD)
- *nec sutilis illi / circulus inpactis loricam texuit hamis (Carmina 2.320)*

Uncertain how to read: Claudian (invective poem, late 4th century AD)
- *flexibilis inductis hamatur [or animatur] lamina membris (In Rufinum 2.358)*

Ancient Greek

Pausanias (geographical work, 2nd century AD)
- *χαλκοῦν θώρακα ἐποιήσατο ἔχοντα ἐπὶ ἑκάστῃ τῶν φολίδων ἄγκιστρον ἐς τὸ ἄνω νεῦον (Graeciae descriptio 9.26.8)*

However, the biggest problem with the term *lorica hamata* is its meaning. Literally, it is translated as 'hooked armour', but it remains unclear why mail would be called 'hooked'. So far two explanations have been put forward. One is that the adjective 'hooked' refers to the hook-shaped fasteners typical of early mail coats up to the end of the 1st century AD (fig. 5.2).[9] These were part of mail coats with shoulder guards that extended from the back and went to the front over the shoulders and the chest, where the fasteners fixed the guards into place. Several of the classical sources that mention *lorica hamata* date from a time when such fasteners had already fallen in disuse, but the term might still derive from them. Often, the etymology of a word stems from an archaism. The main drawback of this explanation is that fasteners were not exclusively used in mail armour. The archaeological record shows that they also featured on hybrid armour, made up of a combination of mail and scale, as in the finds from Vize in Turkey and Augsburg in Germany.[10] The iconographic record further demonstrates that shoulder guards, and consequently fasteners, were equally employed in scale armour.[11] The presence of shoulder guards

[9] Juncher 2016, 95. To my knowledge, she is the only person who has written about this interpretation. Other scholars have supported the same interpretation in personal communication, suggesting that it is a widespread assumption.

[10] Wijnhoven 2016a, 83-84.

[11] E.g. the tombstones of Vonatorix in Bonn, L. Sertorius Firmus in Verona, and an Augustan relief at the Palazzo Ducale in Mantua.

Fig. 5.3. Close-up of a section of Roman mail from Künzing 4 in Germany. It typically consists of two types of rings, riveted and solid, arranged in alternating rows. The term *hamata* has regularly been assumed to refer to the rivets that are present in mail (photograph M.A. Wijnhoven).

and fasteners appears to have been a common trait of armour design up to the end of the 1st century AD, and could figure in all its forms: mail, scale, or a combination of the two. Accordingly, if *hamata* refers to fasteners, the term might not have been applied exclusively to mail.

The second explanation for the term is that 'hooked' relates to the actual rings from which the mail fabric is made. It may allude to the fact that the rings were knitted or 'hooked' together to form the mail weave,[12] or to the rivets that served as 'hooks' to close up the rings.[13] The latter interpretation is based on a sentence from the 5th-century work *Carmina*, by Sidonius Apollinaris, said to describe the characteristic two ring type combination of Roman mail (fig. 5.3), which was shaped by solid rings, punched out of sheet metal, and riveted ones made from wire whose overlapping ends were pierced and closed with a small rivet. The quote '*nec sutilis illi circulus impactis loricam textuit hamis'*,[14] translated as 'she wore no armour fashioned of woven solid and riveted rings' could indeed refer to these two types of rings.

Sidonius' text is now regularly presented in books on Roman military equipment as evidence that the Romans called the mail coat *lorica hamata*, as this was built of solid and riveted rings, designated by the terms *circuli* and *hami*.[15] The flaw of this interpretation is that the words *circulus* and *hamus* are not exclusive to mail either. They also appear in descriptions of other types of armour. For example, in his 4th-century AD chronicle on the armour of the *clibanarii*, Marcellinus uses the phrase: '*personati thoracum muniti tegminibus, et limbis ferreis cincti, ut Praxitelis manu polita crederes simulacra, non viros; quos laminarum circuli tenues, apti corporis flexibus ambiebant*'.[16] Even though we cannot give a positive identification of the armour mentioned, the use of *laminarum* or 'plate (metal)' may refer to scale armour,[17] but certainly not to mail. In the 1st century AD, Silius Italicus likewise uses the word *hamus* to describe the defensive attire of the consul Flaminius: *'loricam induitur; tortos huic nexilis hamos ferro squama rudi permixtoque asperat auro*'.[18]

12 Charles 2003, 158.

13 E.g. Greiner 2008, 97; Richter 2010, 191.

14 *Carmina* 2.321-322.

15 E.g. Robinson 1975, 171.

16 *Res gestae* 16.10.8. Meyrick (2007 [1842], 47) gives the following translation: 'They were protected with armour, in the form of *thoraces*, and girt with bands of iron, so that you might rather have supposed them statues formed by the hand of Praxiteles, than men who were enveloped with thin rings of *laminae*'.

17 Isidore of Seville in *Origenes* 18.13.2 uses precisely this word in his description of scale armour.

18 *Punica* 5.140-141; translation Duff 1927, 243: 'Then he puts on his breastplate; its twisted links were embossed with plates wrought of hard steel mingled with gold'.

19 For various translations, cf. Wijnhoven 2009, 5.

Fig. 5.4. One of the most common types of scale during the Roman period. It has two pairs of holes, located on the left and right edges, through which staple-like strips of metal connect it to adjacent scales. Rows of scales are subsequently attached to an undergarment through the upper hole(s). Top: front and back of a fragment of scale armour from Kops Plateau, Nijmegen, Gelders Archeologisch Centrum Museum G.M. Kam, find no. 439-017. Bottom: row of several scales from Chesters Roman Fort and Museum, inv. no. 2231 (photograph M.A. Wijnhoven).

This passage is difficult to translate and various interpretations have been offered over the years.[19] Nonetheless, the formulation of the armour consisting of *squamae*, i.e. scales, appears to preclude mail armour.[20]

Interestingly, one could also describe Roman scale armour as 'hooked'. The most common type of scale in the Roman period had three sets of holes.[21] One pair was located on the right, one pair on the left, and finally a single or double hole was placed at the top of the scale. The two pairs of holes at the sides connected each scale to the adjacent ones, making up a horizontal row which was then attached to a textile base garment through the top hole(s). The scales were joined by small pieces of metal wire, much like modern staples. These ran through the side holes and bent over at the back of the scale, which faced the body (fig. 5.4). The term 'hooked' might have been applied to scale armour referring to the fact that the scales were connected by metal hooks.

The properties of these scales may also offer an alternative explanation to Virgil's description of armour as '*loricam consertam hamis auroque trilicem*', a phrase he uses three times (box 5.1). Many modern translations assume that he is describing a mail coat, but are puzzled by the word *trilicem*. This has led to interpretations such as 'a corselet of hooked chain-mail and three-leash golden weave',[22] which do not make much sense, especially when we consider the archaeological evidence and the actual weaving patterns of mail (chapter 9). It is more likely that Virgil is not using *trilex* literally but to emphasize that the armour is strong, impenetrable or closely woven together.[23] Then again, if *loricam consertam hamis* does not refer to mail, *trilicem* could allude to the three fixing points found in most scales in Roman armour.

In sum, both explanations for why mail might be called 'hooked' are inconclusive. What seems certain is that the combination of the words *lorica* and *hamata* does not necessarily mean that the phrase is describing mail armour. While it could be true in some contexts, it does not seem to be an unequivocal standard Roman designation. It rather is an association of words often used to describe different types of armour, the majority of them found in poetical works.

[20] In the past I have suggested that this passage may refer to hybrid armour, but I do no longer think this is the most likely interpretation.

[21] Type 4 in Dawson 2013, 21-26.

[22] Poppe 2004, 171.

[23] Charles 2004, 132; Waller 1904, 60.

5.3 OTHER DESIGNATIONS

Lorica hamata is not the only term that has been suggested for mail, and among the alternatives is *lorica catena* or 'chained armour'. Incidentally, Sir Samuel Meyrick, the scholar who devoted most attention to this term and popularized it in the early 19th century, was convinced that it did not apply to mail.[24] Meyrick and other scholars of the time thought that 'true' mail, which he called 'interlaced chain-mail', was invented in the Near East and had not been introduced in Europe until the Crusades.[25] Because he believed that the Romans lacked true mail, Meyrick gave a different reading of the term *lorica catena* so that it would fit his argument.[26] He suggested that it in fact described either an armour made up by detached parallel chains, or an armour made of little plates held together by wires. Archaeological finds have long disproven Meyrick's ideas concerning mail, and contrary to his belief the term 'chained armour' seems a logical designation for mail armour, and is even alluded to by the modern pleonasm chain-mail.

Unfortunately, the term *lorica catena* is almost as problematic as *lorica hamata*. The combination of the words *lorica* and (some version of) *catena* is not exclusive to mail, but is also found in the description of other armour types. Isidore of Seville writes 'S*quama est lorica ferrea ex lamminis ferreis aut aereis concatenata in modum squamae piscis'*.[27] There is no doubt that the armour in question, consisting of 'iron and bronze plaques chained together as in the scales of a fish', can only be scale.[28] Interestingly in the preceding sentence Isidore probably does mention mail armour by stating *'solis enim circulis ferreis context est'*, 'for it [the armour] is woven entirely from iron rings'.

Again, the number of sources that actually use the expression *lorica catena* (box 5.2, top) is limited. In total, there are only five sources that mention the term, and one clearly refers to scale instead of mail. All of them concern poetical works, except for that by Isidore of Seville, which does not date to the Roman period, but to the Early Middle Ages.

The body of evidence for this term becomes larger if Ancient Greek sources are also considered, several of which mention 'chained armour' or *ἁλυσιδωτὸς θώραξ* (i.e. *halusidotos thorax*). Box 5.2 (bottom) gives examples from the surviving corpus of ancient Greek literature. These do not involve poems, but are mainly historical-geographical works and one military treatise. The nature of these texts lends more credibility to the term.

The indications that *lorica catena* was an ancient term for mail are probably stronger than for *hamata*. Nonetheless, the bulk of literary data also demonstrates that this was not a generalized term either. Although *lorica catena* and *ἁλυσιδωτὸς θώραξ* probably refer to mail most of the time, scale armour could also be described as 'chained'. The adjective *catena* may be a literary aid to help the reader visualize the armour being discussed, which may or may not be mail armour.

In addition to *catena* and *hamata*, classical literature contains other expressions that may refer to mail. The combination of the verbs 'to sew' (*insuere*), 'to weave' (*texere*) or 'to knit/assemble' (*nexere*) together with the noun for armour (*lorica* or *thoraca*) can suggest mail armour (box 5.3).[29] Mail is indeed something that could be perceived as being sewn, woven or knitted together. To a certain extent, the same could be said for scale armour. The individual components of scale armour would have been assembled by knitting or weaving the scales together and sewing them onto a textile backing. The conclusion is therefore

[24] Meyrick 1821.

[25] E.g. Boutell 1870, 189. Wade (1883, 209) and Blair (1958, 19) did not agree with this late introduction of mail in Europe, but still adhere to an eastern origin, as does Hodgetts (1883), who favours India as the region of origin.

[26] He even criticizes Montfoucon for thinking that *lorica hamata* was the Roman expression for a mail coat. Meyrick 1821, 351-352.

[27] *Origines* 18.13.1-2.

[28] This passage by Isidore partially supports Meyrick (1821, 352) in his assertions on *lorica hamata*. It can indeed refer to armour made of little plates held together by wires.

[29] Charles 2004, 132-134.

BOX 5.2 EVIDENCE FOR LORICA CATENA IN CLASSICAL SOURCES

Lucan (epic poem, mid-1st century AD)
- *qua torta graves lorica catenas / opponit tutoque latet sub tegmine pectus (Bellum civile 7.498-499)*

Statius (epic poems, late 1st century AD)
- *qua subtemine duro / multiplicem tenues iterant thoraca catenae (Thebaid 7.744-745)*
- *quod mille catenis / squalentis nectat tunicas (Achilleid 1.431-432)*

Valerius Flaccus (epic poem, second half 1st century AD)
- *rigit his molli lorica catena (Argonautica 6.233)*

Sidonius Apollinaris (panegyric poem, mid-5th century AD)
- *cum pondere conti / indutas chalybum saltu transferre catenas / inuentas agitare feras et fronde latentes (Carmina 2.142-144)*

Isidore of Seville (etymological encyclopedia, first half 7th century AD)
- *squama est lorica ferrea ex lamminis ferreis aut aereis concatenata in modum squamae piscis (Origines 18.13.2)*

Examples of ἁλυσιδωτὸς θώραξ in ancient Greek

Polybius (historical work, 2nd century BC)
- *οἱ δ' ὑπὲρ τὰς μυρίας τιμώμενοι δραχμὰς ἀντὶ τοῦ καρδιοφύλακος σὺν τοῖς ἄλλοις ἁλυσιδωτοὺς περιτίθενται θώρακας (Historiae 6.23.15)*
- *καθηγοῦντό τινες Ῥωμαϊκὸν ἔχοντες καθοπλισμὸν ἐν θώραξιν ἁλυσιδωτοῖς, ἄνδρες ἀκμάζοντες ταῖς ἡλικίαις πεντακισχίλιοι· μεθ' οὓς Μυσοὶ πεντακισχίλιοι (Historiae 30.25.3)*

Strabo (historical-geographical work, early 1st century AD)
- *λινοθώρακες οἱ πλείους· σπάνιοι δὲ ἁλυσιδωτοῖς χρῶνται καὶ τριλοφίαις (Geographica 3.3.6)*

Diodorus Siculus (historical work, 1st century BC)
- *θώρακας δ' ἔχουσιν οἱ μὲν σιδηροῦς ἁλυσιδωτούς, οἱ δὲ τοῖς ὑπὸ τῆς φύσεως δεδομένοις ἀρκοῦνται, γυμνοὶ μαχόμενοι (Bibliotheca historica 5.30.3)*

Titus Flavius Josephus (historical work, late 1st century AD)
- *(...) ἔχων δὲ καὶ ξυστόν, οὗ τὴν λαβὴν συνέλκειν σταθμὸν σίκλους τριακοσίους, καὶ θώρακα ἁλυσιδωτὸν καὶ ῥομφαίαν (...) (Antiquitates Iudaicae 7.299)*

Arrian (military treatise, first half 2nd century AD)
- *(...) καὶ θώρακες, οἳ μὲν φολιδωτοί, οἳ δὲ ἁλύσεσι λεπταῖς σιδηραῖς ἐπηλλαγμένοι (Tactica 3.5)*

as ambiguous as for the other mentioned terms. They are all alternative expressions used in descriptions of armour, but not exclusively in association with mail. Yet again, all the Latin sources concern poems of different nature, except for one early-medieval text.

BOX 5.3. EVIDENCE FOR 'TO SOW', 'TO WEAVE' AND 'TO KNIT' IN RELATION TO ARMOUR IN CLASSICAL SOURCES

Statius (epic poems, late 1st century AD)
- *nexilis innumero Chalybum subtemine thorax (Thebaid 4.174)*
- *ter insuto servantur pectora ferro (Thebaid 7.311)*
- *it tremibunda abies clipeum per et aerea texta / loricae tandemque animam sub pectore magno (Thebaid 9.552-553)*
- *quod mille catenis / squalentis nectat tunicas (Achilleid 1.431-432)*

Valerius Flaccus (epic poem, second half 1st century AD)
- *iam pectora ferro / terribilesque innexa iubas ruit agmine nigro (Argonautica 6.110-111)*
- *it medium per pectus et horrida nexu / letifer aera chalybs (Argonautica 6.341-342)*

Silius Italicus (epic poem, late 1st century AD)
- *loricam induitur; tortos huic nexilis hamos ferro / squama rudi permixtoque asperat auro (Punica 5.140-141)*
- *praeterea textam nodis auroque trilicem / loricam (Punica 2.401-402)*

Claudian (panegyric poem, late 4th century AD)
- *nectit thoraca Pyragmon (Panegyricus 195)*

Isidore of Seville (etymological encyclopedia, first half 7th century AD)
- *lorica vocata eo quod loris careat; solis enim circulis ferreis contexta est (Origines 18.13.1)*

5.4 SIMPLY LORICA

The present review demonstrates that the terms from classical literature suggested to indicate mail are all somewhat dubious. They are not often mentioned, and when they are, they do not refer categorically to mail armour. For that reason, this study avoids the terms *lorica hamata* and *catena*.

Despite the uncertainties, there are some ways of establishing when classical sources do discuss mail. The individual context in which each of the terms is used, for example, can give an indication of whether an author alludes specifically to mail.

The corpus of surviving Roman literature seems to lack a consistent term to distinguish mail from other types of armour. In most cases, the texts do not identify the kind of armour involved using only a generic word such as *lorica* or *thoraca*. No specialist terms are found in surviving Roman military manuals or in historical narrations by military men like Caesar. Roman poets provide the main exception and do sometimes offer more detail by applying an array of varying adjectives which point to a certain characteristic of the armour in question. The use of these adjectives is neither consistent nor categorical.

The surviving literature gives the impression that the Romans did not consider it necessary to categorise different forms of armour linguistically. Such attitude would also explain why there are no known literary references to the famous Roman segmented armour, nowadays called by its modern Latinised name, *lorica segmentata*.

The absence of specific categories for body armour is emphasised by Varro's *De lingua latina*. This source is particularly significant as its purpose is to explain the Latin language. Of the word *lorica* Varro

states: 'cuirass (*lorica*), because they made chest-protectors from thongs (*lora*) of rawhide; afterwards the Gallic cuirass of iron was included under this name, an iron tunic made of rings'.[30] In this instance there is little doubt that Varro speaks of mail. Here, not only does Varro offer the origin of the generic word for armour – which supposedly stems from the ancient use of protective leather gear – but he also provides an essential clue as to how mail was perceived. He clearly mentions that over time the mail shirt, or 'iron tunic made of rings', became known simply as *lorica*.

Regardless, it is difficult to imagine that Roman soldiers, who wore armour on a daily basis, did not have different terms to refer to particular armour types. If they existed, perhaps they were simply not written down, but remained in the spoken domain. Alternatively, maybe the relevant works did not survive, as a text must be deemed interesting or important enough to be copied through the centuries. This can result in a bias for generic historical and poetical works over writings of a specialist-technical nature. Already in the 5th century AD the Roman author Flavius Vegetius Renatus complained of this bias, when he attempted to learn about the Roman army of earlier centuries:

> *'The only method, therefore, that remains of recovering the ancient customs is by books, and by consulting the old historians. But they are of little service to us in this respect, as they only relate the exploits and events of wars. And take no notice of the objects of our present enquiries, which they considered as universally known.'* [31]

Despite his complaints, Vegetius himself only employs generic expressions for armour (*catafracta* and *lorica*). As mentioned above, even ancient military manuals, dealing explicitly with army topics, offer no specific terminologies, and the Roman ones actually devote very few words to the themes of armour and soldier equipment. For example, the volume *De rebus bellicis* written by an anonymous author in the 4th or 5th century AD, includes only one mention of armour (*lorica*).[32] Exceptionally the early Byzantine manual *Strategikon,* written in the late 6th century, does dedicate a section to the armament and basic equipment of the cavalryman. It discusses the equipment of a soldier in more detail, making several mentions of armour.[33] But even this merely uses the generic term ζάβα (*zaba*).

If in practice the military men of antiquity had specific terms for different armour types, which seems likely for people who handled armour routinely, then these terms were probably considered too self-evident to include in these manuals. Alas, like Vegetius, we have to make do with the available texts, which are not very illuminating on the subject of mail armour.

[30] Translation by the author. *De lingua Latina* 5.24: *'lorica, quod e loris de corio crudo pectoralia faciebant; postea subcidit galli<ca> e ferro sub id vocabulum, ex anulis ferrea tunica'*.

[31] Vegetius, *De re militari* 1.8; translation Clarke 2013 [1767], 12.

[32] Schneider (transl.) 1908, 18.

[33] Maurice, *Strategikon* 1.2.10; 1.2.53; 1.2.57; 1.2.73; 1.2.96; 7B.15.15; 10.1.20.

6 Decoration in mail garments

'On other [mail] coifs bronze rings have been noticed near the lower edge of the collar, and in some instances they seem to have formed a diamond-shaped pattern, but this cannot be maintained with certainty.'
Bengt Thordeman on the excavation of mail from AD 1361 at Wisby[1]

6.1 GOLD ON SILVER

Throughout the centuries, using materials of a different colour has probably been the most common technique of embellishing mail garments. European mail from the Late Middle Ages and Early Modern period survives in large quantities and regularly shows decorative trimmings of copper alloy rings at the opening for the head, the sleeves or hem (fig. 6.1).[2] Clean and polished, the combination of copper alloy trims over an iron body resembles the play of gold on silver. Early modern mail from outside Europe,

Fig. 6.1. German coat of mail dating to the 15th century with copper alloy trims at the sleeves and hem. Metropolitan Museum of Arts, ass. no. 14.25.1540 (photograph Metropolitan Museum of Art).

1 Thordeman 1939, 106.

2 E.g. Burgess 1957; 1958; Chapman 2004; Reid/Burgess 1960; Wood *et al.* 2013.

Fig. 6.2. Early modern Indo-Persian mail garment with an inscription of the 'Prayer to Ali', often used in time of danger, made by inserting copper alloy rings into the matrix of iron links. Metropolitan Museum of Arts, ass. no. 36.25.57 (photograph Metropolitan Museum of Art).

particularly of Indo-Persian origin, can be much more ornamented, featuring for example elaborate geometric designs throughout the garment, instead of just the borders. The contrasting iron and copper alloy rings can even form Arabic inscriptions on the mail armour (fig. 6.2).[3]

Roman military equipment could be highly ornate as well, as evidenced by cavalry helmets which are usually rich in decoration.[4] Due to their lavish embellishments, some pieces of Roman military equipment are often attributed a purely ceremonial function in the military horse games, or *hippika gymnasia*.[5] Regardless of whether these pieces were indeed used only as 'tournament' equipment or in actual war,[6] they demonstrate that decoration was not alien to the Roman soldier, increasing the likelihood that mail armour from antiquity was embellished too.

The iconographic evidence is basically mute about mail decoration, except for the depiction of coats with vandyked hems and sleeves in Rome's state monuments during the 2nd century AD (chapter 4.4). Otherwise, there are no indications of decorative elements or contrasting materials in mail. This is partly because the original paint that once covered sculptures, tombstones and monuments is now gone. The few frescoes and illuminations that survive from the Late Roman period do give a hint of colour, but only capture the greyish-blue hue of iron rings. Fortunately, in this case the archaeological record can make up for the shortcomings of iconography.

3 Robinson 1967, 39, 98; Stone 1961, 48. This contrasting decorative work in Indo-Persian armour is known as Ganga-Jamni, being likened to the meeting of the dark waters of the Jamna and the muddy ones of the Ganges. The decoration of Islamic mail armour is discussed in: Alexander 1985; 2015, 21-63; Bivar 1964, 33-35, 61-63; Lenz 1919; Rose 1887; 1902.

4 Robinson 1975, 89-106.

5 Garbsch 1978.

6 Junkelmann 1996, 50-56; Narloch 2012.

Fig. 6.3. Mail from The Hague 1, The Netherlands, AD 190-240, consisting of iron with small clusters of copper alloy rings scattered throughout the fragment (photograph M.A. Wijnhoven).

6.2 COPPER ALLOY ELEMENTS

The archaeological record in fact shows that a combination of iron and copper alloy rings was frequent in antiquity. However, the core material in mail armour was invariably iron. Full mail coats are either all of iron rings or include a smaller quantity of copper alloy rings, but none are made up entirely from the latter (fig. 6.3).

Conversely, there are sections of mail that consist solely of copper alloy rings (fig. 6.4). These are fragments which were removed prior to deposition, or which have been preserved while adjacent iron rings corroded away. Copper alloy is less susceptible to deterioration than iron and actually endures better alongside it due to a phenomenon known as bimetallic corrosion. This is when two metals with different corrosion rates are in contact, the more noble metal, in this case copper, will be conserved, while the less stable metal, the iron, decays.[7]

Since mail is generally constituted by iron rings, it is probable that the presence of copper alloy rings indicates some form of embellishment.[8] This seems supported by the fact that copper alloy rings in mail can be simply butted,[9] rendering them less adequate for protection, but suitable as decoration.

7 Rodgers 2004, 107.

8 Some evidence from the Middle Ages suggests that in addition to decoration there may have been some practical applications of copper alloy rings in mail. For example, several mail coifs from the 14th century site of Wisby, in Sweden, have a rim of copper alloy rings above the face opening onto which the textile lining had been sewn. The reason may be that while iron rust would wear away the lining threads, copper verdigris would preserve them. Yet not all coifs present this feature. Cf. Hellman 1995, 27, 31-32; Thordeman 1939, 105-106.

9 James 2004, 110-111; Matešić 2015, 210.

Fig. 6.4. This fragment of copper alloy rings became part of the PUG Collection in the 19th century. Its provenance is unknown, but it probably comes from The Netherlands (possibly Vechten) and is in all likelihood of Roman origin (photograph M.A. Wijnhoven).

The present study has documented a total of 99 finds of mail with copper alloy applications, from 50 different sites predating the 5th century AD.

6.3 DECORATIVE ORIGIN

The origins of copper alloy decorations in mail are still foggy, but it is clear that when this practice began mail had already been in use for a very long time. Mail armour first appeared around the turn of the 4th to 3rd century BC, whereas the earliest examples of copper alloy rings come from the second half of the 1st century BC.[10] This means that it took some two and a half centuries since the invention of mail for the application of copper elements to be introduced.

So far, four finds have been (partially) assigned to the 1st century BC: Titelberg 1 in Luxembourg, Pontoux 2 and Mouzon in France, and Conthey in Switzerland. The first, from the *oppidum* at the Titelberg, consists of a fragment of copper alloy rings closed with iron rivets, which context is unfortunately unknown. It was recently rediscovered in a box at a museum depot alongside Late La Tène pottery shards and some *amphorae* remains from the Roman Republic era. It is therefore uncertain whether the mail and shards are associated or whether the mail fragment should be considered either La Tène or Roman. A tentative date of La Tène D has been suggested for it.[11]

In 1869, during dredging activities in the Doubs river at Pontoux, workers came across two complete mail coats and a long sword.[12] In this case too, the find context is missing and it is even unclear if the three items were found in association or separate from each other. One coat is entirely of iron, the other is mostly of iron but has copper alloy rings. The latter was broken into pieces and nowadays only a small copper alloy fragment survives. Both coats were ascribed to the 1st century BC, although the reasoning

[10] The mail fragments from Aubagnan dating to the second half of the 3rd century BC were described in early publications as containing iron and copper alloy rings. E.g. Fabre 1943, 62. Subsequent analysis of the rings has demonstrated that this is incorrect and that all the fragments are iron. Cf. Hansen 2003, 39.

[11] Metzler 1995, 340, 344-347.

[12] Bailly 1978, 56.

for this is not known.[13] Subsequent studies have been more cautious and consider a Roman context, possibly from the 1st century AD, a likely option.[14]

Like the previous two, the archaeological context of the mail fragment from Conthey is obscure.[15] It was bought from an antiquarian by the Historisches Museum in Basel in 1894 and is thought to have been retrieved from a burial. It has been ascribed to the Early Empire, that is between 15 BC and AD 50, the criteria of which is again uncertain. The very small diameter of the copper alloy rings employed in this piece (3.5 - 4 mm) resembles examples of very fine mail especially prevalent during the 1st century AD (chapter 6.9).

Only the mail remains from Mouzon come from a well-recorded context, dated between 50 BC and AD 50/70. The excavation of the site rendered 17 small fragments of mail and many other items of military equipment such as parts of shields, swords, hafted weapons, *lorica segmentata* remains, and miniature weaponry.[16] The artefacts from Mouzon are a mix of Roman and Gallic material. Possibly the objects were deposited by (ex-)soldiers of Gallic descent serving in the Roman army.

This brief discussion of early sites with copper alloy in mail demonstrates that the evidence from the 1st century BC is ambiguous. Three of the four sites are not well-documented and lack context, making their age speculative. Interestingly, all four were found in territories greatly influenced, and eventually annexed, by the Romans during the 1st century BC.

Nevertheless, the archaeological record indicates that by the next century mail with copper alloy ring decoration had become an established practice. A total of 16 finds from 15 sites date to that period, supporting the idea that its usage must have originated somewhat earlier, probably during the second half of the 1st century BC.

It is notable that this date relatively coincides with the appearance of brass in Europe, known as *orichalcum* in Latin. Brass is a copper and zinc alloy whose spread has been attributed to the Romans. They, in turn, probably adopted it from Asia Minor.[17] Brass is first used in Europe around 60 BC and, especially from the Augustan period onwards, it features heavily in Roman military equipment.[18] Many copper alloy rings in mail may turn out to be brass, but very few finds have been chemically analysed to establish their metal composition. Of the total 99 mail finds with copper alloy, the only two that have been examined had brass confirmed as material: Richborough (c. 79% Cu, 21% Zn),[19] and Chester (c. 85% Cu, 14% Zn, 1% other),[20] both from the United Kingdom. Due to the small sample, there is not much to say until other specimens have been analysed, as it is possible that not all copper alloy rings were made of brass.

6.4 DEVELOPMENT AND DISTRIBUTION

Table 6.1 represents the observed use of copper alloy rings in mail over the centuries. It shows that, from its sudden increase in the 1st century AD, the tradition remains more or less stable until the 3rd century. The rise in 3rd-century finds is mainly due to the high quantity of well-preserved material from the sites of Dura-Europos in Syria and Thorsberg in Germany (with 30 and 12 finds, respectively), which skew the sample resulting in an overrepresentation of that period.[21] Although indeed the number of finds is greater than for previous eras, the number of sites is similar.

13 Metzler 1995, 347.

14 Hansen 2003, 34, 55; Viand 2008, 41. Moreover, the mail coats were said to have been found not far from a Roman bridge. The physical characteristics of the rings also resemble Roman mail, as discussed in chapter 11.

15 Hansen 2003, 173; Müller 1986, 123.

16 Caumont 2011, 195-200.

17 Craddock 1978, 8-9; Istenič 2016, 279.

18 Istenič/Šmit 2007.

19 Biek 1963, 162-3.

20 Fernández Reyes 2014, 455.

21 James 2004, 116-120; Matešić 2015, 209-222, 512-521; Raddatz 1987, 59-63.

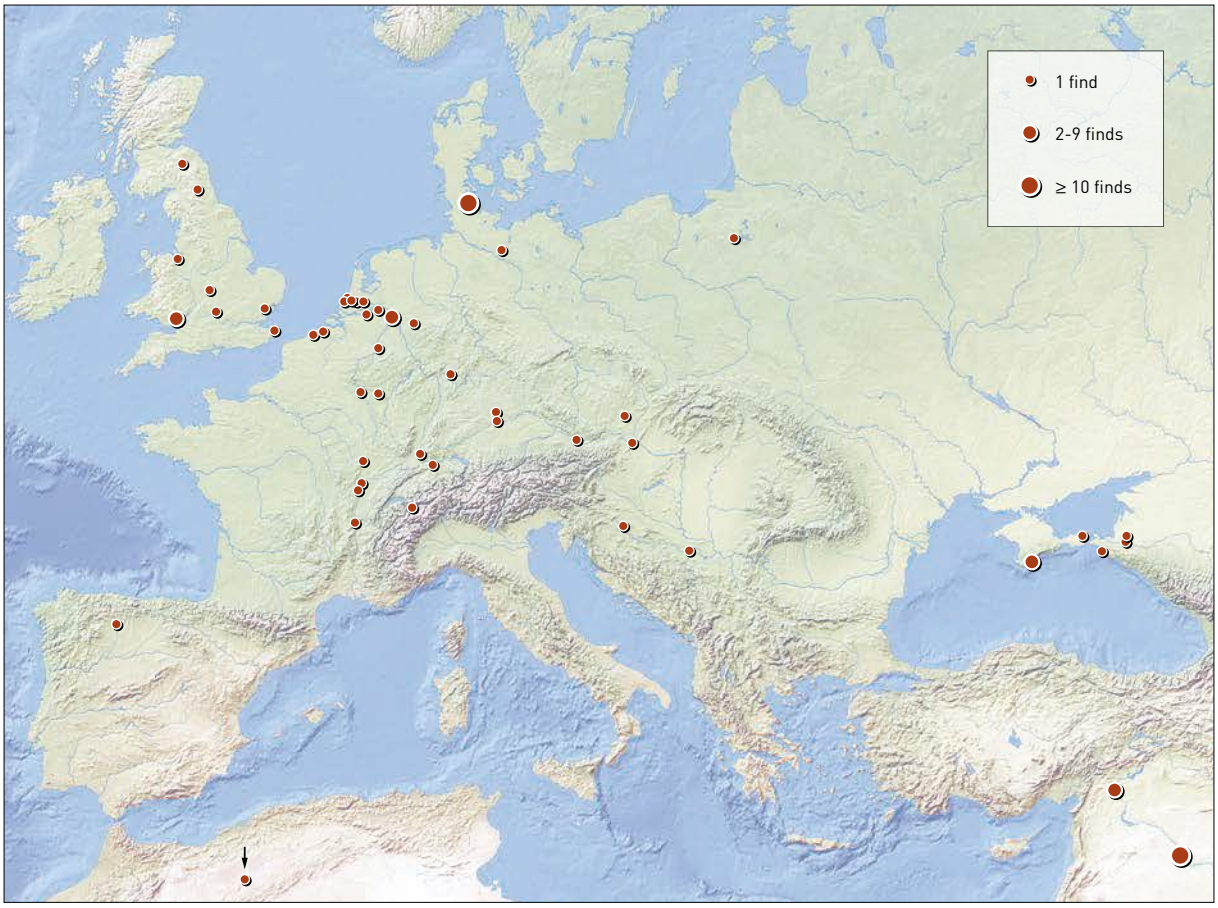


Fig. 6.5. Distribution of mail with copper alloy elements from the 1st century BC to the 5th century AD (map M.A. Wijnhoven/B. Brouwenstijn).

After the 3rd century the use of copper alloy elements in mail armour declines rapidly. For the whole of the 4th and 5th centuries there are only three known finds. Regardless, the practice was never completely abandoned and eventually outlasted the Western Roman Empire. For instance, the coat of mail from Sutton Hoo (AD 610-635), as well as the mail neck guards of the Coppergate helmet (AD 750-775) and the Balyk-Sook helmet (AD 700-850) include copper alloy elements.[22]

century	finds	sites
1st century BC	4	4
1st century AD	16	15
2nd century AD	18	17
3rd century AD	62	18
4th century AD	3	3
5th century AD	1	1

Table 6.1. Summary of the evidence of mail with copper alloy rings through six centuries. Date ranges spanning over two centuries (fully or partially) were counted as single observations for each century. Artefacts with date ranges exceeding 200 years were excluded (e.g. those assigned generically to the Roman period).

[22] Bruce-Mitford 1978, 232-240; Kubarev 1997; Kubarev/Kubarev 2003; Tweddle 1992, 999-1009.

Fig. 6.6. The body of one of the Sassanian attackers lay in a collapsed countermine at Dura-Europos dating to the mid-3rd century AD. The warrior was still clad in his mail shirt decorated with copper alloy rings (photograph Yale University Art Gallery).

The distribution map in figure 6.5 contains all the examples of copper alloy mail dating between the 1st century BC and the 5th century AD. It illustrates that the majority of the specimens come from the Roman Empire, with only ten out of the 50 find sites being located outside its borders. The outlying sites are Dortmund-Oespel, Thorsberg and Hagenow in Germany;[23] Czaszkowo in Poland;[24] Gurzuf Saddle Pass and Panticapaeum in the Crimean Peninsula;[25] Gorgippia, Michajlovskaja Staniča and Tiflisskaja Staniča in Russia;[26] and Kissi in Burkina Faso.[27] But despite lying beyond Rome's frontiers, most of these ten sites have a close connection to the Roman Empire. For example, Hagenow and Thorsberg yielded a mix of artefacts of both Germanic and Roman origin. The Crimean and Russian sites, for their part, were located in the Bosporan Kingdom, a Roman client kingdom which even belonged to the Roman Empire during the reign of Nero. Even the find from Kissi is thought to have been transported from the Roman Empire into West Africa and is used as evidence for early trans-Saharan contacts.

The scarcity of copper alloy rings outside the Roman Empire is not due to an absence of mail. The archaeological record has also revealed a large number of mail finds, but these consist mostly of iron rings.[28] The inclusion of copper alloy elements in mail garments, thus, appears intimately linked with the Roman military. This does not necessarily mean that all mail with copper alloy elements is consistently Roman. For example, a nearly complete coat of mail with copper alloy applications was found in a collapsed countermine at the Roman garrison town of Dura-Europos, in Syria. The owner, whose bones were still inside the coat, has been identified as a member of the attacking Sassanid force. The garment had fairly long sleeves, and both the lower hem and the head opening were trimmed with three rows of

23 Brink-Kloke 1999; Matešić 2015, 209-222, 512-521; Voß 2007, 59-61.

24 Nowakiewicz/Rzeszotarska-Nowakiewicz 2012, 62-63.

25 Goroncharovski 2006, 446; Novichenkova 2009, 283; 2011, 273-274.

26 Bârcă/Symonenko 2009, 304; Goroncharovski 2006, 446; Hansen 2003, 57, 186; Simonenko 2001, 278.

27 Fenn *et al.* 2009 come to this conclusion after extensive metallographic, chemical and lead isotope analyses.

28 Hansen 2003, 166-189.

Fig. 6.7. Copper alloy strip of mail from Vechten 2, The Netherlands. Given its overall shape and the direction of the mail weave, this must have been the decorative edge of a sleeve (photograph M.A. Wijnhoven).

copper alloy rings (figs. 6.6 & 10.19). On the upper chest area copper alloy rings were used to create a decorative trident pattern, reminiscent of the 'heraldic' devices on depictions of early Sassanian warrior's armour.[29] The latter feature indicates that the coat of mail was not of Roman manufacture.

Perhaps unsurprisingly, the distribution of copper alloy mail finds holds further similarities with that of pure brass. The early production of brass is also closely associated to the Romans, particularly the army, which employed it mainly in coinage and military equipment. Except for Asia Minor, there is little evidence that brass was produced outside the Roman Empire.[30] In fact, an increasing body of evidence suggests that since the 1st century AD the use of brass is strongly associated with Roman imperialism.[31]

Altogether, the timing of the introduction of copper alloy elements in mail armour, the date of the adoption of brass by the Romans, and the direct association of both with the Roman military, in addition to the distribution of the finds, lead to the conclusion that the custom of decorating iron mail coats with copper alloy originated as a Roman practice.

6.5 DECORATIVE TRIMMINGS

The occurrence of copper alloy rings in the archaeological record, in itself, does not reveal how these were incorporated into the mail garments. Three types of applications have been observed for the Roman period, each of which will be explained in the following sections.[32] The first is the use of copper

[29] James 2004, 110-111, 116-117.

[30] Istenič 2016, 279; Istenič/Šmit 2007.

[31] Dungworth 1997, 907-8; Ponting 2002a; 2002b; 2012, 163, 165-71.

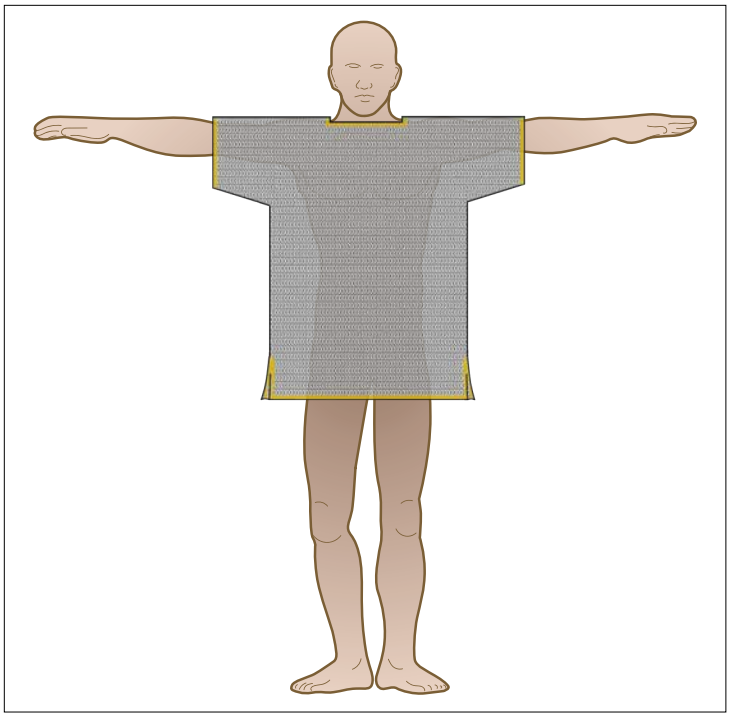


Fig. 6.8. The horizontally located trim corresponds with the lower hem and the neck opening. The vertically placed trim is located at the sleeves. The representation is conceptual and does not refer to a specific find (drawing M.A. Wijnhoven).

alloy rings to create a decorative trim which could be located either on the lower hem, the opening for the head, or the edge of the sleeves. The above mentioned coat from Dura-Europos 1 and the mail remains from Vechten 2 (fig. 6.7) are good examples of the decorative trim application.

The rows of rings in a coat of mail run horizontally on the body and the sleeves (when the arms are spread; see chapter 9 & 10). Thus, the direction of the weave in a copper alloy fragment indicates whether it was placed horizontally or vertically on the garment (fig. 6.8). So, even when only the trim survives, it can still be determined whether it belonged to the neck, the hem (i.e. horizontal placement) or the sleeves (i.e. vertical placement). In Vechten, for example, the direction of the rows in the sole surviving fragment shows that it had a vertical placement on the mail coat, and therefore it must have been a sleeve's decorative trim.

Figure 6.9 includes all the finds that so far have been positively identified as decorative trims.[33] It also lists several other possible finds of trim. Five of the identified trim specimens have a vertical weave which means that they were placed at the edges of sleeves. One of the trims from Thorsberg 3 is entirely intact and makes a complete circle that reveals the circumference of the original sleeve, of 48 cm. The fragment from Vindonissa 1 (Switzerland) dated to the 1st century AD, is also interesting because it may represent some of the earliest physical evidence for sleeved coats of mail. For a large part of the 1st century AD the mail coat did not incorporate sleeves, but had two shoulder extensions at the back that were fixed onto the chest.[34] The vertically placed fragment from Vindonissa may have been a trim for a sleeve, just like the other specimens mentioned here, but another possibility is that it comes from the armhole or the shoulder extensions of a sleeveless coat of mail.

[32] The fragmentary nature of many of the mail remains often makes it difficult or impossible to determine the original placement or technique of the decorative application. For example, the small fragment in fig. 6.4 could have come from a decorative trim or from an inserted pattern.

[33] Some have erroneously suggested that the mail coat from Vimose had a trim of copper alloy rings. E.g. Bishop/Coulston 2006, 170; James 2004, 116. It consists however entirely of iron.

[34] Wijnhoven, 2015a, 94.

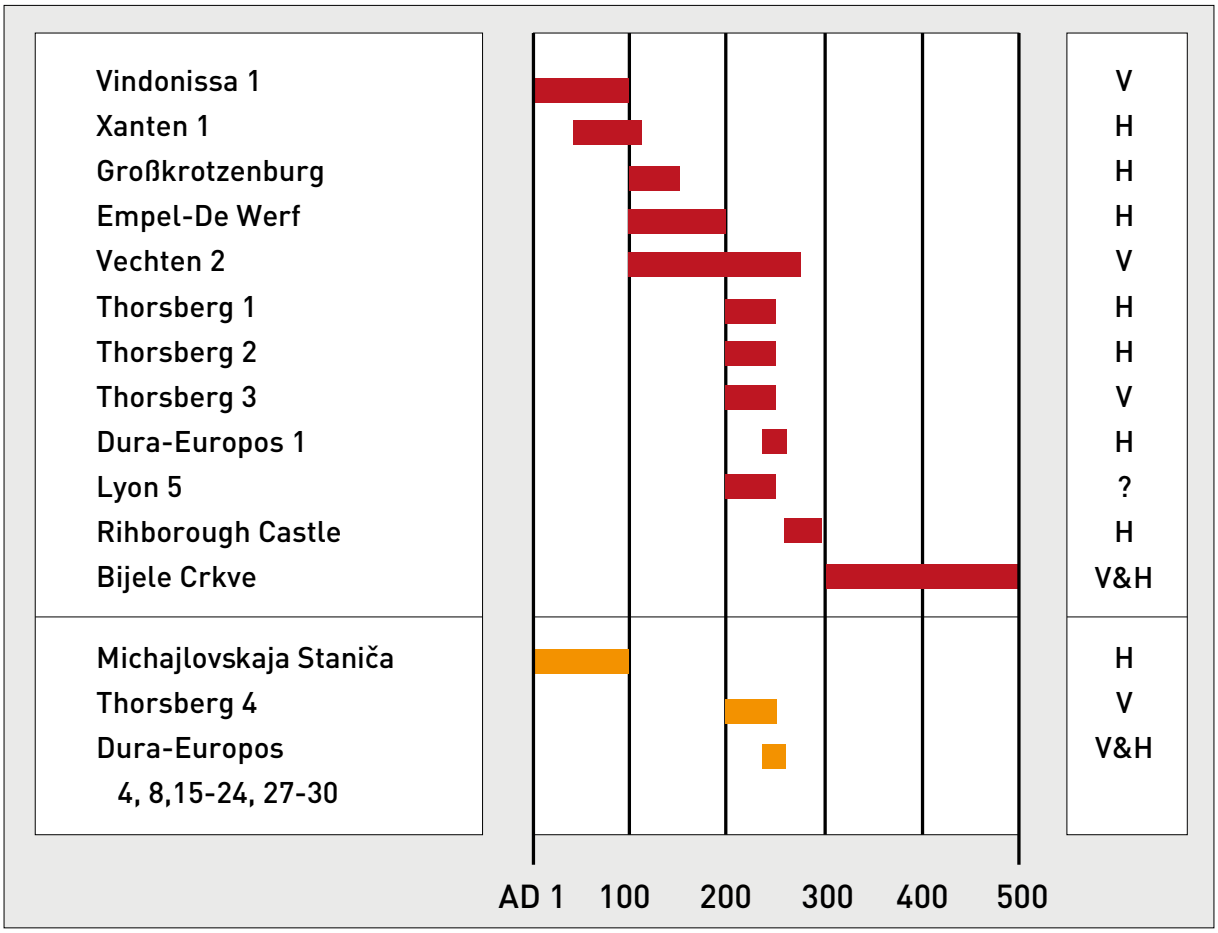


Fig. 6.9. Chronology of copper alloy trimming on mail armour. The top of the table lists all positively identified specimens, the bottom contains possible finds. The column on the right indicates whether it concerns vertical trim (V), horizontal trim (H) or a combination of the two.

The archaeological record has rendered a slightly higher number of horizontal trims, which were applied either at the opening for the head or at the lower hem of the mail coats. Out of the eight examples identified positively, two stand out in particular for their remarkably good condition, that is Thorsberg 1 & 2. The iron bodies of these two mail coats have disappeared but the trims which decorated the perimeter of the lower hems are not only intact, but also confirm that the armour had side splits to give the wearer more freedom of movement.

With regards to their chronology, many remains of copper alloy trims date to the 3rd century AD, partly due to the abundant material from Thorsberg and Dura-Europos. However, the earliest occurrences of decorative trims go back to the 1st century and their use continues well into the 3rd century AD. The find from Bijele Crkve is generally dated to the Roman period due to the lack of find context. However, the characteristics of its rings are typical for the Late Roman period (chapter 11), which might indicate an even longer tradition.

Interestingly, the application of a decorative trim is not limited to mail, but is also observed on segmented armour (*lorica segmentata*). For example, the Kalkriese and Newstead variants sometimes feature a copper alloy trim that contrasted with the iron plates of the armour.[35] This suggests that the use of contrasting trims may have been a more general trend or preference in Roman armour decoration.

[35] Bishop 2002, 23-29, 46-61, 77-78, 92.

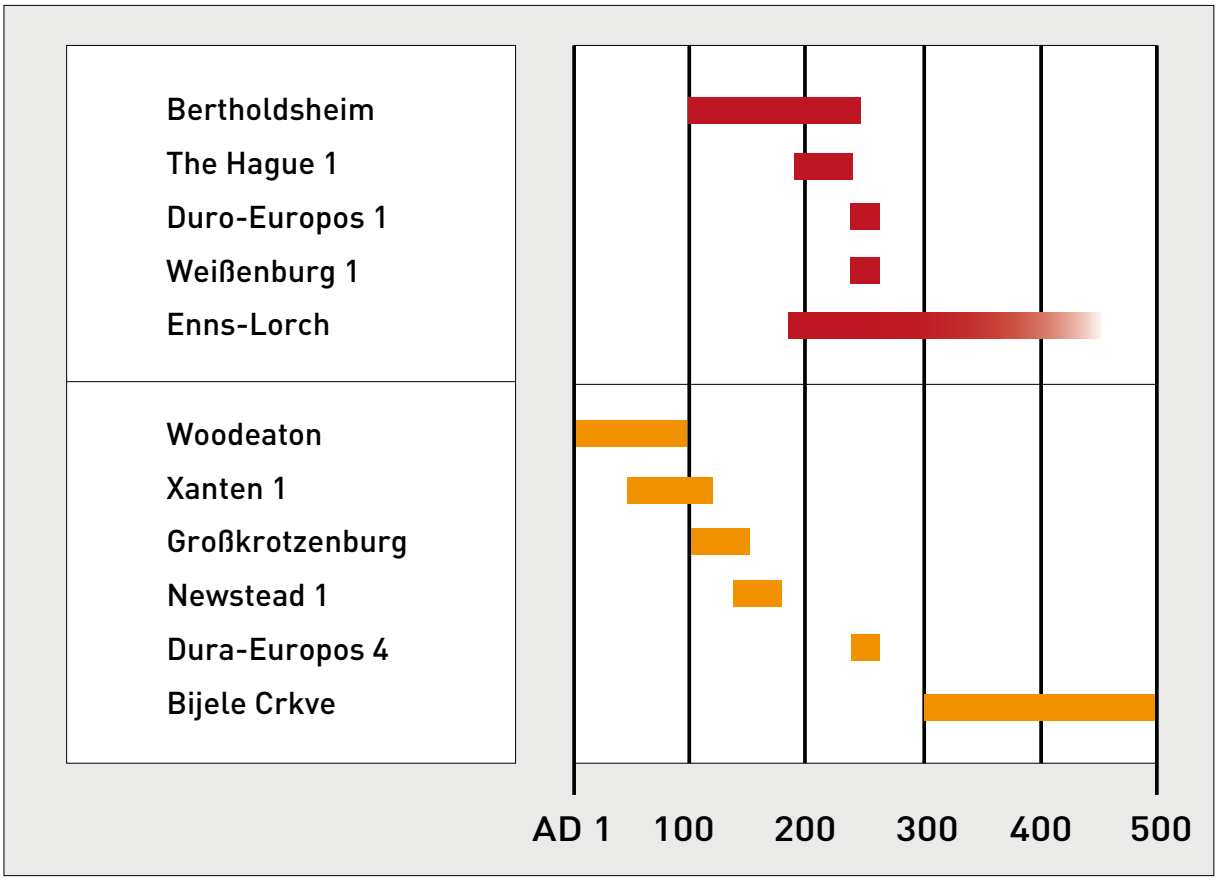


Fig. 6.10. Chronology of copper alloy pattern insertions on mail armour. Positively identified finds are listed at the top of the table and possible finds are at the bottom.

6.6 INSERTED PATTERNS

The second application of copper alloy rings involved inserting these into the iron mail weave to create a decorative pattern. The forked-shape design on the chest of the Dura-Europos coat is a good example of this technique and demonstrates that different applications could be combined in a single garment (fig. 10.19). The number of finds with copper alloy insertions is so far limited to five positive identifications, plus a few other possible examples (fig. 6.10).

Mail remains are generally found in poor condition, which makes it difficult to work out any designs on the weave. The Persian coat from Dura-Europos, with its fork pattern on the chest, is therefore exceptional. Another extraordinary case is the mail coat from Bertoldsheim, Germany (figs. 9.11). For one, this is the only coat of mail to have a set of chest plates to adjust the head opening, a feature more commonly associated with scale armour.[36] More relevant for our topic, it shows copper alloy rings forming horizontal and vertical lines in a criss-cross pattern. Jochen Garbsch, who published the find, thought that the chequerboard pattern ran throughout the entire coat (fig. 6.11).[37] Recent examination by the present author confirmed that the design consisted of intersecting horizontal and vertical lines, but also evidenced that the decoration was more complex and less repetitive than a criss-cross pattern all over the coat.

[36] Contrary to popular understanding, mail coats did not collectively adopt such chest plates during the 2nd-3rd century AD. So far the Bertoldsheim find is the sole mail garment discovered with this feature. Cf. Garbsch 2000.

[37] Garbsch 1984, 245-250, fig. 8.

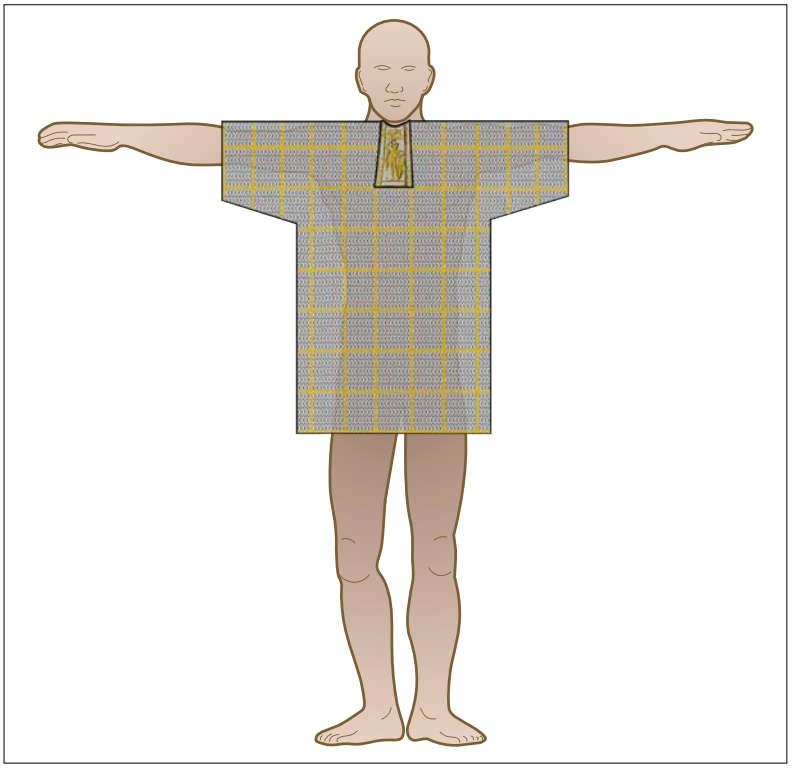


Fig. 6.11. Reconstruction of the Bertoldsheim coat of mail with ornamental pattern according to Jochen Garbsch. The width of the garment and the presence of sleeves are speculative (drawing M.A. Wijnhoven).

Fig. 6.12. Mail from Weißenburg 2, Germany, containing small clusters of copper alloy rings. Top right: the underside of the large fragment. Bottom right: close-up of a cluster (photograph M.A. Wijnhoven).

The remnants from The Hague 1, (fig. 6.3), Weißenburg 2 (fig. 6.12), and Enns-Lorch also contain decorative shapes that are difficult to make out. They are in fragmentary state and cannot be assigned to a specific part of the garment, which impedes determining the placement of the decoration. Nevertheless, all three display small clusters of copper alloy rings positioned at regular intervals from each other. This suggests that the decoration likely consisted of a repetitive geometric pattern. Figure 6.13 presents

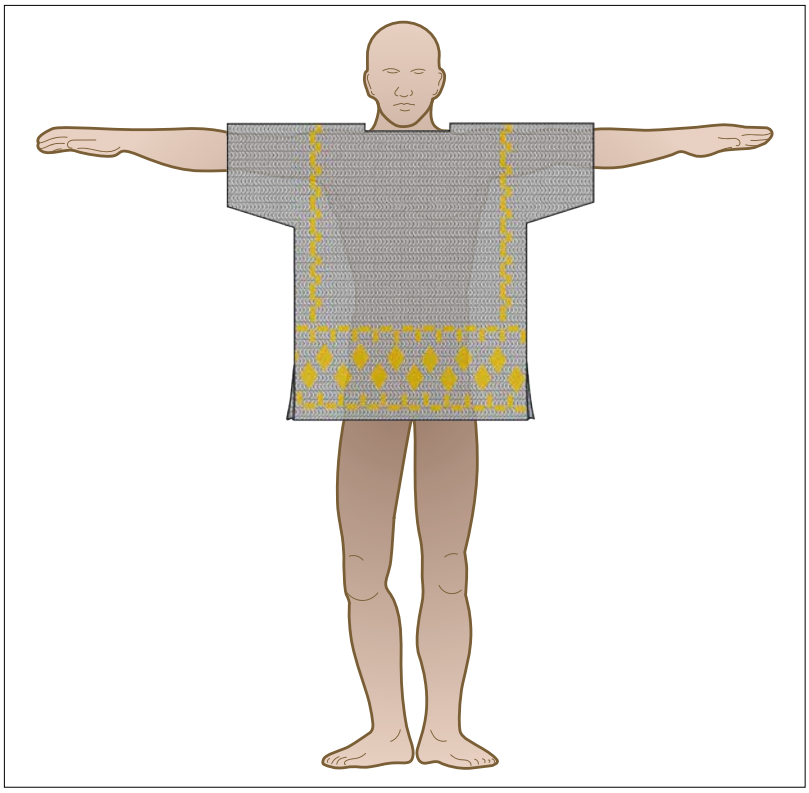


Fig. 6.13. Speculative reconstruction of a mail coat with repetitive geometric pattern insertions. The embellishment is partly based on the hybrid armour from Vize, Turkey (drawing M.A. Wijnhoven).

a speculative design that could be achieved by reiterating a geometric shape, to give the reader an idea of the sort of decoration that these coats may have had.

Regarding chronology, four out of the five finds where this application technique has been positively identified come from the 2nd to 3rd centuries AD. The fifth find, from Enns-Lorch, cannot be dated with accuracy. When only the specimens with positive identification are considered, the use of inserted patterns seems somewhat later than the decorative trims. However, this changes if the possible cases are also taken into account. In sum, the time frame of this decorative technique corresponds at least to the 2nd and 3rd centuries, but may have been in use for a much longer period.

6.7 CONTRASTING RIVETS

Mail from the Roman period consisted of two types of rings placed in alternating rows throughout the garment, namely riveted and solid rings. The former were made from small pieces of wire with overlapping ends closed by rivets. The third and last technique of copper alloy decoration concerns precisely these riveted rings. It constitutes a more subtle, though no less interesting application, involving the insertion of copper rivets in the mail iron rings (figs. 6.14 & 16). In this case, the domed heads of the rivets would have stood out as small dashes of colour on the mail garment.

Examples of Roman era iron mail with copper alloy rivets are found, once again, in Thorsberg and Dura-Europos, but also in Maastricht, The Netherlands, Oudenburg 1 & 2, Belgium, and Sisak 3 in Croatia. Figure 6.15 sums up the current evidence for this decorative technique, which appears to be a later phenomenon corresponding to the Late Roman period. All securely dated finds belong to the 3rd to 5th centuries and even surpass the Western Roman Empire. For example, Oudenburg 2 dates after the Roman occupation. Mail from Justiniana Prima in Serbia, dating to AD 535-610 also displays this feature. The latest incidence of this technique comes from the 7th century burial of Sutton Hoo, in the United Kingdom. Interestingly, this rich Anglo-Saxon grave contains various Late Roman and Byzantine

Fig. 6.14. One of various fragments of mail from Maastricht, with iron rings and copper alloy rivets (photographs Wim Dijkman).

artefacts, some original and some copied. It has even been suggested that these elements were supposed to display a connection between the deceased and the Roman emperors.[38] The presence of contrasting rivets in the Sutton Hoo mail shirt may be seen as a reference to earlier times, but perhaps the whole coat of mail was an actual old Roman piece.

The subtle nature of this ornamentation technique means that its presence is nowadays hard to recognize through mere visual examination. The copper alloy rivets at Sutton Hoo and Oudenburg were only revealed by X-ray analyses. Since the majority of iron mail coats have not been examined in this manner, it is possible that the number of identified cases is an underestimate of its true occurrence among surviving mail remnants.

So far, the finds portraying this type of decoration have been either fragmentary or heavily corroded, rendering it difficult to determine how it would have been applied. The multiple finds from Thorsberg are able to shed some light on this matter. Some of the surviving rings from Thorsberg 11 had rivets made of copper alloy, but others were made of iron, which indicates that the copper alloy rivets were applied only to certain areas of the mail coat and not to the entire garment. Sutton Hoo shows a similar situation.[39]

Furthermore, the Thorsberg 4 material concerns the remains of a sleeve's decorative trim, made of copper alloy rings. A small section of the trim is still attached to two iron rings, one of which still has

[38] Filmer-Sankey 1996.

[39] Bruce-Mitford 1975, 236-237, fig. 181.

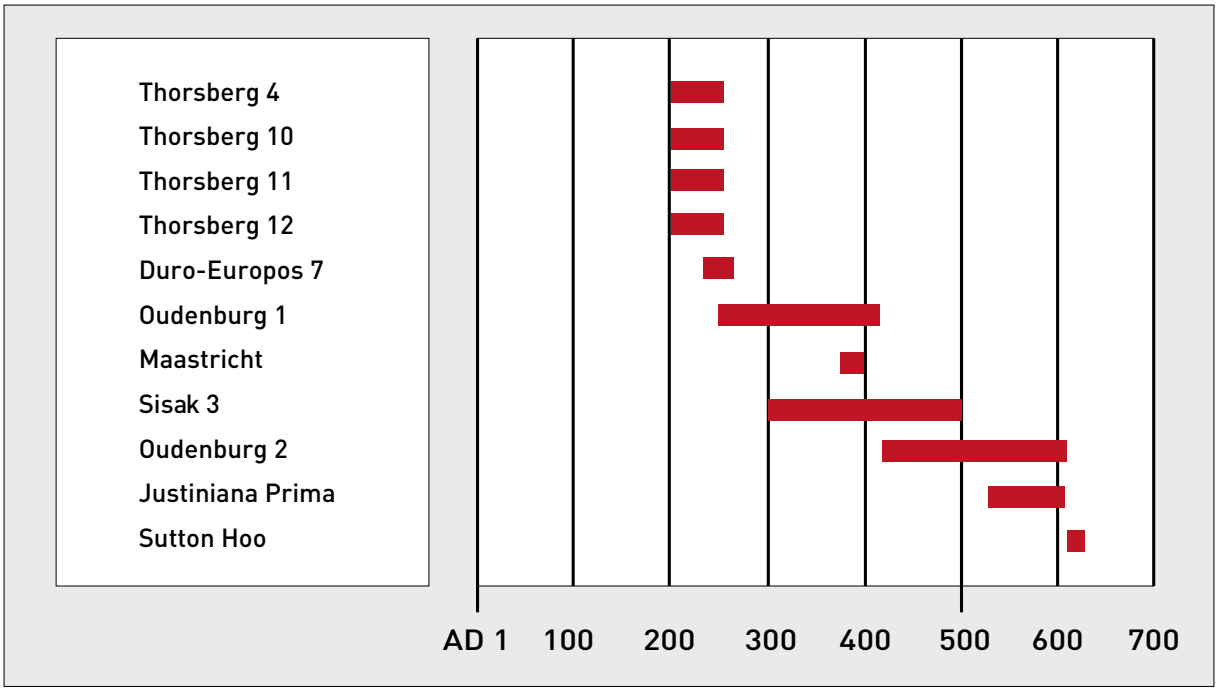


Fig. 6.15. Chronology of the finds with contrasting copper alloy rivets.

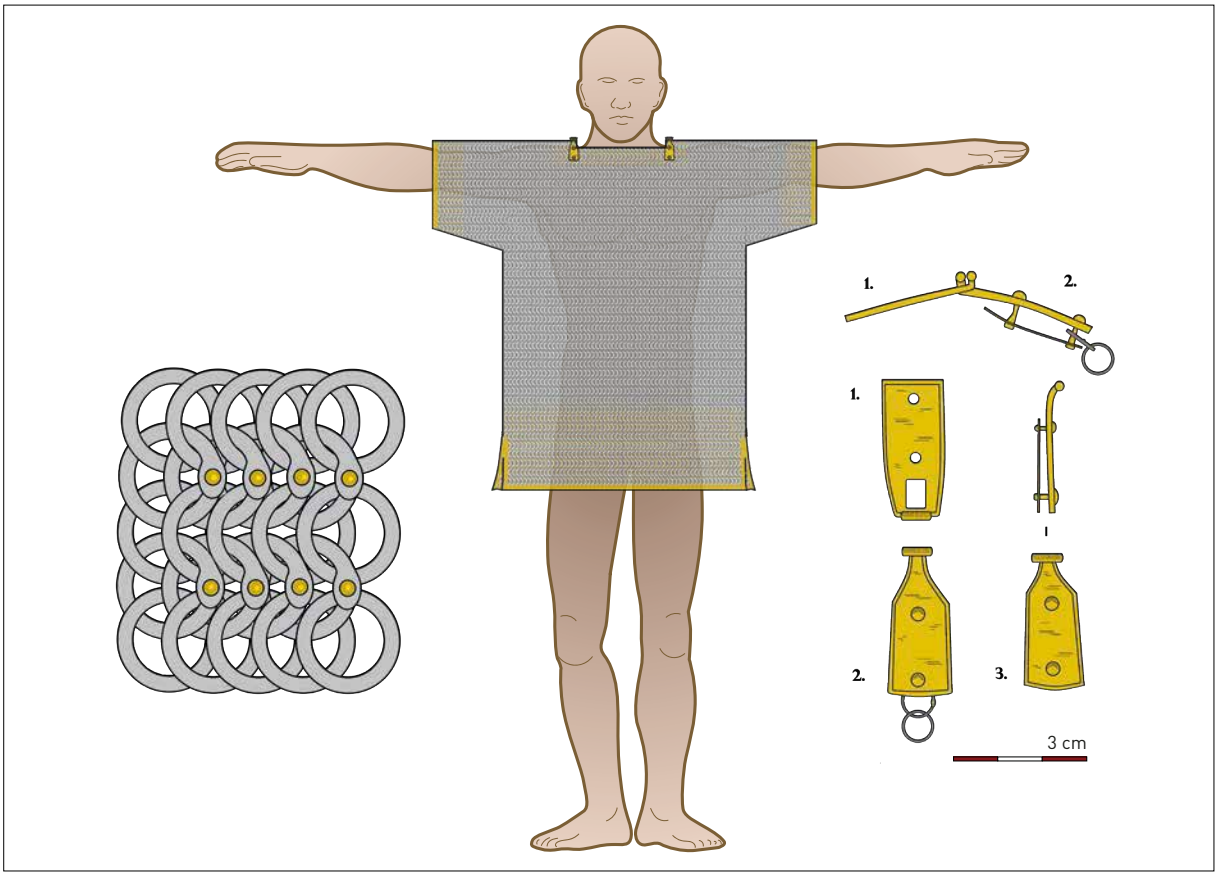


Fig. 6.16. Interpretative reconstruction of a coat of mail from Thorsberg with contrasting rivets. This decorative technique is restricted to the bottom hem and sleeves, which all end in a copper alloy trim. Contrasting rivets are also found at the neck, where two sets of fixtures regulate the head opening (drawing M.A. Wijnhoven).

its contrasting copper alloy rivet. This demonstrates that, in the 3rd century, a single coat of mail could exhibit both a decorative trim and contrasting rivets.[40] It also reveals that the contrasting rivets of the Thorsberg piece were placed, at least, near the sleeves' edges.

Thorsberg 12 contains two sets of mail coat fixtures, constituted by small copper alloy plates (fig. 6.16) with one half ending in an eye and its matching half ending in a hook.[41] These fixtures originate from a single coat and were originally placed at the shoulders, where they regulated the width of the neck opening.[42] One of the two iron rings that still hang from one of the fixtures bears a copper alloy rivet. Thus, Thorsberg 12 illustrates that contrasting rivets were also applied next to the neck opening. This piece, however, shows no evidence of a decorative trim, like Thorsberg 4.

By putting several of the Thorsberg finds together we are able to get a reasonable understanding of how the decorative contrasting rivets would have been applied in a coat of mail. However, this information is so far restricted to the 3rd century AD and it may not be representative for later centuries.

Fig. 6.17. Reconstruction of the hybrid armour from Vize, as seen when worn (drawing A.E. Negin).

6.8 DECORATION OF HYBRID ARMOUR

Hybrid armour, consisting of an outer layer of scales attached to a mail backing, differs in the choice of material from mail.[43] The main material for hybrid armour could be either copper alloy or iron, although the former is the most prevalent of the two in the archaeological record (table 6.2). So far 12 of the 20 known finds of this type of armour are entirely (scales and mail rings) made from copper alloy.

The material for the mail backing consists always of a single metal and is predominantly copper alloy, although iron is observed in the examples from Usk, Augsburg, Jerusalem and Rome. Almost all the scales in hybrid armour are made from the same material, indicating that they contained no decorative patterns. The only three exceptions are the fragment from Healam Bridge in the United Kingdom, the complete armour from Vize and the aforementioned specimen from Augsburg. In the latter two the majority of scales are copper alloy with the iron scales positioned in such a manner that they form a very rich decoration.

The ornamentation of the Augsburg and Vize armour are much alike, but not identical.[44] Both are embellished with patterns of a geometric design by making use of a combination of three decorative elements. These are:

[40] This assertion is reinforced by a principal component analysis, which indicates that the finds of decorative trim (Thorsberg 1-4) may have come from the same garment(s) as those with contrasting rivets (Thorsberg 4-7). Cf. Matešić 2015, 214-218.

[41] Matešić 2015, 520-521.

[42] Wijnhoven 2015a, 98.

[43] Wijnhoven 2009a; 2016.

SITE	SCALES		MAIL RINGS		DATE
	copper	iron	copper	iron	
Vize	X	X	X		AD 35-50
Augsburg	X	X		X	Claudian-Neronian (AD 41-68)
Usk 7		X		X	Neronian (AD 54-68)
Usk 8		X		X	Neronian (AD 54-68)
Usk 9		X		X	Neronian (AD 54-68)
Usk 10	X		X		Neronian (AD 54-68)
Jerusalem	X			X	c. AD 70
Nijmegen 3	X		X		AD 70-104
Nijmegen 4	X		X		AD 70-125
Nijmegen 5	X		X		AD 70-104
Ouddorp	X		X		after AD 75
Xanten 3	X		X		1st - early 2nd century AD?
Newstead 4	X		X		Antonine (AD 138-161)
Healam Bridge	X	X	X		2nd century AD
Dülük Baba Tepesi	X		X		before mid-3rd century AD
Near Rome		X		X	-
Mandeure	X		X		-
Bulgaria? 3	X		X		-
Unprovenanced 1	X		X		-
Unprovenanced 2	X		X		-

Table. 6.2. Finds of hybrid armour and the type of metal used for their components.

- diamond-shapes built by a 1-2-3-2-1 pattern of iron scales.
- horizontal lines made from a single row of iron scales (1-1-1-1 pattern).
- vertical lines formed by a 1-2-1-2 pattern of iron scales.

Vize is the most complete and best preserved armour of the two, which allows its decoration to be reconstructed with relative ease and certainty (fig. 6.17). The decoration on the front (i.e. the extremities of the shoulder guards) is mimicked on the upper back. A similar motif decorates the bottom of the armour. The decorative band is slightly wider on the front than at the back. On both sides the lower and upper motifs are connected by two vertical lines that resemble *clavi* found on Roman tunics, although this may just be coincidental.

Only the top part of the Augsburg armour is preserved, but its decoration can be almost completely reconstructed (fig. 10.23). Just as in the Vize armour, the pattern on the shoulder guards is mirrored on the back. One of the differences in decoration between the two pieces of armour is that the Augsburg one covers more, or possibly the entire width, of the guards. The lower part of the Augsburg armour no longer survives, but a partial vertical line of iron scales runs from the decoration at the shoulder blade downwards, which must be akin to the four vertical lines observed at Vize.

The Vize and Augsburg armours date to AD 35-50 and the mid-1st century AD respectively,[45] while that from Healam Bridge is from the 2nd century AD. Despite this limited number of finds it is possible to conclude that hybrid armour could have been decorated throughout the 1st and 2nd centuries AD, which entails more or less its entire lifespan.

[44] The reconstructions of the decoration of both armours are based upon the extensive notes of Jürgen Driehaus, which were posthumously published. Cf. Driehaus *et al.* 2012, 364-366, 383.

6.9 DECORATION OF 'MINIATURE MAIL'

One specific variant of mail that bears much resemblance to the hybrid armour may be termed 'miniature mail' based on its very small ring diameter.[46] The rings in miniature mail are similar in size to those on the backing of hybrid armour, and the main difference is that there are no scales present (fig. 6.18).

The time frame for miniature mail (table 6.3) is similar to that of hybrid armour and the majority of finds fall into the 1st and 2nd centuries AD. The resemblances between the two armour types, both in the size of their components as in their occurrence through time, make it likely that they were part of the same armour making tradition.

Some miniature mail may actually represent hybrid armour from which the scales have become detached. For example, a fragment from Nijmegen 3 which was originally considered a piece of very fine mail, turned out to be hybrid upon closer examination.[47] It was the presence of only two difficult-to-observe partial scales embedded among the rings that revealed its hybrid nature, even though the remainder of the scales were no longer present.[48]

Whereas the main material for mail is iron and that of hybrid armour is copper alloy, miniature mail does not appear to favour one metal over the other. Iron and copper alloy are both common as main material. Up to present no large fragments or complete armour of miniature mail has been found, making it hard to say how these were embellished. We are nonetheless certain that they were at times decorated, since three out of the twelve finds consist of fragments that combine iron with copper alloy rings. This is also a strong indication that certainly not all miniature mail concerns hybrid armour with their scales now lost, because all known hybrid finds employ a single material for the mail backing.

SITE	MATERIAL		RING DIAMETER	DATE
	copper	iron		
Gurzuf Saddle Pass	X	X	3-4 mm (58 fragments)	30 BC - AD 50
Şimleu Silvaniei		X	4 mm	100 BC - AD 100?
Conthey	X	X	3.5-4 mm	15 BC - AD 50
Dangstetten 1		X	3.1 mm (3 fragments)	15/12 - 8 BC
Colchester 1	X		unspecified	AD 49 - 61
Chester 2	X		3-4 mm	AD 74 - 200
Usk 1, 4, 6		X	2.4-3 mm (11 fragments)	AD 54 - 68
The Lunt – Baginton 1	X		3 mm	AD 60 - 79
Nijmegen 1	X	X	3.7 mm	AD 70 - 120
Xanten 2	X		3 mm	1st - early 2nd century AD?
Mainz 1		X	4 mm	2nd century AD
Samothrace		X	3 mm	-

Table 6.3. Finds of miniature mail with rings up to 4 mm in diameter.[49]

45 Bakker 1985, 90; Driehaus 1968, 15-16; Weber 1793, 68.

46 Miniature mail is here defined as having a maximum outer ring diameter of 4 mm.

47 Wijnhoven 2016a, 77, fig. 4.

48 Similarly the hybrid armour from Xanten 3 has now only two partial scales attached. Cf. Lenz 2006, 20.

49 The mail coat from Es Soumâa has not been included. Waurick (1979, 318-332) reports that it is a solid block of mail and is estimated to have 3-4 mm rings at its surface, while X-rays demonstrate the presence of 7-9 mm rings at its core. Its condition and the two reported diameters make me hesitant about the accuracy of the observations.

Fig. 6.18. Fragment of mail from Nijmegen 1 consisting of very small rings with an outer diameter of approximately 3.7 mm (photograph M.A. Wijnhoven).

6.10 DECORATIVE HEMS

The iconographic record shows an additional type of embellishment for the mail coat, other than the use of contrasting metals. As discussed in chapter 4, representations from the 2nd century AD often depict mail armour with decorative vandyked hems. So far, there is no conclusive physical evidence for this decorative technique among finds from antiquity. Although mail from the Late Middle Ages and Early Modern period indicates that this embellishment could easily be achieved (fig. 6.19). Many pieces feature vandyked borders made from iron rings, like the rest of the garment, or fabricated from contrasting copper alloy links.[50]

The evidence for vandyked borders in antiquity is so far only iconographic, with no conclusive archaeological examples. It is worth mentioning that some Roman triangle-shaped fragments of mail have come to light, but it is unknown whether these can be understood as vestiges of a vandyked mail coat. Among the mail remains from Bijele Crkve in Serbia there is a fragment that appears to be triangular (fig. 6.20).[51] Unfortunately it is too small to determine whether this shape is manmade or rather the coincidental result of the partial survival of the piece. Several fragments of ring weave from Lydney in the United Kingdom have been speculated to form part of a ceremonial headdress.[52] Two of the ringed fragments are arrow-shaped, i.e. they consist of a triangle attached to a rectangular chain of rings. The fragments are woven in a 4-in-1 pattern, as usually seen in mail armour (see chapter 9), but they probably do not come from a piece of defensive equipment. Although their function remains

[50] Burgess 1957, 201; Laking 1920, 177-181; Scalini 1996, 190.

[51] Hoffiller 1911-2, 123-5, fig. 43.

[52] Wheeler/Wheeler 1932, 91, pl. 30b.

Fig. 6.19. Painted wood-carving of a knight dating to approximately AD 1600, now in the Museum der Stadt, Worms. The knight wears a helmet and has a vandyked mail standard for the protection of his neck and upper body (photograph M.A. Wijnhoven).

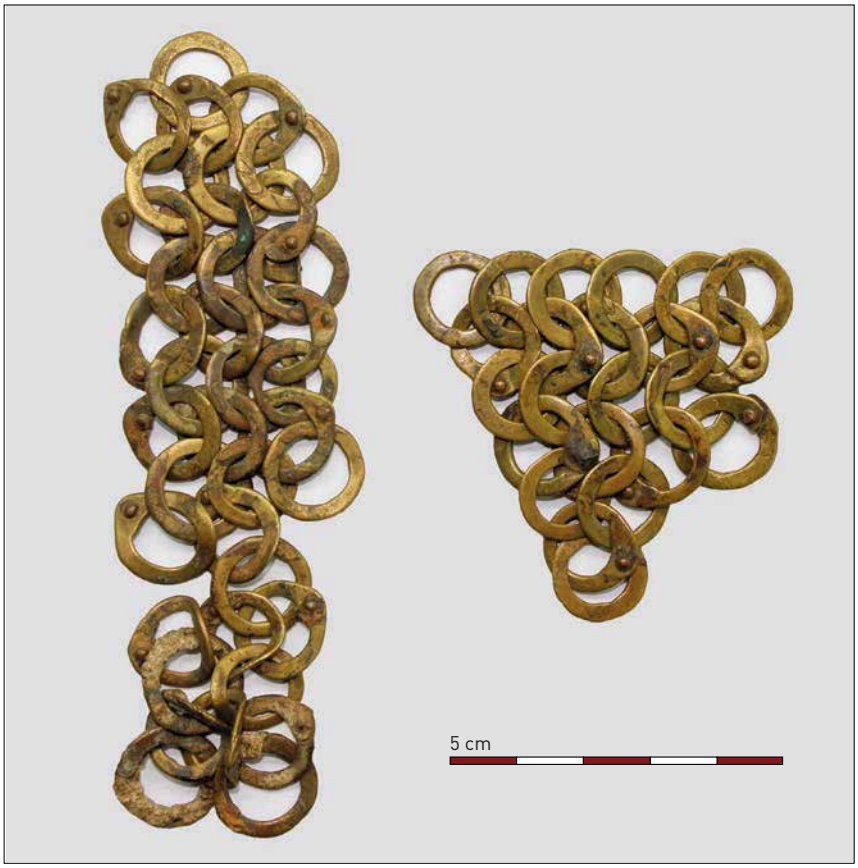


Fig. 6.20. Copper alloy fragments of mail from Bijele Crkve, probably dating to the Late Roman period. The left fragment belongs to a decorative border from a sleeve as indicated by the direction of the mail weave. The right fragment is more or less triangle-shaped (photograph M.A. Wijnhoven).

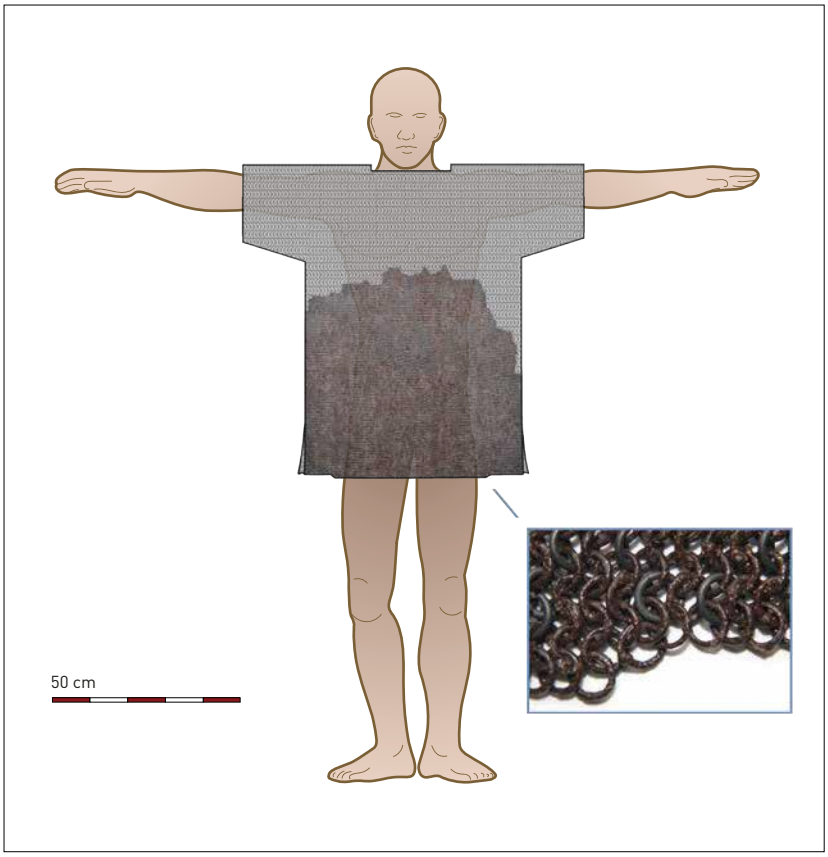


Fig. 6.21. The coat of mail from Novae with a stepped hem (image M.A. Wijnhoven).

uncertain, the pieces do show that the Romans had the skills to make triangle-shaped pieces of ring weave.

One specimen from Novae in Bulgaria demonstrates that the hems of Roman mail coats were not necessarily either entirely straight or vandyked, but could also have a stepped hem (fig. 6.21).[53] Each side of the Novae coat has a split from which several centimetres down, the hemline suddenly deepens by two ring rows, offering just a bit more coverage. The stepped hem is a feature that had never before been recorded among Roman mail. It is unlikely that these steps, no larger than two rows deep, would have made an actual difference regarding protection or mobility. It is more probable that the stepped hem was an embellishment, giving the otherwise straight hem a gentle curve.

6.11 COLOURFUL ROMAN ARMY

Our modern idea of the coat of mail is mostly as a functional piece of equipment. This chapter has presented evidence that there is much more to mail garments than sheer practicality. The earliest evidence for the decoration of mail stems from the latter part of the 1st century BC. The overview shows that the Romans probably started with the decoration of mail by using copper alloy rings that contrasted with the iron body. The material evidence for the employment of copper alloy in mail armour indicates that particularly members of the Roman army frequently invested in this type of embellishment. Besides the various forms of decoration using contrasting metals (whether in mail, hybrid armour or 'miniature mail') there is also some evidence that a coat of mail could be ornamented by altering its straight hemline.

[53] Wijnhoven 2015b.

7 Padded garments

'And first, they must have for the said jacks, thirty or at least twenty-five folds of cloth, and a stag's skin, at least those of thirty with the stag's skin being the best. Cloth that has been worn and rendered flexible, is best for this purpose, and these jacks should be made in four quarters. The sleeves should be as strong as the body… Thus shall the wearer float, as it were, within his jacket at ease; for never have been seen half a dozen men killed by stabs or arrow wounds in such jacks, particularly if they be troops accustomed to fighting.'
The Ordinances of Louis XI of France (AD 1461-1483)[1]

7.1 THE ADVANTAGES AND DISADVANTAGES OF FLEXIBLE ARMOUR

One of the main reasons that mail remained a highly popular type of armament throughout the ages is probably that, due to its flexibility, it offers proper protection while allowing the wearer to move freely. One of the drawbacks of a flexible mesh, however, is that while it provides excellent defence against slashing and cutting, and performs reasonably against stabbing, it cannot fully avert (high-velocity or heavy) projectile points. Likewise, it offers little protection against blunt force trauma, in contrast to plate or segmented armour which are able to redirect the blow force to a larger area. In brief, mail is perfectly able to withstand the cutting action of a sword, but it will not protect the wearer against its impact, which can still cause considerable damage like broken bones.

For that reason, during the Middle Ages the coat of mail was never a standalone armour, but was complemented by a padded garment worn underneath (fig. 7.1). The padding provided an extra layer of defence offering both resistance and more depth to deter stabbing and projectiles,[2] and it greatly reduced the risk of blunt force trauma as it absorbed much of the impact. In addition, padding made mail armour more comfortable to wear, offering protection against pinching and chafing by movement. It also helped distribute some of the weight of the mail coat, which mainly fell on the shoulders and hips. Lastly, a padded garment shielded clothing from the continuous friction of the metal armour.

Medieval mail and other kinds of armour were always worn alongside some form of padded undergarment. There was a large variety of them, with names like gambeson, aketon, jupon, padded jack, pourpoint, lambrequins and arming doublet.[3] Padded or quilted armour could even be used on its own, providing a cheaper and effective alternative to metal armour. Although the written and iconographic sources suggest that padded armour was widely used during the Middle Ages, only a handful of examples survive.[4] Information from texts and the surviving specimens indicate that medieval padded garments were made according to two basic methods. The first consisted of multiple layers of textile, sometimes as

1 Meyrick 1824, 140-141.

2 E.g. Jones 2014, 70.

3 Most of these concern different types of padded or quilted armour, but as with many medieval terms, some of them were used interchangeably or can refer to the same type of armour.

4 The best-known are the jupon of the Black Prince from c. AD 1370, the jupon of Charles VI of France from about AD 1380, an arming doublet from the 15th century in the Kienbusch collection, and the 14th-century pourpoint of Charles de Blois. Cf. Arnold 1993; Blair 1958, l. 29; Blanc 1997; Kelly 2013.

Fig. 7.1. This illumination from AD 1410 shows the padded garment under the mail coat. The combination of mail and padding would offer good protection against different types of trauma. In this case, the mail coat is lifted in order to deliver a fatal stab. The illumination shows Persian king Artaxerxes killing Artabanus in 465/464 BC. Despite the early date of this event, all participants are donned in contemporary armour befitting the early 15th century. Folio 104v in *Des cas de nobles hommes et femmes* by Giovanni Boccaccio, in the Bibliothèque de Genève.

many as thirty, quilted together. The quote at the start of this chapter from the Ordinances of Louise XI of France gives a good description of this quilted multi-layer technique. The second involved two layers of fabric filled with a soft material such as wool, rags, cotton, flax or animal hair, which were then quilted by stitching. This method is for example described by Dominic Mancini when discussing the archers of Richard III in 1483:

Fig. 7.2. Figurine of a warrior wearing a tube-and-yoke cuirass (510-490 BC). Although the raw material of these cuirasses is still debated, as leather or textile, the name *linothorax* suggests that at least some of these corselets were made from linen. Museo Nazionale Etrusco, Rome (photograph M.A. Wijnhoven).

'They do not wear any metal armour on their breast nor any other part of their body, except for the better sort who have breastplates and suits of armour. Indeed, the common soldiery have more comfortable tunics that reach down below the loins and are stuffed with tow or some other material. They say that the softer the tunic the better do they withstand the blows of arrows and swords, and besides that in summer they are lighter and in the winter they are more serviceable than iron.' [5]

Based on medieval written sources and iconography, medieval armour studies usually point to the 12th century AD as the earliest occurrence of the padded undergarment,[6] although it is admitted that an earlier date could be possible. Nevertheless, given the many advantages of using a padded garment underneath the mail coat, we might assume that this practice also existed in antiquity. Moreover, there already was a long tradition of textile armour: for example, the linen corselets known as *linothorax*, which were a type of tube-and yoke-cuirass worn in most of the Mediterranean from the Archaic to the Hellenistic periods (fig. 7.2).[7] The basic design of the early mail coat was even modelled after the tube-and-yoke cuirass. Cornelius Nepus still recalls linen corselets during the 1st century BC, long after they had fallen out of fashion, and attributes their introduction into the Greek warrior panoply to the Athenian general Iphicrates in the 4th century BC. The comment of Cornelius Nepus testifies that the Romans knew of this armour.[8]

That the protective qualities of textile were well understood by the Romans is made clear when Pliny the Elder - discussing the properties of different types of linen - mentions that linen from Cumae is able to 'turn the edge of a steel knife'.[9] What is more, Roman soldiers turned to soft armour for additional protection when needed, as illustrated in Caesar's *Civil wars*:

'…a great dread of the arrows fell on them and to avoid the missiles nearly all the soldiers had made themselves jerkins or other protections out of felt, quilt or hide to defend them against the weapons.' [10]

5 *De occupatione regni Anglie per Riccardum tercium*; translation Armstrong 1936, 99.

6 E.g. Blair 1958, 33; Edge/Paddock 1988, 45-46.

7 Aldrete *et al.* 2013; Gleba 2012; Jarva 1995.

8 *Iphicrates* 1.4.

9 *Naturalis historia* 19.2.11; translation Rackham 1961, 427.

10 *Commentarii de bello civili* 3.44; translation Peskett 1957, 261.

Caesar's account, however, alludes to a provisional solution against a sudden threat, rather than to the standard use of textile protective garments.

Although these examples are no proof for the existence of padded garments under the mail coat, they do demonstrate that the concept of textile armour was well established in antiquity. Archaeological evidence is not easy to come by, since a padded garment from a perishable material does not preserve well, as evidenced by the very few late-medieval specimens that survived. But if we combine different sources of information, including archaeological, textual, iconographic, and experimental, the result suggests the existence of some padded undergarment in antiquity. This has led several scholars to conclude that the use of a padded garment underneath the metal armour was well-known during the Roman period,[11] refuting the idea that padded garments worn under metal armour go back no earlier than the 12th century AD.

7.2 HIMATION, THORACOMACHUS, SUBARMALIS AND CIMMERIAN TUNIC

The most convincing evidence for the existence of a padded undergarment in antiquity is found in written sources. Particularly the relatively unknown and somewhat later Byzantine military manual *Peri strategias* (9th century AD, anonymous author) provides an explicit description to such an item. Discussing the equipment of the soldier, he mentions:

> *'It [the armour] should not be worn directly over ordinary clothing, as some do to keep down the weight of the armour, but over a garment at least a finger thick [c. 1.95 cm according to Byzantine system of measurements]. There are two reasons for this. Where it touches the body the hard metal may not chafe but may fit and lie comfortably upon the body. In addition, it helps to prevent enemy missiles from hitting the flesh because of the iron, the design, and the smoothness, but also because the metal is kept away from the flesh.'*

Several lines later, he closes and reaffirms:

> *'So that the rough material does not chafe the skin, they should wear padded garments under them, as we recommended for iron breastplates and other items. The thickness of the cloth also makes it more difficult for missiles to penetrate, or at least penetrate deeply, into the body.'* [12]

The anonymous author refers to this garment as *himation*, which in Ancient Greek was also applied to a heavy draped type of civilian clothing that functioned as a cloak. The context makes it clear that *himation* should be understood here as a padded garment. Earlier sources from the 6th century also mention the *himation* in a military context. Notably, Maurice in his *Strategikon* emphasizes that a cavalryman should have a broad and full *himation* cut to Avar pattern and made of linen, goat's hair, or rough wool.[13] Similarly, Procopius mentions that Roman bodyguards prepared to fight by putting on their *himatia* and taking up their weapons.[14] In the last two examples, it is uncertain whether the *himation* should be interpreted as a piece of clothing or as some type of padded armour, but the latter is a strong possibility.

De rebus bellicis is another anonymous work that makes a direct reference to padding. This manual probably dates to the 4th century AD and is dedicated to a variety of war machines that, at least accord-

[11] Bishop 1995; Ulb 2006, Sumner 2009, 170-175; Speidel 2007; Stephenson 2006, 57-63.

[12] *Peri strategias* 16.20-27, 59-63; translation Dennis 1985, 55, 57.

[13] *Strategikon* 1.2.

[14] *De bello Vandalico* 3.23.14.

ing to the author, were used by the Roman army at the time. Many of the contraptions described are probably imagined rather than real, rendering *De rebus bellicis* a somewhat unreliable source. Nonetheless, its description of the need and applications of a padded garment corresponds well with modern insights and the medieval narrative on the purpose of padding under armour, lending credibility to the statements on this particular subject. The writer uses the Greek name *thoracomachus* for this armament, of which he states:

> *'The ancients, among the many things which, in their forethought for prosperity, they devised for use in war, prescribed also the thoracomachus to counteract the weight and friction of armour: it is amazingly useful for protecting the body. This type of garment is made of thick woollen cloth [i.e. felt] to the measure and for the protection of the upper part of the human frame; fearful apprehension, guided by cleverness, devised it, so that, after it has been put on first, the lorica, or the cliuanus, or something similar, cannot injure the frail body by the roughness and weight; and again, the limbs of the wearer, helped by this means of relief, will be able to do their work amidst the difficulties of warfare and cold weather. But in any case, so that the thoracomachus may not cause problems for the wearer with its increasing weight when it is soaked with rain, it will be advisable to put over on top a covering garment made of nicely-treated Lybian hide[15] in the shape of the thoracomachus itself. So when, as we have said, the soldier has donned this thoracomachus (which has adopted this name from the Greek because it protects the body) and has put on his socci, too (that is, boots), and iron greaves, with a helmet on his head and a shield and a sword fitted to his side and has caught up spears/javelins in his hand he will be fully armed to enter an infantry battle.' [16]*

Interestingly, this author mentions that the *thoracomachus* was from felt. The application of this material is unheard of in medieval padded garments, but its physical properties make felt well-suited for padding. Judging by other evidence from the Roman period, the use of felt as padding should be considered a real possibility. For example, the aforementioned quotation by Caesar points out that one of the various materials employed to fabricate their padded jerkins was felt. Also, Pliny the Elder mentions felt as a means of bodily protection: 'Self-felted fleeces make clothing, and also if vinegar is added withstand even steel, nay more even fire'.[17] How vinegar was supposed to increase the protective value of felt remains unclear and may be regarded as an old wife's tale. However, modern day felt-making sometimes employs vinegar to enhance its qualities. The soap applied to facilitate the felting is alkaline and disturbs the pH value. By soaking the felt in a bath of water mixed with vinegar the pH value becomes neutral producing a higher quality, longer-lasting felt.[18]

De rebus bellicis also contains an illustration of the *thoracomachus* and the Lybian hide. Medieval hand-written copies depict both as plain T-shaped tunics - corresponding to the descriptions of one being made of felt and the other of leather – but in early printed versions from the 15th century they are represented as quilted (fig 7.3). It is very likely that the illustrator of this later version offered his own

[15] The Lybian hide was probably made of goat or sheep leather. Leather as a material for waterproofing was well-known in Roman times, as evidenced for example by its use in making military tents.

[16] *De rebus bellicis* 15.1-2. Translation is a compilation of Bishop 1995, 1; Ireland 1979, 32-33; Stephenson 2006, 50.

[17] *Naturalis historia* 8.73.193; translation Rackham 1956, 135.

[18] Interestingly, a medieval work by Nicetas Acominatos in AD 1204-1210 also refers to vinegar to make the linen (felt) garments of a crusader resistant to weapons: 'The linen was steeped in sour wine mixed with a certain quantity of salt. As many as eighteen thicknesses were laid on each other and worked together, as they make felt. No arrow could pierce a cuirass made in this manner'. The original work by Nicetas is now lost, but this citation was found in a 1647 commentary on Suetonius by Isaac Casaubon while discussing the linen breastplate of Galba.

Fig. 7.3. The *thoracomachus* and Lybian hide as illustrated in early printed editions of *De rebus bellicis*. In the printed edition these garments were given a contemporary quilted appearance (1590 edition, M.A. Wijnhoven library).

understanding of a padded garment which in the 15th century would have been quilted. Likewise the soldier in the illustration wears the typical contemporary padding of the time with extra puffed sleeves.

Earlier evidence of a possible padded undergarment is found in an instance of everyday military correspondence found on a tablet written in ink at Carlisle, from the early 2nd century AD.[19] In it, a decurion named Docilis writes to the prefect of his *ala* listing the spearmen in his unit who lack spears

[19] Carlisle tablet H476, inv. no. 14.

or pieces of armament. Among them, he repeatedly mentions *subarmales* (*sub* meaning 'under' and *arma* is 'equipment'),[20] which probably is a sort of padding worn under the armour. At times he speaks about the smaller *subarmales*, suggesting that there were several types. A smaller or shorter garment would be fitting, since the spearmen mentioned in the letter were probably horsemen. Remarkably, Docilis consistently lists pairs of *subarmales*, which may indicate that two were worn together. It has been suggested that *De rebus bellicis* provides a clue as to how to understand these pairs, that is as a padded undergarment worn alongside an item of clothing that protected the armour against the rain.[21]

Other documents also mention the *subarmalis*. A tablet from the military fort of Vindolanda, contemporaneous with that from Carlisle, contains a list of clothing supplies among which is a *subarmalo*.[22] This term also appears three times in a much later work, the *Scriptores historiae augustae*, probably from the 4th century AD. It states, for example, that when Septimius Severus entered Rome, he ordered the Praetorian Guard to come out and meet him wearing nothing but a *subarmalis*.[23] The other two passages similarly indicate that the *subarmalis* was a type of clothing, likely to be worn underneath the armour.[24] The term seems to have been in use for at least several centuries, because as late as the 5th century Martianus Capella still applies it in military terminology to describe the figure of Rhetoric.[25] The long use and occurrence of this term in books and correspondence give credence to the idea that the *subarmalis* was a widespread item among the Roman army.

Another allusion to soft armour can be found in Arrian's *Tactica*,[26] from the first half of the 2nd century. There, he describes the equipment of the Roman cavalry during the horse games, or *hippika gymnasia*, which took place on the parade grounds and consisted of difficult manoeuvres and exercises which tested the skills of the horsemen at handling weapons like spears and javelins while riding. Although only dummy weapons were used, the throw and the added momentum of the horse would cause a bladeless spear to still inflict considerable damage. The riders therefore used protective gear in the form of shields, helmets with visors, greaves and, according to Arrian, Cimmerian tunics. He makes it clear that the riders did not wear the regular cuirass, which was probably of metal, and that the Cimmerian tunics were colourful due to embroidering in scarlet, red or blue, and other colours. It is not completely evident what the Cimmerian tunics were, but padded garments would fit well the purpose and context, and therefore seem a very plausible interpretation.[27]

The written sources all in all demonstrate that Roman soldiers were not only aware of the practicality and necessity of padded garments, but that they in fact wore them.[28] These texts show that soft armour could be used as a standalone piece of equipment or underneath metal armour. Unfortunately, they offer few clues as to the fabric and appearance of the padded garments. The archaeological and iconographical record can however shed further light on this matter.

[20] The word *subarmalis* in this document has been interpreted by Tomlin (1998, 55-56) as 'under the arm', which he thought must have been some type of spear. Speidel (2007) has convincingly disproved this idea.

[21] Speidel 2007, 238-239.

[22] Vindolanda tablet 2.184, line 3.8.

[23] *Scriptores historiae augustae – Aeli spartiani Severus* 6.11.

[24] *Scriptores historiae augustae – Trebelli pollionis divus Claudius* 14.9; – *Flavi vopisci syracusii divus Aurelianus* 13.3.

[25] *De nuptiis Philologiae et Mercuri* 5.426.

[26] *Tactica* 34.6.

[27] Padded garments and leather armour instead of metal were also widely employed on horse or foot in mêlées (tournament mock battles) during the Middle Ages fought with dummy weapons.

[28] Classical literature includes other references to what might be understood as padded garments or soft armour. These are less clear-cut than those mentioned in the main text. Cf. Suetonius, *De vita caesarum - Galba* 19.1; Fronto, *Ad verum imperator* 2.19; Cassius Dio, *Historia Romana* 78.7.2 & 79.3.2; *Scriptores historiae augustae - Caracalla* 2.9.

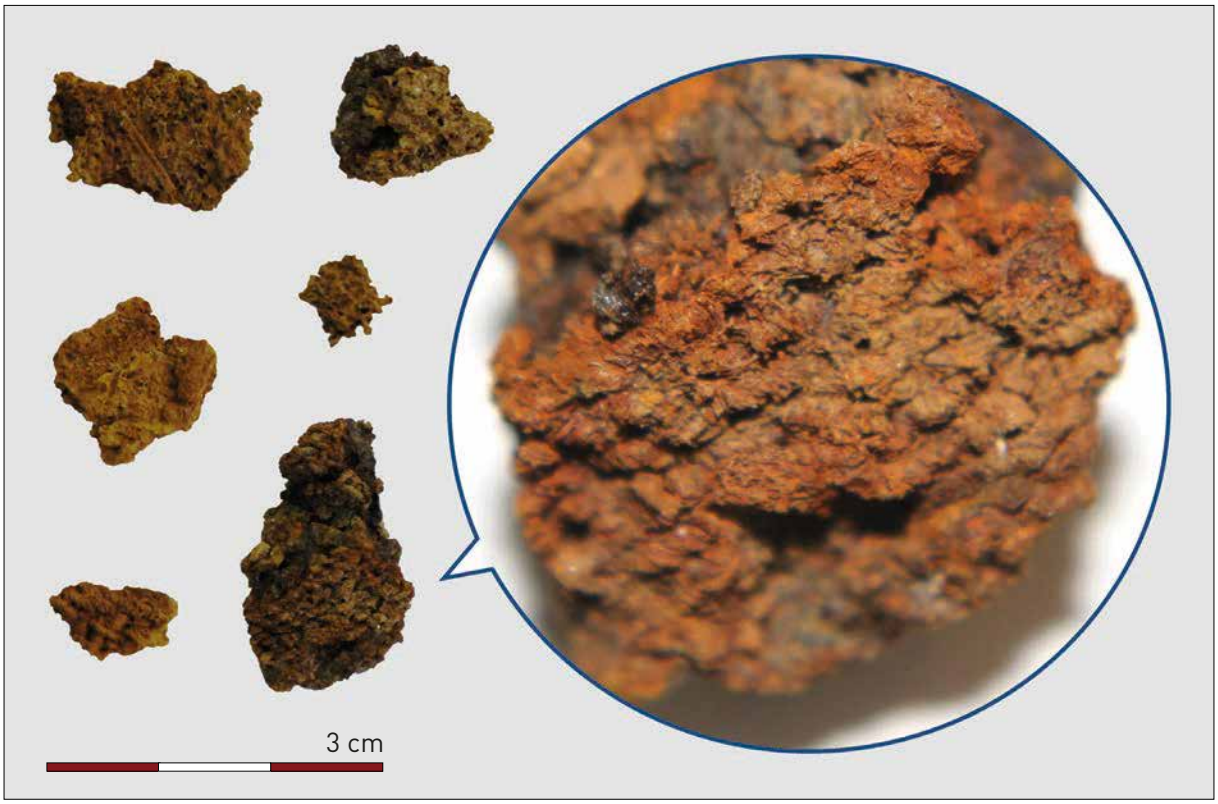


Fig. 7.4. Various of the many mail remains from the Kirkburn coat. Some still have remnants of textile adhered to them, which belonged to a liner placed inside the shoulder guards. British Museum, London (photograph M.A. Wijnhoven).

7.3 TEXTILE AND LEATHER REMAINS

Textile and leather remains are frequently found embedded in the corrosion products of excavated mail, especially in burials. Although these might be interpreted as remnants of (padded) undergarments, they could also originate from other items such as bedding, clothing, bags or sacks in which the mail was kept,[29] or a piece of fabric in which it was wrapped before disposal.[30] Unfortunately, many of the mail fragments that contain mineralised textile or leather are too small or incomplete to say what items the materials came from.

There are only a few cases, listed below, in which textile or leather seem to belong to the mail coat with more certainty.[31] The oldest example is from a Celtic chariot grave in Kirkburn, United Kingdom, dated to the 3rd century BC. It concerns a complete mail coat with shoulder guards that was laid on top of the buried person. Several pieces of textile were preserved alongside the mail (fig. 7.4), some from an item of clothing that covered the deceased, probably a tunic with no relation to the mail coat. However, there is a large cluster of textile inside the shoulder guards identifiable as part of the mail shirt lining.[32] Although it does not extend down the whole coat and its thickness is undetermined, the positioning

[29] The finds from Biberwier, Pontoux 1, Lyon 1, Zwammerdam, Zeugma 3, St. Albans, and Sutton Hoo are all thought to have been deposited in a bag.

[30] E.g. Štrbinci near Đakovo 1 & 2 and Rhenen 2 & 3.

[31] Groller (1901, 92-93) mentions fragments of padded undergarments from Carnuntum. Nevertheless, these are most likely the remains of a textile liner of scale armour.

[32] Stead 1991, 54-56, 122-124; pers. comm. Jody Joy 2013.

of the textile likely helped to carry the weight of the armour, most of which rested on the shoulders, and made it more comfortable to wear. SEM analysis has shown that the lining is made from wool and consists of a medium-grade twill with yarns of mixed spinning. The wool appears to be a good quality worsted.

At a sanctuary in Corent, France, the remains of a nearly complete coat of mail have been unearthed together with various other military items,[33] thought to have been part of a Gallic *tropaeum* erected around 130-120 BC. One side of the mail coat contains organic remains, including two sections with mineralised wool fabric coarsely woven with both S- and Z-spun threads, which makes for a strong textile. At the time of its disposal, the mail coat was covered either partially or completely by this fabric, but it is unclear whether it was part of the coat (as a liner) or part of a garment that was worn with the coat.

The X-ray examination of a mail fragment found in a disturbed burial from the 2nd-1st century BC in Mezmay 4, Russia, revealed that the rings were embedded between two layers of fabric. It has been proposed that the mail coat from which they came had been lined inside and out by textile.[34] Then again, the mail could have been wrapped in fabric upon disposal, which would equally account for the fragment being set in textile.

A 1st century AD Thracian tomb at Vize, Turkey, has yielded a very well preserved piece of hybrid armour. The inside of the cuirass is entirely lined with a medium coarse linen, which is still flexible.[35] The armour was deposited in an unfinished condition, which makes it unclear if the liner was intended as a temporary feature or a permanent one. The liner, made from a single layer of textile, would have protected the clothing and helped against chafing, but would not have added much bodily protection against blunt force trauma.

Almost a quarter of all the graves at the Sarmatian cemetery from the 1st or 2nd century AD near Gorodskoy, Russia, contain mail coats.[36] These must have been long, covering a large portion of the body, since in their current state each coat weighs between 12 and 15 kg. On the inside, the coats preserve organic remains which could be linen or leather, probably the remnants of a protective undergarment, or of an integrated liner.

The strongest archaeological evidence for the padding of a mail coat (beyond a liner) probably comes from a countermine at the Roman garrison town of Dura-Europos, in Syria, dated to the mid-3rd century AD. In a unique incident, the mine collapsed on a member of an attacking force, burying him in action, wearing his full kit. The inside of his coat has an unidentified light-brown fibrous material that is not woven into a fabric. For this reason it has been suggested that it probably entails the remains of a felt garment worn as padding underneath the mail coat.[37] The use of felt as padding is mentioned in classical literature, like the above cited comments by Caesar, Pliny the Elder and the anonymous author on the *thoracomachus*.

Interestingly, textile or leather remains associated to a liner or padding are found relatively more often with mail neck guards attached to a helmet (aventails) than with mail coats. The reason might be that the liner or padding was often sewn on the mail aventail, so they would usually end up being deposited together. Aventails are a fairly late phenomenon in mail development, observed mostly from the Late Roman period onwards. The two most clear-cut archaeological examples of lined mail aventails are both medieval. One from Niederstotzingen (Germany, early 7th century AD), which is covered on both sides by a double layer of coarse diamond patterned textile, and another from Balyk-Sook (Russia, 8th-9th century AD),[38] lined with Chinese silk and several layers of fabric.

33 Demierre 2015, 155-160; Médard 2015.

34 Dedyulkin/Shevchenko 2017, 52.

35 Driehaus 2012, 381-383.

36 Goroncharovski 2006, 446.

37 James 2004, 116.

38 Kubarev/Kubarev 2003; Vogt 2006, 38, 298. Other possible examples come from Brezenheim, Cologne, Turaevo 3, Valsgärde 2, Vendel 1 & 6.

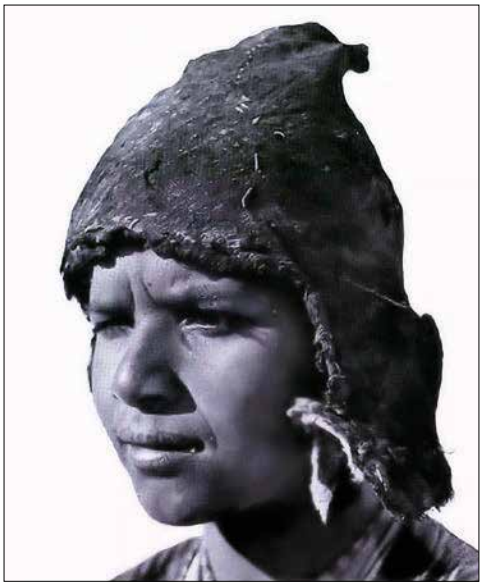


Fig. 7.5. Hat made from wool and felt which has been interpreted as an arming cap used underneath a helmet. Shortly after excavation, one of the local children wore it to pose for a photograph. Dura-Europos, Syria (photograph Yale University Art Gallery).

All the finds of textile or leather linked to armour that have been reviewed so far come from non-Roman contexts. In the Roman sphere, finds that could have served as padding or lining for armour also occur, although up to present their association has been limited to other types of armour than mail.

The use of felt as padding among the Roman military is known archaeologically, particularly from helmet padding.[39] For example, a Late Augustan helmet from Vindonissa, Switzerland, contains a felt padding, although it is unclear if this was a separate piece or was permanently fixed to the helmet.[40] In the case of an iron helmet from Newstead, United Kingdom, the woollen padded liner was glued to the inside with a resin-like substance.[41] A cap from Dura-Europos made of wool and felt is thought to have been worn as padding under a Roman-style helmet (fig. 7.5), due to the fact that it includes ear flaps that follow the outline of the cheek pieces of a Roman helmet, and that its pointed top was strongly folded over.[42] In Egypt, several hats which possibly were worn under a helmet have also been found. One of them, from Didymoi, is made of felt and red-dyed wool with thin yellow stripes and has cheek pieces similar to the Dura-Europos cap.[43] In addition, the written sources confirm the practice of wearing a (felt) hat as padding or liner for a metal helmet.[44] From the late 3rd to 5th centuries AD the pillbox hat or *pileus pannonicus*, made of felt, was used for this purpose.[45] Charioteers also wore crash helmets made from felt or leather for protection (fig. 7.6). The archaeological and historical examples thus demonstrate that felt was widely used by the Romans as a material for padding armour.

The application of linen in defensive garments has a long tradition in antiquity, and it is found in Roman contexts too. Dura-Europos has yielded a 5 mm thick fabric liner for a greave made from undyed linen bound by a leather edging, sewn with three pairs of leather cords to attach it to the wearer's leg.[46] Recently, various linen fragments with a thickness and woven structure very similar to the greave padding from Dura-Europos have been found at Masada, Israel.[47] These, however, obtain their volume not from layers of textile or stuffing, but simply through weft twining. This means that the textile is made up

[39] Felt was also found covering a laminated wooden shield at Fayum, Egypt, dating to the 3rd or 2nd century BC.

[40] Deschler-Erb 2005, 6-11, fig. 4.

[41] Sumner 2009, 165.

[42] James 2004, 101, 109, fig. 51.

[43] Sumner 2009, 166, back cover.

[44] E.g. Vegetius, *De re militari* 1.20.18; Ammianus Marcellinus, *Res gestae* 19.8.8.

[45] Köhne/Edigleben 2000, 92; Wild 1979, 107-108.

[46] James 2004, 128-129, fig. 73.

[47] Granger-Taylor 2011.

Fig. 7.6. Mosaic of a circus charioteer wearing a crash helmet made from felt or leather. He sports other protective clothing, such as wrappings of leather or linen on the legs and a lacing of straps around the torso. Palazzo Massimo alle Terme, Rome (photograph M.A. Wijnhoven).

from composite threads, instead of individual ones, which are twine woven into an exceptionally thick and very firm fabric. One possibility is that the Masada fragments were the *pteruges* of a textile defensive garment, i.e. decorative strips of fabric that stick out at the bottom of armour observed frequently in Roman iconography (see below; fig. 7.13 & 14). This interpretation is strengthened by the fact that the Dura-Europos liner appears to have been made with the same, rare, weft twining technique. Although the fragments are far too small to confirm this, it is tempting to assume that some padded undergarments were made in this manner.

The Roman army used composite materials for padding as well. Another greave liner, now from Vindonissa (1st to 3rd century AD), consists of an inner layer of linen and an outer surface of leather

Fig. 7.7. Depiction of Mars at a Roman altar from Housesteads. He is shown with helmet, spear, shield, greaves and what looks like a padded or quilted garment. Housesteads Museum (photograph M.A. Wijnhoven).

stitched together by lines neatly placed at regular intervals.[48] Furthermore, combined materials are mentioned in Maurice's military manual from the 6th century, where it is said that as a neck protector each soldier should have 'round neck pieces of Avar type made with linen fringes outside and wool inside'.[49] A recent re-interpretation of several leather fragments from Vindonissa also points to the use of composite materials.[50] Originally thought to be part of a saddle,[51] these sheep or goat leather fragments are now believed to have belonged to padding for the shoulders. They display linear perforations at regular intervals, reminiscent of medieval padded garments that were usually stuffed with soft materials and stitched over. To test this idea, one of the fragments was reconstructed and stuffed with sheep's wool to be experimentally worn during a days-long march in full Roman military kit. This showed that such padding protected the shoulders very well from the accumulated weight of the armour, *furca* with military paraphernalia, and shield. Without this protection, the shoulders suffered heavy bruising in less than a day.

The archaeological record is not always in agreement with the written sources, but as far as the use of padding in armour is concerned, they are compatible. The selection of materials mentioned by Caesar as provisional soft armour against arrows (i.e. felt, quilt and hide) are all present in the archaeological record.

7.4 MEDIEVAL ANALOGY, GLADIATORS AND PTERUGES

Based on historical and archaeological data, padded garments should be found in depictions from antiquity, but their identification has proved a difficult task. One of the major obstacles is that iconography allows for different interpretations of what is represented, particularly of materials. So, while armour can be easily recognized, it is not always clear whether it is supposed to be scale, mail, or padded armour. A crosshatching pattern, for instance, may denote any of the three.

Some conventions of padded garments in Roman art are similar to those observed in medieval illustrations. This analogy tentatively supports the representation of padding in antiquity. An example comes

48 D'Amato 2012, 33.

49 *Strategikon* 1.2; translation Dennis 1984, 12.

50 Himmler 2011, 180-181, fig. 14-16.

51 Gansser-Burckhardt 1942, 111.

Fig. 7.8. Mars depicted on a 3rd century dedication by the Twentieth Legion at High Rochester. The god wears a full set of military equipment including a garment that looks like its medieval padded or quilted counterparts. Great North Museum: Hancock, Newcastle (photograph M.A. Wijnhoven).

from Housesteads, in the United Kingdom, where an altar to Mars, god of war, shows him in military gear, donned with helmet, spear and shield (fig. 7.7). His body is covered by a garment made up of what can best be described as 'bulbous rectangles' identical to medieval depictions of quilted or padded garments, as seen in figure 7.3. Another example is the 3rd century tombstone of Severus Acceptus in Istanbul, where the deceased is portrayed beside various items of military paraphernalia, including a coat of rectangular panels.[52]

In a dedication slab to Mars and Hercules in commemoration of the building work of the Twentieth Legion at High Rochester Roman fort, Mars is again depicted in full panoply with spear, helmet, greaves and a shield (fig. 7.8). His body is protected by a voluminous garment covered in vertical lines reminiscent of the medieval padded or quilted garments worn under metal armour, like those seen in figure 7.1.

More substantial proof of the Roman use of padding is found not in images of soldiers, but of gladiators. According to their category, gladiators are usually portrayed wearing textile protection on one or more limbs (fig. 7.9 & 10), sometimes as sole defence and sometimes under metal greaves or arm guards. These items are easily recognisable by the lines placed at regular intervals suggesting stuffed and quilted fabric. This convention is the same as in the above-mentioned examples, but there is generally more consensus that in this case it does represent padding. The agreement arises from the sheer abundance of the imagery, along with current experimental research on the reconstruction and function of gladiator equipment,[53] which demonstrates not only the accuracy of the padding depicted in Roman art, but also its importance as protection during the fights.

The best iconographic evidence for the use of padded garments during the Roman period is hidden in plain sight, which is perhaps unsurprising for an item that is normally worn as an undergarment. There is a wealth of images that show clothing, which is not a tunic, peeking out under the armour. The most logical conclusion is that these are precisely the illusive padded garments that made metal armour much more comfortable to wear. Often these undergarments are recognized only by the presence of *pteruges*, i.e. decorative strips arranged into one or several rows that stick out under the bottom hem and

[52] Sumner (2009, 172, pl. 4-9) reviews other comparable examples, which may be understood as padding or quilting.

[53] Notably Junkelmann 2008.

Fig. 7.9. Tombstone of the gladiator Satornilos from Smyrna, in Turkey, dated to the 2nd-3rd century AD. Satornilos was a thraex as inferred from his gryphon-decorated helmet. He holds a shield and a palm branch as a symbol of victory. His sword arm is protected by a padded sleeve which also covers his hand. He wears padding on both legs, which are covered by metal greaves. Rijksmuseum van Oudheden, Leiden (photograph M.A. Wijnhoven).

armholes of the armour (fig. 7.11 & 12). *Pteruges* are very common and they are found in a very wide array of subject matters and in various media during the entire Roman period, all over the Empire and beyond. They appear alongside all types of metal armour; scale, segmented, plate and mail. The presence of *pteruges* should be considered not only as decorative, but as a key indication of a padded garment underneath the armour.[54]

[54] Ubl (2006) comes to the same conclusion and offers speculative reconstructions based on well-known Roman images of *pteruges* and armour.

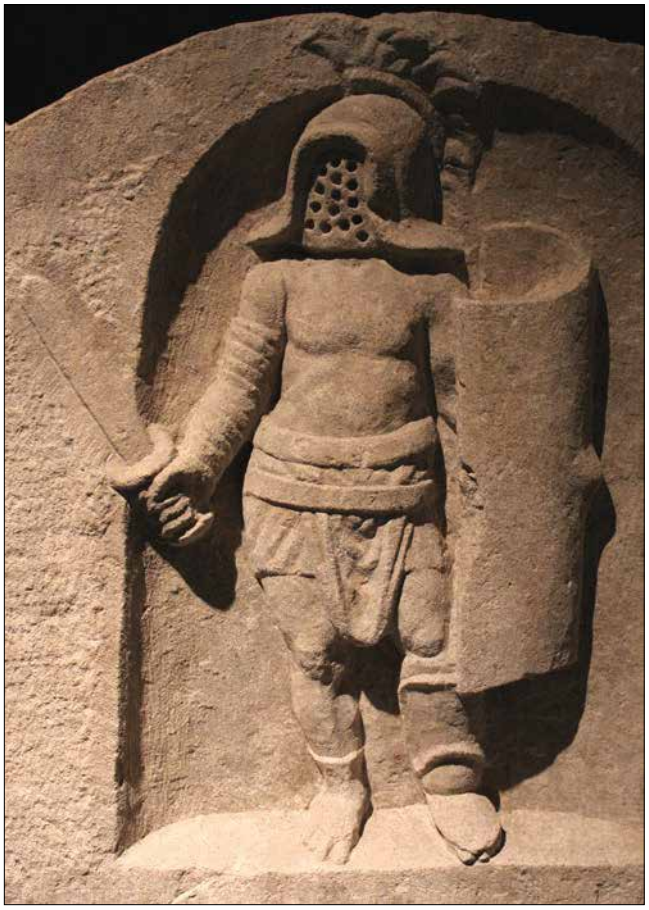


Fig. 7.10. Funerary stele of the gladiator Quintus Sossius Albus, 2nd century Aquileia, Italy. Albus wears the typical equipment of a murmillo, easily recognized by his helmet, large shield and single greave. He wears protective padding on his sword arm, but also underneath the short greave on his left leg. The protection on his leg extends over the top of his foot. Museo Archeologico Nazionale Aquileia (photograph M.A. Wijnhoven).

Fig. 7.11. Tombstone of signifer Gaius Valerius Secundus coloured in to better understand its details. He wears a mail coat with large shoulder guards. His arms and upper legs are additionally protected by several rows of *pteruges* that probably belong to a padded undergarment. The animal pelt that covers his helmet is depicted hovering over his left shoulder. He carries a *gladius* and *pugio*, together with a shield that is suspended from a leather strap, possibly to use it hands-free. Landesmuseum Mainz (photograph M.A. Wijnhoven).

Fig. 7.12. Statuette of a Roman soldier in segmented armour and a helmet. Long *pteruges* which are probably part of a padded undergarment protrude from below his armour. The hem of his tunic can be seen peeking out from under the row of *pteruges*. 2nd century AD, British Museum, London (photograph M.A. Wijnhoven).

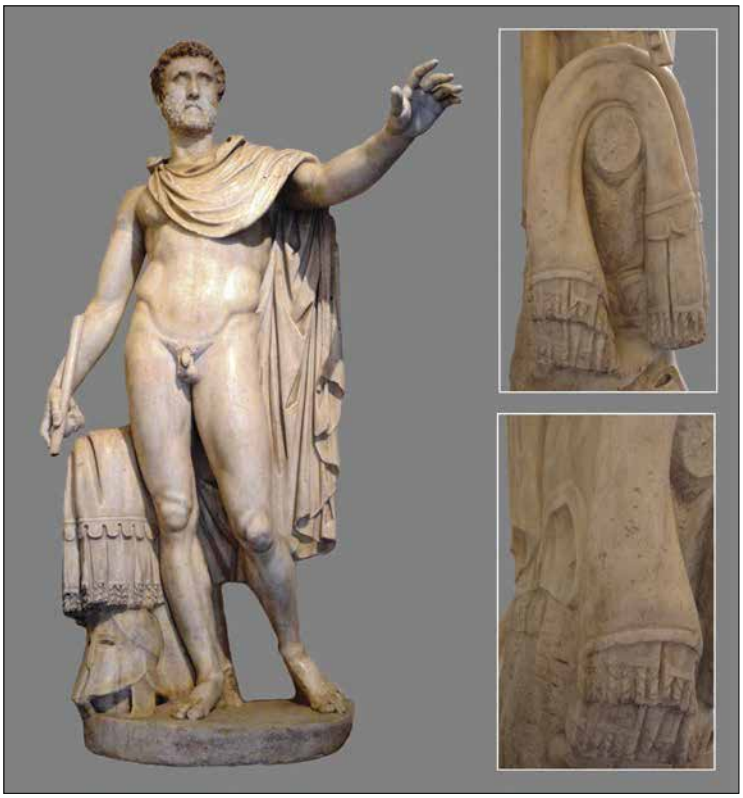


Fig. 7.13. Sculpture of Antoninus Pius including a flexible garment with *pteruges* draped over a tree stump. The close-ups show the front and back section of this garment. Palazzo Altemps, Rome (photograph M.A. Wijnhoven).

Because it was usually sported under the armour, very few depictions show the entire garment with *pteruges*. One of them is a sculpture of emperor Antoninus Pius, housed at the Palazzo Altemps in Rome, which features a garment with *pteruges* at the hem and arms draped over a tree trunk (fig. 7.13).[55] The sculpture is Hellenised, therefore it cannot be fully accepted as factual but it does illustrate that the *pteruges* were neither part of the armour nor the tunic, but of a separate garment.

Information from the Middle Ages, supplemented by modern experimental reconstructions, indicate that padding was fundamental to the proper functioning of metal armour, increasing protection and comfort. If *pteruges* are part of a padded garment, then they should be found aplenty and combined with every type of Roman metal armour, as they are. Furthermore, if we take *pteruges* as a proxy for padded undergarments, then the iconographic evidence for the latter is not scarce but, on the contrary, abundant.

7.5 CONCEALED BY METAL ARMOUR

Taken independently, each of the available sources provides limited evidence for padded garments in antiquity. But when combined, the picture of this evasive apparel starts to emerge, revealing that not only were the protective qualities of padding known since antiquity, but also that it was in use throughout the entire Roman period and afterwards.

Padded armour could function alone or together with metal armour. Due to its flexibility, mail particularly required a padded undergarment to protect the wearer against blunt force trauma, and the available evidence suggests that a variety of materials were used to create these garments in antiquity. Despite being essential, padding has not yet received much attention as a piece of military equipment, its presence being concealed by metal armour in more than one way.

[55] Similar sculptures that include garments with *pteruges* draped over a tree trunk are found at the Kunsthistorisches Museum in Vienna (torso of an emperor), the Centrale Montemartini (inv. 2418) and the Museo Chiaramonti (inv. 152) in Rome, and the Bergama Müzesi (statue of Trajan or Hadrian).

8 The craft of making mail rings

> *'The iron armour concerned, does not consist of such iron scales and pieces, but rather of thousands of small rings, which are thus tightly woven and fastened in one another, so that they protect against the more nimble guns and withstand and stop smaller bullets that bounce off from them. In this manner and of such work, armoured caps, coats and shirts, with or without sleeves, gloves, trousers, stockings and all types of clothing are made, likewise objects hanging from the body such as belts and pouches.'*
> Christopher Weigel, *Book of trades* [1]

The concept of *chaîne opératoire*, as a methodological tool for analysing the technical steps of mail making within a socio-cultural context (chapter 1), is at the heart of this chapter and those that follow. This particular chapter focusses upon the rings that make up a mail garment. These usually consist of riveted and solid rings. The riveted rings are made by shaping metal wire into a circle with overlapping ends that are subsequently pierced and sealed by a small rivet. The solid rings are punched out of sheet metal or made by welding a wire ring shut. The subsequent chapter will look at the manner in which the rings were woven together into a mesh, while chapter 10 discusses the different techniques the mail maker employed to tailor a garment. Finally, chapter 11 focuses upon the small characteristics of mail rings as a possible indicator of age and provenance.

8.1 THE MAIL MAKER'S PROCESS

Contrary to what one might expect, written sources describing the manufacture of mail are conspicuously lacking. As is often the case with traditional crafts, the ancestral knowledge and skills required for the fabrication of mail were probably transmitted orally from master to apprentice. Formal texts of the craftsman's work process as a learning aid seem to be a recent development, likely related to institutional education. Perhaps for this reason, there are no texts or handbooks explaining the production of mail armour from antiquity.

There are few written mentions of the production of armour in general. The *Notitia dignitatum* is a text written during the Late Roman period which details the administrative organisation of the Western and Eastern Empire. It includes a list of state factories responsible for the production of equipment for the Roman army together with their specific location and function. Amongst these are *loricaria* and *fabricae armorum*,[2] which must have been factories specialised in the production of armour. Given that segmented armour was no longer in fashion by the time the *Notitia* was compiled, it must refer to the manufacture of scale, lamellar and mail armour. Also Flavius Vegetius Renatus mentions military workshops in his writings and states that '[the legion] had also travelling workshops in which they made shields, cuirasses, helmets, bows, arrows, javelins and offensive and defensive arms of all kinds'.[3] While these texts do mention the production of armour, they do not offer any specific information on the manufacturing process.[4]

1 Weigel 1698, 57; translation by the author.

2 *Notitia dignitatum*, Occidens 9; Oriens 11.

3 Vegetius, *De re militari* 2.5; translation Clarke 2013 [1767], 40.

4 James (1988, 259-260) offers several more references to texts that mention workshops making military equipment during the Late Roman Empire. These unfortunately do not add to the understanding of the mail maker's activities.

Fig. 8.1. Fresco from the House of the chariots in Pompeii, depicting a scene from the Iliad in which Hephaistos (or Vulcan to the Romans) makes armour for Achilles. In the foreground, an assistant does chasing work on a helmet which is raised on a pedestal. He uses a small hammer and a chasing tool. In the background, a square mushroom-shaped anvil and several large hammers can be seen. Museo Archeologico Nazionale, Naples (photograph M.A. Wijnhoven).

Texts from the Middle Ages and Early Modern period do not say much more. The closest we get to a description of a mail maker's activities comes from the so-called *Books of trades*, an early-modern genre of books that compiled different occupations, illustrated by an image and a short text.[5] The opening quote of this chapter comes from such a book published in 1698. Its author, Christopher Weigel, asserts that by this time the profession of the mail maker was waning.[6] The text throws some light on the occupation of mail maker, but offers little information about the actual craft.

While there are no technical manuals, the art of making mail armour persisted in some regions of the world well into the 20th century, and it is from this time that we finally get two accounts of the making of mail. When mail was still being produced in Europe, early explorers probably did not deem this craft exotic enough to describe it. But in the 20th century, some scholars of European armour started taking an interest in the survival of the craft, albeit mostly as a curiosity. Of the two accounts, the more extensive one was written by A.J. Arkell who in 1940 witnessed the production of a mail coat ordered by him in Omdurman, Sudan.[7] The craftsmen built the coat out of butted rings exclusively and seemed unfamiliar with the use of riveted and solid rings, which was the norm throughout history (chapter 11.3). Arkell's

5 E.g. Sachs/Amman 1568.

6 Weigel 1698, 56-58.

7 Arkell 1956.

description is still very interesting since it details several activities that a mail maker working with riveted rings would have also undertaken.

It took the master craftsman at Omdurman, working with a team of some six assistants, a total of twelve days to complete the butted coat of mail, which weighed around ten kilograms. Arkell describes that the process started with the fabrication of metal wire, drawn through a drawplate of European manufacture on a locally-made draw-bench. Subsequently, the wire was wound by hand into a coil with the use of a mandrel. The size of the rod inside the mandrel determined the diameter of the rings. The coil was then cut into rings with a large pair of top cutters. A team of three men worked in weaving the rings together. The first used a pair of pliers to close the gap in the rings, bringing their ends neatly together. The second widened the gap in several rings and inserted four rings from the first man in each of them. He then closed the ends of the gaping ring, resulting in sets of five interconnected rings (i.e. one ring connected to four others). The third man, who was the master craftsman, connected the sets of five together, being responsible for the creation of the final garment.

The other narration of mail making comes from Ewart Oakeshott who in the mid-seventies described the production of a completely riveted mail from half a century earlier.[8] This is the only actual account of riveted mail making, and is thus worth quoting in its entirety. Oakeshott, a renowned scholar of arms and armour, wrote it in a book directed to adolescents, which accounts for his tone:

> *'Well, although I have never seen it done, I know two people who have… The other was an old soldier who fifty and more years ago served on the north-west frontier in India. There he once saw an old Pathan making a mail shirt. He sat at a little table outside his hut in a remote Khyber village; along the wall on the ground squatted about half-a-dozen little boys, all winding wire around rods for all they were worth. The boy at the end of the row was cutting through the wire coils and handing the rings to a man who swaged and pierced the open ends. He put the finished rings in a heap by the old man's hand and, as fast as your mother knits her jumper, the old Pathan was taking a ring and a rivet, linking the ring, putting in the rivet and closing it with his pliers.'*

It is interesting that both descriptions mention a master craftsman that weaves together the final product, while a team of approximately six assistants do all the preparatory work. Such division of labour makes sense considering the thousands of rings needed to make a single garment. It is an effective way to cut down labour costs per garment and speed up production. Given the highly repetitive nature of the craft it is expected that such division was always the norm. This is, at least, confirmed for the High Middle Ages onwards. There is a good deal of historical documentation for this period that the mail maker was a fulltime profession embedded within the guild system.[9] A master mail maker could even have multiple journeymen working in his workshop, each with their apprentices and labourers.

The ratio of one master craftsman responsible for the final assembly of the mail garment to approximately six lesser skilled labourers doing all the preparatory steps may also prove a constant through time. This ratio is mainly dictated by the mail making steps, meaning that more assistants would get in the way, and fewer would not produce sufficient rings for the master craftsman to be able to work continuously.

In addition to historical sources and ethnographic observations, there are several images of mail makers at work that offer insights into the activities that took place in the workshop. Unfortunately, none come from antiquity. For the Roman period we do have depictions of smiths in action, some even making armour (fig. 8.1), but these often involve representations of the god Vulcan holding a piece of metal over an anvil with a pair of tongs, while wielding his hammer. However, mail making is very different

8 Oakeshott 1974, 39.

9 Frangioni 1978; Hummelberger 1961; Pfaffenbichler 1992, 8, 26-30; Rose 1929.

Fig. 8.2. The earliest image of a mail maker is an illumination from *The romance of Alexander*, dated around AD 1250. The mail maker works a ring on an anvil by holding it with a tong in one hand and wielding a hammer in the other. Facing him is a person holding the finished product, a mail hauberk that includes mittens and a hood. Cambridge University Library (MS O.9.34 – folio 24v).

from the fabrication of plate armour in which a sheet of metal is hammered into shape. The mail maker's tools are different and may be more akin to those of a jeweller than a blacksmith.[10]

The earliest depiction of a mail maker dates from around AD 1250 and concerns an illumination in *The romance of Alexander* (fig. 8.2).[11] At the centre of the scene there is an anvil with two horns securely embedded into a wooden stump. The mail maker is working on a mail ring which he holds with a pair of tongs in one hand and a hammer in the other. His pose and the manner in which he uses the tools are reminiscent of depictions of smiths making plate armour or helmets, although these do not correspond well with the activities involved in the process of mail making. It is possible that the illustrator was not interested in the accurate depiction of the mail maker and borrowed the attributes of a plate armourer to get his point across.

Other portrayals of mail makers come from between the 14th and the late 17th centuries, the majority being from the 15th century. In their totality, these representations are rare, with just over a dozen in existence.[12] Despite their low numbers, they offer more insights into the tools and activities that took

[10] Sim 1997, 370.

[11] *The romance of Alexander*, Cambridge University Library, MS O.9.34, folio 24v.

[12] In addition to the mentioned manuscript *The romance of Alexander*, these are: *Matricula societatis fabrorum civitatis Bononiae*, MS 26, folio 37v, Senato della Repubblica Biblioteca, Bologna, mid-14th century. The same depiction in two different French translations of Giovanni Boccaccio's *De claris mulieribus*, MS 16 G V, folio 11 and MS 20 CV, folio 15, British Library Royal Collection, AD 1400-1440. Four depictions in *Die Hausbücher der Nürnberger Zwölfbrüderstiftungen*, MS Amb 317.2, folio 9v, 26v, 92v and 103r, Stadtbibliothek Nürnberg, 1425, 1540, 1473 and 1484. One in *Proverbes en rimes*, MS W.313, folio 10v, The Walters Art Museum, Baltimore, c. 1490. Two illustrations from the *Books of trades,* in Sachs/Amman 1568 and Weigel 1698.

Fig. 8.3. Left: the mail maker Hanns Ackerman (died in AD 1484) surrounded by various tools of his trade. Besides the suspended beam which holds a mail shirt, we can see on his workbench a hammer, a small anvil, a knife, several loose rings and a glass. There is also the outline of an unidentified conical object. Hanns uses a pair of tongs to add rings to the segment he is working on. Right: the mail maker Heintz (died c. AD 1425) shown weaving mail while sitting on a bench. A wooden rod suspended by ropes is used to hang a mail shirt. Although the perspective is somewhat off, we can assume that, for practicality, the rod with the shirt was suspended above the workbench. Stadtbibliothek Nürnberg (MS Amb 317.2 – folio 9v & 103r).

place in the mail maker's workshop. Figures 8.3 & 4 are the most detailed of these depictions, which include elements common to all the illustrations of mail makers. Figure 8.3 comes from *Die Hausbücher der Nürnberger Zwölfbrüderstiftungen*, a collection of hand-painted portraits of the inhabitants of two poor-houses, who are shown at work in their original occupations alongside the tools of their trades. The respective subjects are Hanns Ackerman, who died in 1484, and a mail maker named Heintz, who died around 1425. Figure 8.4 is a highly detailed copperplate engraving from Weigel's *Book of trades*, which accompanied the text discussed above, and is also the most recent one.

All the illustrations show the mail makers weaving rings onto a mail garment, sitting down, often behind a bench on which (part of) the finished product rests. The manufacture of individual rings is not portrayed, except in the earliest figure, from 1250.

Many of the images show a contraption constituted by a wooden beam suspended from a wall or the ceiling, on which the mail garments are hung. Although its purpose may have been merely to store or display the finished product, it is more likely that it served an important function in the mail making process. In Weigel's engraving the beam is above the work bench, and in the *Hausbücher* illustrations it is seen in approximately the same position, although the perspective is less clear. If the height of this device was adjustable, it could have been used during mail weaving to hold the unfinished piece at the right height above the work table so that the mail maker could easily add rings or sections of mail to the garment. This would have facilitated the handling of the piece during construction, giving the maker a

Fig. 8.4. The mail maker illustrated in Weigel's *Book of trades*. This copper engraving is the most detailed illustration of a mail maker's workshop. In the background there is a toothed wheel mounted on a stump, probably part of a mandrel (e.g. the gearing part) for coiling wire. A pair of large shears is mounted on another stump, next to one or two small anvils and a hammer. In the foreground the mail maker is shown seated behind his workbench weaving rings into a section of mail. A beam with several randomly arranged mail garments is located above the bench. Behind, there are two mounted wooden spheres, which could have been used for making mail coifs (Weigel 1698, M.A. Wijnhoven library).

good overview of the process, especially when making complex patterns to expand or take in the garment (chapter 10). The tools of the mail maker would have lain within reach, on top of the work bench.

The Weigel image includes several tools used at various stages in the mail making process. In the background there is a big gear wheel mounted on top of a wooden stump, which looks nothing like any tools known today, but most likely functioned as part of a mandrel for coiling metal wire, as described in the ethnographic accounts. A large pair of shears is mounted on top of another stump and may have been used to cut the coils into individual rings. The design and placement of the shears are depicted in the exact same way as in the workshops of plate armourers, who used them to cut sheets of metal.[13] It is improbable that this form of shears would have been used by the mail maker to cut coils; rather we may be dealing with an iconographic convention referring to the archetypical cutting tool of the armourer, and not the particular instrument of the mail maker. Cutting tools are included in two other figures. A wood print from *The book of trades* by Hans Sachs and Jost Amman, from 1568 (fig. 10.34), shows a pair of regular scissors hanging from a peg on the wall, while the portrait of the mail maker Hanns Ackerman in the *Hausbücher* depicts a knife lying on his workbench. These tools do not seem very appropriate for cutting coils into separate rings either.

A number of the illustrations show a small anvil and hammer. These would have served to overlap and flatten the ends of riveted rings before piercing them. Moreover, the anvil in the workshop of Hanns Ackerman (and possibly one in the Weigel engraving) contains a hole, which is a small but important feature designed to enable piercing the overlap with an awl. Once pierced, the ring would be riveted.

One last tool observed in the illustrations is a large pair of tongs employed by the mail maker to add rings to the garment in progress. These were used to open the already flattened and pierced overlap and interlock the rings together. Most probably the tongs also served to set the rivets, for which they likely had a small dimple to shape the rivet head as it was placed in the overlap and closed. In most images the tongs are large and have long handles, which would have allowed the mail maker to apply, with minimum effort, a large amount of pressure on the rivet head giving it its characteristic shape.

Many of the objects shown in the illustrations seem to have a suitable function in the mail making process. Remarkably, these do not include any specialised tools for making solid rings. In Europe, solid rings in mail armour fell in disuse during the mid-14th century. This means that by the time most of the illustrations were created, mail making workshops did not have the implements for producing solid rings anymore, leaving a huge gap in our understanding of how these were made.

Archaeological excavations have yielded many tools from antiquity. For example, hammers, small anvils, tongs, and piercing awls from the Roman period, like those from London and Saalburg (fig. 8.5). Unfortunately, these cannot be attributed with certainty to the craft of mail making, as many of the instruments used by mail makers were also used in other trades.

In their totality, the sources provide almost no information on mail making in antiquity. As said above, there are no texts describing the activities of the mail maker, no depictions from this period, and no tools specifically ascribed to mail manufacture. However, the medieval and early-modern illustrations alongside two recent ethnographic descriptions allow us to identify the basic steps of the mail making process, and in particular the production of riveted rings. We can assume that, to large extent, this procedure must have been similar in antiquity.

A final resource to recover the methods of the mail maker is analysing the actual remains of mail armour to reverse-engineer the stages of production, or *chaîne opératoire*. This can later be tested through experimental archaeology and trial reconstruction. Some studies have attempted to recreate the process

[13] Examples can be observed in Brueghel and Van Balen's painting *Venus at the forge of Vulcan*, and in *Die Hausbücher der Nürnberger Zwölfbrüderstiftungen* MS Amb 317.2, folio 42r. The collection of the Royal Armouries includes an original pair of great shears from the Greenwich armoury; cf. Dupras 2012, fig. 12.

Fig. 8.5. Several Roman tools useful to the mail maker (not to scale). The hammer, small anvils and tongs are displayed at the Römerkastell Saalburg. The awl, thought to be for leather working, would also be suitable for piercing the overlap of the riveted rings in mail making. This example comes from 1st or 2nd century London and is now at the British Museum (inv. PRB 1856.7-1.1307) (photograph M.A. Wijnhoven).

of making riveted rings, like the seminal works of the Baron de Cosson and W. Burges, and E. Martin Burgess.[14] Modern reproductions of mail armour, for their part, vary in accuracy.[15] These contemporary garments are seldom produced using experimental archaeology methods,[16] but are made for recreational, educational or display purposes, for instance by reenactors and museums.[17] Modern mail making is nonetheless able to provide important additional observations on the craft as it allows to test the feasibility of the mail making activities on a practical level.

[14] Burgess 1953a; De Cosson/Burges 1880, 564-566, pl. 11. Other studies dedicated to this subject are e.g. Arnswald 2004; Fabian 2018; O'Connor 1992a, 1066-1074; Schmid 2009; Sim/Kaminski 2011, 111-134.

[15] E.g. Brewer 2002; Price 2000; Schnee 2010.

[16] E.g. Koepfer *et al.* 2011.

[17] E.g. Peterson 1992; Sumner 1997; Verstraaten/Oorthuys 2012.

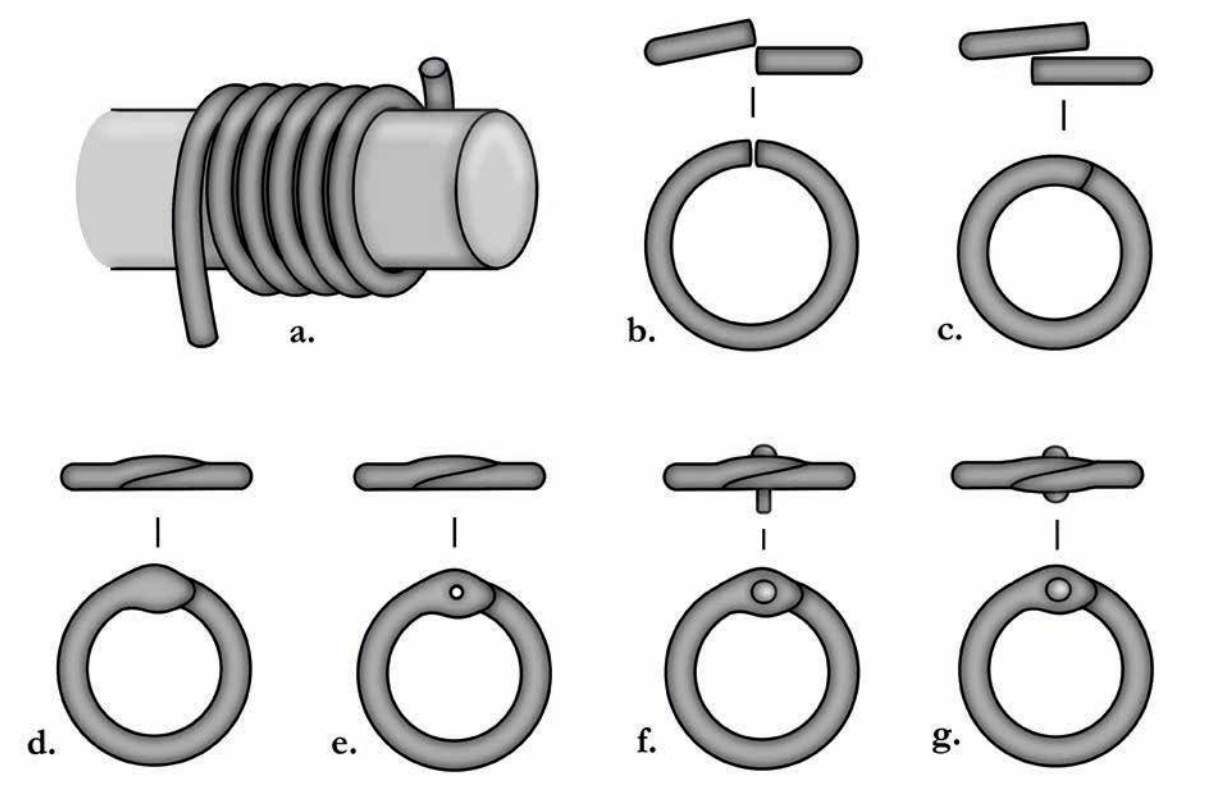


Fig. 8.6. Some basic steps for making riveted rings: a) winding wire into a coil; b) cutting the coil into separate links; c) overlapping the ends of each ring several millimetres; d) flattening the overlap; e) piercing a hole in the overlap; f) inserting the rivet into the hole; g) setting the rivet. During the last step the overlap can also be slightly reformed, which aids in closing the ring firmly (drawing M.A. Wijnhoven).

Putting all insights together, it is possible to identify at least twelve basic steps in making the riveted rings used in mail garments (fig. 8.6):

1. Obtaining metal wire. This will be the raw material for the rings.
2. Winding the wire into a coil. Probably done with the aid of a mandrel. The diameter of the rod inserted into the mandrel will determine the size of the rings.
3. Cutting the coils into separate rings. There are several tools that may be suitable for separating the rings from the coil. If no further work is done, the mail maker will end up with butted rings that are ready for weaving into the mail fabric. For riveted mail, more steps are necessary.
4. Overlapping the ends of each ring several millimetres. The diameter of the rings will be reduced somewhat by this action.
5. Flattening the overlap of the rings. This can be done with a general hammer and small anvil or with a specialised tool, such as a die. Flattening facilitates the piercing of the overlap, since otherwise the awl will skive off the rounded surface. In some regions and periods the entire ring is flattened during this step.
6. Piercing the overlap. This can be done with general hand tools, such as an awl and a hammer together with a hard surface, or with a specialised tool that mechanises the piercing action. When a simple awl is used, its point must be protected when piercing the overlap, for example by having a small hole in the anvil that receives the point.
7. Making the rivets. During antiquity the rivet heads are domed on both sides of the ring. These rivets may be pre-made by pressing the top of a small section of wire into a shaper to form one of the two

rivet heads. Alternatively, they can be left unworked, which means that both rivet heads are formed simultaneously during the last step of the sequence.
8. Opening the overlap of the ring. This is done with tongs and allows weaving the rings together.
9. Inserting the ring into the mail mesh. The mail maker must carefully follow the weaving pattern of the garment.
10. Closing the overlap. This is done with tongs. It is important that the holes at each side of the overlap align perfectly to accept the rivet.
11. Inserting the rivet in the hole of the overlap.
12. Setting the rivet. This can be done with a large pair of tongs with small depressions on the inside that shape the final rivet heads. The pressure of the tongs not only shapes the rivet heads, but can also be used to reshape the entire overlap, when closing the ring permanently.

The order and details of these steps vary over time and regions (chapter 11), but the basic stages are well established and have remained relatively similar. Much less understood are the manufacture of the metal wire used to make the riveted rings, and the production technique for the solid rings, topics that have been much debated in the field of armour studies.

8.2 THE MANUFACTURE OF METAL WIRE

Nowadays, the standard method of making wire is to draw it out of a piece of metal by forcing an ingot through a series of tapered holes of diminishing sizes called a drawplate (fig. 8.7, left). Each time, the metal becomes more elongated and thinner in diameter. A single drawplate can contain several holes of tapering dimensions. Alternatively, separate dies with increasingly smaller holes may be used.

The earliest reference to wire drawing was written in AD 1122 by the Benedictine monk Theophilus whose work described the trades of painting, glassmaking, and metalworking. He noted that the process required 'two iron [plates] three fingers wide, narrow at the top and bottom, thin throughout and pierced with three or four rows of holes [of diminishing size] through which the wires may be drawn'.[18] Evidently, metal wire is much older than this description, and its production and use in antiquity, especially in jewellery, have been much discussed in the literature.[19] Nowadays a drawplate is made from a harder material than the metal that is being drawn. One of the discussion points has been whether the capability of making a hardened drawplate existed before the High Middle Ages. E.G. Thomsen and H.H. Thomsen however demonstrated that this point is moot and that wire drawing could be achieved successfully in antiquity using what they called 'soft dies'.[20]

What is more, the archaeological presence of drawplates shows that wire drawing predates Theophilus' writings. We even have a few drawplates from Roman times, for instance from the sites of Vindolanda in the United Kingdom and Altena in Germany, both of which contain several tapering holes.[21] Two other possible single-hole drawplates come from the Danish sites of Illerup Ådal and Vimose respectively.[22] An obstacle against identifying these tools as drawplates is that a similar looking implement, called a 'nail iron', was used in the fabrication of nails, and they could be mistaken for one another (compare fig. 8.7 left and right).[23] Some of the mentioned pieces, like the one from Altena, have a long groove placed between the tapering holes, which is a likely feature of a drawplate (fig. 8.8). The groove would have been filled with a lubricant to facilitate drawing the metal wire. The last word on the subject has probably not

[18] Theophilus, *De diversis artibus* 3.8; translation Hawthorne/Smith 1979, 87-90.

[19] E.g. Carrol 1972; Newbury/Notis 2004; Oddy 1977.

[20] Thomsen/Thomsen 1974; 1976.

[21] Blake 1999, 56; Buchwald 2005, 311, 324; Pleiner 2006, fig. 49; Sim 1997, 368, pl. 33; Travis/Travis 2011, 79-80, fig. 39. There are about 20 finds of drawplates from the Viking period. Cf. Armbruster/Eilbracht 2006.

[22] Dobat 2008, 25-29, 57-59.

[23] Oddy 1977, 82; Thomsen/Thomsen 1974, 217.

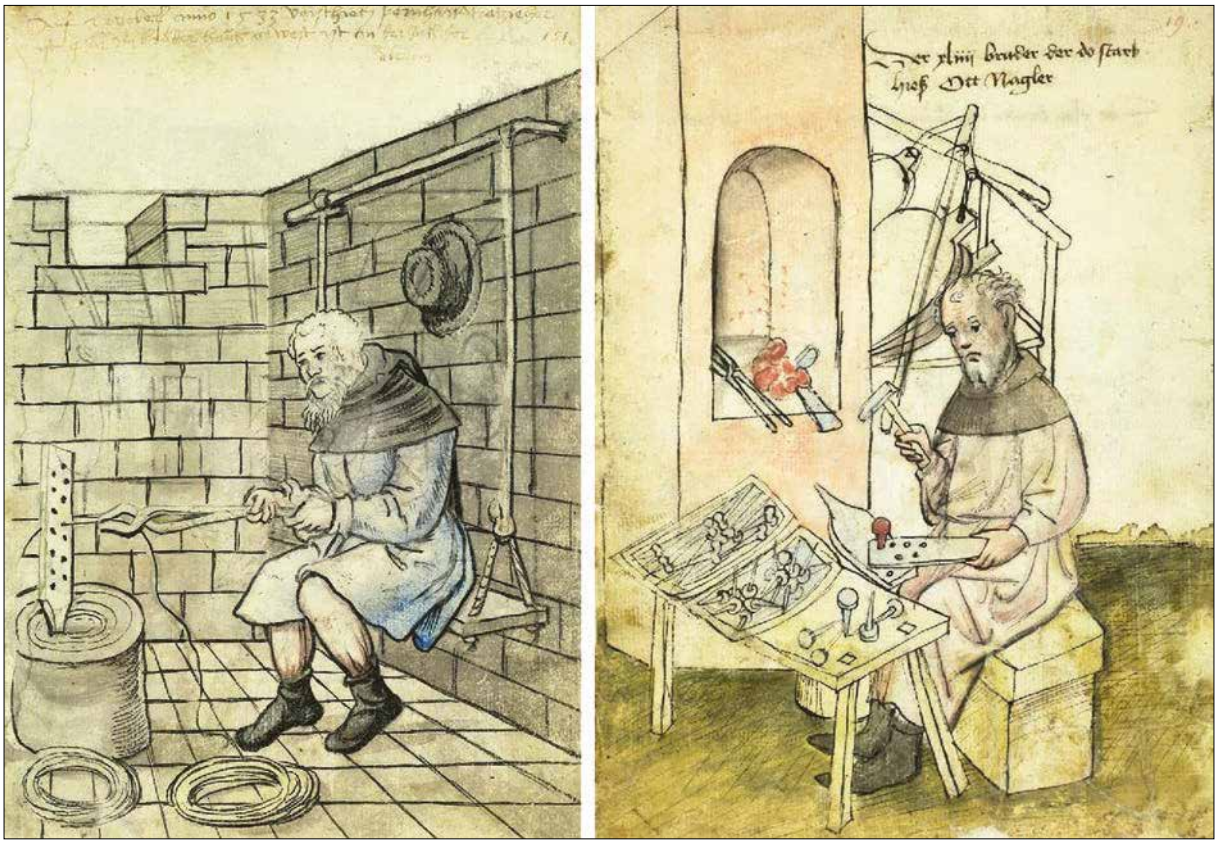


Fig. 8.7. Left: illustration of the wire drawer Pernart (Bernard), from *Die Hausbücher der Nürnberger Zwölfbrüderstiftungen*, AD 1533. The drawplate is mounted solidly on a stump, while the wire drawer sits on a swing, which allows him to use his entire body in the action of drawing the metal wire. Right: from the same manuscript comes the depiction of the nail smith Ott(o), painted around AD 1425. Otto uses a nail iron on top of his anvil, which resembles in general appearance the drawplate. Despite the resemblance of these tools, the wire drawer and the nail maker depicted in the *Hausbücher* were two specialised professions that did not combine each other's activities. Stadtbibliothek Nürnberg (MS Amb 317.2 – folio 19r & 151r).

been written yet, however most scholars now concede that wire drawing did occur in antiquity for gold, silver, and copper, alongside other methods of making wire.

Drawing iron is altogether more difficult than working with non-ferrous metals, due to its higher tensile strength. Whereas precious metals may be drawn manually, iron needs more force, requiring mechanical assistance in the form of a windlass or a waterwheel.[24] In AD 1540, Vannoccio Biringuccio mentioned, for example, that brass and iron needed to be drawn with the power of a watermill, while finer materials such as gold and silver could also be drawn by hand.[25]

Mail itself may be considered by some as evidence of iron wire drawing, but this contention is incorrect.[26] Wire could have been made using other manual methods such as hammering, block-twisting, strip twisting, or strip drawing (fig.8.9).[27] Hammering is the most basic of these methods, by which an ingot is hammered out until a wire of a semi round diameter is formed. Making round wire in this manner is no easy feat and can be aided by rolling the hot piece of metal between two hard surfaces. Block-twisting

[24] Lazar 2018, 104-105; Thomsen/Thomsen 1974, 1218-1219.

[25] Vannoccio Biringuccio, *De la pirotechnia*; translation Smith/Gnudi 1942, 377-381.

[26] Burgess 1960, 151; Smith 1959, 66.

[27] Oddy 1977, 83-86.

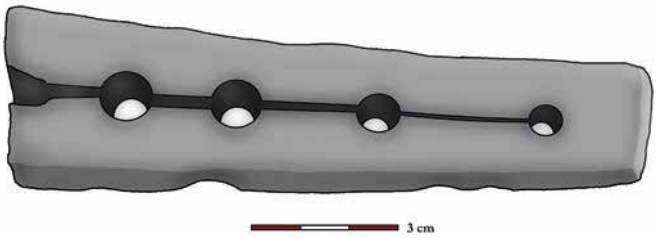


Fig. 8.8. Drawplate from Altena, Germany, consisting of holes of diminishing sizes. There is a groove between the holes, probably to store lubrication to aid the drawing action. This feature makes it almost certainly a drawplate and not a nail iron (drawing M.A. Wijnhoven).

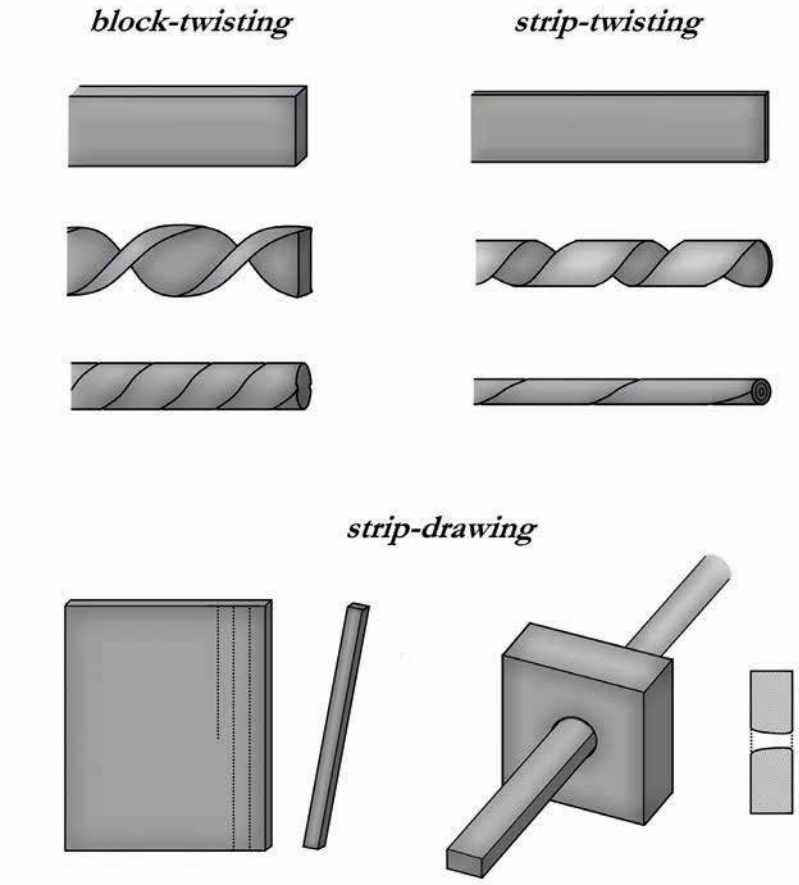


Fig. 8.9. Three methods of making metal wire, in addition to wire-drawing: block-twisting, strip-twisting and strip-drawing. In block-twisting a rectangular rod is twisted into wire, while strip-twisting uses a thin strip of metal instead. Strip-drawing involves very thin sheet metal being cut into strips which are fed through a finishing die to give the wire the desired round cross-section (drawing M.A. Wijnhoven).

is done by hammering out an ingot into a square rod of the desired diameter which is then twisted as tightly as possible and rolled to obtain a smooth surface. Strip twisting makes use of a thin strip of metal wrapped around a core which once removed is twisted and tightened, leaving a hollow interior. Lastly, strip drawing involves strips of metal, cut with shears from thin metal sheet, being fed through one or several finishing dies which are basically the same as the last (few) hole(s) of a drawplate, but with the advantage that they can consistently form perfectly round wire using much less force, allowing a single person to create the iron wire.

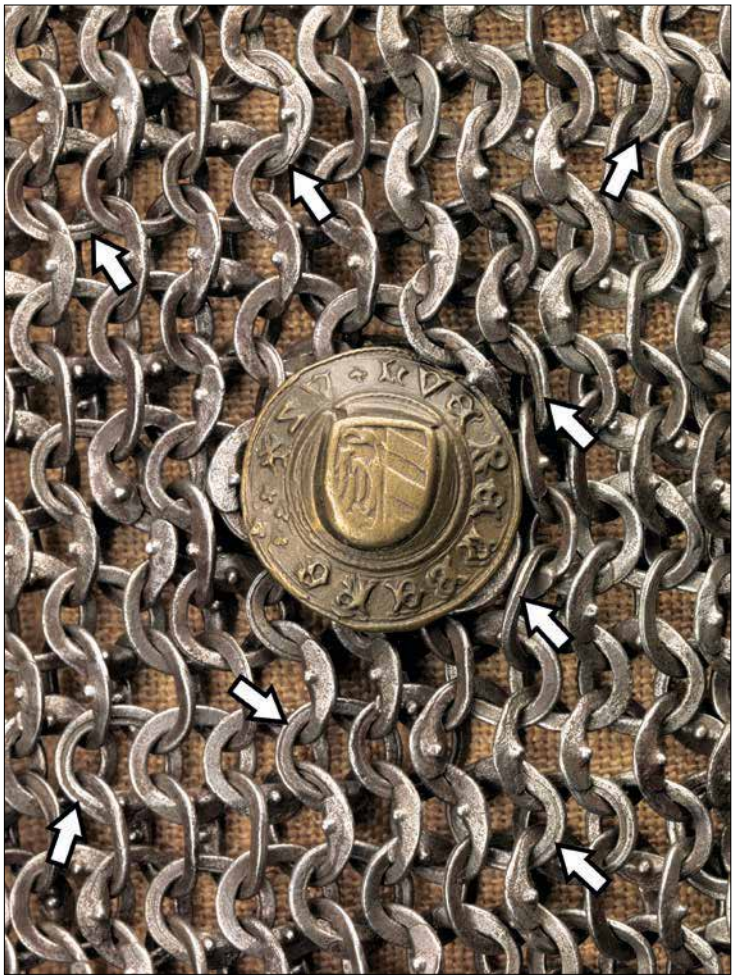


Fig. 8.10. Close-up of the rings in a 15th century German coat of mail at the Metropolitan Museum of Arts in New York, inv. no. 29.156.68. The rings have been made from strip-drawn wire, evidenced by the grooves that run around the circumference of many rings. Such grooves are formed when part of the strip folds over on itself while being drawn. The arrows point to some clearly visible grooves (photograph Metropolitan Museum of Arts).

While the fabrication of iron wire for mail has been widely discussed,[28] technical studies that can provide more solid evidence have been relatively scarce. Metallography, for instance, is a technique that uses microscopy to examine the physical structure and components of a metal and holds great potential for mail studies. Cyril Stanley Smith has carried out one of the most extensive metallographic studies in mail so far. He analysed 16 rings from European and Oriental mail ranging from the Late Middle Ages to the Early Modern period,[29] and concluded that in most European rings the wire had been drawn extensively. However, in some rings it had been drawn just slightly, suggesting that they were probably made from a strip of metal fed through one or several finishing dies, meaning that they were produced by strip drawing (fig. 8.10).[30] Some of the Oriental rings turned out to be made from drawn wire as well, but others were made by cutting a thin strip and then filing them to their present shape. Smith's analysis demonstrates that wire for making mail could be and was made using different techniques, even contemporaneously in the same region. Since Smith's publication, several subsequent metallographic studies have confirmed his findings.[31]

[28] Burgess 1953, 48-49; 1960, 151-153; Chapman 2004, 54-58; Sim 1997, 365-368; Smith 1959 65-67, 1960: 289-290; Vike 2000, 28; Williams 2003, 29-30.

[29] Smith 1959; 1960.

[30] Huber *et al.* (2004, 38-45) in their study of late-medieval and early-modern European mail come to a similar conclusion.

[31] Evidence for drawn wire in European mail from the late 13th–15th century: Manojlovic *et al.* 2017, 42-47; Petrov *et al.* 2015, 571; Williams 1980, 111-116, 125-126; Wood *et al.* 2013, 219-220. Evidence for strip drawn wire in European mail from the 15th century: Chapman 2004, 55; Vike 2000, 27-28. Evidence for drawn wire in Oriental mail: Bottomley/Bowstead Stallybrass 2000, 133; Williams 1980, 132.

Extensive metallographic studies on mail predating the 14th century are absent, but there is an increasing body of research that addresses how iron wire for mail armour was made in antiquity. David Sim, taking an experimental approach, concludes that the drawn iron wire lies well within the capabilities of the Roman craftsman.[32] His experiments using Roman tools and technology prove that a functioning drawplate could have been made from the same iron as that being drawn. Sim does notice that hand-drawing might have been nearly impossible because of the force needed, but suggests that adding a drum pulley system to aid the drawing action would have solved this problem.[33] Finally, his experiments with hand forging indicate that it does not yield wire which fits the requirements of Roman mail, making it an unlikely technique for that period.

Metallographic examinations of individual pieces of mail from before the 14th century are gradually becoming more common. An analysis of the 10th-century mail coat from Gjermundbu, Norway, indicates that the riveted rings were made from drawn wire.[34] Likewise, the wire in the mail aventail of the Coppergate helmet (AD 750-775) was probably manufactured by drawing, although this has not been determined conclusively.[35] A recent metallographic study of the wire in the Iron Age mail from Piquía, Spain, dated to 100-50 BC, also showed it was drawn.[36] The same was concluded after an examination of the complete coat of mail from Hedegård in Denmark, dating from around the start of the Western calendar.[37] Arne Jouttijärvi studied the latter piece further, alongside three mail finds from the Roman Iron Age in Denmark and northern Germany, confirming that all were made of drawn wire.[38] However, not all metallographic analyses point to this technique. The mail rings from Zemplín (1st century AD), Slovakia, were made by roll-drawing.[39] This is a specific type of strip drawing where, instead of using a rectangular strip to pull through a finishing die, a thin metal sheet is rolled lengthwise and then pulled through one or several finishing dies to compress the material and give it a smooth outer finish.

While the origin and first appearance of wire drawing remain unknown, it has become clear that this technique could certainly have been used in early mail making. Metallography has confirmed that at least from the 1st century BC onwards wire drawing was practiced. Nevertheless, wire drawing is in no way the only adequate technique for making wire for mail armour. Strip drawing and wire drawing existed side-by-side in medieval times and the find from Zemplín indicates that this was no different in antiquity.

Whether the wire was fully drawn or strip drawn seems to have been mostly dependant on the tools available. When a workshop had mechanical aids, then wire drawing was used, and in their absence strip drawing was a very useful technique. Strip drawing is relatively simple, requires almost no specialised tools, and allows one to fabricate wire that is smooth and of even diameter with minimum force.

The co-existence of two iron wire making traditions could be due to a divergent scale of production. It is plausible that smaller workshops relied more upon strip drawing that required only rudimentary tools, while larger workshops were able to invest in mechanised aids. The choice of production method may also be an indication of specialisation, with workshops using mechanised devices focussing mainly on wire production, and workshops using strip drawing fabricating a range of products.

Historical sources reveal that wire drawing and mail making were specialised professions during the Late Middle Ages and the Renaissance. It is uncertain if this also applies to the previous periods. There is unfortunately not much to indicate whether a Roman mail maker drew his own wire or would have acquired this from another workshop. Likewise, it is hard to determine if a workshop making iron wire would also have been responsible for other similar products, such as wire brooches.

[32] Sim 1997.

[33] Sim/Kaminski 2011, 118-123.

[34] Vike 2000, 14.

[35] O'Connor 1992a, 1066.

[36] Quesada-Sanz *et al.* 2019, 166.

[37] Malfilâtre 1993, 21-25.

[38] Jouttijärvi 1996, 56-57.

[39] Özşen/Willer 2016.

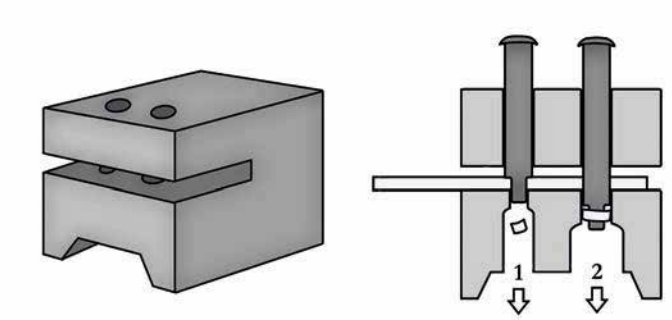


Fig. 8.11. Solid rings created from sheet metal undergo two punching actions: one to create the inside and one to create the outside of the ring. Archaeology has not rendered specific tools for making solid rings yet, but this illustration demonstrates how such tools may have looked like and functioned (drawing M.A. Wijnhoven).

8.3 THE MANUFACTURE OF SOLID RINGS

The manufacture of solid rings has been much debated in the study of mail armour, in part due to the limited information available. There are no descriptions, illustrations or surviving specialised tools that throw light on this matter. To add to the problem, solid rings disappeared in European mail during the 14th century, whereas most historical mail comes from the 15th century onwards. This means that most well-preserved specimens of European mail are unable to provide information. In Oriental mail, solid rings were used for much longer, for example in Indo-Persia and the Ottoman Empire, but were eventually abandoned as mail stopped being used in combat and was replaced by fully butted ceremonial garments during the 19th century.

Two methods have been put forward for the manufacture of solid rings, namely punching and forge welding. The punching technique does not use wire but creates rings entirely from sheet metal. This can be done through two separate punching actions (fig. 8.11), one to cut the inner diameter and one to cut the outer diameter of the ring, or by a single punch cutting both at once. Alternatively, it has been suggested that only the inner diameter was punched, while the outer parts of the ring were clipped to shape.[40] Opponents of the punching method stress that it would have required durable high-precision tools which were likely unattainable in the past, and are absent in the archaeological record.[41] David Sim has demonstrated experimentally, to the contrary, that it is possible to create such precision tools by using relatively simple technology available in the Roman period.[42] Interestingly, the same raw material (i.e. metal sheet) used in wire making for the riveted rings through strip drawing can be used for producing solid links through punching.

The forge welding technique involves making solid rings from wire whose ends overlap at least partially, like in riveted rings. These are then heated to a very high temperature, of over 1200˚C, and their ends are welded together by applying pressure, usually with a hammer. Once heated, the armourer has a very small window of opportunity to forge weld. The small mass of the rings in addition to the use of a cold anvil makes them cool very quickly and if they are not hot enough, the weld will not take. Forge welding is a complex smithing technique that increases in difficulty when dealing very small objects such as mail rings, since their mass is so small that in fast rising temperatures they can easily overheat and melt or burn away.

E. Martin Burgess raises an interesting point against forge welding.[43] He notes that some mail garments contain brass solid rings in their decorative borders, that look similar to the iron rings. Unlike iron, brass cannot be forge welded and these rings must be made through punching. Nevertheless, most

40 De Cosson/Burges 1880, 565-566, pl. 11.

41 E.g. Greiner 2006, 201; Smith 1959, 61.

42 Sim 1997, 359-366; Sim/Kaminski 2011, 123-134.

43 Burgess 1960,153.

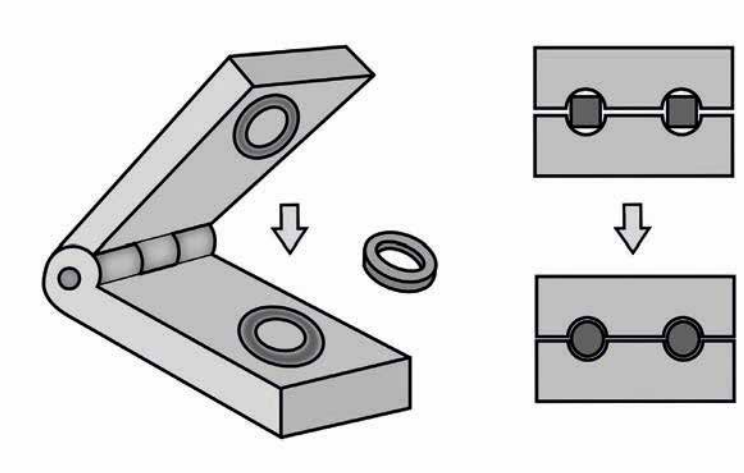


Fig. 8.12. Solid rings can be reworked after manufacture. One technique to do this is by swaging the ring between two dies (drawing M.A. Wijnhoven).

scholars agree that forge welding was certainly used in some Oriental mail of the Early Modern period,[44] particularly in low quality specimens in which the welding is clearly visible and not well done. Visual examination of solid rings is not always enough to determine how they were made as the rings could be reworked to apply the desired finish and thereby erasing traces of the manufacture process.[45] Reworking could be done by filing, grinding, hammering, or swaging (fig. 8.12). In the latter technique, the ring is pressed between two dies, altering the cross-section and finishing of the ring. Mispressed rings and the presence of 'flash', formed by the excess material that spills out of the dies, are tell-tale signs of swaging. For example, the 10th-century coat of mail from Gjermundbu in Norway contains several misspressed rings and rings with flash. Likewise, some 17th-century mail coats from Bikanir in India show traces of flash.[46]

As in the case of iron wire production, metallography can provide more information about the manufacture of solid rings. The direction of the slag inclusions should help differentiate welded from punched links (fig. 8.13a-b). Because welded links are made from wire, the direction of the inclusions should follow the circumference of the ring, at least when drawn wire has been used. In punched rings, the inclusion stripes would not run along the circumference, since they are created from sheet metal.

Even with the aid of metallography, determining a manufacturing technique may remain difficult. For example, J.R. Vilella examined 13 solid rings (nine 16th-century German, two 17th-century Turkish, and two 18th-century Persian rings) and concluded, although hesitatingly, that they were more likely made by forge welding than by punching.[47] Similarly, a metallographic study of the mail aventail of the 8th-century Coppergate helmet established that the solid links had been made by welding,[48] but the evidence given has been questioned.[49] Finally, Cyril Stanley Smith studied several solid links and indicated that they were all made from wire.[50] However Vegard Vike doubted this interpretation stating that Smith likely confused the observation of slag stripes with the formations caused by layered, heterogeneous iron; punching through sheet can deform these layers, causing them to resemble stripes observed along the curvature of the ring (fig.8.13c).[51]

44 E.g. Bottomley/Bowstead Stallybrass 2000, 135; Burgess 1960, 153; Smith 1959, 61, 64-65.

45 E.g. Burgess 1960, 154; Jouttijärvi 1996, 56; Kalsbøll Malfilâtre 1993, 44-55; Smith 1959, 65; Vike 2000, 34-35.

46 Bottomley/Bowstead Stallybrass 2000, 136.

47 Vilella 1958.

48 O'Connor 1992a, 1003-1009.

49 Bottomley/Bowstead Stallybrass 2000, 134; Vike 2000, 33.

50 Smith 1959, 61-66; 1960, 290.

51 Vike 2000, 34.

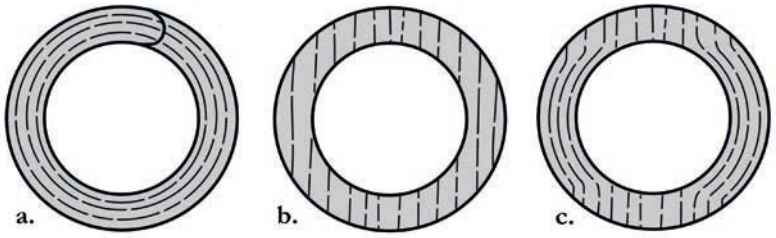


Fig. 8.13. The slag inclusions in a solid ring will differ according to the manner in which it was made. The inclusions will follow the circumference of the ring when the ring is forge welded from drawn wire (a), but it will not follow its circumference when punched from sheet (b). The punching action itself will deform the slag lines somewhat, meaning that parts can follow the curvature of the ring (c). Careful observation of the slag lines is therefore necessary (drawing M.A. Wijnhoven).

Not all metallographic studies of solid rings have generated debate. The analysis of a piece of Indian armour from 1733 demonstrated that the solid rings had been punched from sheet metal.[52] The 17th-century high quality mail coats from Bikanir, like their lower grade counterparts discussed above, all contained solid rings made by forge welding. This means that both techniques were being simultaneously used in India,[53] but unlikely in the same workshop.

The punched technique appears dominant in medieval Europe. A 14th-century brass mail ring from Nottingham turned out to be punched,[54] corroborating Burgess' statement on the manufacture of solid brass rings. A 15th- or 16th-century coat of mail from Verdal, a 1250s mail coif from Tofta, a 10th-century mail coat from Gjerbundbu and contemporary mail from Birka have all been confirmed to contain solid links made from sheet metal.[55] Again, punching is not the only technique and besides the questioned Coppergate specimen, there are also welded links in the 10th-century mail coat from Prague, said to have belonged to St. Wenceslaus.[56]

Punching also seems to be the preferred technique in pre-medieval Europe. The Roman Iron Age examples from the Danish and northern German sites of Hedegård, Vimose 7, Brokær and Thorsberg 20 were also made in this manner.[57] For this period there is one find that indicates that forge welding was also practiced. A metallographic study demonstrated that the solid rings of a 2nd century mail from Sörup in northern Germany were made by welding, as indicated by slag inclusions and the presence of a weld seam.[58]

No mail rings from a Roman context have undergone metallographic examination, but it is still possible to draw conclusions on the manufacture of solid rings based on direct visual observation. Interestingly, these rings are almost never reworked or reshaped after fabrication (chapter 11). This also means that, when well-preserved, the rings often retain physical traces of their production method.

The mail finds from the Roman Empire have solid rings with three visual marks that all point to punching from sheet metal. The first is that the rings may be marginally deformed into a cone-shape, when seen from a horizontal plane (fig. 8.14). That is, the inner edge of the links is slightly higher than the outer edge (or *vice versa* depending on which side of the ring is observed). The cone-shaped deformation can best be explained as the result of two separate punching actions employed to form the inner and outer diameter of the rings.[59] After the first punch there is less surrounding metal to retain the ring in its original flat shape, so

52 Edge 2001, 230-231.

53 Bottomley/Bowstead Stallybrass 2000, 135-137.

54 Williams 1980, 132-134.

55 Ehlton 2002/2003, 41; Grandin 2008, 20-21; Vike 2000, 14, 23.

56 Checksfield *et al.* 2012.

57 Jouttijärvi 1996, 56-57, 59-60. For the Hedegård find see also Kalsbøll Malfilâtre 1993, 26.

58 Drescher 1981, 186-187.

59 Wijnhoven 2009a, 39.

Fig. 8.14. Punching rings from sheet metal can result in conical-shaped solid rings, such as observed here in the solid rings of the hybrid armour from Newstead 4 in the United Kingdom. In addition to their conical shape, these rings also contain burrs from the punching action (photograph M.A. Wijnhoven).

that the second punch can result in a slightly cone-shaped ring. This can easily be corrected during reworking by flattening the ring between two hard surfaces such as a hammer and anvil. Solid rings in mail from the Roman Empire are (almost) never reflattened and the conical deformation feature is observed in mail from multiple sites. The conical shape is especially evident in solid rings of hybrid armour, perhaps due to the minute size of the rings and the relative thinness of the sheet used for their manufacture. Tiny rings are more easily deformed than larger and thicker rings. The second manufacture mark consists of a slight ridge-like deformation observed at the inner and outer edges of one side of the solid rings (fig. 8.15). These are again best explained by the rings being punched from sheet. In this case the sheet metal is thick enough to not deform conically, but the punching action pushes some of the metal towards one side of the ring creating a small ridge. The third feature is the presence of coarse burrs at the edges of solid rings, which again points to punching from sheet metal. Solid rings in hybrid armour often have very clear burrs (fig. 8.14).

Based on the burrs seen in mail from the Roman Empire, Berhard A. Greiner has proposed a third method of manufacture for the solid rings.[60] He suggests that instead of welding or punching, these rings were made on a lathe. The rings would start out as a forged rod that is smoothed by turning it on a lathe, and then drilled to create a hollow tube. Finally, the tube is cut into separate rings with a chisel while spinning on the lathe. Greiner's experiments demonstrate that cutting a hollow tube on a lathe will leave burrs. The

[60] Greiner 2006, 200-203.

Fig. 8.15. Close-up of a mail fragment from Carlingwark Loch in the United Kingdom (AD 80-200). The solid rings clearly demonstrate ridge deformations at the inner and outer edges. The arrows point to some of the more clearly visible examples (photograph M.A. Wijnhoven).

lathe turning method is interesting, but these marks can also be produced when rings are punched. What is more, lathe turning does not account well for the cone-shaped deformation, while punching does.

To summarize, both forge welding and punching are found in mail and can co-exist, as observed in India and Europe. The dominant tradition for the manufacture of solid rings in Europe seems to have been the punching method. Also for antiquity most evidence points to this technique. The solid rings from Sörup remind us that despite the dominance of the punched production method, the alternative of welding was also practiced.

The choice for punching or welding may also have to do with the size and level of specialisation of the workshop producing mail. Punching solid rings requires specialised equipment and befits a larger or more specialised workshop. This fits well with our understanding of the large scale production of mail for the Roman army and can explain why only punched rings are found in the Roman Empire. In contrast, forge welding solid rings can be executed without any specialised tools, but does require more skill. It is expected that smaller or less specialised workshops would often lack the tools to make punched rings, and would opt to produce solid rings by forge welding.

8.4 UNRAVELLING THE USE OF BUTTED RINGS

In addition to riveted and solid rings, mail can be made of butted rings. Modern reconstructions in museums and re-enactment, for example, are sometimes constructed with butted links (fig. 8.16). Likewise, most Indian mail garments from the late 1700s up to the early 20th century are entirely butted.[61] By that

[61] Bottomley/Bowstead Stallybrass 2000, 133; Karlova *et al.* 2015, 250; McGhee 2016, 159-161.

Fig. 8.16. Reconstruction of a Roman centurion at the Roman Army Museum, Brampton. Like almost all museum displays, this centurion wears a mail coat of butted rings (photograph M.A. Wijnhoven).

time firearms had become standard in warfare and mail no longer served as battle equipment, but had obtained a ceremonial role. It is much simpler and less time consuming to make mail with butted rings, since many of the difficult steps needed to make riveted or solid rings are omitted. The downside is that it produces a relatively weak armour since the rings can be pried open without much force. The latter may be compensated by using a very heavy gauge ring, but this in turn makes the armour much heavier than one made with riveted and solid rings. For ceremonial purposes a mail garment that is heavy or made of rings that open easily may do, but not when it is used to protect the wearer's life in actual combat.

In the past armour quality could literally make the difference between life and death. Functional mail should be simultaneously as strong and light as possible; therefore using butted links would not be preferred. Nonetheless, of all the mail finds in the database predating the 6th century AD, there are 42 that have been described in the literature as made with butted rings, either partially or completely. Many of them constitute Iron Age examples from the first centuries BC. It has been generally accepted that butted rings were used in early mail,[62] perhaps because this fits the idea of a linear development from simple to complex technology over time. Archaeology and related disciplines like anthropology and history, how-

[62] E.g. Hansen (2003, 56-57) and Canestrelli (2018, 20) conclude that mail was first butted and only later during the Iron Age, it became riveted.

BOX 8.1 PROBLEMS CONCERNING THE DESCRIPTION OF MAIL RINGS

Literature descriptions of mail vary in accuracy and should not always be taken at face value. Sometimes, due to lack of experience with this material, critical details are left unmentioned. In addition, there is no standardised nomenclature for the study of mail, which increases the frequency of unsystematic descriptions. For instance, a recurrent source of confusion is when a ring type is named after a production technique without any verification from visual marks, X-rays or metallography. Several authors, for example, refer to solid rings as 'welded', despite lacking evidence of how they were made. In such cases, it would be better to apply neutral terms such as 'solid' or 'whole' rings, and only speak of welded or punched rings when there is data to support it.

Likewise, mail fragments are frequently described as butted when no rivet heads can be observed. However, bad preservation may conceal construction details like rivet heads. What is more, metallography or X-ray photography can reveal riveted rings in specimens previously classified as solely butted. Whenever mail is too corroded for even these methods, then descriptions should not offer an interpretation of the rings' nature, but only mention that no rivet heads are visible.

Often, ring dimensions are also badly indicated. Descriptions commonly omit if the ring diameter concerns the inner or outer surface, or do not mention the type of rings the measurements were taken from. Most mail contains more than one ring type and these are usually not of the same size. Therefore, it becomes impossible to determine which rings the given dimensions belong to, e.g. riveted, solid, or from a specific area in the garment. Lastly, riveted rings usually do not have a round diameter, but are oval, so the measurements will depend on the points where they were taken (from overlap across or from side to side). Most studies fail to mention this or even consider these differences; as a result, there is a relatively large variation in ring sizes in the literature that does not correspond to reality (box 10.1).

Ideally a description should be objective and thorough, clearly stating which observations are done and what their implications are (box 11.1 offers a framework for the description of mail rings). The terminology used should reflect this objectivity. Close-up photographs or detailed drawings of the rings' characteristics are important tools that should become standard in the recording of mail.

ever, have recurrently demonstrated that such notion is not only oversimplified, but also often incorrect. Therefore, a critical review of the literature (box 8.1) and an inventory of the finds are needed to verify whether such assertions hold true.

At closer examination, a considerable proportion of mail remains described as butted has turned out to be constructed of riveted and solid rings. The mistaken descriptions have often been the result of a superficial analysis of the material and the difficulty of identifying rivet heads by an untrained eye. For example, the Iron Age finds from Lexden and Baldock 1, and the mid-1st-century AD remains from Stanwick were first classified as butted,[63] but after a more thorough inspection it was observed that it consisted of riveted and solid rings.[64] The mid-3rd-century AD fragments of mail from Weißenburg 1

[63] Laver 1927, 248; Stead 1991, 56.

[64] Foster 1986, 83; Gilmour 1997, 30; MacGregor 1962, 21; Spratling 1981, 14; Stead 1991, 56.

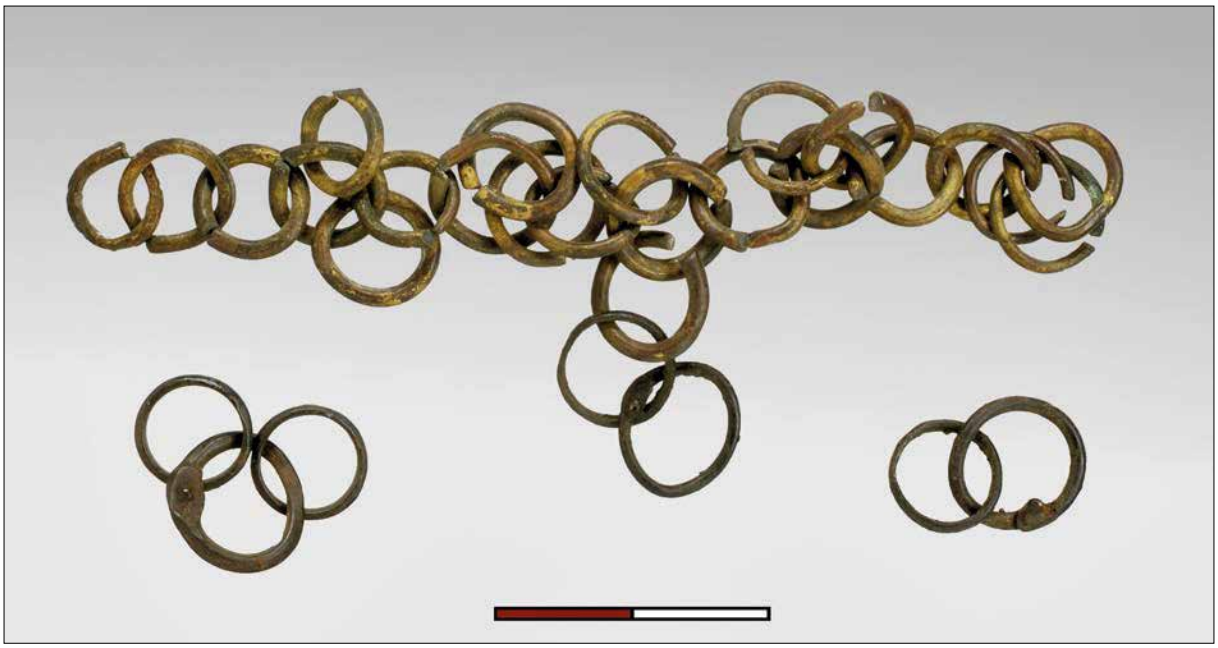


Fig. 8.17. Thorsberg 6 comprises interconnected copper alloy rings closed by simply butting the ends of the rings together. These rings were part of a decorative trim attached to an iron coat of mail otherwise made of riveted and solid rings, as suggested by several associated iron rings of these types. (photograph M. Höflinger, Museum für Archäologie Schloss Gottorf, Stiftung Schleswig-Holsteinische Landesmuseen Schloss Gottorf, Schleswig).

(fig. 9.5) were said to include the three types of rings: riveted, solid and butted.[65] However, the author could not find any butted rings during the direct examination of its largest fragment.[66]

Whereas being able to directly identify rivet heads in mail remains proves that riveted rings were used, not being able to see them with the naked eye does not mean that they were not present, although this is often assumed. For example, the Iron Age mail from Opalenie in Poland and the Roman mail from Housesteads 2 in the United Kingdom are both said to be made of butted rings since no rivet heads are visible on them.[67] It must also be remembered that mail generally does not preserve well and the specifics of its construction tend to get lost. For instance, the Iron Age specimen from Popeşti 1 in Romania is described as butted,[68] but its condition is simply not good enough to reveal whether the rings were butted, riveted or solid. However, examination techniques such as metallography or X-radiography are able to reveal the presence of rivets in mail even when the naked eye cannot detect them. This was the case in the 1st-century AD mail find from Zemplín in Slovakia which had been originally reported as made from solid and butted rings, but metallographic analysis showed that it in fact was constructed of solid and riveted rings.[69] Similarly, the 3rd-century BC mail from Kirkburn in the United Kingdom, one of the earliest finds of mail, was thought to be all butted[70] until X-ray images undoubtedly showed that half of its rings were riveted,[71] and the remaining half were presumably solid. Unfortunately, even metallography and X-radiography are not always able to shed light on mail construction, as the rings are often too corroded to reveal this information.[72]

65 Hansen 2003, 167.

66 They might be present among the other fragments.

67 Allason-Jones 2009, 457; Bochnak 2009, 13, fig. 8.5.

68 Vulpe 1976, 212, fig. 15.

69 Hansen 2003, 189; Longaurová/Longaur 1990, 352; Özşen/Willer 2016.

70 Stead 1991, 54.

71 Gilmour 1997, 32.

72 E.g. the 2nd century BC find from Es Soumâa. Cf. Waurick 1979, 322.

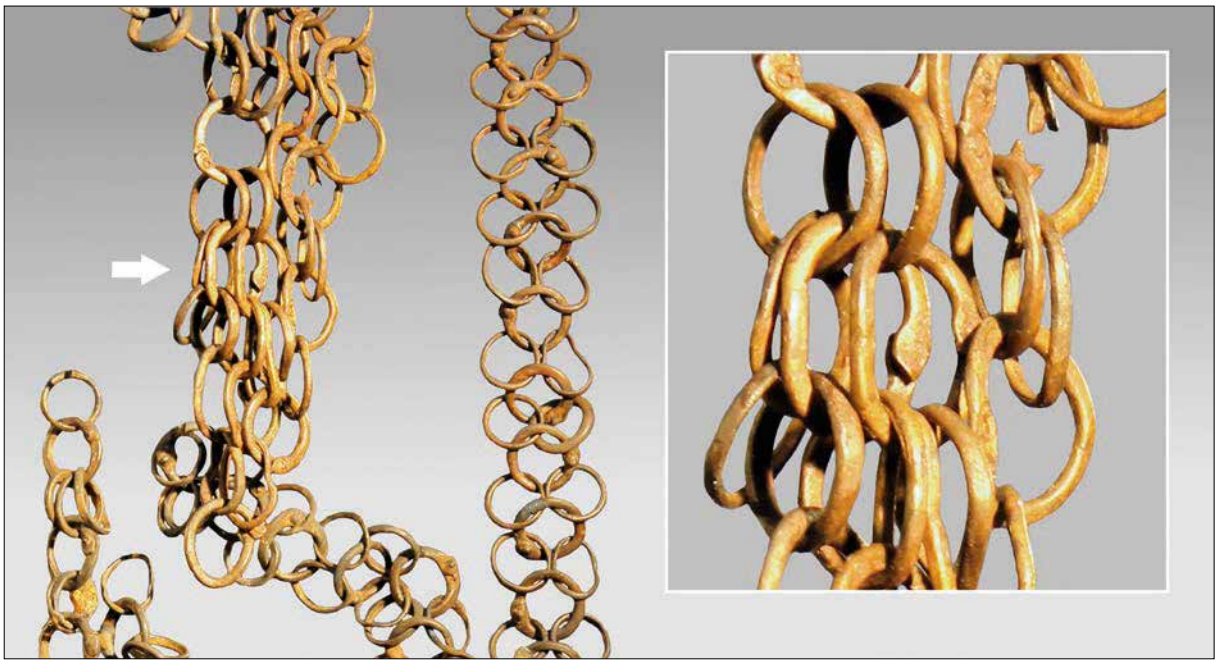


Fig. 8.18. The decorative copper alloy rings from Xanten 1 in Germany are made from riveted and solid rings. Among the remains there are several repair rings that have an overlap but are left unriveted. One of these is shown here (photograph M.A. Wijnhoven).

Not all finds reported as made of butted rings are incorrect. In fact, there are two circumstances in which butted rings are expected. One is as a decorative copper alloy trim in an otherwise riveted and solid iron mail coat. Of all mail finds said to be butted, almost half (n=19) concern decorative copper alloy rings, most of them from Thorsberg in Germany (fig. 8.17) and Dura-Europos in Syria, both from the 3rd century AD.[73] They are also known from Caerleon in the United Kingdom and Kissi in Burkina Faso, although in these cases it is not entirely certain whether the butted links actually belonged to mail armour.[74] It should not be surprising that decorative trims were occasionally made from butted rings, since they did not serve a structural purpose but were ornamental to otherwise strong mail garments. This takes us to the second circumstance in which butted rings are expected, namely repairs.

Thorsberg 1 and 5 and Xanten 1 are made from riveted and solid links, but also contain repairs done with butted rings.[75] In Xanten 1 these even include an overlap to simulate riveted rings, but are unriveted (fig. 8.18). The 1st-century AD mail from Woodeaton also contains a repair made with butted copper alloy rings;[76] in this case they are not located at the edges of the garment but are inserted into the matrix of solid and riveted iron rings.[77] Hybrid armour shows butted ring repairs, too. In the unprovenanced find 5 (possibly from the Balkans) the butted repair rings are thicker than the other riveted and solid rings. The unfinished hybrid armour from Vize in Turkey also has a section of butted rings, which might have been added not as a repair, but in a rushed attempt to complete the armour so it could be deposited in the burial chamber of the deceased.[78]

73 James 2004, 110-111, 118-119; Matešić 2015, 210-211, 512-513.

74 Chapman 2004, 88; Fenn *et al.* 2009, 122.

75 Lenz 2006, 19-20; Matešić 2015, 208-210, 512-513.

76 Jope 1957, 106.

77 This could also point to a decorative technique, as explained in chapter 6.6. One option does not necessarily exclude the other.

78 Driehaus *et al.* 2012, 389.

Fig. 8.19. The coat of mail from Ciumeşti dates approximately to the second half of the 3rd century BC. It is made entirely from butted rings (photograph M.A. Wijnhoven).

Two relatively well-known Iron Age finds, that feature in almost all studies concerning early mail armour, differ from the pattern observed so far. These are the coat of mail from Ciumeşti in Romania (fig. 8.19) and a mail fragment from Tiefenau in Switzerland (chapter 9.2).[79] Both are made entirely of butted rings. The Tiefenau find is unique in its own right, being the only piece from antiquity that is woven in a 6-in-1 pattern. This is denser than that normally employed in mail armour. To a certain extent this mitigates the lessened protection offered by butted links, but also makes the mail garment especially heavy. The Ciumeşti coat of mail is however woven in a regular 4-in-1 pattern observed in all mail from Europe.[80]

The early finds from Ciumeşti and Tiefenau have probably aided in consolidating the idea that mail started out butted, only later to develop into armour made from riveted and solid rings. This is however a false premise. As we have already seen, right from the introduction of mail there is evidence for the use of riveted and solid rings, such as observed in mail from Kirkburn and Fluitenberg (chapter 2). This evidence demonstrates that there is no linear evolution from simple to complex. This does leave the conundrum of how to explain the butted rings in the Ciumeşti and Tiefenau examples.

The fact that these two butted mail garments come from the centuries BC is an important clue. This is a time in which the knowledge of how to make mail armour is limited to relatively few craftsmen and insiders. It is very likely that the art of making mail, especially the technically advanced riveted and

79 Müller 1986; Rusu 1969.

80 The rings from the Ciumeşti find have been described in many ways in the literature: all-butted, all-riveted, solid and butted, and riveted and solid with butted repairs. Cf. Edge 2001, 227; Ritchie/Ritchie 1997, 48; Rusu 1969; Williams 2003, 29. Examination by the author has demonstrated that it is entirely made from butted rings.

solid rings, was guarded with care. The coat of mail was a highly exclusive object in Iron Age society and mainly associated with the warrior elite. As is the nature of humans, exclusivity in itself instigates the desire to be part of those few.

The Ciumeşti and Tiefenau finds must be seen in this light. The craftsmen that created them did not have the knowledge (or the tools) to produce a mail coat with riveted and solid rings. Apparently they were not part of the inner circle of knowledgeable craftsmen. Instead of making the 'real deal', they resorted to a product that looked like it, but in reality offered much less protection on the battlefield. Despite being an inferior product, the mere similarity to the prestige object of a mail coat constructed with riveted and solid rings, made them desirable enough. While these inferior coats did not adequately satisfy the needs of warfare, they did satisfy the need for social status.[81] Simply put, this phenomenon may be understood as the ancient equivalent of the modern 'knock-off' bag of expensive name brands. It is expected that with time the knowledge of making riveted and solid rings became less exclusive. Probably with more craftsmen being able to produce these rings, the demand for these butted imitations also waned. Given the steady increase in mail finds from the 1st century BC onwards, the butted imitations are expected to have ceased around the start of that century.

The above review allows us to put the use of butted rings into context and confirm that like all armour, mail balanced maximum strength with minimum weight. Many supposedly butted mail finds are the result of superficial examination. The analysis of early mail demonstrates that the use of riveted and solid rings has always been the norm, and that butted rings are only observed in mail under special circumstances. Three of these have been identified: as decorative trims, as repairs, or as an imitation of a desirable object. It is now also possible to refute the idea of linear development of mail from simple to complex. Lastly, these results highlight the need for a careful re-examination of reported butted mail remains, preferably using science-based techniques in addition to direct visual examination.

8.5 LOOSE RINGS

Mail making does not require many tools or a large work area, as verified by modern mail makers who frequently operate from home, even in a single room. While identifying workshops in archaeology can be challenging, recognizing a workshop that produced mail is even harder precisely because they do not demand a particular space except for a well-lit area. Consequently, very few workshops with evidence of mail making activities have as yet been identified.[82]

Finds of loose rings can offer a valuable clue. Whenever mail is retrieved in archaeological excavations, it usually is as a mesh of interconnected rings, as in its working condition. However, the archaeological record sometimes yields agglomerations of only loose rings, which may be an indicator of mail making activities. It is reasonable to assume that during mail production individual rings fall, scatter, and get embedded in the ground. In addition, rejected rings are frequently discarded as they have no use or value. Therefore, in a space where mail is made, we may expect a scatter of loose rings or clusters of loose rings accumulated in corners, drainage pipes or sidewalks, as a result of clearing the work area.

Just as the presence of hammerscale is used as evidence of smithing,[83] loose rings can be an indicator of mail making. In such cases their identification requires a meticulous analysis of the soil, since both are

[81] Another example of this phenomenon are the high quality medieval Ulfberht swords, that were imitated by other workshops. These imitation swords could be of questionable quality. Cf. Williams 2009.

[82] Such as the workshop for armour repair (including mail) from León 2 in Spain, associated with the Seventh Legion. Cf. ILRUV 2012. Or the workshop from 12th century Novgorod in Russia. Cf. Petrov/Kainov 2019.

[83] Dungworth/Wilkes 2007; Starley 1995.

Fig. 8.20. Loose rings from Caerleon 6 in the United Kingdom. These probably fell to the workshop floor and were swept out to the street, where they accumulated. On the left are the copper alloy rings and on the right the iron ones. The rings are in different stages of production, with the majority being 'freshly' cut from the coil, and others already riveted. There are also some solid rings (photograph M.A. Wijnhoven).

easily overlooked. Metal rings can be detected by (wet) sieving, running a magnet or a metal detector over the residue, or making an X-ray scan of soil samples.

Since searching for loose rings is not standard practice, not many of such clusters have been reported. One example comes from a *vicus* in Woerden, The Netherlands, where 42 loose copper alloy rings were retrieved, dating to AD 150-250.[84] Another example is from early 3rd-century Caerleon 6 where large quantities of loose copper alloy and iron rings were recovered by wet sieving (fig. 8.20). They were found within the legionary fortress, along a street, in an area with a lot of workshop activity.[85] Probably, as the craftsmen regularly swept the workshop floor, they built up a deposit of loose rings in the street outside the workshop. Also within the Roman auxiliary fort of Hauarra in Jordan, dating to the Trajanic era, hundreds of loose rings were found.[86] They were located in an area that included a forge and rendered bits and pieces of armour other than mail and scrap metal, suggesting workshop activity dedicated not only to the fabrication or repair of mail, but to a broader scope of metalworking and recycling. The systematic excavation of a 9th century site at Pohansko in the Czech Republic has also rendered about 100 loose rings, scattered around the workshop as they probably fell and were then treaded into the dirt floor.[87] So far, there are only few recorded examples,[88] but with more awareness it is likely that more locations will be positively identified as spaces where mail was made or repaired.

84 Hoss 2008, 244.

85 Pers. comm. Mark Lewis, 2016.

86 Pers. comm. John P. Oleson, 2018.

87 Pleiner 2002.

88 Further finds of great quantities of loose rings that could point to workshop activity are found in Inveresk 1 in the United Kingdom and Birka 1 in Sweden.

8.6 THE MAIL MAKING WORKSHOP

The insights offered in this chapter demonstrate that mail making was a dynamic craft and that there was more than one way to produce a mail garment. For example, the evidence for iron wire production shows not only that wire drawing was already practiced in antiquity, but also that two distinct wire making traditions co-existed. This co-existence is likely an indication that wire was being produced in workshops that could vary in the level of specialisation and scale. Large and specialised workshops are thought to have used wire drawing, while smaller and less specialised workshops could still produce wire by strip drawing.

A similar pattern is observed for the production method of solid rings, which can be made by punching or forge welding. For antiquity punched rings appear to be the norm, but the find from Sörup proves that forge welding was also done. Again, the choice of one over the other could well be an indication of workshop specialisation and scale. Punching requires specialist tools, more akin to larger or specialist workshops, while forge welding can be done by any craftsman that has this skill.

Unfortunately there are no written texts or images of mail making in antiquity. However, images from the Late Middle Ages and Early Modern period provide an insight into the activities and tools used in making mail. It is very likely that the mail maker from antiquity would have recognised many if not all of the tools and manufacture steps. Similarly, the division of labour as put forward by two ethnological accounts, is also highly appropriate for mail making in any other period. Probably the most experienced craftsman was responsible for the final assembly of the mail garment, while more or less six assistants would do the simpler prior steps. For the Roman army in particular, it can be supposed that one knowledgeable craftsman (for example the *immunes* discussed in chapter 3) would be in charge of approximately six unskilled (ex-)soldiers or civilians, providing the main labour force. This also fits well with the mail making activities identified through assemblages of loose rings, discussed above. These assemblages have been found in Roman forts and in a *vicus*. It is imaginable that some workshops had more than one skilled craftsman, so provided there was enough assistance, the workshop could turn out several garments at the same time.

It is difficult to determine if the mail maker in antiquity dedicated all his time to mail making or if he was also responsible for the production of other objects. We do know that the mail maker was a specialist during the Late Middle Ages and Early Modern period. What is more, mail makers of that time did not even produce their own wire, but made use of a professional wire maker.

There are some indications that favour specialism for the manufacture of mail in the Roman army. First, is the mere scale of armour production, which could easily accommodate specialised professions. This is particularly the case for the Late Roman period when armour was mainly produced in state factories. Second, a systematic analysis of the characteristics of Roman mail rings (see chapter 11) demonstrates a high level of uniformity not only during the Late Roman period, but also during the Principate. This consistency supports the standardisation of mail making practices. It is expected that such standardisation is more akin to specialist craftsmen than to those responsible for a large range of items. Less standardisation is observed during the Iron Age and for the territories outside the Roman Empire (also chapter 11). This points to diverse mail making traditions and might be an indication that the craft was less specialised and that mail was one of various items that these craftsmen produced.

9 Weaving patterns

'Understanding how a garment is made, and from what type of material, is key to understanding the manner in which it might be worn and how it was experienced on the body. The properties of any given textile will influence what can be made of it, and how it might be made.'
Mary Harlow & Marie-Louise Nosch[1]

Weaving pattern refers to the repetitive manner in which the rings are placed and connected to form an integral structure that makes up the mail weave. Metal rings can be woven together in many different ways, each variant with its own unique qualities, and the options seem almost limitless.[2] By the first millennium BC, various weave patterns to form a ringed mesh had been developed even before mail armour was invented (chapter 2.1). The great variety of weaving patterns can especially be observed in Japanese mail armour (*kusari*), which employs a wide array of ring configurations (fig. 9.1).[3] This chapter will take a closer look at the patterns that prevailed in antiquity.

There are more than 600 entries of mail finds in the database that date from before the 5th century AD. The weaving pattern was determined through personal examination, whenever possible, supplemented by descriptions and photographs in literature. Often, the pattern could not be determined due to either poor preservation, or lack of a published detailed description. Nonetheless, the pattern was discernible in over 50% of the mail finds.

9.1 FOUR-IN-ONE PATTERN

Despite the numerous different manners in which rings may be linked together to form a mesh, all mail from antiquity is woven using the 4-in-1 pattern. In fact, this weaving pattern was prevalent in Europe since the invention of mail until its demise. It is also the only pattern observed among the medieval mail finds included in the database of this study, and it is the standard for all historical mail in Europe, from the Late Middle Ages to the Early Modern period. The exploration of other weaving patterns is seen only outside of Europe, and mainly in Japan.

The name of the 4-in-1 pattern is self-explanatory, referring to a weave where each ring connects to four others. The rings are placed in rows, where none of the rings within the same row connect to each other, but each is woven through two rings in the row above and two in the row below. Figure 9.2 offers a schematic representation of this pattern and illustrates which rings are connected.

With a few exceptions, the great majority of mail in the database consists of a combination of riveted and solid rings. Given its nature, a solid ring cannot be connected to another solid ring. It needs an open riveted ring to weave it into a mesh, which is then closed in the final step. Since in a 4-in-1 pattern each ring connects to two in the row above and two in the row below, it means that the rows alternate between riveted and solid rings (fig. 9.3).

1 Harlow/Nosch 2014, 20.

2 Gut 2009.

3 Robinson 1967, 195, fig. 103; Stone 1961, 402-403, 426, fig. 537; Yamagami 1928, chapter 9.

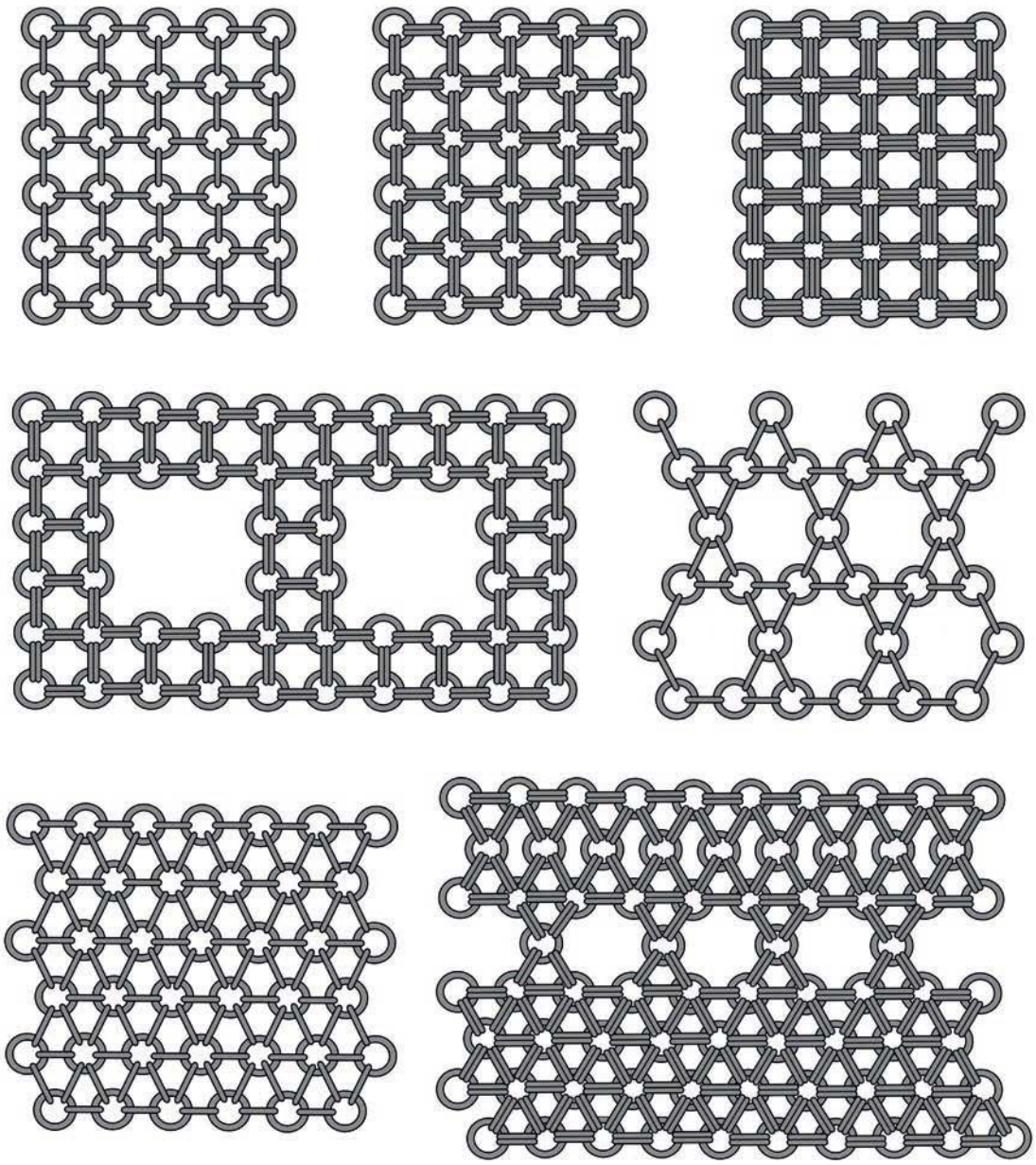


Fig. 9.1. Japanese mail is woven into a variety of patterns, several of which are demonstrated here. Most Japanese patterns are built up with sturdy flat-lying rings (*naka-gusari*) that are connected to rings of a lighter gauge and are only visible in profile (*kake-gusari*). The combination of these two can be arranged in many different geometric shapes (drawing M.A. Wijnhoven).

The 4-in-1 pattern has directionality, meaning that it is able to stretch much more in the direction of the rows than at an angle of the rows (fig. 9.4). Surviving mail coats from medieval and early-modern times invariably show that the rows were placed horizontally in relation to the body. The rows in the sleeves have the same direction as the trunk, when seen with the arms extended. There are only a few mail garments from antiquity in good enough condition to inform us about the placement of the rows, but these consistently confirm the same horizontal alignment.

This orientation is actually logical from an ergonomic perspective. The ability of mail to stretch is quintessential to allow movement without much restriction. If one moves the torso or arms, sits down or rides a horse, then the chest, back or mid-rib can expand, increasing the body's circumference. The capacity of the 4-in-1 pattern to stretch horizontally means that the mail coat adapts itself to the wearer's

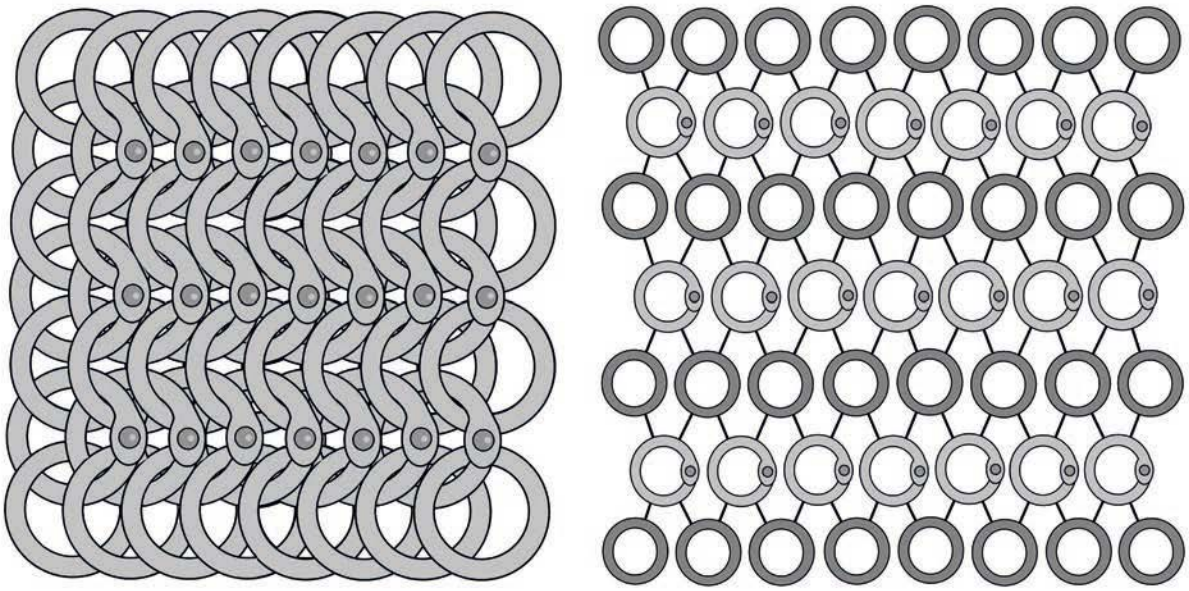


Fig. 9.2. Left: realistic drawing of the 4-in-1 weaving pattern. Right: schematic representation with lines indicating which rings interconnect. The rings are arranged in rows and the links within the same row do not join. Instead, each ring connects to two rings in the row above and two in the row beneath. The type of ring alternates per row from solid to riveted (drawing M.A. Wijnhoven).

position, making it comfortable to wear. Furthermore, it also allows the mail coat to fit people of different sizes, making it easy to hand over from person to person. The unrestricted mobility and the one-size-fits-all qualities of mail woven in a 4-in-1 pattern would have made it certainly attractive and partly explain its popularity through the centuries.

The concept of 'row slope' is another characteristic of the 4-in-1 weaving pattern that is important to mention, especially for its influence on the construction of a mail garment, which will be the subject of the next chapter.[4] While none of the rings within the same row interconnect, they do overlap partially. If the mail fabric is laid down on a flat surface, each ring rests upon its neighbours causing them to slope (figs. 9.3 & 5). All the rings within a single row always slope in the same direction, with the row above and below going in the opposite direction. So if the first row slopes to the right, the second must slope to the left and the third to the right, and so forth. If two pieces of mail were attached together without matching their ring slope, the rows would clash, causing the rings stand up awkwardly (chapter 10.3). The ring slope is something that the mail maker must be aware of and involves additional planning in the construction of a garment.

Although the 4-in-1 pattern is almost omnipresent, there are exceptions. In the period under discussion there are two: a coat of mail found at Tiefenau and another at Bertoldsheim.[5]

[4] The phenomenon of 'row slope' was first described by Burgess 1958, 202.

[5] The find from Michajlovskaja Staniča could possibly entail another exception. Cf. Kaminskaja *et al.* 1985, 229-230. It has been described as a large fragment with two rows of copper rings at its edge. Each copper ring is said to connect to five other rings. This description, when compared with mail from all over the world, seems unlikely. Unfortunately the publication does not contain photographs or drawings of this particular detail.

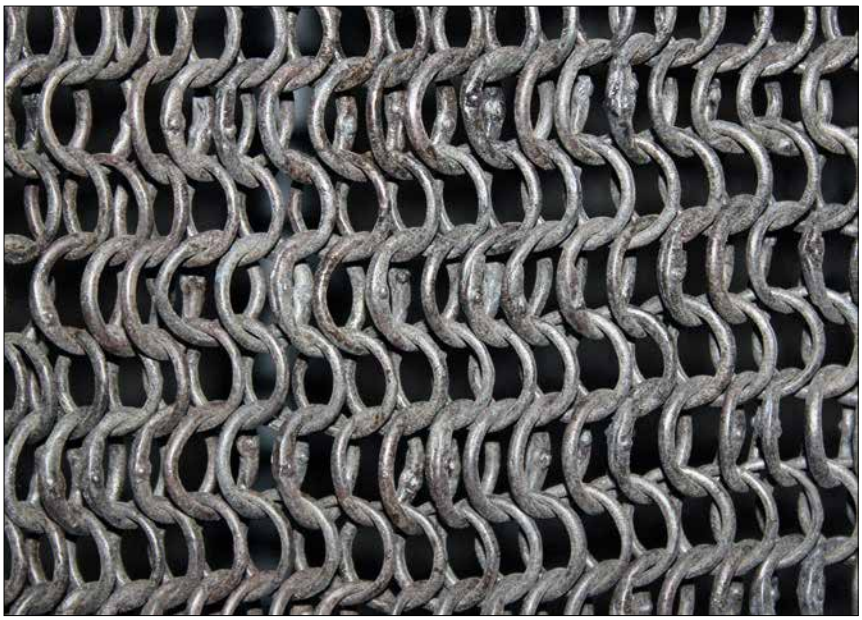


Fig. 9.3. The 4-in-1 weaving pattern in the Vimose coat of mail, Denmark, dated to the 2nd or early 3rd century AD. The 4-in-1 pattern is made in rows and each ring passes through four others, i.e. two in the row above and two in the row below. The rows alternate between riveted and solid rings. The rows of riveted rings slope towards the right and those with solid rings slope towards the left (photograph M.A. Wijnhoven).

Fig. 9.4. The photograph shows an all riveted piece of mail made by the author and woven in a 4-in-1 pattern. This pattern allows the mail to expand significantly in the direction of the rows. At the top the fragment is in a relaxed position, and at the bottom it is stretched (photograph M.A. Wijnhoven).

Fig. 9.5. The presence of rings aligned in rows that alternate in the direction of their slope makes it easy to recognise the 4-in-1 pattern, even if a piece of mail is heavily corroded. A good example is this large fragment of mail from Weißenburg 1, Germany, dating to the mid-3rd century AD (photograph M.A. Wijnhoven).

9.2 SIX-IN-ONE PATTERN FROM TIEFENAU

During the mid-19th century a single large block of mail was found at Tiefenau, Switzerland. It was retrieved alongside many other objects probably involving a votive lake offering dating back to the 2nd or 1st century BC. The block of mail was very corroded and had been exposed to fire prior to deposition. In order to understand the mass of mail better and see if there was anything interesting inside, its discoverers took the drastic decision of chopping the block to pieces with an axe (fig. 9.6).[6] Unfortunately, with this action what would have been a complete coat of mail from the La Tène period was destroyed. Through time, some fragments were lost or disintegrated, while others were given away to interested collectors. To this day only one fragment that can be attributed to this find survives with certainty.[7] Another fragment, in the collection of Musée Cantonal d'Archéologie et d'Histoire in Lausanne, is likely to have come from the same coat of mail.[8] The British Museum also possesses a small section of mail that contained a now missing label with the word 'Tiefenau' (fig. 9.7).[9] It is impossible to know for certain whether this piece indeed originates from the same mail coat, but it is likely. Especially since the inventory number (1860,0919.1) indicates that it became part of the Museum's collection in 1860, which corresponds with the dispersion of the Tiefenau fragments among collectors all over Europe.

The fragment that surely comes from Tiefenau was mechanically cleaned in the 1980s. Before this treatment only parts of rings were visible through the corrosion, but afterwards a flexible mesh of rings emerged.[10] Against the generalized 4-in-1 pattern, a divergent weave was observed at Tiefenau, in which the rings connect to six others instead of four.[11]

This 6-in-1 pattern is very similar to the 4-in-1 weave. Both techniques make use of rows, the only difference being that each ring connects to three in the row above and three in the row below (fig. 9.8). This small difference in the weave pattern results in a mail with considerably different qualities, much heavier and more rigid. The 6-in-1 pattern has occasionally been observed in mail from the Late Middle Ages, but never applied to the whole garment (fig. 9.9), as it would probably make the garment too heavy and cumbersome. The medieval examples demonstrate that the 6-in-1 pattern was sometimes applied to the collar which, with the higher ring density, could stand on its own.

Since the majority of the Tiefenau coat of mail is lost, it is impossible to say whether the 6-in-1 technique was applied to the entire garment or just to a small section of the coat in order to reinforce certain areas. The two possible fragments from the same coat, now in the British Museum and Musée Cantonal d'Archéologie et d'Histoire, have not been mechanically cleaned and do not yet reveal their weaving pattern. Whatever the case, after this single occurrence from Tiefenau it takes around a millennium and a half before evidence for this weaving pattern is found again.

6 De Bonstetten 1860, 15.

7 Müller 1986.

8 Müller 1986, 121. Inv. no. CT 2442.165.

9 I thank Julia Farley from the British Museum for pointing out this find to me.

10 Müller 1986, 119-121, fig. 6.

11 Poux *et al.* 2015, 245, pl. 22 conclude from X-rays done on mail remains from Corent that these are woven in a 6-in-1 pattern. The X-ray shown in the report looks however similar to those taken of regular mail woven in a 4-in-1 pattern.

Fig. 9.6. Some of the fragments of the Tiefenau coat of mail after having been chopped to pieces, as recorded in 1860. All are now lost, except for the top left fragment, which was mechanically cleaned in the 1980s and turned out to be woven in a 6-in-1 pattern (drawing from De Bonstetten 1860, table 8.2-5).

Fig. 9.7. A fragment of mail possibly from the mail coat from Tiefenau, now in the British Museum. The heavily corroded condition of this piece does not reveal its weaving pattern. Possibly this may be determined by mechanical cleaning, if there is this enough of the original material left (photograph M.A. Wijnhoven).

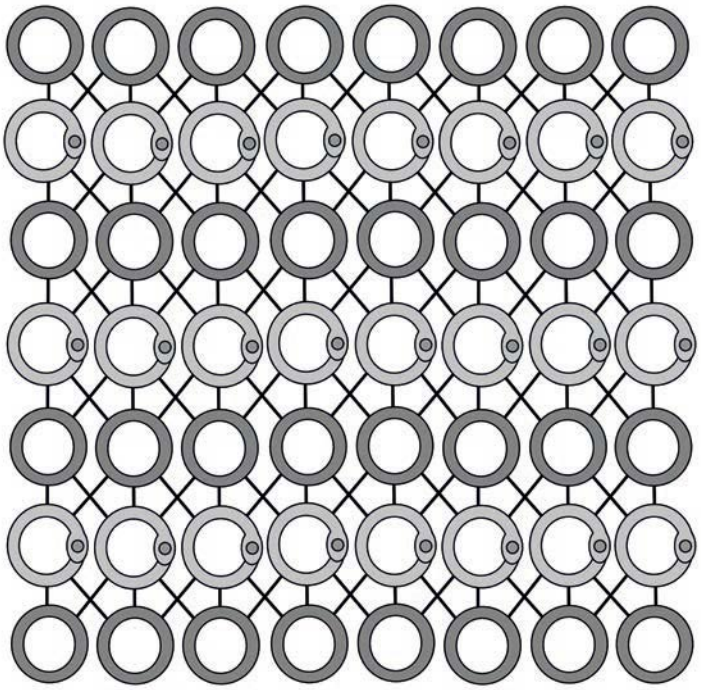


Fig. 9.8. Schematic representation of the 6-in-1 weaving pattern with lines indicating which rings interconnect (drawing M.A. Wijnhoven).

Fig. 9.9. A standard of mail covering the neck and shoulders, dating from approximately AD 1350 and now in the British Museum (inv. no. 1856,0701.2244). The lower part is made from triangle shaped pieces of mail woven in a 4-in-1 pattern that contain alternating rows of riveted and solid rings. The collar covering the neck consists solely of riveted rings woven in a 6-in-1 pattern, which gives it rigidity (photograph British Museum).

9.3 PINCHED LOOP-IN-LOOP PATTERN FROM BERTOLDSHEIM

The other coat of mail with a divergent weaving pattern comes from Bertoldsheim, Germany (fig. 9.10). It was discovered in 1981, and is unequivocally Roman, dated between the end of the 1st and the middle of the 3rd century AD.[12] The garment was probably complete when deposited, folded several times over and then rolled up. Subsequent corrosion has made it impossible to unroll, thereby obscuring many aspects of its construction. However, what can be observed points to a ringed garment that is in many ways unique among mail.

[12] Garbsch 1984; 2000, 111, 116.

Fig. 9.10. The coat of mail from Bertoldsheim. Top left: set of chest plates originally attached to the mail coat. Top right: the mail remains with one of the chest plates *in situ*. Bottom left: decorative vertical lines were created through the use of regular copper alloy rings. Bottom right: decorative horizontal lines were made with figure-eight shaped links. Archäologie-Museum Schloss Neuburg an der Donau (photograph M.A. Wijnhoven).

Probably, the most eye-catching feature of this coat are the chest plates located at the neck opening. Not only is this the only set of chest plates ever found in association with mail, but it is also exceptional in its shape and construction.[13] The coat from Bertoldsheim, furthermore, has rings of different materials creating a play of colour that matches the chest plates. While the combination of different metals for the rings as a means of decoration is common in Roman mail (chapter 6), few finds contain as many decorative elements as the Bertoldsheim coat. The garment is covered in horizontal and vertical lines created by copper alloy rings inserted into a matrix of iron rings.

The bulk of the Bertoldsheim garment is woven in a regular 4-in-1 pattern, including all the iron rings and the copper alloy vertical lines. However, the horizontal lines are created by an altogether different type of link, which is also woven together in another manner. Instead of the usual round riveted or

[13] Garbsch 2000, 115-121. Basically there are three types of chest plates. The first consists of a matching set of plates whose shape is each other's mirror image. Such sets are usually found in association with scale armour. The second type is the singular trapezoid-shaped plate. Garbsch (2000, 109) speculates that these may have been applied to textile instead of metal armour. Lastly, there is the miscellaneous piece from Bertoldsheim which, in general outline mimics the trapezoid shape (like the second type), but in fact consists of two elements (like the first type).

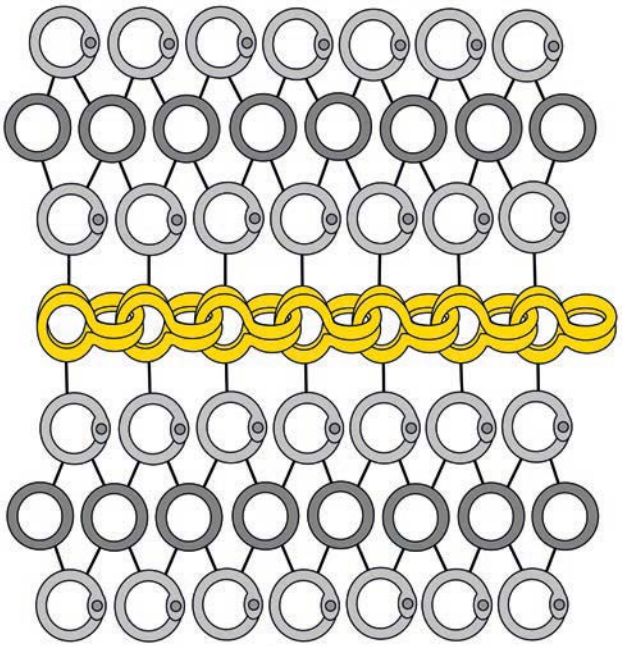


Fig. 9.11. One of the two possibilities of how figure-eight-shaped loops can be interconnected with a regular 4-in-1 pattern to form a single mesh (drawing M.A. Wijnhoven).

solid rings, the horizontal lines are made of so-called 'figure-eight-shaped' links (fig. 9.10, bottom right). This type of link is well known, albeit not in armour. It is frequently observed in metal chains and was very popular for making jewellery in antiquity. People in the Roman Empire seem to have been particularly fond of these links, often employing them in jewellery chains.[14] Modern jewellery makers use the term 'pinched loop-in-loop' for this type of chain. Interestingly, the cross-section of the wire used to create the Bertoldsheim links is square and not round, just like in most jewellery chains of this type,[15] suggesting that this element might have been inspired by gold smithing techniques.

The current condition of the Bertoldsheim mail coat does not allow observing how the horizontal copper alloy rings exactly interconnected with those from the iron matrix. The iron is too corroded to see such details. The copper alloy links have withstood time better and it is clear that each horizontal line is made of a single chain of pinched loop-in-loop links. Despite the lack of details, there are only two possibilities for how a horizontally placed loop-in-loop chain can connect to the 4-in-1 pattern. In the first, shown in figure 9.11, each figure-eight link is connected to four elements: i.e. to a riveted ring in the row above, to one in the row below, and to two figure-eight links located at its right and left. Alternatively, each figure-eight loop is attached to two riveted rings above and two below, instead of one.

9.4 FOUR-IN-ONE PATTERN IN HYBRID ARMOUR

The universal use of the 4-in-1 pattern also applies to hybrid armour. This type of protective gear consists of an inner layer of mail that serves as a backing for an outer layer of scales. Perhaps the most striking characteristic of hybrid armour is the minute size of all its components, with the rings often measuring no more than a few millimetres in diameter. The outer scales are equally small, rarely exceeding 11 millimetres in length.

The mail backing is woven in a regular 4-in-1 pattern, consisting of alternating rows of riveted and solid rings. The scales that cover the outside of the garment do not resemble those commonly seen in

[14] Johns 1996, 90-91; Higgins 1980, 14-16.

[15] Higgins 1980, 15-16.

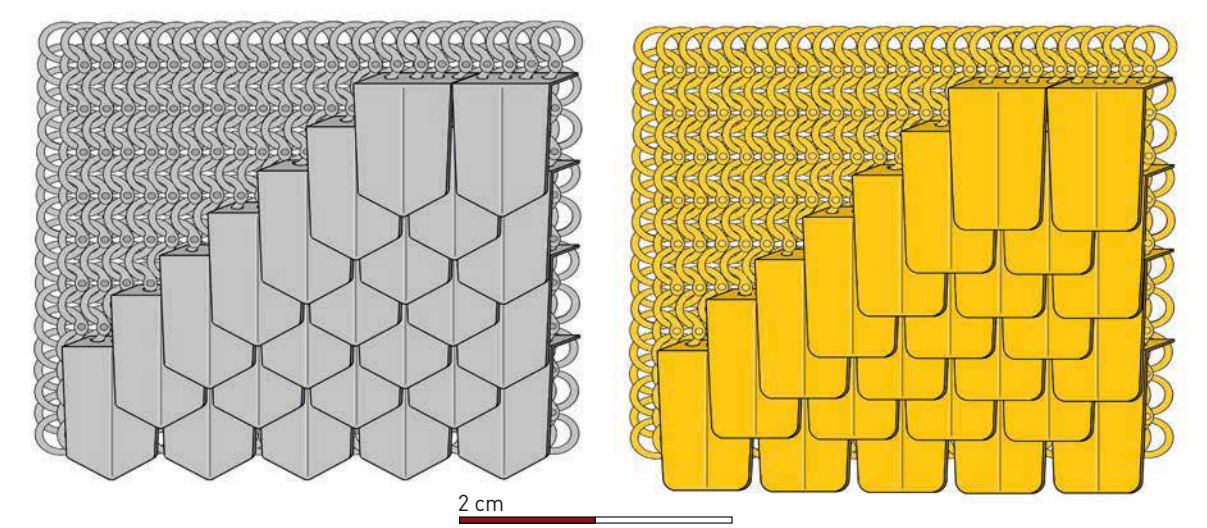


Fig. 9.12. The placement of the scales in hybrid armour results in an imbricated pattern. The scales can be of iron or copper alloy, with either triangular or straight ends with rounded corners. All scales contain a ledge with holes through which the riveted rings of the mail backing are woven. The rings in the drawing are not to scale (drawing M.A. Wijnhoven).

Fig. 9.13. Section of the Ouddorp hybrid armour (The Netherlands, AD 70-200). This fragment has lost scales and rings, but its construction can still be observed clearly. (photograph M.A. Wijnhoven).

Roman scale armour. In hybrid armour each scale has a 90° angle fold at the top, forming a ledge where four small holes are located (fig. 9.12 & 13). The scales are attached to the mail by riveted rings inserted through the holes in the ledge and then riveted shut, thereby integrating them into the mail weave. Each scale is consequently attached to four riveted rings. The scales do not overlap in a horizontal direction, but are placed side by side, so that on every other row of the mail backing (i.e. the rows with riveted rings) there is a continuous row of scales. Vertically, the rows of scales superimpose downwards. Each row of scales is situated at half distance from the one above and below, giving the armour an imbricated pattern.[16]

[16] Wijnhoven 2009a, 3.

Fig. 9.14. In Japan mail was combined with other materials to form a piece of armour. Top: one of several hip armour sections (*gessan*) that suspends from the cuirass (*dō*). Bottom: an armoured sleeve (*kote*). Both pieces belong to the Edo-period that lasted from AD 1603 to 1868 (photograph E. Tulin).

9.5 FAVOURABLE CHARACTERISTICS

The 4-in-1 weaving pattern has some favourable characteristics which probably account for its unchallenged popularity. It was basically the only pattern employed in antiquity, and remained in use until the demise of mail in the Early Modern period.

The 4-in-1 pattern offers a good balance between protection, weight and mobility. These three key aspects are highly relevant for any amour throughout history. For example if an armour type offers a lot of protection (e.g. by covering much of the body or being very thick), as trade-off it will be much heavier and will reduce mobility. Extra protection thus comes at a price; the armour will become more cumbersome and limit the range or quickness of motions of the wearer. In mail, the 6-in-1 pattern offers more protection, but its added weight makes it less suitable for use in the entire garment. Perhaps for this reason, there is just one piece of evidence for this pattern in antiquity. It is not until the Late Middle Ages-Early Modern period that this pattern reappears, but only to the extent that its properties allow

it to produce an upright collar. In contrast, the 4-in-1 pattern offers a more desirable balance between protection and weight. Particularly, its ability to stretch allows for greater mobility, comfort, and fit to the body, which may explain why it was preferred over other patterns of similar weight and protection.

This begs the question of why in Japan there is such a large variety of weaving patterns other than the 4-in-1. This phenomenon can only be understood when considering the particular context of this mail. Japanese armour made use of several materials including metals, leather, rawhide, textiles, lacquer, wood and papier-mâché (fig. 9.14). Mail was used in Japan from at least the late 13th century,[17] however not as a stand-alone armour. It mainly served to connect elements of armour or to cover small areas that could not be protected with more rigid forms of armour, and it was almost always combined with other materials such as a textile backing.[18] Within this context mail of indigenous Japanese patterns flourished; the qualities of these weaves well suited for their purpose. It was only through direct European contact in the mid-16th century that Japan became familiar with the 4-in-1 pattern.[19] While this new weave was added to their repertoire, it did not replace all others. It is also at this period that we first find in Japan complete garments made from mail,[20] woven in the a 4-in-1 pattern.

[17] Woosnam-Savage/Hall, 2002, 92.

[18] Dalewicz-Kitto *et al.* 2013, 42.

[19] Absolon 2017, 292-294; Yamagami 1928, chapter 9.

[20] Absolon 2017, 294-296.

10 The construction of mail garments

'Craftsmen do not use patterns and techniques at random; they tend to adhere to the methods which they have been taught. This would be especially true of a craft so ancient and repetitive as mail-making. It is the writer's belief that the patterns found in mail have a very real historical, and perhaps geographical, significance. Investigation into these patterns may be the road to further knowledge of a craft which probably died out within the last century…'
E. Martin Burgess[1]

As a specific type of body armour, mail has featured prominently in many studies on the development of arms and armour. But it was not until the mid-20th century, with the publication of E. Martin Burgess's *Further research into the construction of mail garments*, that the construction of the mail coat was better understood.[2] His study and subsequent work, however, concerned only 'historical' mail coats from the Late Middle Ages and Renaissance which had survived into modernity being passed down from owner to owner.[3] The same is true for other scholars that followed in his footsteps.[4]

The construction of mail before the 14th century, by contrast, has remained unexamined, mainly due to the fact that almost no historical mail from those times has survived.[5] For earlier periods we depend entirely on mail from archaeological contexts, the condition of which is usually far from ideal. Excavated mail is often so profoundly corroded that they reveal little, if anything, about its construction.

Fortunately, not all of the mail retrieved archaeologically is that decayed. Some remains preserve their original flexibility, with movement of the individual rings. One of the best-known examples, and perhaps the best-preserved, is a coat of mail from Vimose 1, Denmark, which dates back to the second half of the 2nd or early 3rd century AD.[6] This specimen is almost complete and still entirely flexible, which makes it one of the highlights of the Nationalmuseet in Copenhagen. Other flexible mail remains include those from the Iron Age site of Radovanu in Romania and the Roman Iron Age site of Thorsberg in Germany.[7]

While such archaeological finds can offer information about the construction of the mail coat, no work has been done on this subject previously. This chapter constitutes a first attempt to build up a picture of the constructional details of early mail through the available evidence. The rarity of archaeological mail in a good enough condition to infer its construction means that this chapter relies heavily on a small number of artefacts. A few well-preserved examples were examined in person by the author (e.g. Vimose, Novae, Kirkburn and Carlingwark Loch), while others were studied using detailed descriptions given in the literature (e.g. Augsburg, Vize, Dura-Europos and Hedegård).[8]

Before discussing early mail, the next section first offers an overview of the constructional techniques of mail armour. Although this knowledge has been built exclusively on examinations of medieval and more recent specimens,[9] it is relevant to put the findings of early mail into context.

1 Burgess 1953b, 202.

2 Burgess 1953b.

3 Burgess 1957; 1958; Burgess/Robinson 1956; Reid/Burgess 1960.

4 E.g. Wood *et al.* 2013; Chapman 2004, 43-49; Krogh 2016; Schmid 2003, 4-7; Hellman 1995.

5 The hauberk attributed to St. Wenceslaus is one of the few historical items of mail predating the 14th century and probably dates to the 10th or 11th century. Cf. Checksfield *et al.* 2012, 239.

6 Wijnhoven 2015a.

7 Matešić 2015, 208-224; Vulpe/Căpitanu 1971.

8 Augsburg and Vize: Driehaus *et al.* 2012; Dura-Europos: James 2004; Hedegård: Kalsbøll Malfilâtre 1993.

10.1 CURRENT KNOWLEDGE BASED ON LATE MAIL FROM EUROPE

It is well known that plate armour needs to be carefully sculptured to fit the human body, whereas mail, being flexible, easily adapts to the figure of any person. It might therefore appear that constructing a shirt of mail did not require much technique, and that a one-size-fits-all mail rectangle would have worked in every case. However, the examination of late-medieval and early-modern European mail has shown that it was meticulously designed to balance protection, weight, and mobility. Textual evidence further demonstrates that mail was made to order and could even be tailored to the individual client.[10]

Tailoring and the equilibrium of protection, weight and mobility were accomplished through the application of various constructional techniques.[11] One involved shifting the rings' heaviness, or gauge, throughout the garment. The heaviest rings were placed at the trunk of the body, which is the most vital, while lighter rings were employed for the sleeves, the bottom part covering the legs and sometimes even the back of the shirt.[12] A single coat of mail could include rings of up to four different thicknesses. The use of different links in one garment offered a well-thought balance between heavy protection, where most needed, and a reduction of weight, where possible.

Usually the inner diameter of the rings was the same throughout the garment. This means that although different gauges were used, the mail fabric did not expand or reduce. Inner diameter variations in a single garment did occur at times, albeit to a much lesser extent in shirts than in other mail garments. These are most common in items designed to only protect the throat and upper part of the body, such as the so-called standards, bishop mantles, and tippets.[13] In fact, size variations in mail shirts were most common at the collar, where a smaller ring size was employed to provide greater stiffness (fig. 10.1). The shift to smaller rings at the neck was an alternative method to the already discussed change from a 4-in-1 to a 6-in-1 pattern at the collar (chapter 9.2). Of these two techniques the first has been used more often. Varying the rings' inner diameters could also be a means to deliberately shape a mail garment, as this would enable the fabric to expand or reduce in certain places. In practice, however, this was rarely done.

One of the most basic methods for giving a mail garment a three-dimensional shape was placing the mail fabric at an angle. Probably the easiest way to visualise how this technique creates a three-dimensional shape is to think of an L-shaped piece of mail whose inner sides are brought together and connected. The piece can now no longer lay flat and has acquired a three-dimensional shape. Moreover, the rows will be at a 90 degree angle in the place where the two inner sides of the L meet. Mail fabric placed at an angle is observed in most, if not all, late European coats of mail, especially at the armpits. In a mail shirt the rows of rings run horizontally on the body and sleeves. The direction of the body thereby intersects the underside of the sleeve at the armpits, which is where the mail fabric connects at an angle (figs. 10.2-3).

9 Outside Europe, mail armour has been used extensively in several regions, especially in the Middle East and India. However, there are few studies of armour from these parts. Burgess (1960, 152) did note that oriental mail was different from Western mail of comparable age, for example, that its construction made little use of shaping techniques such as increasing or decreasing the mail fabric.

10 Blair 2005; Fragioni 1978, 485-492.

11 The techniques described in this paragraph, with the exception of the use of different gauges of rings, were first explained in Burgess 1953b, 197-200. Examples of mail with these characteristics can be found in his works (Burgess 1957; 1958; Burgess/Robinson 1956; Reid/Burgess 1960) and those of others (Laking 1920; Scalini 1996; Schmid 2003; Trapp 1995 [1929]; Wood *et al.* 2013).

12 E.g. Burgess 1958, 197-198; Reid/Burgess 1960, 51; Schmid 2003, 4-5.

Fig. 10.1. This type of mail garment is known as a bishop's mantle. This 16th-century example has a collar made from smaller rings, which are also heavier, making it stiffer and stronger than the other parts that cover the upper torso. In order to create a three-dimensional shape and flare out towards its bottom, this mantle is made up of triangular shapes. A vertical line can be observed at the centre where two of the triangles connect. Livrustkammaren Stockholm, inv. no. LRK 23327 (photograph Jens Mohr).

A similar technique to give dimensionality was the insertion of triangular or rhomboid pieces, called gores (also known as gussets). The employment of gores is probably best known from textile clothing manufacture, but was also applied to shape mail armour.[14] Mail items that protected the neck and shoulder area, such as mantles and standards, were often shaped using triangular insertions (figs. 10.1 & 5).

A far more complex shaping technique is to increase or decrease the number of rings following a preconceived plan, as it is done in knitting. This was achieved through the use of 'idle links' that pass through only three rings (two above and one below or *vice versa*), instead of four. This would result, respectively, in a decrease or increase of the fabric below the idle link (fig. 10.6). In a coat of mail, extra rings were inserted into the area of the shoulder blades to provide greater movement of the arms and shoulders. Often, the fabric at the trunk of the body was decreased to reduce the weight of the garment, only to be expanded from the hips down to give more mobility to the legs and the lower torso (fig. 10.7).

The use of idle rings allowed not only to change the number of rings in a single row, but also to modify the number of rows themselves (fig. 10.4 & 8).[15] Row reductions are usually found in sleeves,

[13] Laking (1920, fig. 508, 522-525, 530-531) features multiple mail garments for the neck and upper body, like the ones mentioned.

[14] In clothing manufacture gores (or godets) are triangular pieces of fabric inserted into the seam to give a garment extra fullness, while gussets are pieces of fabric sewn under the arms or crotch to allow for a greater range of motion. In the study of armour gussets can also refer to sections of mail affixed to a textile padded undercoat. These were used to protect the armpit regions of the body where plate armour gave no protection.

[15] There are two techniques for reducing the amount of ring rows. One leaves a small hole, the other a small knot. Cf. Burgess 1953b, 198-199, figs. 5-6. Here we only illustrate the first technique.

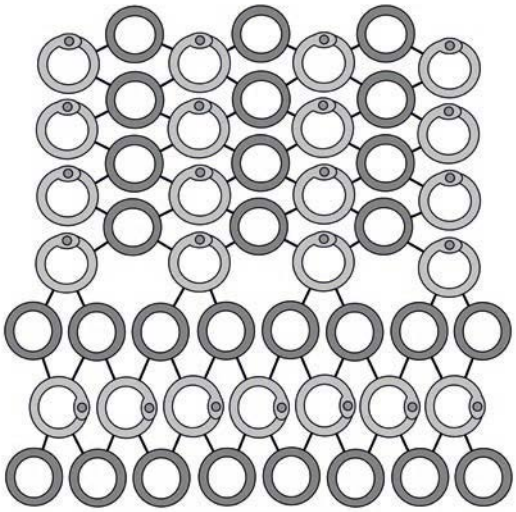


Fig. 10.2. Schematic representation of one of the methods of shaping mail three-dimensionally by placing it at an angle. This technique is often observed on the armpit area of a mail coat (drawing M.A. Wijnhoven).

Fig. 10.3. At the armpit of this 15th century German coat of mail the ring rows are at a 90 degree angle as a result of giving it a three-dimensional shape. Collection of the author (photograph M.A. Wijnhoven).

Fig. 10.4. A 15th or 16th century mail sleeve that contains four of the construction techniques under discussion. First, the insertion of a diamond-shaped piece of mail can be seen at the elbow, adapting the sleeve to the human arm. Second and third, the cuff is made with smaller, heavier rings, which have been placed at an angle of the sleeves. The result is a cuff that fits tightly to the wrist. Fourth, the sleeve tapers at the lower arm, which is done by the use of idle rings to reduce the number of rows. Livrustkammaren Stockholm, inv. no. LRK 23319 (photograph Jens Mohr).

tapering towards the end to reduce the weight. As stated above, the rows run horizontally in the sleeves, therefore reducing the number of rings would not cause tapering, but reducing the rows would. Generally, the reduced rows were located on the inside of the sleeve, and sometimes in the body of the mail coat, where they were used to extend the length of the back and keep the hem perfectly aligned. The extra length on the back of the shirt gave room to bend more easily.

The purposeful placement of idle links throughout the garment suggests that the mail maker would have started at the top of the shirt and worked his way down. It is unlikely that he worked with drawn patterns, but rather worked from memory, applying different constructional techniques where necessary.

The mail maker thus possessed an arsenal of constructional techniques which allowed him to shape and tailor the mail garment. The variation that he could achieve was very large. During the Late Middle

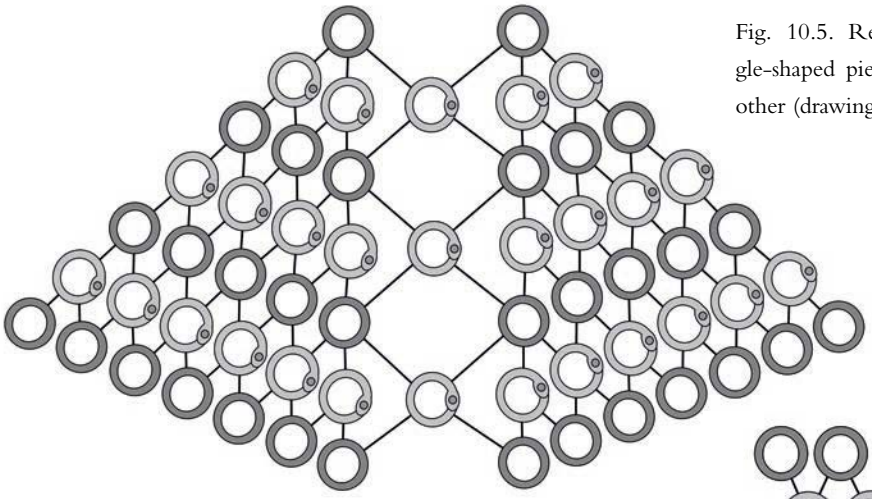


Fig. 10.5. Representation of how two triangle-shaped pieces of mail are connected to each other (drawing M.A. Wijnhoven).

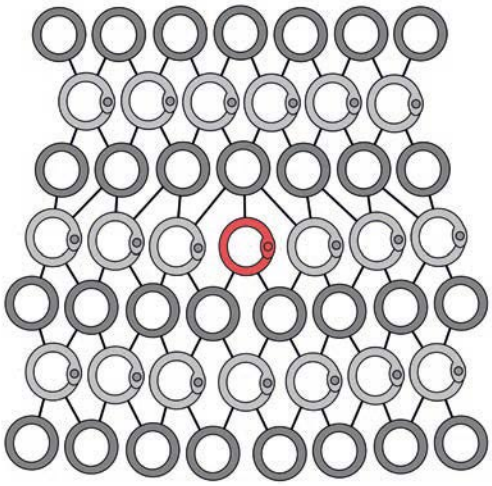


Fig. 10.6. Schematic representation of the use of an idle ring (red) to expand the number of rings in a row (drawing M.A. Wijnhoven).

Fig. 10.7. The lower part of this 15th or 16th century mail coat flairs out by using idle rings. The garment also has a vandyked hem which is outlined by rows of copper alloy rings. The opening for the head is round and also trimmed with copper alloy rings. Livrustkammaren Stockholm, inv. no. LRK 32871 (photograph Jens Mohr).

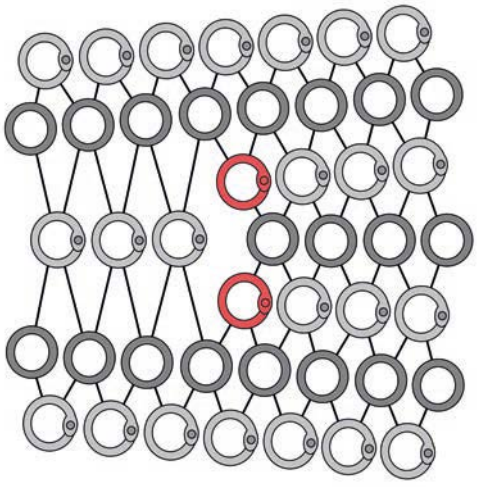


Fig. 10.8. Representation of the use of idle links (red) to change the number of rows (drawing M.A. Wijnhoven).

Ages and Renaissance almost all mail garments contained at least one, but often several of the techniques here described.

10.2 PRESENCE OF CONSTRUCTIONAL TECHNIQUES IN EARLY MAIL

The assessment of early mail reveals that very few of the construction methods seen in the Late Middle Ages and Early Modern period are present. For instance, the technique of using different ring sizes in different parts of a mail garment is mostly absent in antiquity.[16] This technique was used often in late mail to balance protection and weight or to reinforce a specific part of the garment. None of the examined early mail finds contains clear evidence of this technique. These specimens include large, well-preserved fragments in which such feature would be hard to miss if present (fig. 10.9).

Descriptions of early mail in the literature do sometimes mention multiple ring sizes. This does not mean, however, that these are examples of this technique, i.e. the purposeful placement of different rings in different parts of the garment. Usually the information offered is too slim to come to a conclusion. Moreover there are many other reasons why more than one ring size can be reported, as is discussed in box 10.1.

The overall impression is that there is little concrete evidence for this construction technique in early mail. The technique may not have been unknown to early mail makers, but its application was limited, especially when compared to its use in late-medieval times.

BOX 10.1 DESCRIPTION OF RING SIZE IN LITERATURE

The literature describing early mail sometimes makes mention of more than one ring size. Alternatively, it can offer a single measurement with a range so large that it can easily accommodate different ring sizes. Both are not necessarily evidence for the purposeful placement of different size rings in different parts of a mail garment. There are alternatives for how to understand this information:

- The great majority of mail armour is made from two types of links, riveted and solid, and these usually do not have the same size. Much of the literature that offers two ring sizes, does not indicate if this applies to regular solid and riveted rings or to the construction technique under discussion.
- While solid rings are round, riveted rings are not. Almost all riveted rings have an oval shape and when the overlap faces the top, the horizontal diameter will differ from the vertical diameter. Ignoring this feature can give the impression of several ring sizes or a large size range.
- Most early mail has been repaired in antiquity. Repair rings usually have another size or gauge, sticking out among rings of 'regular stock', and sometimes do not follow the weaving pattern. They tend to be scattered throughout the garment and their location and isolation give away that their function is not related to construction.
- The large range of ring sizes found in many publications is most likely caused by the condition of archaeological mail, which is normally corroded. This can affect the rings to such an extent that they expand, making it only possible to give an estimation of their size.
- When mail is heavily corroded it turns into a solid mass, leaving only a partial outline of the rings. In these conditions it is difficult to estimate the ring sizes for which a range is generally given.

[16] The coat from Ciumeşti in Romania has two ring sizes in one of its largest fragments. Alongside the main rings, smaller and lighter rings are placed in two areas. Examination by the author demonstrates that the lighter rings are probably placed at the hem of the neck and armhole. They appear not to be used for tailoring the garment, but as a trim. The lighter rings at the hem were possibly covered by leather or textile piping.

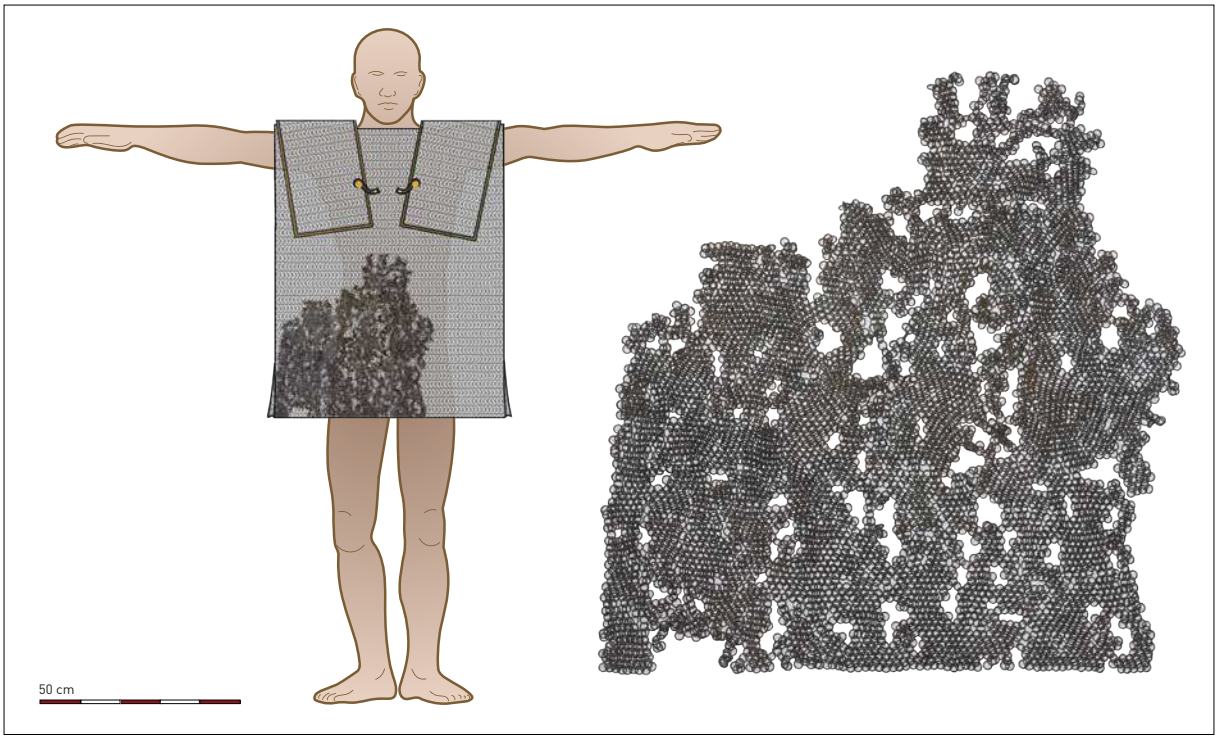


Fig. 10.9. The site from Vimose in Denmark rendered several mail coats. Of these, Vimose 6, is large and still flexible, made from riveted and solid rings, and can be dated to the 1st century AD. It still preserves two of the original edges, which are the bottom hem and the left slit that is positioned on its side. The fragment contains no constructional techniques like those seen in the Late Middle Ages and Renaissance, such as the use of different ring sizes or idle links (photograph M.A. Wijnhoven).

The next constructional technique which involves placing sections of mail at an angle to shape the garment has not been observed in early mail either. None of the examined artefacts contains this feature, nor does the literature mention it. Conversely, European coats of mail from the Late Middle Ages and Early Modern period invariably use this technique to give a three-dimensional shape to the armpits, mimicking the anatomy of the arms.

The application of triangular or rhomboid pieces of mail (gores or gussets) to shape a garment is also absent in early mail. The ancient mail maker was probably familiar with making triangular sections of mail, as indicated by 2nd century depictions (chapter 4) and the possible triangle-shaped fragments from Bijele Crkve in Serbia and Lydney in the United Kingdom (chapter 6).[17] However, these were not placed in the garment to tailor it but were attached at the hems as a decorative feature.

The last set of techniques to shape mail garments concerns the use of idle links through which the fabric could be expanded or taken in. The method of inserting idle links to change the number of rings in a row, often used in late mail to shape the trunk of the coat, is entirely absent in early mail. Whereas the insertion of idle links to modify the number of rows, used in late mail for example to taper the sleeves, is also found in early mail, although in limited supply. It is observed in the sleeves of the mail coat from Vimose and probably in the one from Dura-Europos. Both finds will be discussed in greater detail below.

All in all, early mail differs a lot from the familiar image of mail from the Late Middle Ages and Early Modern times. The early mail maker did not make much use of the late construction techniques.[18] The overall impression is that early mail underwent little tailoring or shaping. The relative absence of tailoring does not necessarily indicate that such techniques were unknown, but that early mail makers took

[17] Hoffiller 1911-2, 123-5, fig. 43; Wheeler/Wheeler 1932, 91, pl. 30b.

[18] Wijnhoven 2015b; 2018.

Fig. 10.10. The Vimose coat is in excellent condition for a garment that has been archaeologically retrieved. In fact, most of the damage was caused prior to deposition (photograph M.A. Wijnhoven).

a different approach to their craft. As will be discussed, this approach is very much a product of its time and cannot be understood separate from the wider context of the society in which it developed.

10.3 CONSTRUCTION OF EARLY MAIL BY WORKING IN THE FLAT

To understand why early mail diverges so much from later specimens, we must understand the work process of the early mail makers. A good starting-point to figure this out is to take a detailed look at the best preserved specimen of that period, which is the mail coat from Vimose in Denmark.

THE COAT OF MAIL FROM VIMOSE

The Vimose armour was found in Funen, Denmark, in a bog containing thousands of artefacts, most of them military. The coat of mail itself was likely manufactured outside the Roman Empire (chapter 11), and dates approximately to AD 150-220.[19]

[19] Wijnhoven 2015a.

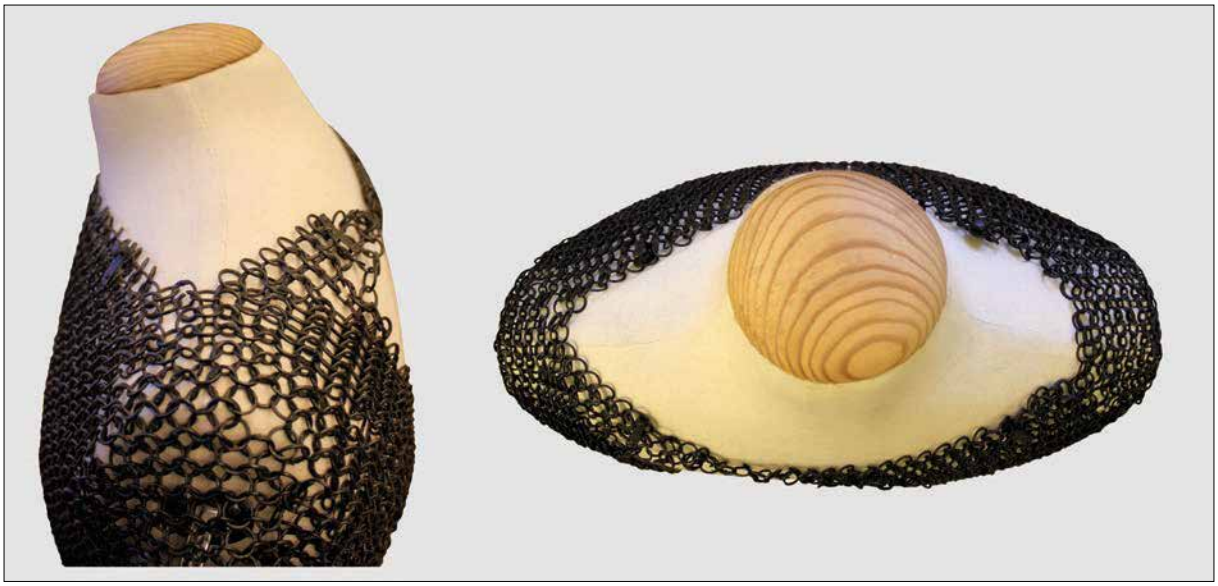


Fig. 10.11. The slit-like neck opening of the Vimose coat was created by leaving 25 rings out, but looks nowadays somewhat larger because of damage (photograph M.A. Wijnhoven).

The measurements of this garment surpass a meter in length, down to knee level, and reach some 35 cm long on the sleeves, which would have covered the upper arms almost completely (fig. 10.10). Given its length, the shirt surely had splits at the hem to allow the wearer to walk with ease.

The rings of the mail are quite large and sturdy. The outer diameter of the solid rings measures 12.4 mm on average. The riveted rings are also large, having a diameter of 13.2 mm, measured horizontally. The thickness and diameter of the links are constant throughout the entire garment, meaning that no rings of different sizes were introduced.

The trunk of the coat does not show any shaping techniques and is completely rectangular, having the same width on top, centre, and bottom. Counting down from the neck opening to the end of the shirt, one side is 117 rows long, and the other is only 115. This variation in length supports the assumption that the coat originally had splits on the bottom hem. The circumference of the coat encompasses 146 rings.

The neck opening is positioned in the middle of the top part. It simply entails a large horizontal split (fig. 10.11) created by leaving out 25 riveted rings from one single row in the mail fabric. The distance from the head split to the armpit is 30 on one side and 29 on the other, meaning that it is more or less located at the centre.

The slit is large enough to allow the head to pass through comfortably, so much in fact, that part of the neckline and upper shoulders would have been left unprotected. In addition, the length of the neck slit would have made it impractical, as the heavy coat would drag to one of the shoulders when in motion. To keep the mail from moving and have it stay put on both shoulders, the Vimose garment has an ingenious closing mechanism for the head opening, made of four small applications, two on each side of the slit (fig. 10.12). The fixtures consist of plain rectangular iron plates on one side, fastened to the mail by two rivets and held in place by a single rectangular washer. These would have been used to fix two leather straps, now missing. The slit closed by fastening the straps to the two fixtures on the opposite side, which are of similar shape, but also contain a button. The opening could be easily adjusted by pulling the buttons through a hole in the leather straps.

The sleeves constitute an extension of the horizontal ring rows of the main body. Counting down from the armpit, one of the sleeves is made up of 20 extra rings per row. The length of the other sleeve is difficult to determine because the armpit is no longer intact, but is likely the same. The sleeves taper

Fig. 10.12. The neck opening is regulated through four fixtures, two of which are located on each side of the coat. The two fixtures depicted at the bottom would have held a leather strap. These straps connected with the buttons on the fixtures on the other side of the neck opening thereby closing it (photograph M.A. Wijnhoven).

Fig. 10.13. The sleeves are turned upwards to expose the five row reductions at the underside, which have been marked with dots (photograph M.A. Wijnhoven).

towards the end by reducing the number of ring rows from 60 at the armpit to 50 at the sleeve's hem. On the underside, the sleeve rows are reduced two at the time, each sleeve containing five of these reductions (fig. 10.13). The technique used is that of idle links for row reductions, seen in figure 10.8. Together with the sleeve from Dura-Europos, the Vimose coat is the only evidence for this construction method in early mail.

The armpit region in medieval specimens makes a 90 degree angle between the body rows and the underside of the sleeve, to form a three-dimensional shape at the pivoting point of the sleeve. In contrast, the armpit of the Vimose coat is 'flat', created simply by connecting the front and back of the trunk and seaming up the undersides (fig. 10.14).

The area under the intact armpit, moreover, reveals an important clue about the manner in which the coat was constructed. Here each row of rings suddenly shifts from riveted to solid (and *vice versa*) in a vertical line (fig. 10.14, below). That is, each single row on the circumference of the trunk consists of riveted rings on one side of the garment and solid links on the other.

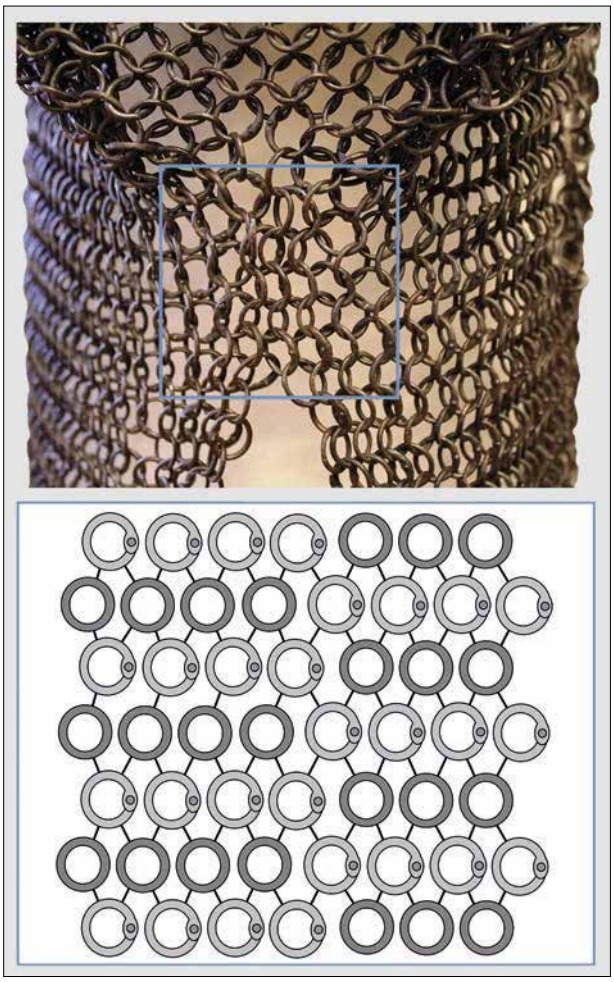


Fig. 10.14. The mail weave is not placed at an angle at the armpit but at the area below, in a straight line downwards, the ring rows shift from riveted to solid (and *vice versa*). This feature is clear evidence that the Vimose coat was made 'in the flat' (photograph M.A. Wijnhoven).

The sudden change in ring type at the armpits downwards in the Vimose coat is the result of how it was constructed, which in turn has to do with the phenomenon of ring slope, mentioned in chapter 9.1. The rings in a 4-in-1 weaving pattern do not lay entirely flat but slope towards the right or left. All the rings within a single row always slope in the same direction, with the row above and below going in the opposite direction. This means that within a single flat section of mail all the riveted rings slope to one side and all the solid rings slope to the other. However, when a flat piece of mail is folded over, the slope of each ring of the folded section will be inverted. For example, riveted rings sloping to the left will slope to the right on the folded section. Since all the rings within one row must have the same slope, the folding over causes that the riveted rings on one side can no longer be connected to their riveted counterparts on the other side, as this would result in a break in the direction of the slope. In order to keep this feature, the rows of riveted rings must be connected to the rows with solid rings on the other side.

At the Vimose coat the change from riveted to solid in each ring row can be traced in a straight line underneath the armpits. This indicates that the coat was constructed as a single large flat panel of mail encompassing both sides of the garment and sleeves (fig. 10.15). Only in the last step of manufacture would the large flat sheet of mail have been folded at the centre, creating a front and a back, and closed at the sides of the trunk and undersides of the sleeves, finally forming a true coat of mail. The splits at the sides of the garment were created by not closing the two sides until the hem, but leaving a part open.

This approach is very different from medieval and later mail coats, where each single row only contains one type of ring for the entire circumference.[20] This difference is because late mail coats were constructed by adding rings 'in the round', while the Vimose garment was made 'in the flat'.

MAIL REMAINS FROM NOVAE

As it turns out the Vimose coat is not unique. In fact, the insights obtained from the examination of the Vimose garment have made it possible to identify similar patterns in other, less well-preserved remains such as those from Novae in Bulgaria.

[20] Burgess 1958, 202.

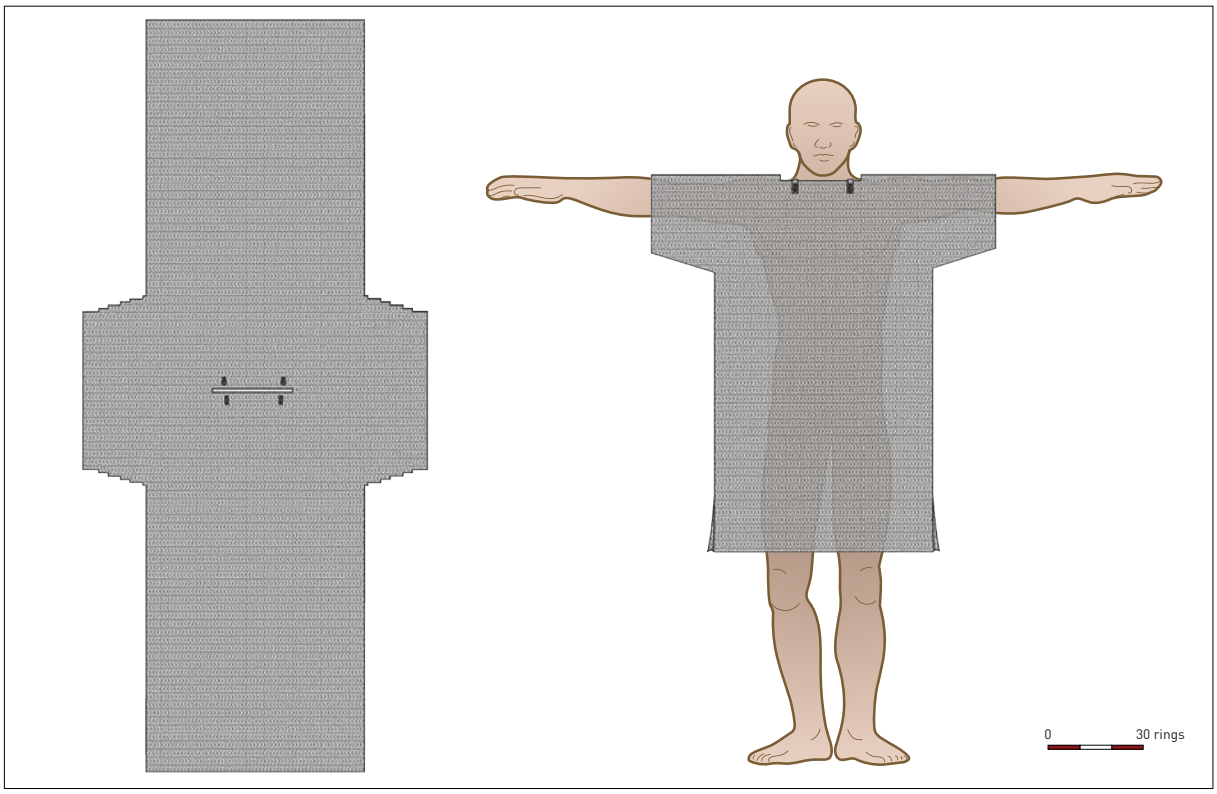


Fig. 10.15. Construction plan of the Vimose coat. First, this garment was woven in one large piece encompassing front, back and the sleeves. The coat was finished by folding it over and closing the sides of the trunk and the undersides of the sleeves (drawing M.A. Wijnhoven).

In the 1950/60s, a total of 21 fragments dating to the Roman period were found in the Danube river not far from the legionary base at Novae. Although these were still flexible, they had suffered much ring loss and the original mail weave had disintegrated, rendering its original shape unrecognisable. By putting back the surviving rings in their original position and using the technique of filling in the gaps with butted dummy rings, the weave was stabilised. Moreover, this procedure also made it easier to understand the surviving fragments.[21] Finally, all the separate remains were assembled into one large composite fragment (fig. 10.16).

All the rings are of the same dimension. There is no evidence of construction techniques to tailor the coat, such as inserts of mail gores or the use of idle links. One of the fragments is particularly large, measuring 63 by 38 cm at its widest point. It contains two original edges: one vertical and one horizontal, constituting a corner. The horizontal edge undoubtedly constitutes the lower hem of the garment. The vertical edge is one of the two side splits found at the bottom, whose function was to allow the wearer to move around freely. Roman depictions of mail coats often show the presence of splits, which were almost invariably located at the sides of the garment (chapter 4).

Just as in Vimose, a transition of ring types is observed. The alternation of ring types can be traced in a vertical line throughout the rows at the upper left section of the large fragment (fig. 10.17). This observation not only confirmed the manner in which the coat of mail was made, but also pinpointed the position of the large fragment in the original coat (fig. 10.18).

The change of ring types also allowed for the width of the coat to be established. The change of ring types observed on the upper left of the fragment must have been located exactly underneath the armpit

[21] Wijnhoven 2015b.

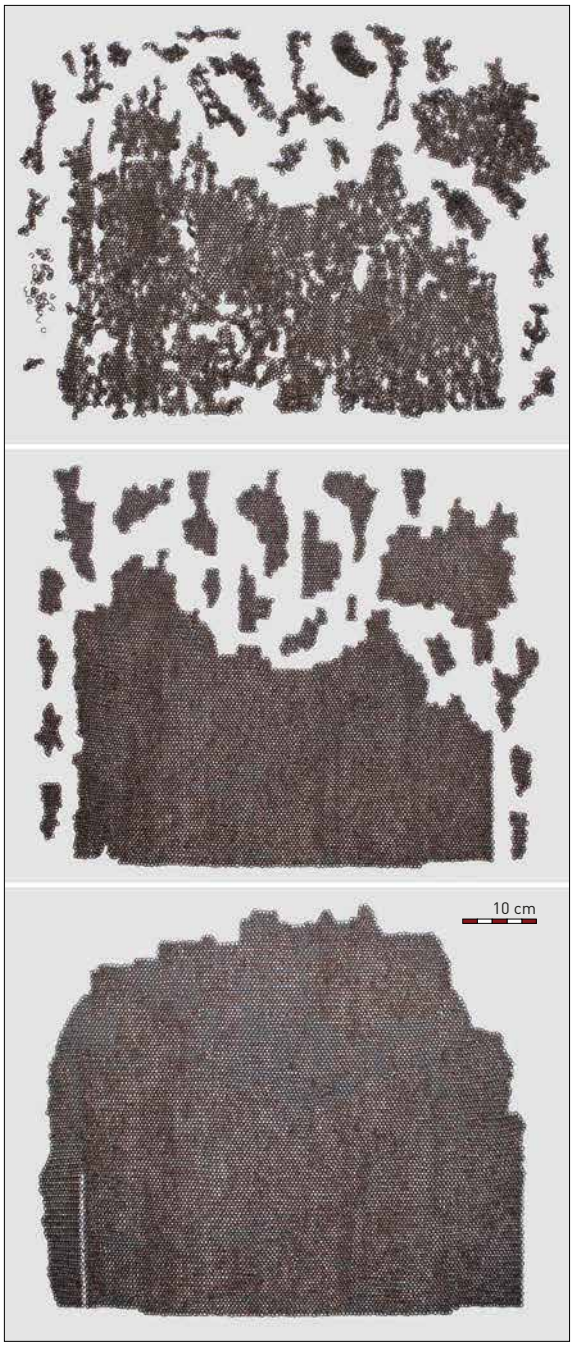


Fig. 10.16. Three stages in the treatment of the Novae remains. Top: the original condition of the fragments. In this condition it is difficult to understand the pieces, recognise hemlines, or know where they were originally located. Centre: the remains have been treated by returning all rings to their original position and filling in the missing rings. In this condition it is possible to determine their original location and obtain information on the construction techniques employed. The straight edge on the right of the large fragment is the preserved split of the coat of mail. Bottom: the loose fragments are reconnected to create one large fragment (photograph M.A. Wijnhoven).

and therefore demarcated the left end of the width. The preserved split on the right side of the fragment indicated the other end. The distance between the right split and the left change of ring type gave the width of the garment. In this case it was 122 rings wide, which correspond to approximately 59 cm.

The mail remains from Novae reveal that it was constructed in the same manner as the Vimose coat. It was also made as a single flat panel of mail only to be folded and closed during the last stage of manufacture. Novae further shows that working in the flat was practised both inside and outside the Roman Empire.

MAIL FROM DURA-EUROPOS

At the site of Dura-Europos, in Syria many pieces of militaria were found in a collapsed countermine related to the Sassanid siege of the Roman garrison town during the mid-3rd century AD. The collapse trapped in various individuals from both fighting sides together with their military equipment. Since the mine became sealed off the bodies and equipment were kept complete. The archaeological excavations of the 20th century discovered the remains of several coats of mail mostly in fragmentary state.

One of the coats, associated to a member of the attacking Sassanid force, stands out.[22] It still contained the skeletal remains of its wearer (fig. 6.6), which made it easier to interpret and allowed for some major observations about its construction. Although the coat was complete, it sustained post-depositional damage and is no longer flexible. Therefore, its exact form is difficult to determine, but it is clear that it followed a 'pullover' pattern. The length at the back, which was better preserved, now measures circa 52 cm. It contains several creases and would have been originally about 60-70 cm in length, reaching approximately to the top of the thighs. Only the left sleeve survives, but it shows that the coat had fairly

[22] James 2004, 116-117, figs. 52-55.

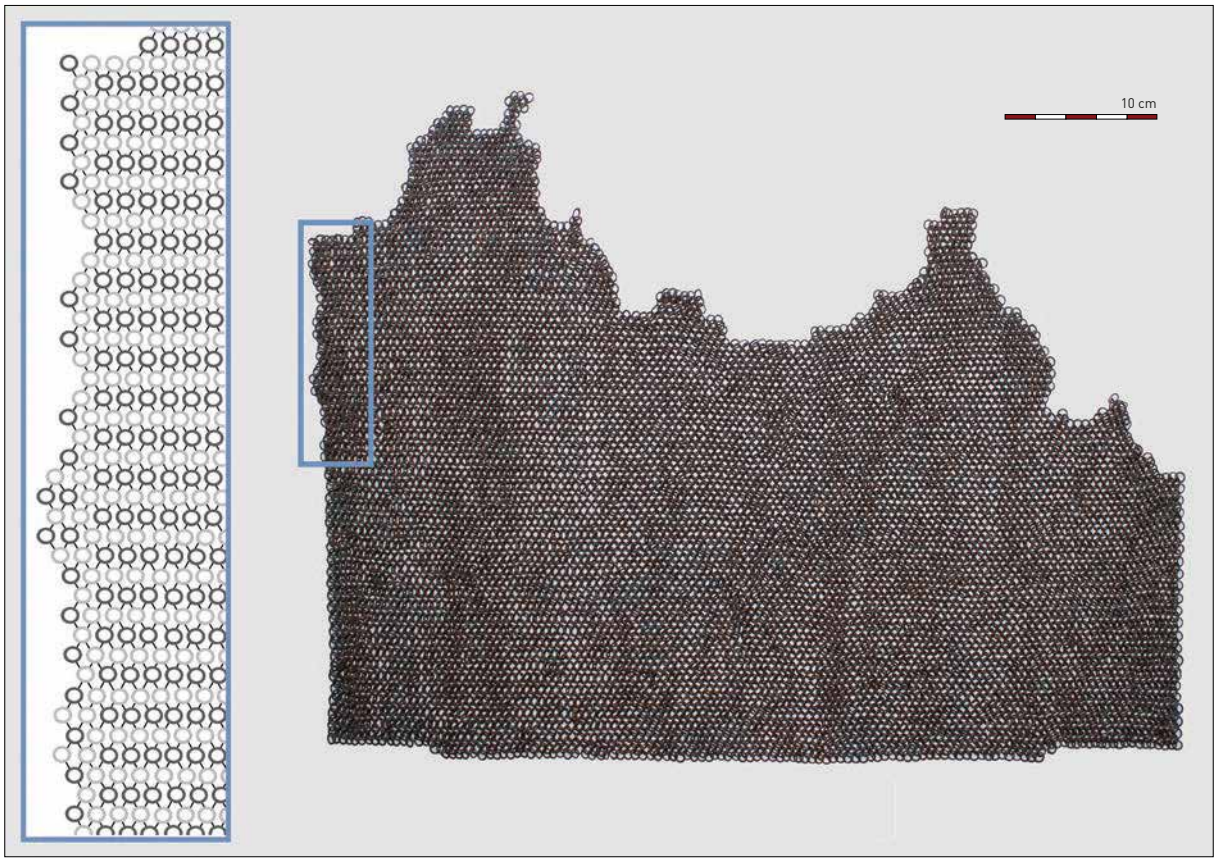


Fig. 10.17. Large fragment of mail from Novae. The shift in ring types can be traced down in a vertical line. Left: schematic representation of the section where the shift occurs with solid rings in dark and riveted rings in light grey (photograph M.A. Wijnhoven).

long sleeves that extended at least below the elbows, and perhaps up to the wrists. The lower hem of the coat was trimmed with three rows of copper alloy rings. There was a 10.5 cm split at each side of the hem, to facilitate movement. As in Vimose, the neck opening consisted of a simple slit in the mail. In this case, however, the slit was trimmed with three rows of copper alloy rings and did not have any fixtures to regulate the aperture. Finally, copper alloy rings were also used on the upper chest area to create a decorative trident pattern.

Unfortunately, the current condition of the Dura-Europos coat of mail does not allow us to say with certainty how it was constructed. Nonetheless, the presence of (long) sleeves, the splits at the sides, and especially the slit-like neck opening, strongly suggest that it must have been constructed in a similar way as the Vimose coat of mail (fig. 10.19).

Among the many mail finds from Dura-Europos there is a separate sleeve of mail.[23] Its exact find spot is unknown, but it is likely to have come from the same countermine, as attested by the presence of human arm bones still inside it. Although unconfirmed, this sleeve may have come from the coat of mail just described, which is missing one. The sleeve is only partially preserved and now measures 32 cm in length.[24] The arm bones inside, however, reveal that it would have reached halfway down the forearm, just short of the wrist. The distal end of the sleeve is well preserved and has an approximate circumference of 28-32 cm, while the other side has an estimated circumference of 40 cm. Such a reduction in circumference can best be achieved through idle links to decrease the number of rows. Unfortunately, the condition of the sleeve does not allow to observe these idle links.

[23] Dura-Europos 6 in the database.

[24] James 2004, 117-118, fig. 59.

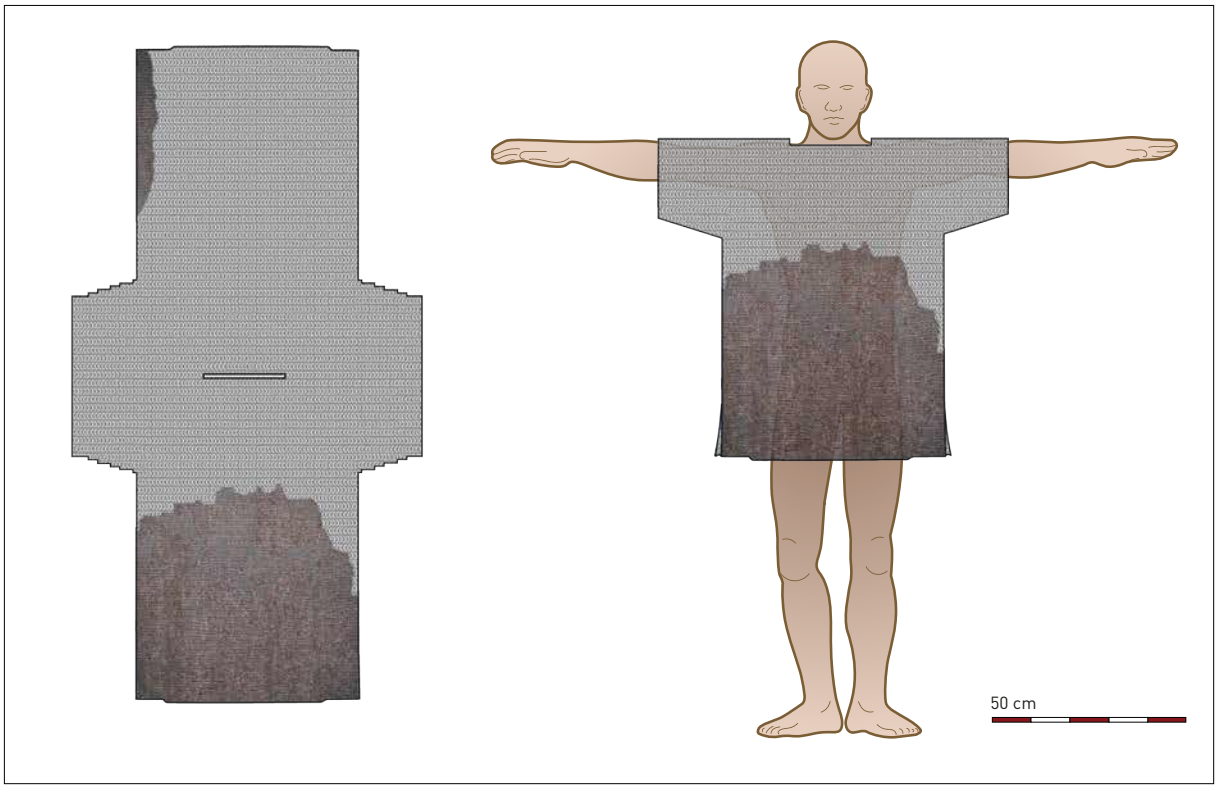


Fig. 10.18. Left: construction plan of the Novae coat of mail in relation to the composite fragment. Right: location of the composite fragment in the coat of mail. Note the similarity in construction to the Vimose coat (image M.A. Wijnhoven).

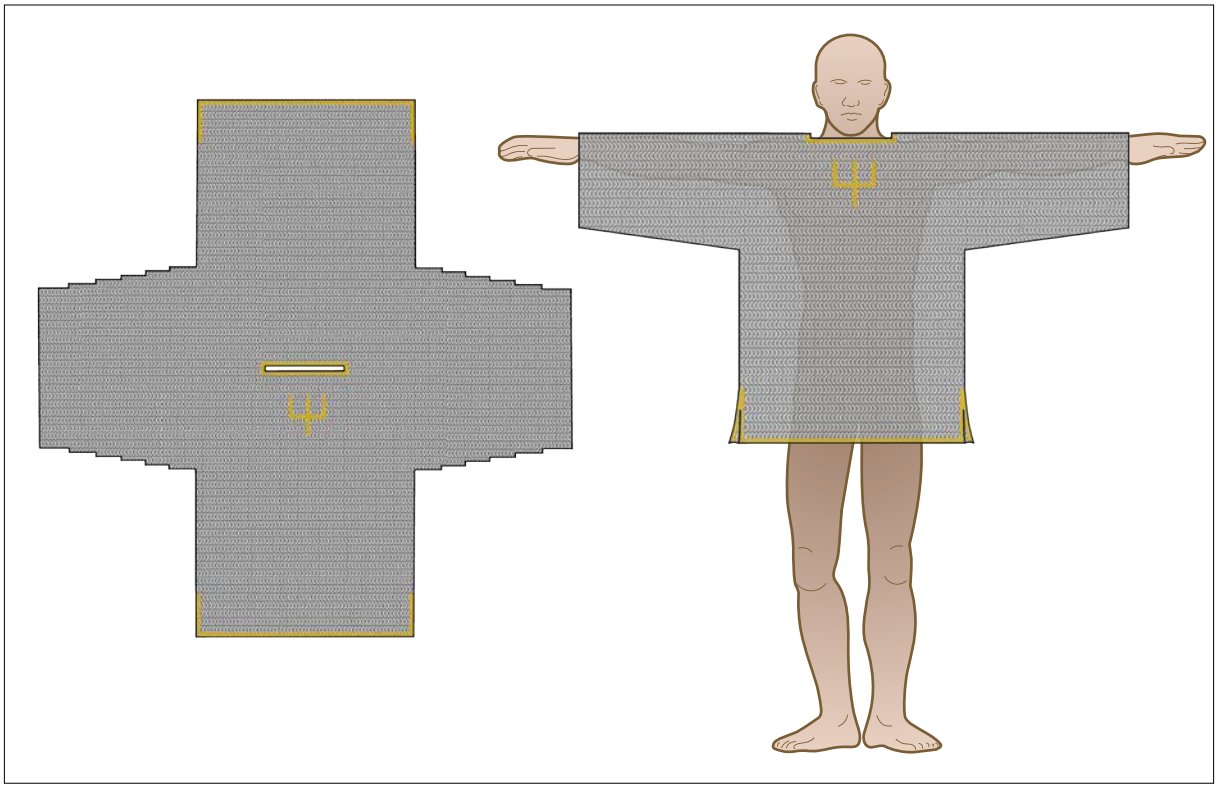


Fig. 10.19. The coat from Dura-Europos 1 was probably made in the flat as well, just like Vimose and Novae. Left: possible construction plan. Right: how the coat would have looked like when worn (drawing M.A. Wijnhoven).

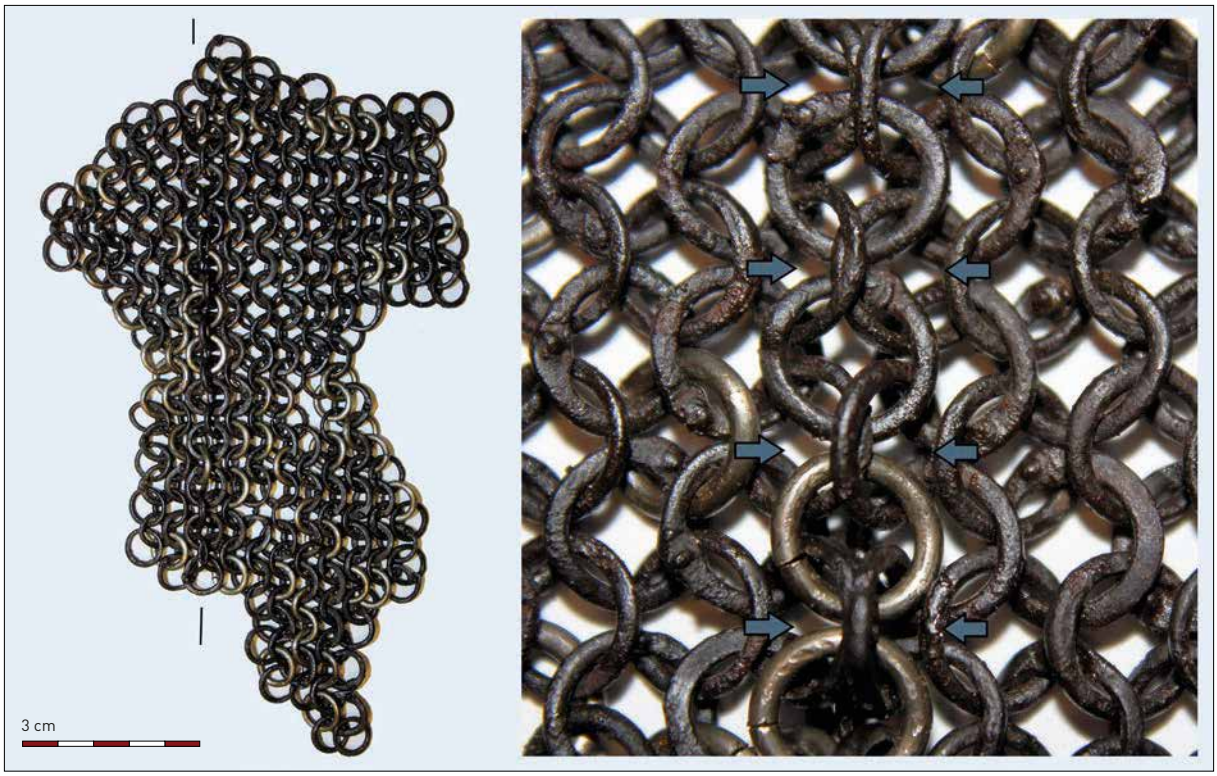


Fig. 10.20. Left: mail fragment from Carlingwark Loch which demonstrates that this coat of mail was made as a flat sheet folded over and closed at the sides. A change in the rings' slope is observed in a vertical line throughout the rows; its location is indicated by two small lines. Right: close up of the change in ring slope, with the arrows indicating where these clash, making the mail fabric pucker (photograph M.A. Wijnhoven).

MAIL MAKER'S MISTAKE AT CARLINGWARK LOCH

Several pieces of mail were found in a hoard at Carlingwark Loch in the United Kingdom, dating from the late 1st to 2nd century AD.[25] The contents of the hoard, deposited inside a cauldron, consist of many metal objects, some of them indigenous and others of Roman provenance. Given the number of surviving fragments, a substantial part of a coat of mail must have been inside the cauldron. Despite being fragmentary, the condition of the rings themselves is very good and many of their finer details have been preserved. To consolidate the weave after excavation, someone inserted butted links in many of the fragments.

Some sections preserve the original edges of the garment, but one fragment in particular reveals how the coat was constructed (fig. 10.20). Like the coats of mail discussed above, this example is also made in the flat as a single large panel of mail, to be folded and closed at the sides during the last stage of manufacture. It appears, however, that in this case the mail maker made a mistake when closing up the sides. As mentioned earlier, the phenomenon of ring slope makes it important that rows of riveted rings are connected to rows of solid links, making sure that all rings within one row slope in the same direction. When working in this manner, a shift in ring type (solid to riveted or *vice versa*) is observed in a straight line where the two parts of the coat were connected.

At Carlingwark Loch the mail maker did not respect the slope of the rings and simply connected the rows of riveted rings at the front of the garment to the riveted rows at the back. The result is that instead

[25] Burgess 1955, 50, pl. 2; Capwell 2003, 23; MacGregor 1962, 28.

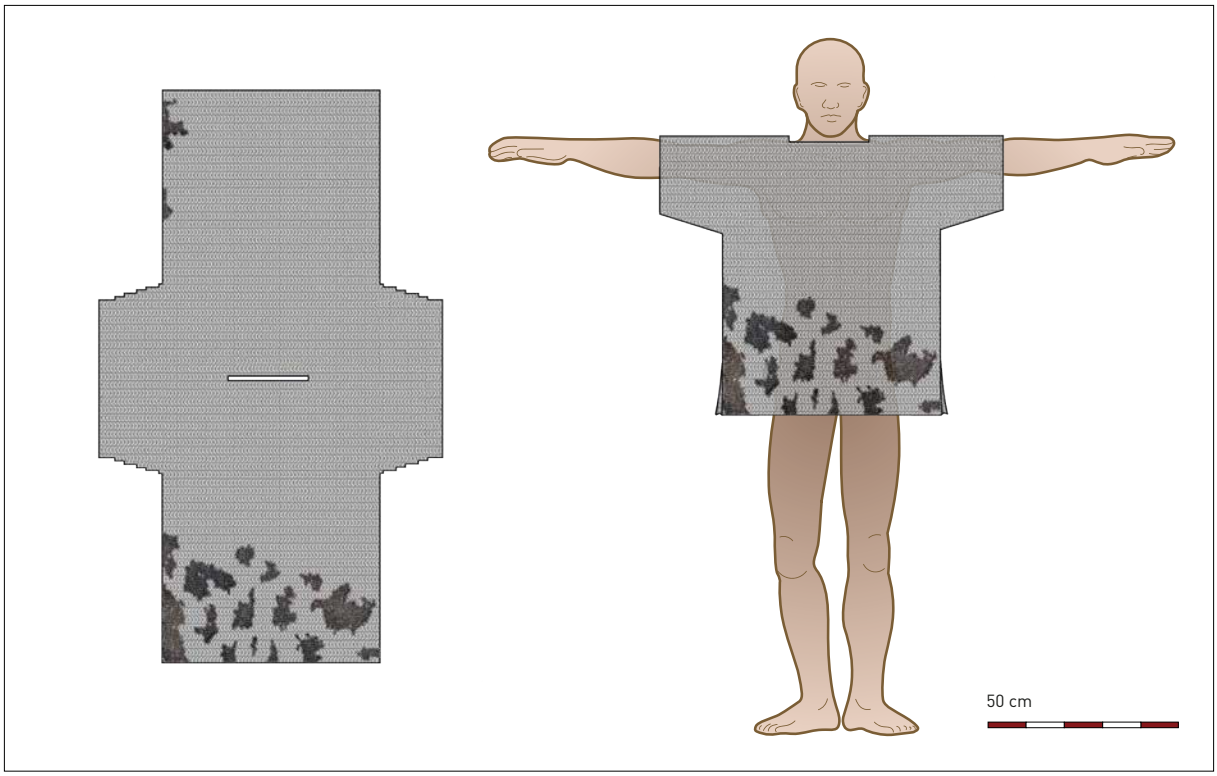


Fig. 10.21. Reconstruction plan of the Carlingwark Loch coat of mail, showing the larger surviving parts and their respective possible location on the garment. Only diagnostic fragments that preserve a hemline or the clash of ring slope can be located within the coat with more certainty, the others could have come from anywhere (image M.A. Wijnhoven).

of a vertical line with a shift in ring type, there is now a vertical line of clashing rings. This is not ideal, as the clash will stand up or pucker somewhat, and can snatch more easily; furthermore it is not aesthetically pleasing as it breaks an otherwise continuous slope. Even so, the coat would have still functioned well enough to protect its wearer.

The find from Carlingwark Loch illustrates that it was constructed in a similar fashion as the other coats of mail. This insight together with some fragments that preserve part of a hem even allows for a partial reconstruction (fig. 10.21).

10.4 CONSTRUCTION OF TEXTILE CLOTHING AND MAIL

One of the most striking features of the coats of mail discussed above is their strong constructional resemblance to textile clothing of the time. This likeness is best observed in the Vimose coat due to its excellent preservation. Its construction closely mirrors that of the tunic, one of the most widespread types of clothing during the Roman period,[26] both within the Roman Empire and beyond its borders.[27]

Probably the most indicative similarity between the coats of mail and the tunic is the two-dimensional approach of their construction. In antiquity, and particularly among the Romans, clothing such as tunics and cloaks were almost always 'woven to shape'.[28] This means that instead of creating garments by cutting

[26] Croom 2010, 16-18; Pausch 2003, 71-76; Pritchard 2006, 49-59; Sumner 2009, 33, 60.

[27] Pausch 2003, 56-59.

[28] Granger-Taylor 1982.

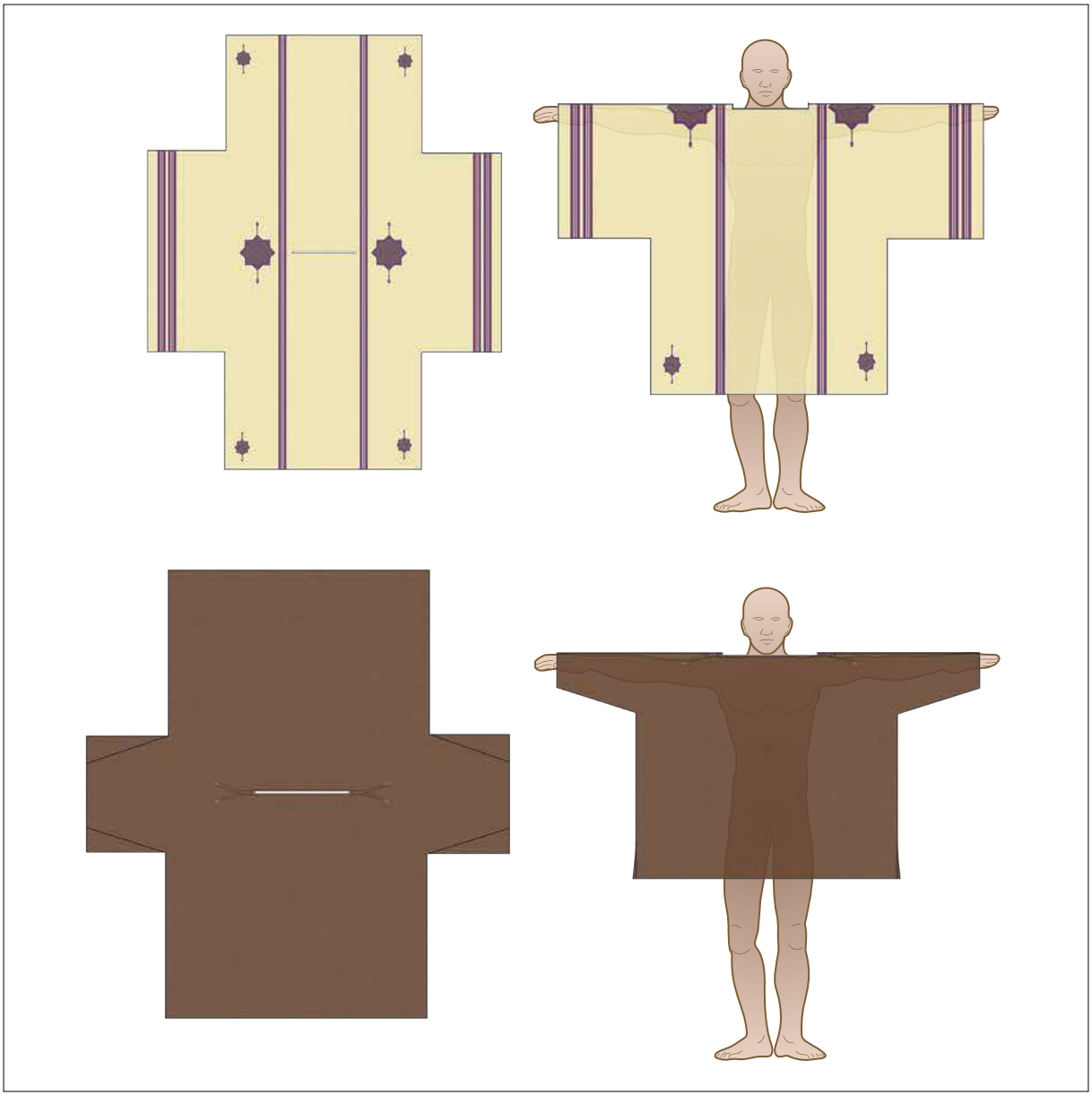


Fig. 10.22. Top: reconstruction of original lay-out of a 3rd or 4th-century cross-shaped tunic from Egypt in the collection of the Whithworth Art Gallery. Bottom: construction plan of the Reepsholt tunic from northwestern Germany dating to the 1st-4th century AD. Note that the tunics are constructed in the same manner as the coats of mail discussed above (drawing M.A. Wijnhoven).

smaller pieces of textile from a larger cloth and sewing them together, the entire garment was created as one single piece on the loom.[29] A tunic that was woven to shape did not require much 'post-loom' work, since there was no cutting and only minimal sewing. Just like the coats of mail, the tunics were folded and closed at the sides during their last stage of manufacture.

[29] This approach had several advantages: no textile was wasted in the manufacture of the tunic, little subsequent needlework was involved, and the selvedges of the cloth provided more resistance against the fraying of the fabric than a sewn hem.

In the particular case of Vimose its construction also imitates a specific type of tunic: the so-called 'cross-shaped' or 'cruciform' tunic (fig. 10.22),[30] which was highly popular in Roman times, especially in the Mediterranean and the Near East. As its name indicates, this tunic resembled a cross when finished on the loom, with two sections forming front and back and the other two making up the sleeves. When making a cross-shaped tunic, a narrow section was first woven at the centre, producing the first sleeve. The full width of the loom was then used to create the body. The neck opening was formed as a vertical slit with closed edges in the process of weaving; the threads being turned back at the middle and returning towards the outer edges. Finally, the second sleeve was woven by copying the measurements of the first sleeve. At a final stage the tunic was taken from the loom, folded and sewn along the sides and the undersides of the sleeves.[31]

The tunic was a very ample garment, loose-fitting on the upper body, and could have wide sleeves. The male tunic usually reached down to the knees. Often, the bottom part of the sides was left open, creating two splits that allowed sufficient movement of the legs. Because of its loose shape, it was worn with a belt. A tunic found in a bog in Reepsholt (northwestern Germany) illustrates the intimate similarity in construction between the coats of mail, notably the one from Vimose, and the tunic (fig. 10.22). This find, dated between the 1st and 4th century AD, is interpreted as made in the Barbaricum after Roman fashion.[32]

In sum, there are many constructional similarities between the textile tunic and the mail coats. Both are constructed 'in the flat', known in textile studies as 'woven to shape', starting out as a single large panel, to be folded and closed. Splits to accommodate the movement of the legs are created by not closing the sides at the bottom hem, leaving this part disconnected. As for the head opening, this consists of a simple slit. The sleeves in mail resemble those of the cross-shaped tunic in particular, and they can be tapered.

The observed resemblance between the tunic and the coat of mail is no coincidence. There are some indications that in antiquity the coat of mail was seen not as a piece of armour but as a tunic in its own right, albeit a protective one. Varro, who wrote in the 1st century BC, speaks of *ex anulis ferrea tunica*, or the 'iron tunic made of rings', to refer to the mail coat when he is explaining the etymological origin of the word for cuirass (*lorica*).[33] This strongly suggests that the mail coat was perceived as a tunic.

The influence of clothing, and of fashion in clothing, is well established for plate armour from the Late Middle Ages and Renaissance. For example, Edwart Oakeshott, scholar of medieval and early modern arms and armour asserts: 'when it comes to arms, we are in the realm of fashion: changes in style applied as much to the armour worn and the weapons carried as they did to the clothes a man put on and the accessories chosen to set them off.'[34] Oakeshott is not alone in noticing a relationship between clothing and armour and recently this subject has been touched upon by various studies concerning Renaissance armour,[35] where such relationship is clearly observed. Since the actual use of armour on the battlefield was rapidly waning during this period, issues concerning practicality and protection became less important and allowed for other aspects, like fashion, to become more apparent.

Until now, there had been no observations of a similar link between (civilian) textile clothing and armour before the Late Middle Ages.[36] The insights into the construction of early mail now demonstrate that such relationship was also present in antiquity. Although fashion surely played a part in the devel-

30 Extant cruciform tunics are e.g. discussed and illustrated in: De Moor *et al.* 2010; Pritchard 2006; Verhecken-Lammers 2010.

31 Hald 1946, 67-69.

32 Fuhrmann 1942; Hald 1980, 336-338; Nockert 1991, 120; Potratz 1942; Vedeler/Jørgenson 2013, 120.

33 Varro, *De lingua Latina*, 5.24.

34 Oakeshott 2000, 27.

35 Pyhrr *et al.* 1998; Patterson 2009; Springer 2010.

36 Hoss (2014, 12-72) is one of few scholars that takes the concept of fashion into account and uses it in relation to social group identity as a theoretical framework for her examination of the Roman military belt.

opment of early mail armour, it is not the only factor. Also important is the craftsman's approach which, while influenced by fashion, is mainly the product of apprenticeship and tradition (chapter 8 & 11). Additionally, we must consider the craft in its context and time, which are reflected in the maker's actions. So if in antiquity they thought of mail as a tunic or a piece of clothing, then we would expect it to be built as a piece of everyday dress. Since clothing was fashioned by weaving on the loom, the mail maker also worked 'in the flat', and did not consider working 'in the round' as his late-medieval counterpart.

10.5 CONSTRUCTION OF THE COAT WITH SHOULDER GUARDS

So far all the mail coats discussed in this chapter in relation to their construction concern a tunic-like design with sleeves. This model is observed in depictions of mail from the mid-1st century AD onwards (chapter 4). For the period prior to the introduction of the sleeved mail coat, another design was omnipresent in the iconographic record, which is the mail coat with shoulder guards.

Unfortunately most finds prior to the mid-1st century AD are not preserved well enough to provide information on their construction. The mail coat from Radovanu in Romania is one of the few exceptions, but has not been examined or published in detail.[37] However, the fact that shoulder guards existed not only in iconography is confirmed by finds such as Kirkburn in the United Kingdom, from the 3rd century BC. Although the preservation of the remains does not allow for detailed conclusions, two shoulder guards can be clearly observed (fig. 2.15).[38]

The best archaeological evidence for the presence of shoulder guards is the numerous finds of fasteners which served to keep them in place (chapter 3). Generally, the fasteners are found isolated from the mail coat they once belonged to, but some coats like those from Chassenard in France and Hedegård in Denmark still have their fasteners *in situ* and (partly) attached.[39]

Fasteners are not always observed among the remains of mail coats from before the 1st century AD. It can be that they became lost due to their fragmentary nature, but they can also be concealed inside a solid block of corroded mail, in which case only a technology-aided examination can reveal their presence. Remarkably, all finds of complete coats from this period, which have been examined and published, have been shown to contain fasteners, attesting to the presence of shoulder guards. The only possible exception so far is the 2nd century BC coat from Es Soumâa in Algeria, which is largely complete and has been X-rayed, but seems not to contain fasteners.[40]

The archaeological record thus indicates that up to the 1st century AD the coat of mail with shoulder guards was the norm.[41] In this case, archaeology and iconography corroborate each other. Although the actual occurrence of mail coats with shoulder extensions is well supported, unfortunately there is little technical information available on their construction. In fact, the best source on the construction of armour with shoulder guards is not mail, but two specimens of hybrid armour.

37 Borangic 2011a, 185-186, 190-191, 223.

38 Stead 1991, 54-56.

39 Beck/Chew 1991, 37, 43-45; Kalsbøll Malfilâtre 1993, 17-20.

40 Waurick 1979, 318-332.

41 Some have stated that the Iron Age mail coat from the Carpathian Basin does not have shoulder guards. E.g. Borangic 2011b, 123; Borangic/Paliga 2013, 12; Torbov 2004, 57. However, a review of complete and well-examined specimens from that region demonstrates that fasteners, and thus shoulder guards, are present.

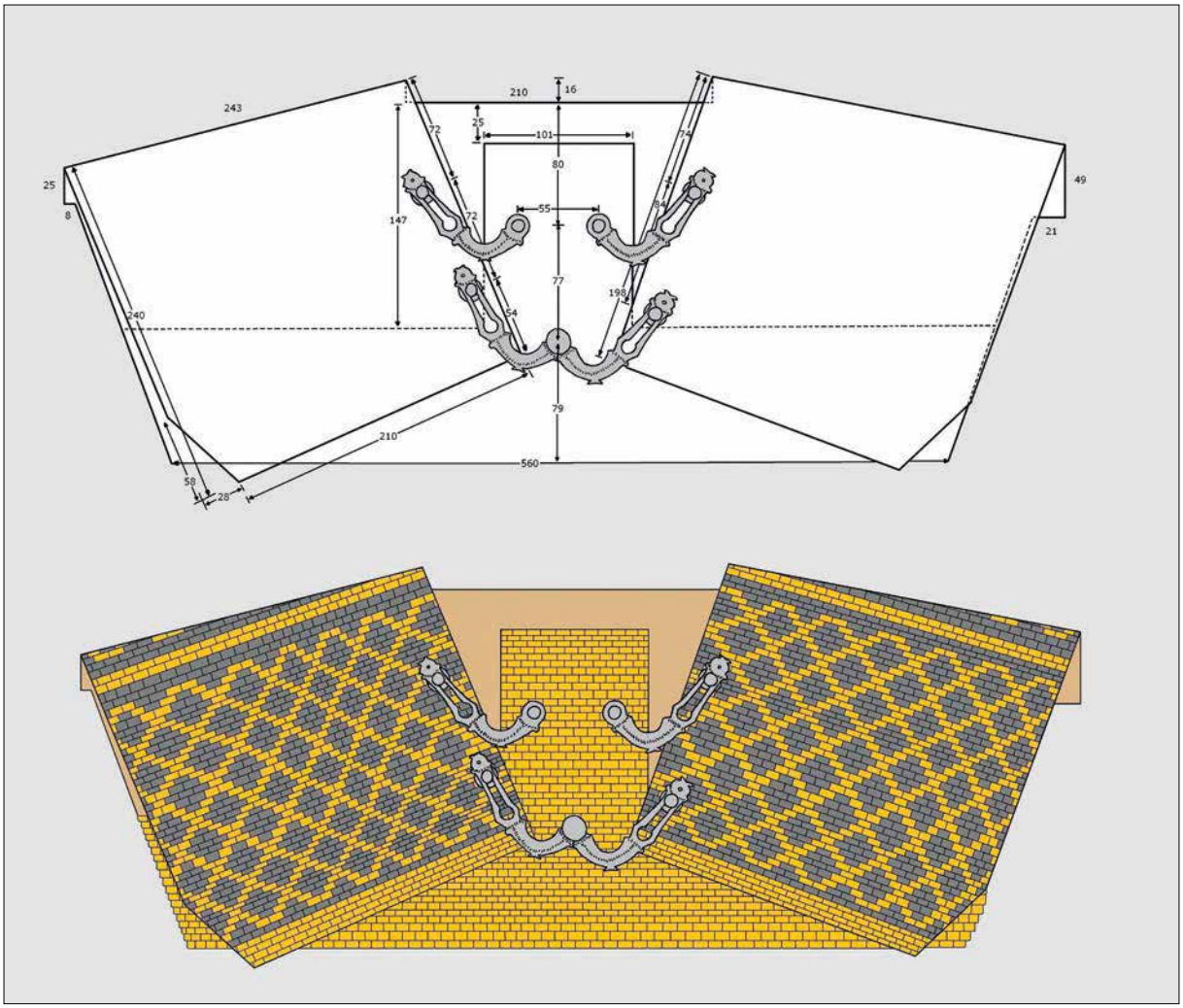


Fig. 10.23. Measurements of the Augsburg hybrid armour according to the stereographical X-rays (adapted from Driehaus *et al.*, fig. 10a) and its reconstruction to scale (drawing M.A. Wijnhoven).

CONSTRUCTION OF THE HYBRID ARMOUR FROM VIZE AND AUGSBURG

Two finds of hybrid armour, from Augsburg in Germany and Vize in Turkey, have been examined and published so thoroughly that their construction plan can be reconstructed almost entirely.[42] The armour from Augsburg was originally enclosed in a timber chest, in which it was deposited around the mid-1st century AD. The garment is partially preserved as a rolled up solid block, but with the aid of radiographic techniques it has been possible to look inside it and make out its contents. Stereographical X-ray images at various depths allowed the garment's outline to be observed at various points, and even measure it over short distances, allowing for a partial reconstruction of the pattern.[43] The images show that only the upper part of the armour survives. They also reveal the presence and precise location of fasteners and buttons that hold the shoulder guards in place. Figure 10.23 illustrates the armour's original measurements. The garment leaves the shoulders open, as they are covered by two large shoulder pieces that extend from the back to the chest and are joined by fasteners on the front. Representations of armour usually show such

[42] Wijnhoven 2016a, 80-83.

[43] Driehaus 1968; Driehaus *et al.* 2012, 366-371, fig. 10a.

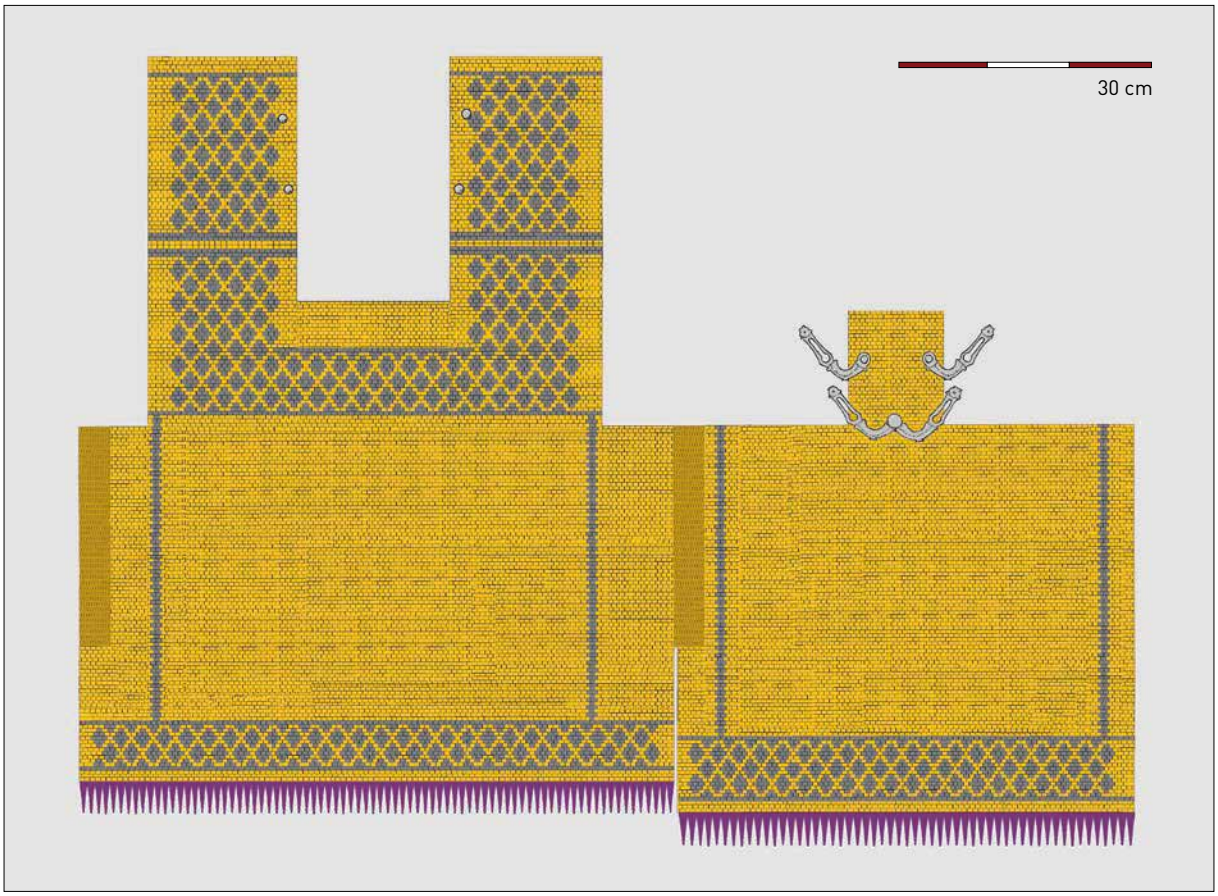


Fig. 10.24. Interpretation of the construction of the Vize armour in finished condition. The armour is wrapped around the body and then closed at the left side of the wearer. The guards are brought over from the back, covering the shoulders, and fastened at the upper chest. At the front a small rectangle protects the upper chest where the guards offer no coverage (drawing M.A. Wijnhoven).

fasteners only as a single pair, but the Augsburg garment includes two pairs very similar in shape. The garment has a small flap at the front's top which is covered at the sides by the shoulder extensions. This served as protection for the vulnerable upper breast and lower neck area.

While the painstaking examination of the Augsburg armour is able to reveal information on constructional details, it is the excellent state of preservation of the Vize hybrid armour that enables further understanding. The armour from Vize was found in a Thracian high-status tumulus from around AD 35-50 and almost all of the elements that make up the armour are preserved, rendering it near-complete.[44] The armour was however not yet finished when deposited, perhaps due to the owner's untimely death, which hampers the interpretation of this remarkable artefact.[45] This means that some parts of the armour may be temporary, and others still had to be added, adjusted, or assembled.

The construction of the Vize armour is very similar to that of Augsburg (fig. 10.24).[46] It consists of rectangular front and back panels, which differ from each other in size.[47] The shoulder guards are a

[44] Driehaus 1968; Onurkan 1978.

[45] Driehaus *et al.* 2012, 386-391.

[46] Jürgen Driehaus unfortunately passed away before concluding his extensive study of the Vize armour. The presented reconstruction is made by the author based on his notes and conclusions, published posthumously in Driehaus *et al.* 2012, 372-394.

[47] Based upon the size differences, Driehaus *et al.* (2012, 393-394) consider the possibility that the front and back panels could have come from different garments and may have been assembled just for the occasion of the funerary rites.

continuation of the back panel and were fastened to the front by the double pair of fasteners. A small flap is located at the front to protect the upper breast and lower neck. The front and back were probably manufactured separately and only put together during the last few steps of the armour's construction.

Although some small differences between the Vize and Augsburg armours are observed, such as the size and the outline of the shoulder extensions, their construction is basically the same. Both armours also have two important constructional similarities with the sleeved mail coats discussed previously. First, all are constructed as a single large flat panel. In the case of the sleeved coat of mail this large panel is permanently transformed into a wearable item by folding and connecting front and back. In hybrid armour this connection is temporary. In order to wear it, the user wraps the armour around his torso and closes it on the left side of his body. He takes the guards from the back of the armour, over the shoulders, and then attaches them to the front with a double set of fasteners. The other common characteristic is that the Augsburg and Vize armours consist basically of rectangular shapes and do not show any evidence of tailoring techniques so common in the Late Middle Ages-Early Modern period.

HYPOTHETHICAL CONSTRUCTION OF MAIL WITH SHOULDER GUARDS

Although hybrid armour is not the same as mail, the constructional similarities give an important clue on the construction of the mail coat with shoulder guards. Since both the sleeved mail coats from the Roman period and hybrid armour with shoulder guards are constructed 'in the flat', it seems that this was the norm for all of early mail. It is highly likely that the mail coat with shoulder guards was constructed in a similar fashion, as a flat sheet of mail, folded over and closed where needed, with little to no tailoring.

Building upon this assumption, there are basically two ways in which the coat with shoulder guards could have been constructed. The first follows the construction plan of hybrid armour very closely (method 1 in fig. 10.25) and consists of a single panel of mail that includes front and back. The shoulder guards are an integral continuation of the back. The coat is created by folding the back onto the front and then connecting the sides (A in figure 10.25) making a tube of mail. If desirable, the coat can have splits formed by not connecting the sides of the bottom hem. When worn the shoulder extensions are brought over the shoulders and attached to the set of fasteners in the front, not unlike a pair of modern dungarees.

The second method is quite different, despite being similar in appearance when worn (method 2 in fig. 10.25) and consists of two parts: the coat itself and an additional yoke-shaped piece. The coat is made from one large rectangular section of mail, which is folded horizontally (method 2a) or vertically (method 2b) and then connected in all the necessary places. This results in a rectangular garment with holes for the arms and head. The base of the yoke-shaped piece is then permanently connected to the back of the coat. When worn the extensions of the yoke are brought over the shoulders and attached to the fasteners at the front. Once in place, the guards also cover up parts of the head opening of the coat. The second method of construction needs much more material than the first to cover the same amount of surface on the wearer's body, since the use of the yoke means that large part of the upper torso is covered in a double layer of mail. This may be perceived as an advantage, but also has drawbacks such as using up more material and ending up with a heavier garment.

Although studies on the construction of the early mail coat have been scarce, many works in English indirectly reveal how they understand the construction by their choice of words. The term 'shoulder doublings' or 'doublers' is regularly employed to refer to the shoulder guards,[48] indicating (probably inadvertently) the use of the second constructional method. One of few exceptions is the reconstruction of

[48] E.g. Bishop/Coulston 2006, 63, 95; D'Amato/Sumner 2009, 128; Travis/Travis 2011, 69; Sumner 1997, 15, 22, 35.

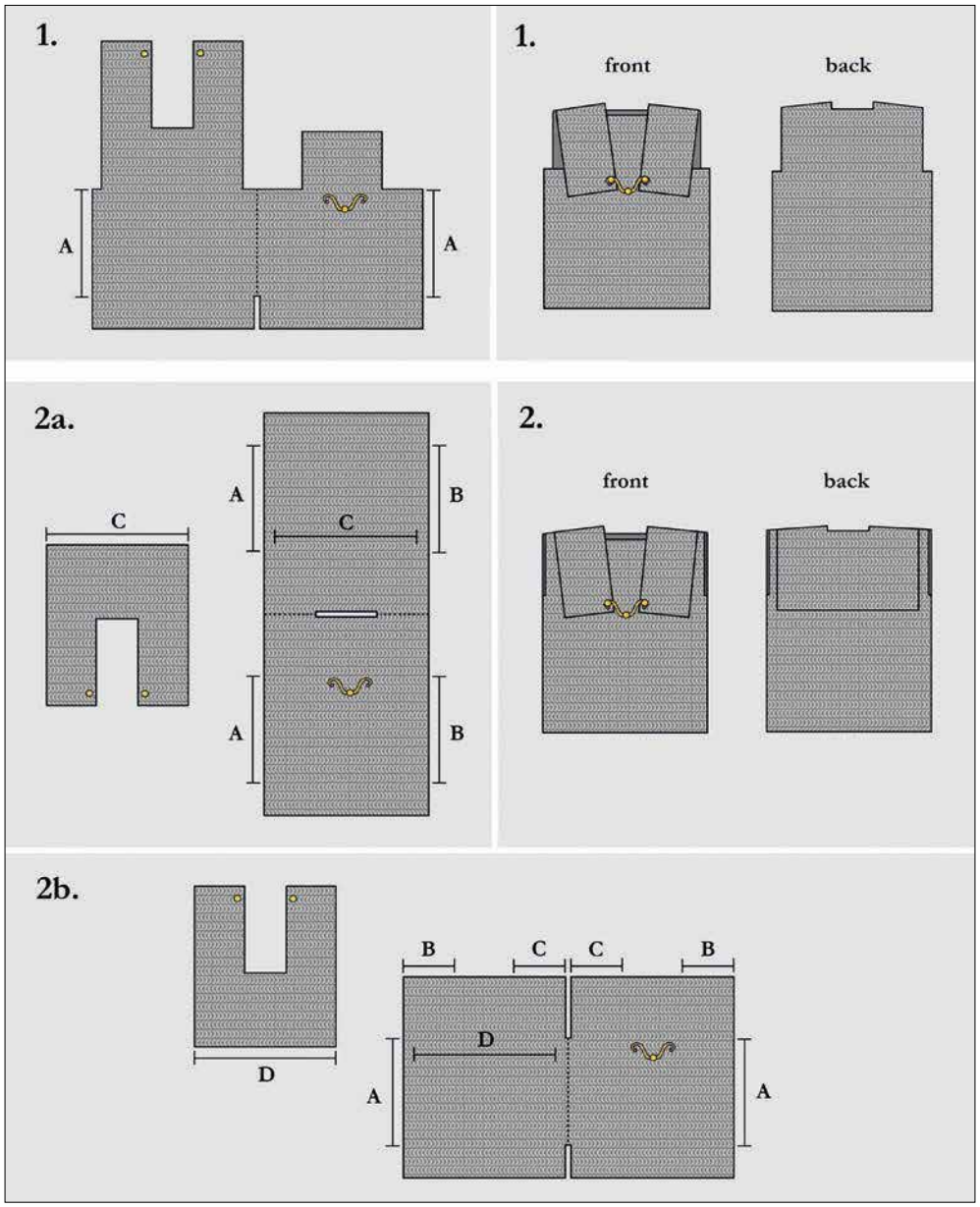


Fig. 10.25. Hypothetical reconstruction of the early mail coat with shoulder guards. 1) Coat created out of a single sheet of mail. In this design the shoulders are covered by a single layer of mail, i.e. by the guards only. 2) Coat created out of two sheets. The shoulders are here covered by a double layer of mail, i.e. the trunk itself covered by the guards. This model can be constructed in two manners (drawing M.A. Wijnhoven).

the Kirkburn coat of mail, which follows the first method with only a single layer of mail protecting the shoulders (fig. 10.26).[49] My own examination of this coat of mail leaves the matter of its construction undetermined, since its condition is not good enough to draw conclusions.

Due to the general lack of informative archaeological finds there is no leverage towards either of the methods. Representations of the mail coat shed some light, despite them often being too ambiguous to provide detailed information on their construction. Some representations appear to have only a single

[49] Stead 1991, 54-55.

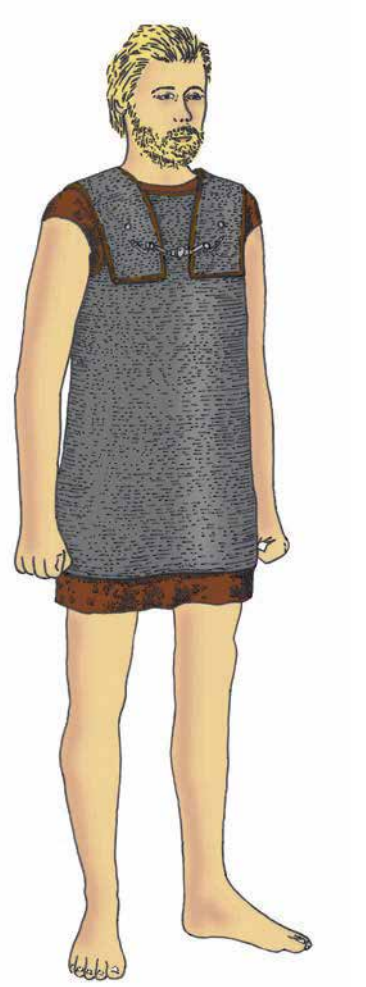


Fig. 10.26. The Kirkburn coat of mail has been reconstructed with a single layer of mail protecting the shoulders, 3rd century BC (drawing M.A. Wijnhoven, after Stead 1988, 115).

layer of mail on the shoulders, such as the statue of a warrior from Las Atayelas and some of the soldiers on the altar of Ahenobarbus (figs. 4.12 and 4.14). Others demonstrate a double layer of mail, as can be observed at the funerary stelae of Sextus Valerius Genialis and Marcus Favonius Facilis (figs. 4.30 & 4.32). The double layer of mail is best identified on the statue of a Romanised Gaul found at Vachères in France, because of its highly detailed carving (fig. 4.16).

The depiction of the mail coat appears to corroborate the two possible construction methods of the coat with shoulder guards. Interestingly the single layer is only observed until the 1st century BC, while the double layer method occurs mostly from the 1st century BC until the demise of the coat with shoulder guards in the 1st century AD.

10.6 MAIL WITH SHOULDER GUARDS AND TEXTILE CLOTHING

The resemblance in construction between the sleeved mail coat and the textile tunic is clear. In contrast, the design of the coat of mail with shoulder extensions is much harder to tie in with a specific textile garment from antiquity. Its link with everyday clothing is still there, although in a less obvious and indirect manner.

The construction of the mail coat with shoulder guards is based on another piece of body armament, i.e. the tube-and-yoke cuirass, also known as *linothorax*, frequently portrayed on Greek vases from the 6th century BC onwards. The exact nature of these cuirasses is debated since all evidence is iconographic with no known archaeological examples in existence,[50] but the representations indicate that they were made of a sturdy yet flexible material such as textile or leather. When mail was invented, the tube-and-yoke cuirass was one of the most popular forms of armour therefore it would not be strange if the early mail coat were constructed after it. So, even when mail was new, its design was deeply rooted in the long-existing tradition of its time.

Despite the lack of archaeological specimens, the basic construction of the coat with shoulder guards can be inferred from scale armour that was also inspired by it, such as the 4th century BC scale armour from Golyamata Mogila in Bulgaria (fig. 10.27),[51] and the abundance of detailed representations. From these sources we can conclude that the tube-and-yoke cuirass contained three main elements: a torso, a yoke-like shoulder guard, and a skirt of *pteryges* (fig. 10.28). Sometimes the yoke and skirt are depicted as if they were constructed separately and sewn onto the torso piece, other times they are portrayed as a single continuous sheet that included all its elements, like the Golyamata Mogila armour. In any case,

[50] Aldrete *et al.* 2013; Gleba 2012; Everson 2004, 193-195; Jarva 1995.

[51] Agre 2011, 72-84.

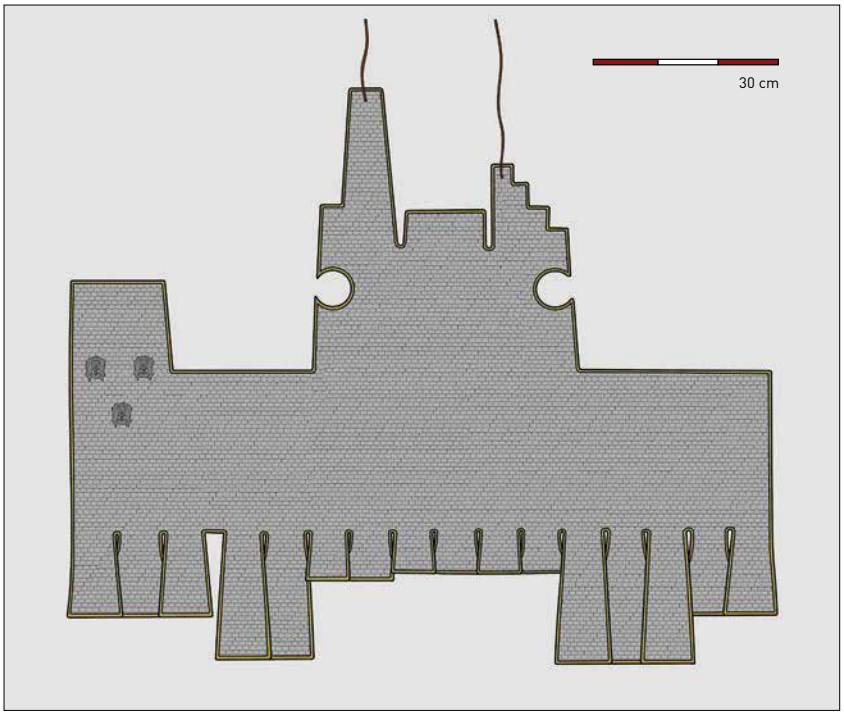


Fig. 10.27. Construction plan of the 4th century BC scale armour from Golyamata Mogila in Bulgaria. The body armour is made from one single sheet comprising all elements (drawing M.A. Wijnhoven).

it comprised a piece of armour that could be laid out flat and, when worn it wrapped around the body to be closed at the side, with the yoke guards going over the shoulders and a system of metal fittings at the front.

Although the mail coat with shoulder guards did not derive from civilian clothing, the tube-and yoke cuirass on which it is based does have a strong tie with everyday dress from antiquity. Unlike modern clothing, which has openings for the head and arms, much of ancient Greek dress was not sewn shut, but left open and wrapped around the body when worn.[52] The Greek equivalents of the Roman tunic were the female *peplos* and the unisex *chiton*, both consisting of a rectangular piece of cloth that was folded and sewn at the side to form a cylinder. Alternatively, the textile cylinder could be constructed from two rectangular pieces of cloth sewn together on both sides. In the *peplos* the open section at the top was folded down creating a deep cuff, which gave it a capelet-like appearance. Women pulled this garment over their head and attached it back to front at the shoulders with two large pins forming openings for the neck and arms. In the *chiton* the top of the textile cylinder was not folded over, but left plain. The open top was also fastened by placing pins or buttons on two or more points connecting front and back, creating openings for the head and arms (fig. 10.29). Both *chiton* and *peplos* were voluminous garments sometimes worn with a belt to gather them at the waist.

On top of the *peplos* or *chiton* one would wear a second layer of attire such as the *himation,* which was a large rectangular cloth that served as a mantle. A typical male style of wearing it was to lay one end on the left shoulder and draw the rest round the body from the back, throwing the other end either across the left forearm or over the shoulder.[53] The *chalmys* was another type of mantle, used among the Greek military. It likewise consisted of a seamless rectangle cloth that was normally pinned with a brooch at the right shoulder. These two demonstrate that outer garments in ancient Greece were not constructed like a shirt either, but made use of a single piece of cloth that was draped over the shoulder(s) and pinned in place if needed.

[52] Cf. Abrahams 1908; Bieber 1928; Bonfante 1975; Lee 2015.

[53] Abrahams 1908, 54.

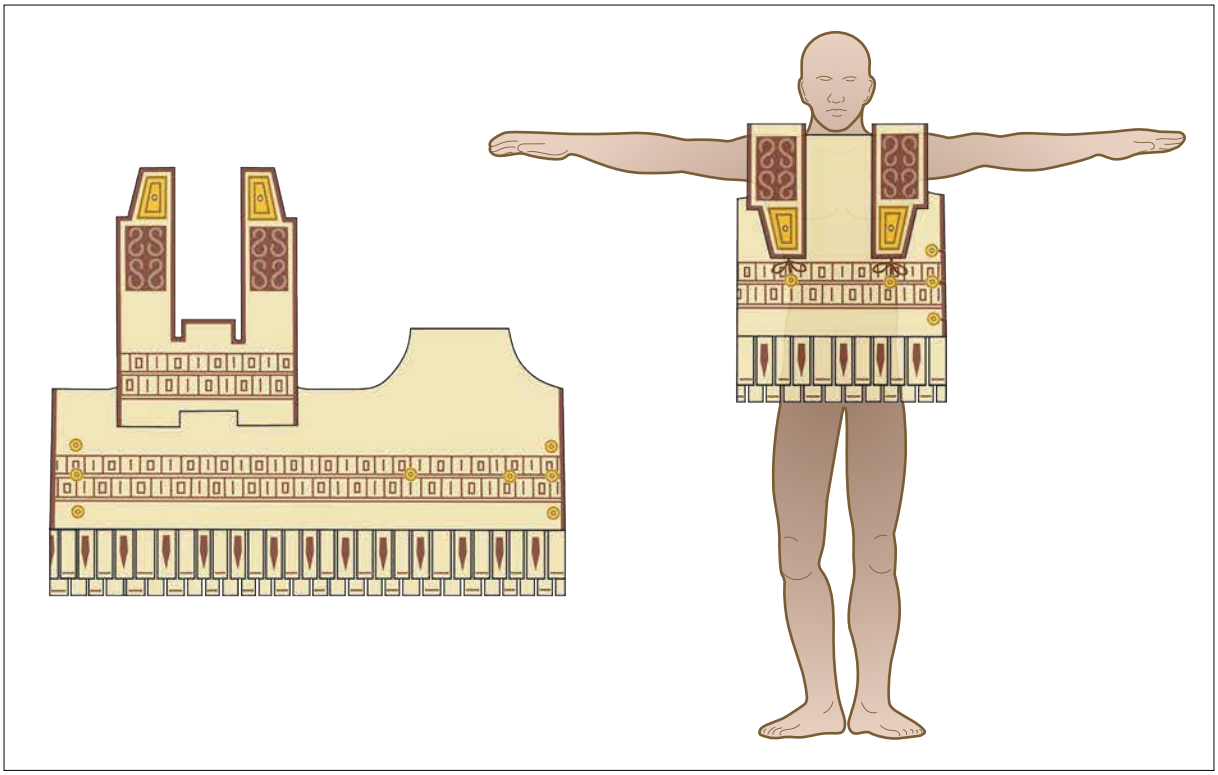


Fig. 10.28. Reconstruction of a tube-and-yoke cuirass based upon a fresco painting from the Amazon Sarcophagus in Tarquinia dated to 350-300 BC (drawing M.A. Wijnhoven).

This side note on ancient clothing makes it clear that while the tube-and-yoke armour is not a literal adaptation of specific textile clothing, its constructional solutions are very much embedded in everyday dress. Just like the *chiton* and *peplos*, it consists of a flat panel that is wrapped around the body to form a cylinder open at the top. The system of shoulder extensions that allows the tube-and-yoke cuirass to be worn reminds us directly of the textile outer garments that were similarly sported over the shoulder. The yoke guards of the armour also connect back to front creating temporary openings for the head and arms, as in the Greek undergarments of the time.

10.7 THE DEVELOPMENT OF MAIL ARMOUR THROUGH THE AGES

Either explicitly or implicitly, there is a continuous dialogue between military equipment and the society where it is produced and mail armour is no exception. The mail maker's approach to work and problem-solving techniques are highly influenced by what is familiar. Therefore, if the coat of mail was thought of as a piece of protective clothing,[54] it makes sense that it was constructed like an everyday garment.

[54] Varro's quote from antiquity confirms the association between clothing and mail, but this is also evident in more recent sources, such as the records of issues and payments from 1544/5 to John Malte, King Henry VIII's tailor, in which mail is similarly referred to as a *tunica de maile*. Cf. Blair 2005.

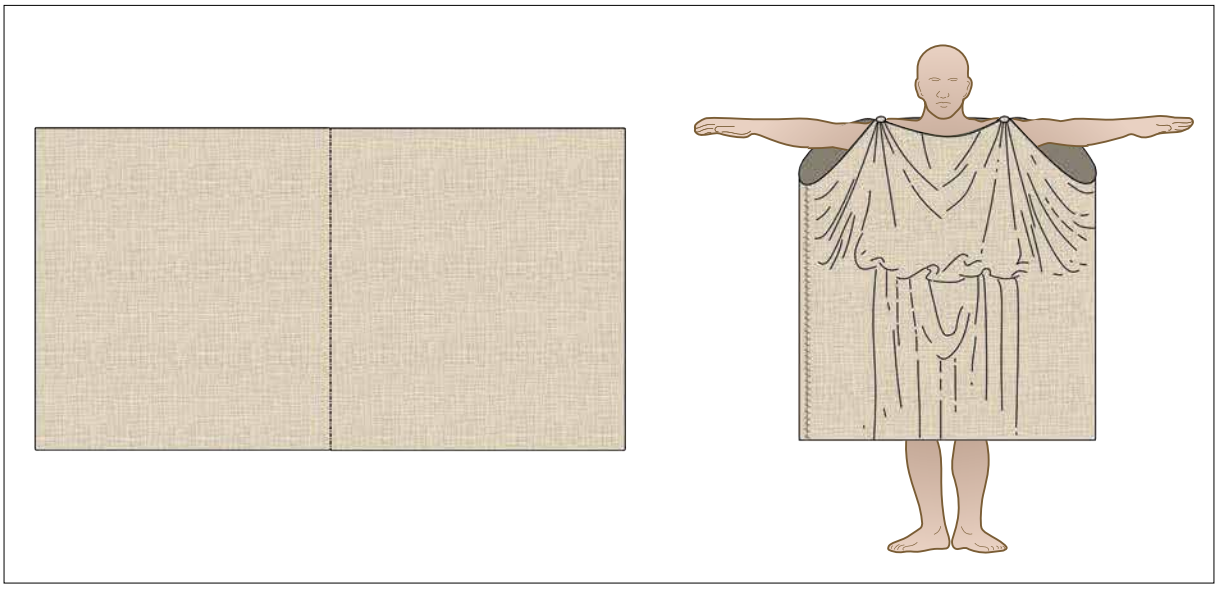


Fig. 10.29. The *chiton* is made out of a large sheet of textile which is folded over and sewn shut on one side. Very often, the top of this garment was left open and only closed when worn by pins or buttons that temporarily connected front and back, instantaneously forming the openings for the arms and head (drawing M.A. Wijnhoven).

The close association of mail armour with textile clothing opens the possibility of making predictions about the constructional development of the coat of mail through the ages. For example changes in the construction of textile garments might correlate with changes in the construction of the mail coat. Textile clothing from antiquity, like mail, has survived only in exceptional circumstances. However there are enough well-known examples to get an idea of how clothing making changed and hence to hypothesize about the development of mail coat construction, even for periods in which archaeological information is scarce or lacking altogether. The following is precisely a tentative hypothesis of that development, to be tested by future finds and research. Its scope is much wider than the period concerning the present study and spans up to the Middle Ages and Early Modern period, since the latter have served as a reference point for understanding early mail. In a way, we have come full circle on the construction techniques discussed at the beginning of this chapter.

3RD CENTURY BC – 1ST CENTURY AD

By using textile clothing as reference, the construction of the coat of mail during its earliest years should resemble the tube-and-yoke cuirass; that is a tube-like coat, open at the top and closed by two shoulder guards when worn (type 1 in fig. 10.25). Eventually, this construction was replaced by one similar to the sleeveless Roman tunic, with a fixed opening for the head and arms. This change likely occurred when Greek 'tube-like' garments, like the *chiton*, lost in popularity to the sleeveless tunic of Roman style.

Although the construction of the mail coat changed, it preserved the shoulder guards which then functioned as true 'doublers' (type 2 in fig. 10.25). In this design the guards no longer served a constructional purpose and were probably just remnants of the previous model, rather than a feature for additional protection as has been sometimes suggested.[55] This is supported by the iconographic record. Up

[55] Bishop/Coulston 2006, 63-64; Daly 2005, 70; Fields 2012, 56.

Fig. 10.30. The coat of mail from Gammertingen from around AD 570 (photograph Landesmuseum Württemberg, H. Zwietasch).

to the start of the calendar depictions of the coat of mail invariably show the presence of shoulder guards, but during the 1st century AD mail coats do not always have this feature and are basically constructed as a sleeveless tunic (chapter 4.2-3).[56] This suggests that such attributes were being gradually discarded.

1st century – 6th/7th century AD

The sleeveless tunic was the standard male garment during the Roman Republic. Sleeves, and especially long sleeves, were even considered effeminate or not-Roman.[57] During Augustus' reign, tunics with short sleeves were already in use, but it was not until about a century later, that the sleeved tunic became more customary. It is hard to say whether the early representations refer to actual sleeves or a type of 'false sleeve' created by broadening the tunic and having the surplus material cover the shoulders down to the upper arms.[58] The adoption of actual sleeved tunics by Roman society is difficult to pinpoint,[59] but must have happened no later than the 2nd century AD, mainly due to foreign influence, which often arrived via the army. The Roman army, and particularly the non-Roman auxiliaries, was one of the main lines of contact between Roman society and the customs from beyond the Empire.[60] In any case, by the 3rd century the sleeved tunic had generally replaced the earlier forms.[61]

The transition from sleeveless to sleeved tunic is mirrored in the construction of the coat of mail. Representations of mail during the 1st century AD sometimes already feature what looks like mail coats

56 Cf. the grave stelae of Titus Flavius Bassus, Vellaunus, Quintus Carminius Ingenuus, Leubius and Insus (figs. 4.33-34 & 4.36).

57 E.g. Sumner 2003, 6; 2009, 17, 45-47; Speidel 2011, 11.

58 Pausch 2003, 86-89, 172-180.

59 Archaeological evidence for sleeved tunics comes from Les Martres-de-Veyre (Wild 1985, 371) and Lendbreen (Vedeler/Jørgensen 2013). Both consist of a single sheet of textile folded over and sewn shut, with sleeves made separately. The earliest archaeological remains of a tunic with integrated sleeves comes from 2nd century Palmyra (Staufer 2000). Archaeological evidence for the sleeved tunic is plentiful in Egypt from the 3rd century AD onwards (e.g. Pritchard 2006). The Reepsholt tunic from Germany is an example from outside the Roman Empire (Potratz 1942). The tunic from Thorsberg dating to the 2nd-3rd century AD has sleeves, but is constructed differently and is an early example of cut-to-pattern clothing (Möller-Wiering 2011, 42-48).

60 De Blois/Cascio 2007; Strobel 2007, 278-279. For clothing in particular: Sumner 2009, 45-47; Speidel 2011, 11.

61 Croom 2010, 38; Sumner 2009, 41-42.

with short sleeves, although some could be 'false sleeves'.[62] Since Trajan's reign, the design with shoulder guards is entirely discarded and only true sleeved coats of mail are represented. Fasteners – clear indicators of the presence of shoulder guards – disappear from the archaeological record by the end of the 1st century, further corroborating the introduction of a new mail coat design with no shoulder guards.

Until the 7th century the great majority of textile clothing in Europe was woven on the loom, meaning that garments required little to no work after completion,[63] needing only to be folded and sewn shut where necessary. In the same tradition, contemporary mail makers sought similar solutions in the construction of the mail coat. For instance, 'working in the flat' did not involve much tailoring, making most items from this period fairly straightforward.

Based on the data from textile clothing woven on the loom, and the sleeved tunic in particular, we can suggest that the construction of the mail coat probably remained largely unchanged from the 2nd to the 7th centuries. Although informative finds from this period are few and far between, the coat of mail from a grave in Gammertingen, Germany, dated c. AD 570, appears to confirm this expectation (fig. 10.30).[64] This coat is now in a rigid condition, but because it was laid out flat it preserves some of its constructional characteristics. Clearly it is a fairly long coat, its remnants nowadays measuring 84 cm in length (excluding the attached protection for the neck or head), it has short sleeves, now approximately 7 cm long, and the body is rectangular and appears devoid of any tailoring. The presence of an integrated neck or head piece is nonetheless a new feature. The Gammertingen mail coat demonstrates that working in the flat was still being practised by mail makers in a time when woven to shape garments were the norm.

7th/8th – 12th century AD

The production of woven to shape clothing in Europe started to diminish during the Early Middle Ages and ceased to exist around the 7th or 8th century AD.[65] Since then, clothing was cut to pattern from larger sheets of textile.[66] Although this entailed loss of material and more sewing work, it also offered new possibilities regarding construction. For instance, garments could be given three-dimensionality by adding panels of textile underneath the arm, and had a more elaborate opening for the head compared to the previous slit-like construction. Cut-to-pattern clothing was constructed by panels that did not need to be rectangular, allowing the garments to become more shaped and tailoring techniques to be developed, such as the use of triangular insertions of fabric, called gores (fig. 10.31).[67] However, until the 13th century tailoring was only moderately applied and the overall impression is that up to this point clothing was fairly wide, with some shaping.

The mentioned changes in the production of textile clothing likely influenced the way in which mail makers constructed a coat of mail. The introduction of cut-to-pattern garments, means that the mail maker was no longer restricted to working in the flat. Like in textile clothing, construction would have switched to making loose panels of mail, instead of a single continuous one, which in the last stage would be assembled to create a full coat.

62 Cf. the funerary stelae of Vellaunus, Gaius Castricius, the anonymous rider from Ribchester and the anonymous infantryman in Bonn (figs. 4.37-37 & 4.39). The column base from the praetorium of a fort in Mainz offers also a good example (fig. 4.20).

63 Pritchard 2006, 45.

64 Gröbbels 1905, 34-35; Riemer/Heinrich 1997, 54-55, 58-60.

65 Granger-Taylor 1982, 22.

66 E.g. the Migration era woollen shirt from Högom, the late 7th or early 8th-century shirt from Bernuthsfeld, and the 11th-century linen shirt from Viborg. Cf. Ewing 2006, 81-82; Hald 1980, 399; Nockert 1991; Schlabow 1976, 72-73.

67 Scott 2011, 23-32.

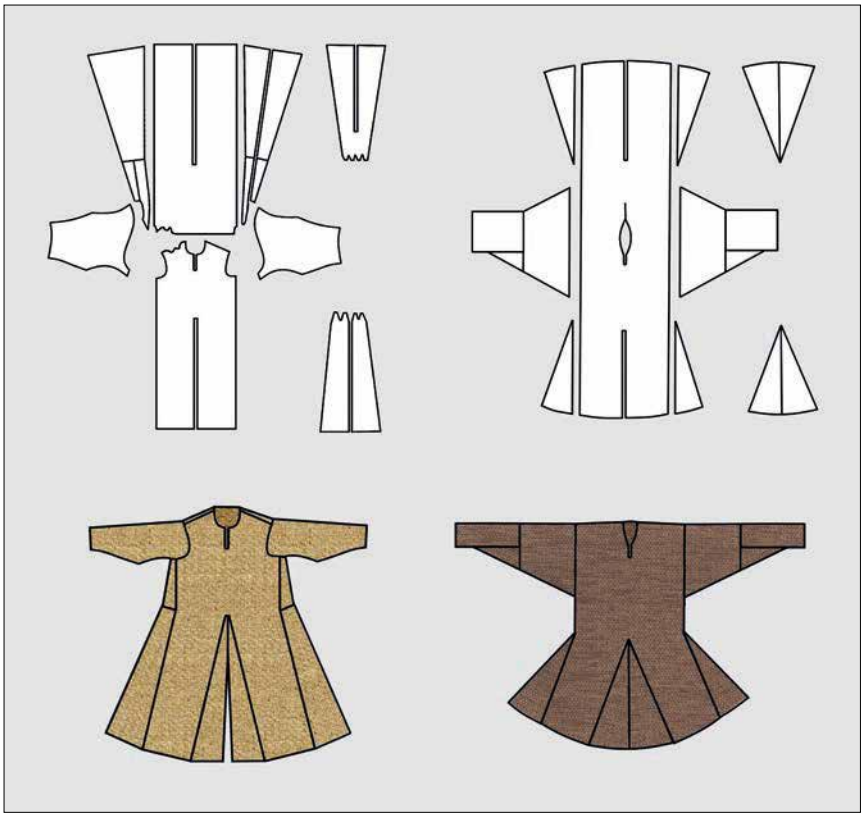


Fig. 10.31. Construction plan and reconstruction of the kirtles from Moselund on the left and Kragelund on the right, in Denmark dated around AD 1100 (not to scale). The garments make use of triangular gores for tailoring. The armpit area is not flat but has also been given shape by inserting textile panels (drawing M.A. Wijnhoven).

The popularity of cut-to-pattern clothing from the 7th or 8th century probably marks the moment when the same construction techniques were adopted in mail making. Some of the characteristics of cut-to-pattern clothing show clear parallels with two of the mail construction techniques discussed at the beginning of this chapter. The first is placing the mail fabric at a 90 degree angle underneath the armpits to obtain a three dimensional shape, similar to the use of fabric panels in clothing for the same purpose. The second technique is using triangular or rhomboid pieces of mail to tailor the coat, just like in textile clothing.

At present, archaeological evidence cannot verify these expectations due to the scarcity of well-preserved or well-published coats of mail from this period. The earliest informative examples come from the 10th-11th centuries, but these do demonstrate that the mentioned construction techniques were already being applied in mail making. The mail coat housed at the Cathedral Treasury in Prague, and attributed to St. Wenceslaus (fig. 10.32),[68] probably is the oldest example of a historical mail passed down the generations. The sleeves on the coat of St. Wenceslaus are attached to the torso underneath the armpits at a 90 degree angle, just as in all late mail. Also, it was tailored by inserting triangular sections of mail to flare out the lower part.[69] This mail garment, with its wide sleeves and full skirt mirrors contemporary dress not only in construction but also in appearance.[70]

The coat of mail from Milhailovo, in Bulgaria, is another archaeological garment that has survived remarkably well, perhaps because its rings were coated in a thin layer of silver. Unfortunately, its description does not say whether the above techniques were used or not, but it does reveal that the garment has

[68] Bravermanova 2012; Checksfield *et al.* 2012; Laking 1920, 167-171; Pleiner 2012.

[69] Checksfield *et al.* 2012, 238-239.

[70] A large number of clothing excavated at Herjolfsness in Greenland is illustrative for the similarity in construction. The garments are at least 800 years old and make similar use of gores. Fransen *et al.* 2010.

Fig. 10.32. The St. Wenceslaus coat of mail is probably the oldest piece of historical mail and probably dates back to the 10th century. A separate aventail from the 15th century covers the neck and upper torso, probably to cover a much damaged area in the coat (photograph Schránil 1934, pl. 16).

three different gauges of rings.[71] The heaviest rings are placed on the areas of the chest and torso, while the lightest are found on the back, the sleeves, and the bottom. An intermediate gauge ring connects the areas in between. The Milhailovo specimen represents the earliest evidence so far for the use of different ring gauges to even out protection and weight in a mail garment.

13TH CENTURY – EARLY MODERN PERIOD

From the 13th century onwards, clothing turned more tight-fitting and more tailored to the body.[72] During the second half of the 14th century this trend accelerated resulting in extravagant shapes of clothing. For instance, the so-called 'pigeon breast' silhouette became popular, the outline of which was faithfully copied in the plate armour of the time.[73] The extreme shaping and tailoring of clothing probably reached its height with the Gothic art movement in the 15th century (fig. 10.33). Like in architecture, garments from this period commonly had sharp angles, with some parts widened beyond functionality and others narrowed to fit the body tightly.[74] Plate armour of the 15th century closely followed this fashion, most notably seen in what is called Gothic armour.[75]

71 Zlatkov 2014, 134.

72 Crowfoot *et al.* 1992, 176-181.

73 Clothing: Houston 1996 [1939], 72-121; Newton 1980; Norris 1999 [1927], 199-274; Scott 2011, 33. Armour: Blair 1958, 56-60; Edge/Paddock 1988, 76-80; Price 2000, 349-357.

74 Houston 1996 [1939], 139-198; Norris 1999 [1927], 353-453; Thursfield 2001.

75 Blair 1958, 77-111; Capwell 2015; Edge/Paddock 1988, 94-122.

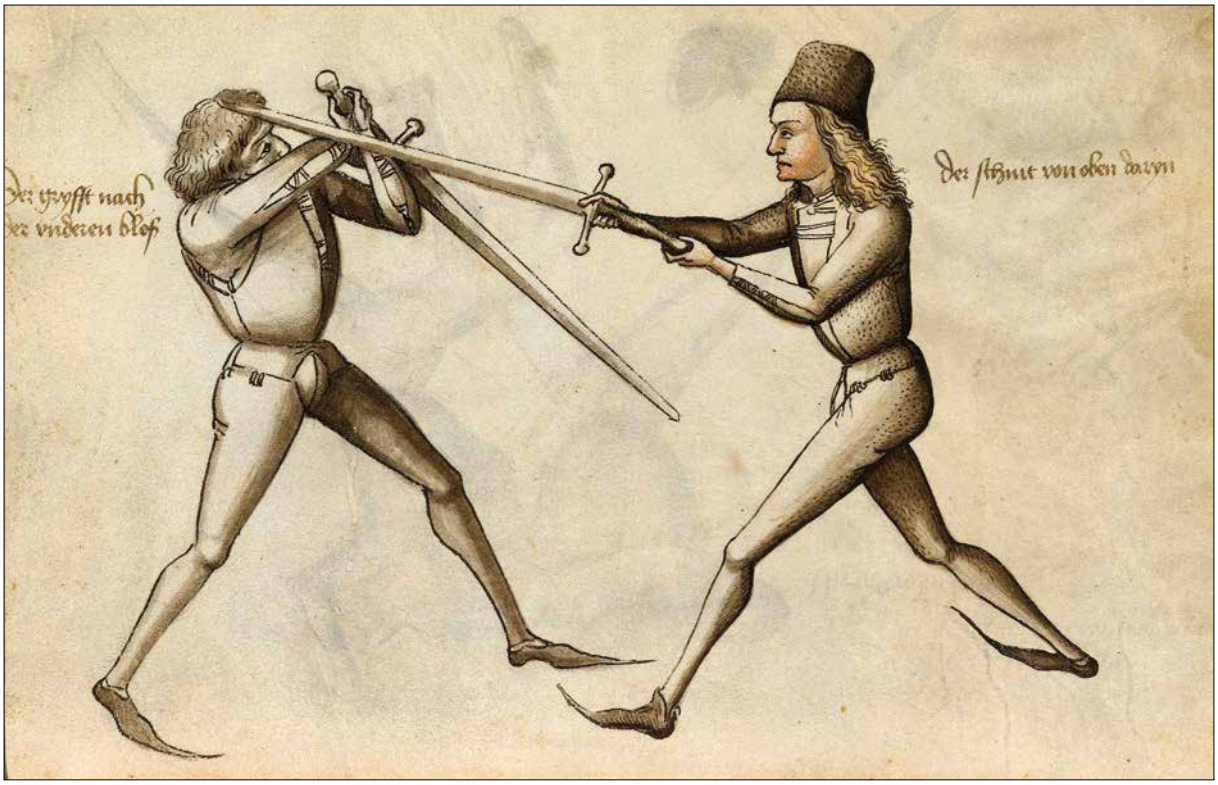


Fig. 10.33. Clothing in the Late Middle Ages was highly tailored, especially in the gothic fashion of the 15th century. Illustration from Hans Talhoffer's *Fechtbuch* or Fencing book, written in 1467. Bayerische Staatsbibliothek (BSB-Hss Cod.icon 394a – folio 10r).

The popularity of highly shaped textile clothing is reflected in the mail of that time. Many mail garments from the 15th century and later have survived and, as discussed at the beginning of this chapter, an assessment of their construction shows that a vast array of techniques were employed to tailor and shape them. These include the earlier mentioned methods of putting mail at a 90 degree angle and the use of triangular inserts for shaping.

The height of highly tailored textile clothing influenced mail makers, who started using even more triangular mail inserts to tailor mail garments. But the utilisation of inserts adds an important complication related to the concepts of ring slope and ring type. As indicated above, two pieces of mail can only be connected neatly when the rows of riveted rings in one section slope to the same side as those in the other section. The same applies to the solid rings in both sections. Therefore, the mail maker must be very mindful of the ring slope and ring type when connecting pieces of mail; a task that can become quite daunting when linking several different sections.[76] The increased use of inserts to tailor the mail garment to contemporary fashion also meant increased complications when connecting the parts. By the second half of the 14th century, when textile clothing became very tailored, mail makers came up with two solutions to this problem. One was abandoning the use of alternating rows of riveted and solid rings in favour of an all-riveted construction thereby simplifying the construction of mail garments.[77]

[76] Burgess (1958, 202) gives a good example of the difficulties of working with ring slope in combination with solid and riveted rings.

[77] Burgess (1958, 201-203) is the first scholar that tries to explain why solid rings were discarded at the end of the 14th century. He notices that the main advantages of mail made from riveted and solid rings are that it takes less time to construct a garment (fewer rings have to be riveted shut) and that it is generally stronger (solid rings are not prone to open under force). The disadvantages are that it restricts the number of patterns the mail maker may use and increases the brainwork involved. He gives

Fig. 10.34. A mail maker working at a table in his workshop, while a visitor inspects his wares. Woodcut by Jost Amman from Hans Sach's 1568 *Ständebuch* or Book of Trades in English (Sachs 1568, M.A. Wijnhoven library).

The second solution involved the use of idle links on a large scale, while working 'in the round'. Although mail makers probably continued to make sections of mail to be assembled into a final mail garment, as attested by the constant use of triangular inserts in late mail armour, this method became supplemented by another, best described as 'working in the round'. That is, the mail maker started at the top of the garment and worked his way down to the bottom hem by adding rows in the round. This procedure lends itself especially well for applying idle links. As in a knitted fabric, rings can be added or dropped to shape the garment. Since a single row could be added at a time, working in the round would also be easier with riveted rings only, as opposed to mail made from riveted and solid rings which requires adding two rows. Probably, single rows were added in the round where idle were used, while entire sections of mail were added in the round in areas with no shaping.

an excellent account of the problems the mail maker faces when working with the combination of solid and riveted rings in a complex design. Burgess, nevertheless, does not believe that those disadvantages were the reason for solid rings being discarded. Instead he points to the development of increasingly dense mail weaves as the reason for all-riveted mail becoming the norm. Dense mail gives the craftsperson little space while adding new rings. Mail existing of solid and riveted rings must be added two rows at a time, which restrains the available space. All-riveted mail can be added a row at a time and is easier to work with when space is limited. Although Burgess is correct about the available space, this never was a restriction in the past, as demonstrated by Roman mail made from rings of a minute diameter.

10.8 CONSTRUCTION IN CULTURAL CONTEXT

A coat of mail from, say, the 3rd century may in principle look very similar to one from the 15th century, but remarkably their construction differs to a large extent.

Our understanding of mail garment construction remains best for late mail, which has survived in large numbers and often in good condition. It is clear that the craftspeople that produced late mail employed a wide variety of construction techniques to tailor the garments (fig. 10.34). The sparse archaeological evidence from before the 14th century points to a much more limited use of these techniques, while early mail even lacks most of them. This, however, should not be seen as a lack of ability or knowledge, but as a result of the cultural context in which the mail coat was created. Mail manufacturers adopted designs that were familiar to them, and therefore popular textile clothing was of great influence. The manner in which textile garments were constructed through time opens not only the possibility of predicting how mail was made, but also of explaining the differences in construction techniques observed in mail armour through time. This is an important reminder that to understand armour, it cannot be studied in isolation but must be analysed within its cultural context.

11 Ring characteristics

'In the absence of a known context in which to place seemingly 'unique' items like this, there will inevitably be much discussion as to the place and time of their manufacture… and therein lies our problem. It is relatively easy (albeit time-consuming) to record the differences between various disparate examples of mail in collections around the world, but until we can create a reliable database of securely-provenanced and closely dateable mail, anything we may attempt in the way of a dateable mail typology is inevitably likely to be open to argument.'
David Edge[1]

11.1 THE RELEVANCE OF THE SEEMINGLY IRRELEVANT

Armour research in Europe grew out of an interest in medieval plate armour. Ever since, studies of this type of armour have mainly been an art historical endeavour through which age and provenance are determined by stylistic comparison. This method works well for objects that are well preserved or relatively intact, but can rarely be applied to archaeological mail armour, which is seldom complete or in a good state. Corroded mail fragments do not lend themselves to stylistic analysis, which is largely why archaeological mail has often been deemed uninformative and thus neglected (see chapter 1.1). Since entire archaeological mail garments are rare, it is more fruitful to shift the analysis to the level of the individual rings to establish age or provenance. Moreover, this approach requires only a few well-preserved rings.[2]

At first glance, the rings in a coat of mail may look the same whatever period or region they originate from. On closer inspection it becomes clear that there are minute, unique differences among them. The main mechanism underlying these differences is the way in which mail makers approached their work. As any craftsperson can attest, there are several ways to make an artefact. The steps in the creation process, the choices made during manufacture, and the tools used to execute them will all affect the final product. The making of an object is not limited to just conscious decision-making and creativity. Many decisions are subconscious[3] and often based on previous experience, particularly on how the craft was learned, that is, certain steps or tools will be used simply because they were part of the craft apprenticeship process. And although individuality comes into play whenever non-standardised items challenge the creativity and ability of the craftsperson, this rarely applies to mail making, which is a highly repetitive task involving a predetermined set of steps and tools reiterated thousands of times in a single garment, and millions of times over a crafting life.

Small variances in the *chaîne opératoire* of mail making and its tools generate rings with slightly different characteristics. Since the production of mail was likely taught from master craftsman to apprentice over many generations, it should be possible to recognise workshop traditions. This does not mean that we might be able to identify objects from a specific workshop, only that it may be possible to trace back some styles of mail manufacture specific to certain periods or regions.

1 Edge 2004, 24.

2 Wijnhoven 2009b, 33; 2010, 141.

3 E.g. Morsella *et al.* 2016.

BOX 11.1 DESCRIPTION OF MAIL RINGS*

RIVETED RING**

Cross-section of the wire
round / oval / flat / other

Direction of the overlap
clockwise / anticlockwise

Shape of the overlap
oval / stumpy / paddle / watershed / other

Rivet

rivet hole:	round / square / slit
rivet shank:	round-oval / square-rectangular / wedge / triangular / other
rivet head:	one side / both sides

Measurements***
outer diameter (horizontal and vertical)
inner diameter (horizontal and vertical)
wire thickness
wire width
overlap (thickness, width, length)
rivet head diameter

SOLID RING

Cross-section of solid ring
rectangular / square / D-shaped / round / other

Measurements
outer diameter
inner diameter
thickness
width

GENERAL

Evidence for repairs
rings with different characteristics than the main stock

Evidence for manufacture of wire
e.g. draw marks, incomplete drawing through a finishing die, surface finishing, etc.

Evidence for manufacture of solid rings
e.g. burrs, weld-marks, deformations, (un)even thickness or width, etc.

Evidence for reworking the rings
e.g. cross-section rings, tool marks, misshaped rings, faceted appearance, etc.

Type of metal and its qualities
e.g. iron, steel, copper alloy, hardness, crystalline structure, etc.

* The categories given are exhaustive up to the 10th century AD, but possibly not in the subsequent period.
** Where relevant, the description for the riveted rings can also be used for butted rings.
*** Measurements are always made with the overlap facing North.

The ring variations are most informative when analysed in a comparative long-term perspective. For this reason, this chapter adopts a wider timeframe, allowing for the recognition of possible changes in the transition from the Roman period to the Middle Ages. Another aim of taking up a broader temporal range is to provide researchers with a typological sample to differentiate Roman and medieval mail, much needed in cases when the archaeological context is missing. With this purpose in mind, the database and discussion includes finds up to the 10th century AD.

Mail rings must be described in detail in order to systematically analyse their individual characteristics. This study followed the procedure summarized in box 11.1, which lists the ring properties that were recorded during examination, whenever possible. This was complemented by a detailed review of available literature, based on the same list of features.

11.2 RING SIZE

Ring size, particularly outer diameter, is the one characteristic most often reported in the literature of mail finds. To a large extent, ring dimensions determine the general appearance of the mail garment, as well as the amount of time invested in making it (fig. 11.1). For example, even though the mail coat from Vimose 1 in Denmark has large rings with an outer diameter of almost 13 mm, it still took 19,123 (±10) rings to complete.[4] As size decreases, the number of rings included in a garment rapidly increases. A mail coat made from 7-8 mm outer diameter rings can have up to 150,000,[5] and a specimen consisting of rings just over 3 mm is estimated to comprise the astounding amount of 350,000 rings![6] Therefore, ring size was probably a very conscious choice made by the mail maker.

Three scholars have suggested in the past that the size of the rings can reveal something about the age and provenance of mail. First, based on a limited number of Iron Age finds (n=9), Leif Hansen concluded that ring diameter appeared to become smaller between the 3rd and 1st centuries BC.[7] Second, using a fairly small sample (n=13) from the 1st century BC to the 4th century AD, Karl-Heinz Lenz noted that rings were small until the reign of Claudius and then increased in size over the centuries.[8] Lastly, in her attempt to establish whether the mail finds from Thorsberg in Germany were of Roman origin,[9] Suzana Matešić used Hansen's database to estimate the ring diameter and the thickness of about 90 well-dated finds. From this, she inferred that a few of the Thorsberg fragments were likely Roman, but some might have been made in the Barbaricum. Moreover, she noticed that almost all of the mail found within the Roman Empire had rings of less than 10 mm in diameter, whereas mail rings from outside were frequently larger.

The results of the present study confirm and expand on the insights from the authors above. Many entries in the database include ring diameter, since it is the feature most often reported, but the analysis excludes those whose dating is dubious. The inclusion criteria are the same as explained in box 2.3.[10] In total, the analysis contains 328 entries from the database. The finds are not distributed evenly over time,

4 Wijnhoven 2015a; Wijnhoven/Moskvin 2020.

5 Wood *et al.* 2013, 210, table 1-2.

6 Driehaus 1968, 15.

7 Hansen 2003, 56-57.

8 Lenz 2006, 19-20.

9 Matešić 2015, 214-218.

10 The following additional conditions apply to the analysis of the data. Whenever a size range is given instead of a single measurement, it means that the average ring size has been used. When all the rings in a mail specimen have the same size but one or a few diverge, only the measurement of the main stock is considered, as the odd rings are likely repairs. If the measurements are known for both riveted rings and solid rings, then these are counted separately. When the horizontal and the vertical diameters of the riveted rings are known, then the average of the two is used. Lastly, if one entry in the database has mail fragments that differ from each other in ring size, then these are counted separately. When an entry has several fragments with the same ring size, they are taken as one.

Fig. 11.1. Ten examples of mail meticulously recreated in virtual reality. Each fragment contains 30 rows of 15 rings, making a total of 450 rings per fragment. The ring characteristics, such as the outer diameter, directly affect the overall size of the fragment and the density of the fabric. The scale of the magnifying glass is 2.5x (drawing A. Moskvin and M. Moskvina).

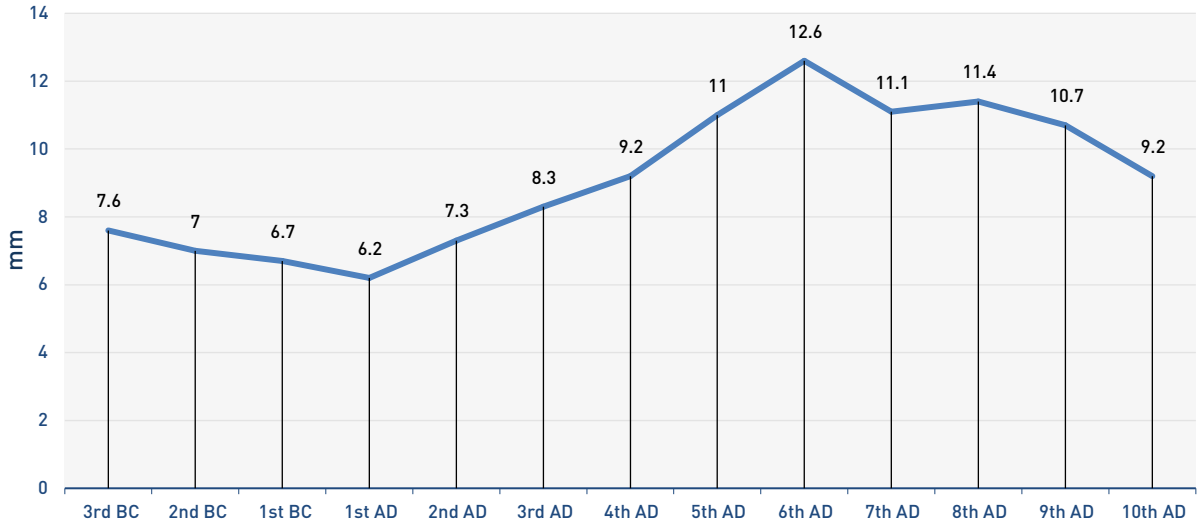


Fig. 11.2. Average outer diameter of mail rings in mm through the centuries.

meaning that the majority fall between the 1st century BC and the 6th century AD. The periods before and after render fewer informative finds.

Figure 11.2 offers an overview of the average ring diameter through time, revealing several trends. Around the time mail originates in the 3rd century BC, the average ring size is 7.6 mm. From this point onwards, the average size decreases to a minimum of only 6.2 mm during the 1st century AD. This trend is then reversed, with a gradual increase in average ring size until the 6th century AD, during which it gets up to 12.6 mm, twice as large as in the 1st century AD. Although there is a smaller number of finds from the 7th to the 10th centuries, the available information indicates that the ring size decreases again, but overall remains fairly large compared to the period before the 3rd century AD.

In addition to the average size of the rings varying over the centuries, the analysis shows clear differences between Roman and non-Roman mail. It is important to mention once more that the term 'Roman' refers here to finds from the Roman Empire (the great majority coming from its borders) and those finds associated with its army. The Roman army itself being, of course, a hotchpotch of citizens and non-citizens from many parts of the Empire and beyond. The term 'non-Roman' denotes the finds outside the Empire and that are not associated with the Roman army. Again, this concerns a large geographical area inhabited by many different peoples.

Figure 11.3 displays the average ring outer diameter through time. The period prior to the 1st century BC is not included as there is no information of Roman ring diameter from that time. The figure shows that while Roman and non-Roman mail do not diverge much initially, differences in ring size become substantial during the 1st century AD. When Roman mail is at its smallest ring size, with an average of 5.7 mm, mail from outside the Empire is much larger, at 7.5 mm. Regardless of the period, Roman mail consistently has a smaller ring diameter than non-Roman mail. However, both types become larger from the 1st century AD onwards.

The different ring sizes of Roman and non-Roman mail through time seems to point to distinct mail making traditions. The provenance of mail armour in the Barbaricum was already touched upon in chapter 3. It used to be thought that mail from this region was of Roman production and its presence outside the Empire was explained by processes of war booty, trade or gift exchange.[11] The continuous, significant difference in ring size between Roman and non-Roman mail observed here, suggests the existence of an autonomous indigenous mail production tradition beyond the Roman Empire.

While the average outer ring diameter changes with time, it cannot be used as a direct dating index. The mail remains from the sanctuary at the Gurzuf Saddle Pass, in the Crimean Peninsula, illustrate this.

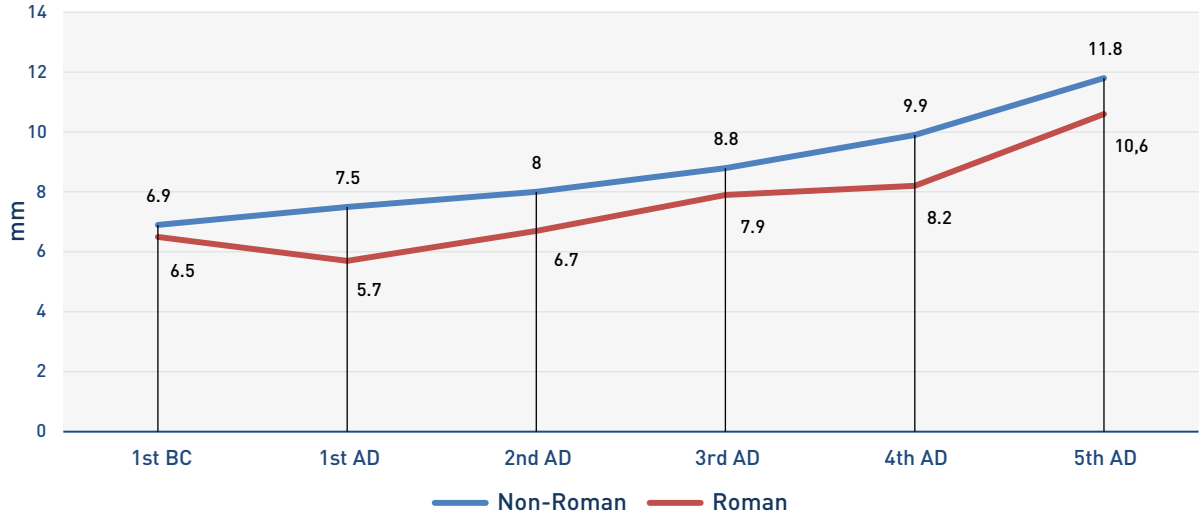


Fig. 11.3. Average outer diameter of Roman and non-Roman mail rings from the 1st century BC to the 5th century AD.

Almost 900 fragments of mail were discovered at this site, dating from 30 BC to AD 50. They came from a minimum of twelve mail garments, all intentionally cut up in pieces.[12] Among them, there are pieces with rings as small as 3.5-4 mm in diameter and pieces with rings substantially larger, of a diameter over 10 mm. This attests that a single find, from the same period and context, can contain mail rings of various sizes. A similar situation has been noted in the finds from Vimose in Denmark, Pohansko in the Czech Republic, and Birka and Spelvik in Sweden.[13]

In contrast to the average ring diameter, the range between largest and smallest ring diameter in each century can be an indicator of age. Figure 11.4 plots the observed range through time. The graph and underlying information allows for several cut-off points. In the period under discussion, rings with a diameter of 5 mm or less are only found up to the 3rd century AD. In fact, there are only two finds that measure a maximum of 6 mm during the 4th century. These are Passau 2 in Germany and Møllegårdsmarken 1 in Denmark, with respective dates of AD 300-320 and 250-320. It is not until the 10th century that mail rings of such size appear again. At the other end of the spectrum, very large rings become fashionable when smaller ones fall out of use. Rings with a diameter of over 14 mm are lacking prior to the 4th century AD, but are found in all subsequent centuries.

Hybrid armour (figs. 11.20-21) was in existence between the late 1st century BC and the 2nd century AD. The tiny diameter rings of that armour type are also found in the so-called 'miniature mail', which closely resembles hybrid armour except for its lack of scales. Unsurprisingly, the ages of both armours are also similar, meaning that mail with a ring diameter of 4 mm or less is found almost exclusively between the reign of Augustus and the end of the 2nd century AD. There are only two possible exceptions, although they do not provide very strong evidence. There is the heavily corroded mail coat from Es Soumâa in Algeria (130-118 BC), where the ring's small diameter has been roughly estimated, and the mail from Şimleu Silvaniei in Romania (100 BC and AD 20) still partly dating to the period in question.[14]

11 E.g. Adler 1993, 105; Böhme 1975, 2014; Engström 1992, 29-30; Hansen 2003, 82; Kaczanowski 1994, 216-219; Müller 2003, 437-438; Raddatz 1959-1961, 52-54; Waurick 1982, 114-116.

12 Novichenkova 2009; 2011.

13 Ehlton 2002/2003; Macháček *et al.* 2007, 178, 180-181; O'Connor 1992, 1184.

14 Borangic 2011a, 189-190, 225; Waurick 1979, 318-332.

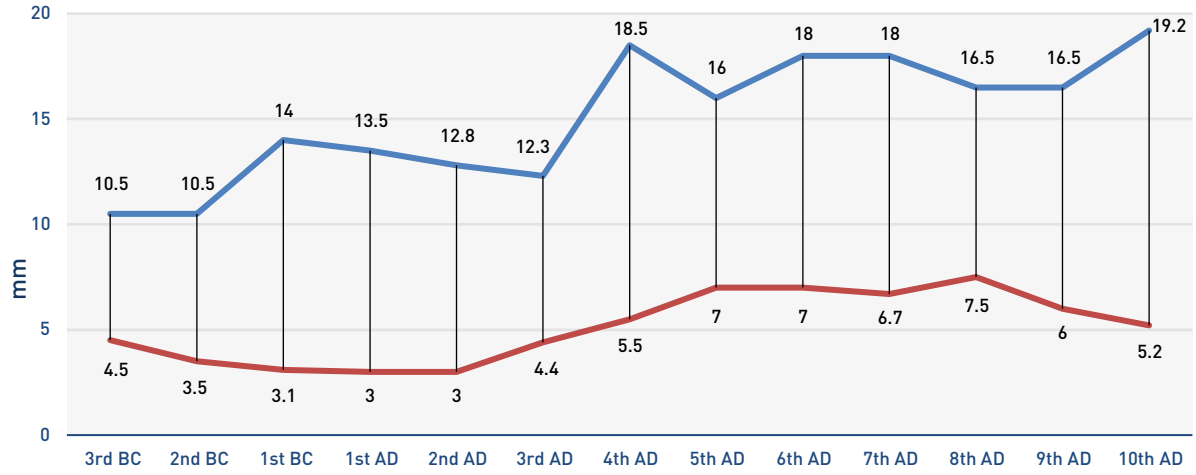


Fig. 11.4 Size range of the outer diameter of mail rings through time. The red line indicates the smallest recorded ring per century and the blue line represents the largest one.

Table 11.1 summarizes the chronologies drawn from the size of the outer diameter of mail rings.

OUTER DIAMETER	AGE
≤ 4 mm	Augustan – 2nd century AD
≤ 5 mm	3rd century BC – 3rd century AD
≤ 6 mm	3rd century BC – AD 320 or 10th century AD
> 6 mm and ≤ 14 mm	3rd century BC – 10th century AD
> 14 mm	4th century AD – 10th century AD

Table 11.1. Age estimates based on the outer diameter of mail rings.

11.3 DIRECTION OF THE OVERLAP AND RING TYPES

Most mail garments from the period of interest are constructed of a mix of riveted and solid rings. Mail built entirely of riveted rings occurs, but is relatively rare in the archaeological record (n=19).[15]

The riveted links are made from metal wire shaped into a circle with the ends overlapped, flattened, pierced and riveted shut. The overlap in riveted rings can go in two directions, clockwise or anti-clockwise (fig. 11.5). There are no advantages of one direction or another, neither does it affect the strength or construction of the final product. Hypothetically, a single coat of mail can be constructed from a combination of clockwise and anti-clockwise rings, but that is never the case. All the riveted rings in a single garment always overlap in the same direction. Considering that there are between 10,000 and 350,000 rings in one garment, this cannot be a coincidence.

[15] It is however very common in historical mail, since solid rings fell out of use in Europe during the 14th century, giving way to wholly riveted garments. C.f. Burgess 1957, 203; 1958, 201-203.

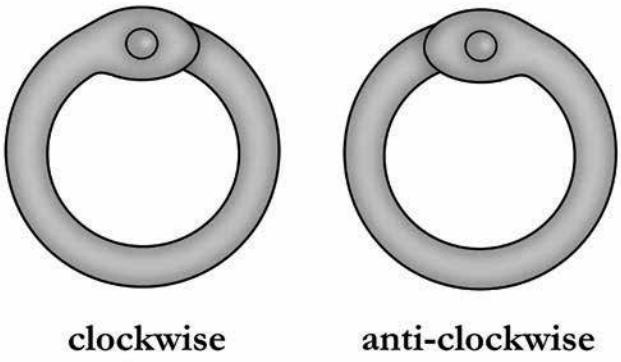


Fig. 11.5. The overlap of riveted rings can be positioned clockwise or anti-clockwise (drawing M.A. Wijnhoven).

The types of rings used in a mail coat, together with the direction of the overlap in riveted rings, turn out to be highly informative. In fact, these features allow to: 1) distinguish Roman from medieval mail; and 2) reaffirm the existence of an autonomous mail production beyond Rome's borders.

AVAILABLE DATA

This analysis was able to determine the ring types and the direction of the overlap in 110 entries of the database spanning from the 3rd century BC to the 10th century AD (fig. 11.6), which is approximately 14% of all the finds in the database. This percentage is relatively low, partly due to material conservation but also because the literature generally lacks good detailed descriptions of mail, and specifics such as the direction of the overlap often go unreported.

Other aspects of mail examined in this chapter are recorded with the same low frequency, due to similar reasons. In addition, the finds are not evenly distributed over time. For example, out of the mentioned 110 entries, 71% fall between the 1st and 5th centuries AD, with only 14% between the 3rd to 1st centuries BC, and 15% in the medieval period. These numbers are comparable for all other mail features as well.

Among those 110 finds examined for ring type and overlap direction, we observe three variants:

- Variant 1) mail made from solid rings and riveted rings with a clockwise overlap.
- Variant 2) mail made from solid rings and riveted rings with an anti-clockwise overlap.
- Variant 3) mail made solely from riveted rings with an anti-clockwise overlap.

So far, no specimens of only riveted rings with a clockwise overlap have been observed, despite them being completely feasible. The majority of the finds (n=83) belongs to variant 1. Variants 2 and 3 are less common for the period under study, with 19 and 8 examples respectively. Figure 11.6 plots a timeline for each of the three variants.

3RD TO 1ST CENTURY BC (FIGS. 11.8-10)

Variant 1, made from solid and clockwise riveted rings, is already found during the 3rd century BC. It is also the most common variant (n=11) between the 3rd and 1st centuries BC, although not the only one. During the 1st century BC variant 2, consisting of solid and anti-clockwise riveted rings, is observed four times, i.e. at Radovanu and Huneduora in Romania, Piquía in Spain (fig. 11.10) and Hedegård in Denmark.[16] Variant 3 is only observed a single time and remains uncertain as it concerns an unprovenanced mail fragment from Bulgaria (no. 2) that was attached to a medieval helmet in the Veliko Tarnovo Museum of Archaeology.[17] It is clear that helmet and mail do not belong together, but how they came

[16] Borangic 2011, 185-186, 190-191, 223; Kalsbøll Malfilâtre1993; Quesada Sanz *et al.* 2018; Sîrbu *et al.* 2007b, 48-49, 72, 75, 81-82, 196, fig. 42-44.

[17] Dimitrov 2009/2010.

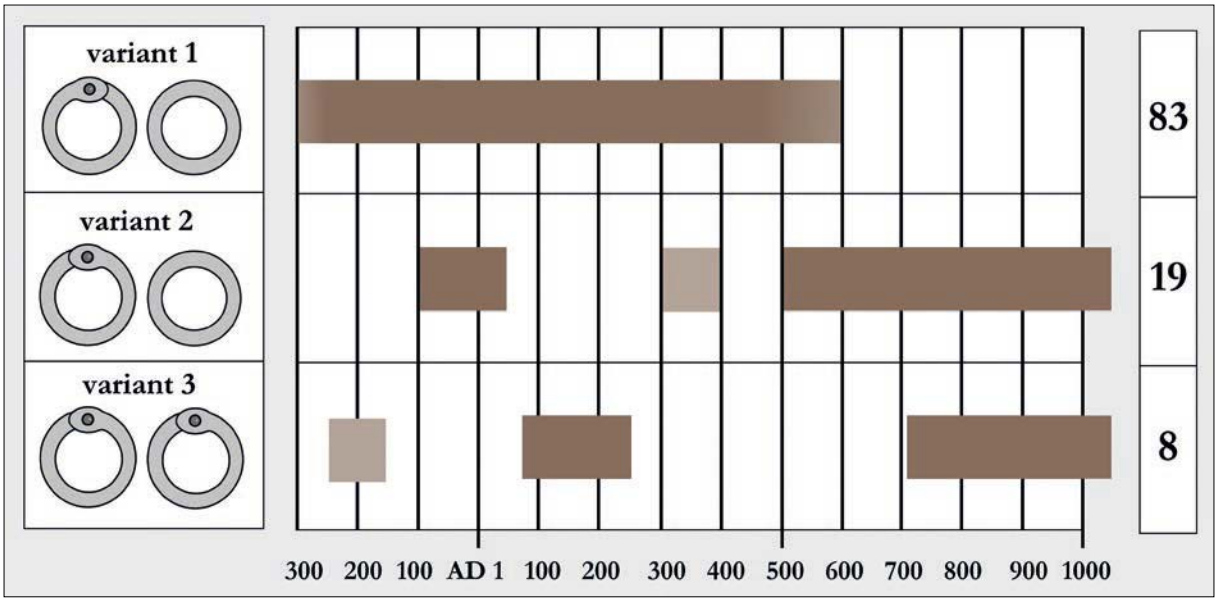


Fig. 11.6. Occurrence and number of finds of the three observed mail variants through time. The dark brown colour indicates more than one find of known provenance. The lighter brown is for either a single find with this characteristic or for mainly unprovenanced finds.

to be associated is still unknown. The mail fragment has several fixtures attached to it, including a wheel-shaped fastener (fig. 4.6b). Based on an iconographic analogy of this type of fastener, the mail has been tentatively dated to 250-150 BC.

In spite of the relatively few finds from the period between the 3rd and 1st centuries BC, we can draw some preliminary conclusions. Variant 1 is the earliest and most prevalent during this time. Even if in small numbers, the presence of variants 2 and (possibly) 3 demonstrates that there was room for other mail making traditions. The occurrence of all three variants points to only moderate standardisation in the mail production during this period.

1st to 5th century AD (figs. 11.16-21, 11.25-26, 11.29-33)

Roman mail diverges from the pattern of the previous centuries (figs. 11.7). There is absolutely no variation among the 52 Roman specimens, all corresponding to variant 1, made from solid and clockwise riveted rings. This observation serves as a very useful criterion for determining whether a piece of mail is Roman, or not. As a rule of thumb we could say that, if a mail garment consists of solid rings and clockwise riveted rings, then it *may be* Roman. However, if it is made of a different combination, then it *is certainly not* Roman. The fact that only variant 1 is found in the Roman Empire further attests to a high level of standardisation as compared to the centuries BC.

There are a significant number of finds (n=31) from the same period that come from beyond Rome's borders. Unfortunately, the non-Roman finds from the 5th century could not be examined in person and the existing literature is not detailed enough to determine the mail ring variants. Among the remaining examples that were observed, variant 1 was once more prevalent, although not unique. Variant 2 has only two observations. The first is the find from Hedegård in Denmark, mentioned above. This was originally dated to 50 BC – AD 50, but considering other characteristics discussed below, is more likely to date from before the start of our current era, as it is still very much in the tradition of the Iron Age. The time gap between this and the next find of variant 2 is substantial and consists of another unprovenanced find

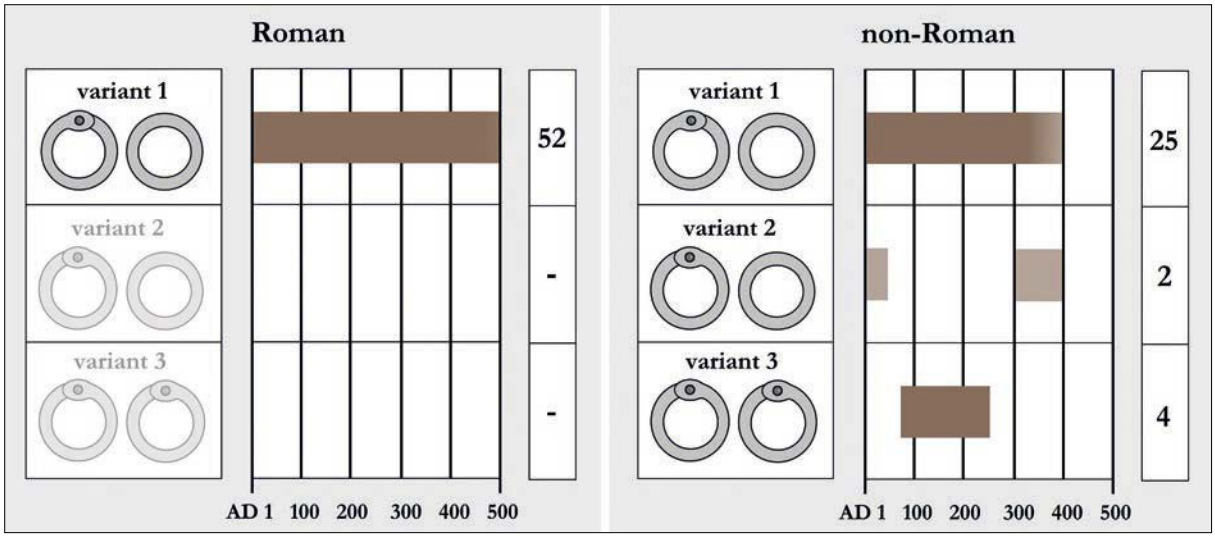


Fig. 11.7. Occurrence of the three observed mail variants during the 1st to 5th centuries AD in Roman (left) and non-Roman (right) contexts. Roman mail always features clockwise riveted rings and solid rings, while outside the Roman Empire there is more variety. Dark brown: several finds of known provenance. Light brown: single find or several finds of unknown provenance.

from Bulgaria (no 1; fig. 11.31). It was probably part of the grave inventory of a horseman, as indicated by the accompanying horse bit and helmet fragments. The helmet nasal is typical of the Deurne-Berkasovo ridge helmets, suggesting a tentative date of the 4th century AD.[18] The remains include 33 pieces of mail, many with signs of having been in contact with fire, possibly from a cremation. All include anticlockwise riveted and solid rings. This find is a possible early case of variant 2, which would become dominant in the Middle Ages, as discussed below. Because of its unknown origin, this find must be treated with caution.

Variant 3, made completely of anti-clockwise rings, with no solid rings, is observed in four occasions. The earliest, dated to AD 70-260, comes from a grave at Gränby in Sweden and was deposited along a shield boss and two swords.[19] The other three come from a bog deposit at Thorsberg in northern Germany, and date to AD 200-250 (fig. 11.33).[20] Many of the thousands of military items deposited there were purposely destroyed,[21] and it is possible that these three fragments actually originated from the same garment.

It has been frequently discussed whether mail found in the Barbaricum is of Roman production. The occurrence of variant 3 in northern Germany and Sweden supports the argument that the Barbaricum had its own distinctive workshop tradition. This does not exclude the presence of Roman mail in the Barbaricum, but it gives strong evidence for an autonomous local mail production. Likewise, it does not mean that all examples of variant 1 outside of Rome are Roman imports, as the workshop tradition of variant 1 was already present in the Barbaricum during the Iron Age.

6th to 10th century AD and afterwards (figs. 11.36-39)

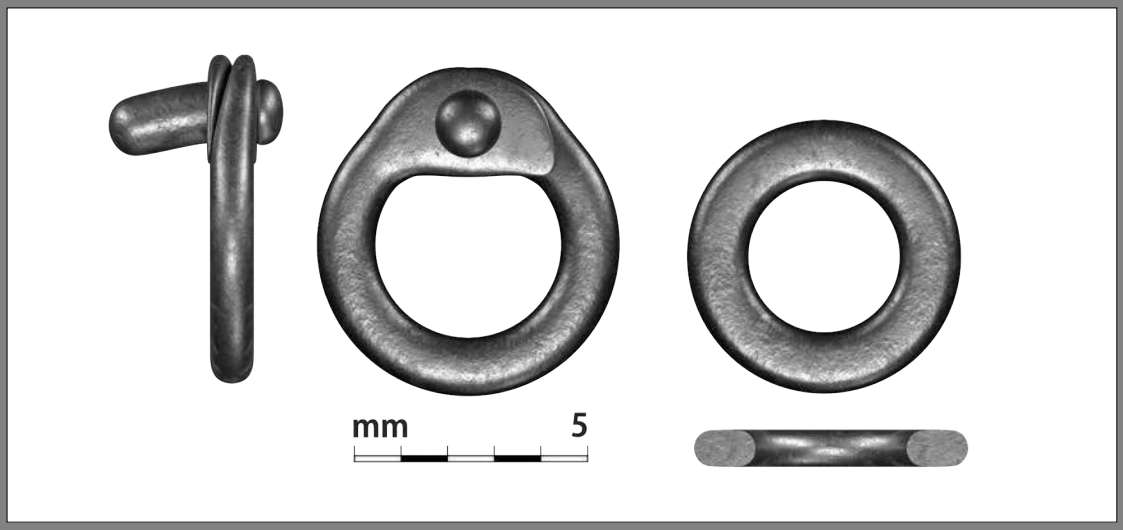
By the Early Middle Ages the direction of the ring overlap in mail armour changes suddenly and completely, from the dominant clockwise direction to anti-clockwise (fig. 11.6). From this time onwards there is not a single find of variant 1, which had lain at the heart of the Roman mail making tradition. The latest

[18] Miks 2014, 32-33.

[19] Arwidsson 1934, 256, fig. 12.

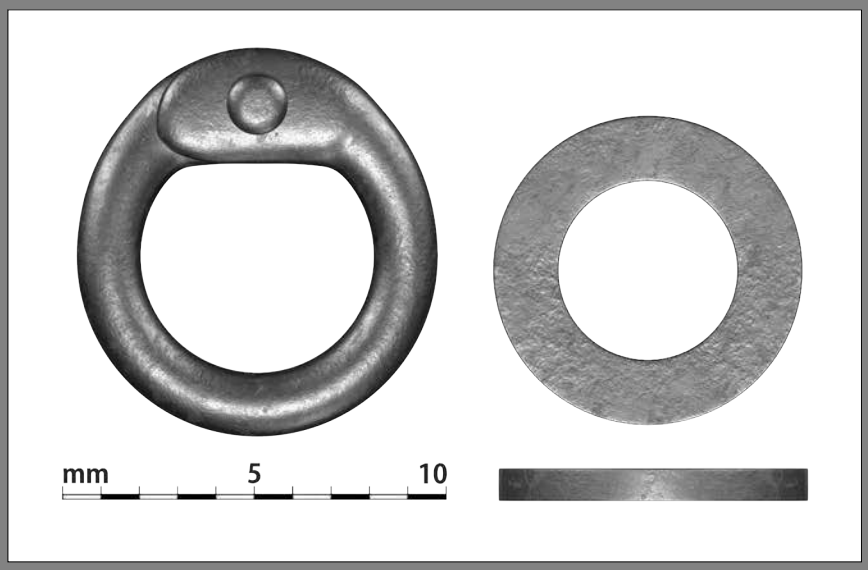
[20] Matešić 2015, 212, 215, 223, 513-514, pl. 104-105.

[21] Lau 2010, 137-140.



←↑ Fig. 11.8. Fluitenberg, The Netherlands (300-115 BC). The mail fabric consists of alternating rows of clockwise riveted rings and solid rings (variant 1). The rings are relatively small for the period, and very sturdy. The cross-section of the riveted rings is oval (shape 2). The rivet has a round head on one side, protruding from the other side (variant 2a) and has been upset and slightly bent to lock it into place. The shape of the overlap in the riveted rings is triangle-shaped oval (variant 1b). The solid rings have been reworked to rid them of sharp edges; their cross-section is rectangular (variant 1). The rings are very similar to those of the Iron Age mail armours from Hedegård in Denmark and Hunedoara in Romania (photograph M.A. Wijnhoven; drawing A. Moskvin and M. Moskvina).

Fig. 11.9 Unprovenanced find 1. Based on its ring characteristics, it must date to the centuries BC. It has alternating rows of clockwise riveted rings and solid rings (variant 1). The riveted rings have a flat cross-section (shape 3a). The rivet has a round end on one side and protrudes on the other side (variant 2a), just like the rings in the Fluitenberg find. The overlap is large oval-shaped (variant 1a) and the cross-section of the solid rings is rectangular (variant 1). Like other Iron Age finds, this specimen is woven with sturdy rings into a heavy and relatively stiff mail fabric (photograph M.A. Wijnhoven).



↑→ Fig. 11.10. Piquía, Spain (100-50 BC). This find has alternating rows of anti-clockwise riveted rings and solid rings (variant 2). The cross-section of the riveted rings is flat (shape 3a). The rivet has round heads on both sides (variant 1). The overlap is large oval-shaped (variant 1a). The cross-section of the solid rings is rectangular (variant 1) and resembles a washer. This find, together with the other Iron Age finds featured in this chapter, demonstrate that Iron Age mail was made from sturdy rings with large overlaps, and was carefully finished (photograph F. Quesada Sanz; drawing A. Moskvin and M. Moskvina).

possible occurrences of variant 1 are two mail neck guards, one attached to a *Spangenhelm* from Vézeronce in France, and another associated to an unprovenanced banded helmet from Egypt.[22] The helmet from Vézeronce is an isolated find that holds no clues to its age, but *Spangenhelme* generally date between AD 480 and 610. The unprovenanced helmet from Egypt is more problematic, it has been dated between the end of the 4th and the 7th century on stylistic grounds, but it is uncertain whether the mail and the helmet originally belonged together.

It is tempting to link the demise of variant 1 to the fall of the Western Roman Empire. The appearance of a new mail making tradition could, in such case, indicate the incursions of new peoples and/or ideas from outside the Empire. If correct, one would expect variant 1 to have persisted at least somewhat longer in the Byzantine Empire. Mail finds like those from Justiniana Prima in Serbia, dated AD 535-615, do not support that idea. These are already made in the 'new tradition' of anticlockwise rings. However, because many surviving *Spangenhelme* are assumed to have been produced in Byzantine workshops,[23] the

[22] Grancsay 1949, 276; Vogt 2003, 11, 29; 2006, 37-38, 271.

[23] E.g. Adams 2010, 96; Böhner 1994, 472-507; Stein 2003, 45-56; Vogt 2003, 25; 2006, 185-187. Stein (*ibid.*) has determined, by looking at the decoration of *Spangenhelme*, that the helmet from Vézeronce likely comes from the Eastern Roman Empire.

Fig. 11.11. All mail has anti-clockwise riveted rings from the 6th century AD on. Left: close-up of a 15th century German coat of mail (inv. no. 14.25.1540) made entirely from riveted rings. The coat also includes several rings with a maker's mark. Right: close-up of a Turkish or Syrian mail coat, c.16th century (inv. no. 14.99.28). This shirt is made from riveted and solid rings, each decorated with a concentric pattern (photographs Metropolitan Museum of Arts).

mentioned mail guards from the Vézeronce helmet and the unprovenanced helmet from Egypt could indicate some continuity into the Byzantine period, but their ages and origins are too unclear to allow for any solid conclusions.

Although this study only looked at the material evidence up to the 10th century AD, there is something to add about the subsequent period. The riveted rings in all historical mail specimens, i.e. those passed down and preserved in armouries, churches, and other places, are always anti-clockwise (fig. 11.11). This is a worldwide pattern that applies to mail from Europe as well as from Asia (Minor) and Northern Africa.[24] Given that this mail tradition is consistent throughout the 6th to 10th centuries, it is fair to assume that the overlap in riveted rings was invariably anti-clockwise since the 6th century AD, and remained so until the demise of mail. This offers a second strong criterion for distinguishing Roman from medieval mail. Whereas Roman mail has clockwise riveted rings, medieval mail has anti-clockwise rings.

A NORTHERN EUROPEAN MAIL MAKING TRADITION

Variant 3, made of all-riveted anticlockwise rings, was observed only eight times among the 110 cases (fig. 11.33). The literature offers another 11 examples of mail described as all-riveted, but the information

[24] This is based on my own observations. Examples can be seen in: Alexander 2015, 20-55; Bottomley/Bowstead Stallybrass 2000; Krogh 2016; Wood *et al.* 2013.

does not include the direction of the overlap. If we assume that these all are part of the same mail making tradition, an interesting pattern appears (table 11.2).

FIND	COUNTRY	AGE
Unprovenanced 1	Bulgaria	250-150 BC
Gränby	Sweden	AD 70-260
Thorsberg 13	Germany	AD 200-250
Thorsberg 14	Germany	AD 200-250
Thorsberg 15	Germany	AD 200-250
Zadowice *	Poland	AD 300-400
Süderbrarup *	Germany	AD 1-450
Cheine *	Germany	AD 1-450?
Tuna 1 *	Sweden	AD 1-1000
Tuna 2	Sweden	AD 1-1000
Gamla Uppsala 1 *	Sweden	AD 200-300 or AD 550-790
Rickeby *	Sweden	AD 550-790
Niederstotzingen *	Germany	AD 600-620
Valsgärde 1 *	Sweden	AD 600-680
Gamla Uppsala 2	Sweden	AD 710-750
Nalaviberg *	Sweden	AD 800-1000
Starigard – Oldenburg *	Germany	AD 800-1100
Mount Athos *	Greece (Byzantine Empire)	AD 976-1025
Milhailovo	Bulgaria (Byzantine Empire)	AD 900-1100

Table 11.2. Finds of mail consisting of all-riveted rings. *The direction of the overlap has not been determined.

The great majority of all-riveted mail comes from Southern Scandinavia and Northern Europe, notably Sweden, northern Germany and Poland. All-riveted mail already occurs there during the Roman Iron Age, and continues into the Migration, the Vendel, and then the Viking periods. The only non-northern finds of this type come from the 10th or 11th century Byzantine Empire, i.e. Mount Athos in Greece and Milhailovo in Bulgaria.[25] It is of course well known that there was a strong link between the Byzantine Empire and peoples from southern Scandinavia during the Viking period, most notably the Vangarians that served as guard in the Empire.[26]

Apart from the earliest occurrence of variant 3 (unprovenanced 1 from Iron Age Bulgaria), the finds point to a fairly small and localised mail making tradition. Its main sphere of influence is in southern Scandinavia and northern Germany, where it may have persisted uninterrupted during the first millennium AD. It is likely that the occurrence of all-riveted mail in the Byzantine Empire was the result of contact with this area. The two Byzantine finds could then either be imports of mail armour, or mean that northern mail makers were carrying out their craft in the Empire. Since this chapter does not look at the archaeological evidence beyond the 10th century, it is unknown if, where, and for how long the all-riveted tradition persists. Among historical mail from the Late Middle Ages in Europe we do see that

[25] Petrov *et al.* 2015, 575-576; Zlatkov 2014.

[26] E.g. Androshchuk 2013; Blöndal 2007.

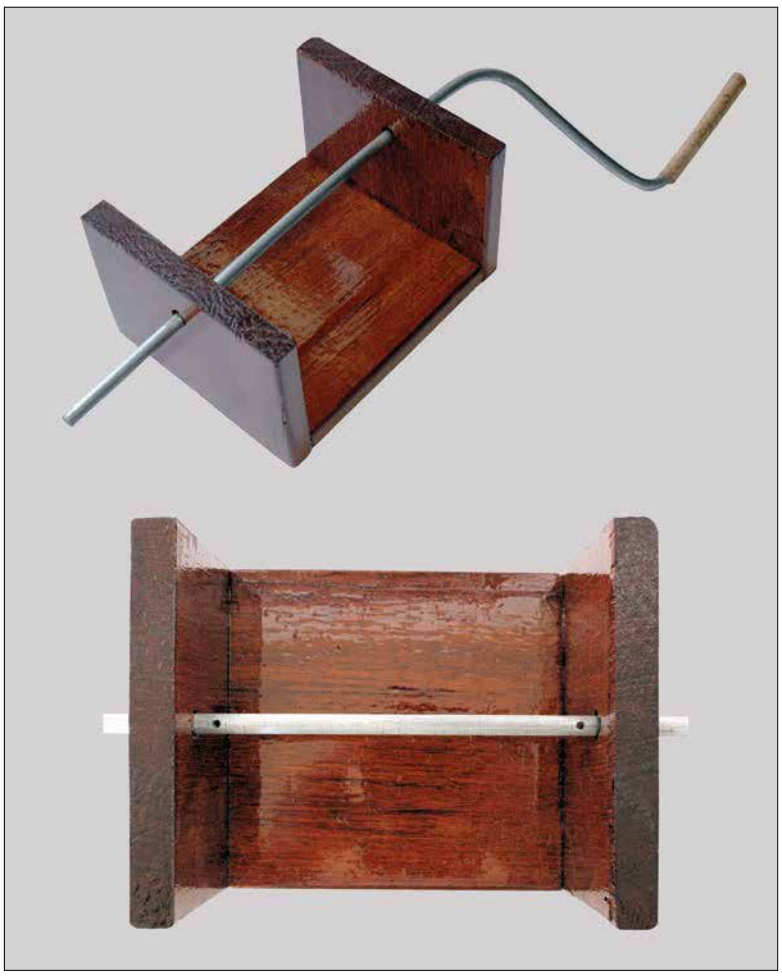


Fig. 11.12. A modern mandrel for winding coils, made by the author. The rod contains two holes, one on each side of the mandrel. These holes help the metal wire engage with the mandrel. The wire can be coiled from left to right or worked from right to left (photograph M.A. Wijnhoven).

all-riveted mail becomes the norm during the 14th century, replacing the formerly dominant anticlockwise riveted and solid mail (variant 2).[27] It remains uncertain whether the 14th-century all-riveted mail holds any ties to the localised all-riveted tradition of the first millennium AD.

UNTANGLING THE CONSISTENCY OF THE OVERLAP DIRECTION

The question remains of why mail makers consistently placed the overlap of riveted rings in the same direction. The answer is not found in the choices of individual mail makers, but in the many generations that preceded each of them, which we can trace back as various distinctive traditions.

The key to understanding this issue is the *modus operandi* of the mail maker. The ring overlap must have been such a routine step in the mail making process that it was done automatically, unawarely leading to the same end result. The first in-depth study to address the mail making process and the tools used in it was done by E. Martin Burgess, who also hypothesized about how the overlap might have been made.[28] He suggested that the individual rings were driven through a tapering hole in a steel block using a punch whose head was shaped so that the ends of the ring would overlap. Burgess published his study in 1953 and since then modern mail makers, most of them active in re-enactment, have proven that such tools are not necessary. For example, the rings can be overlapped simply by placing them vertically on a

[27] Burgess 1958, 201-203.

[28] Burgess 1953, 49-50, fig. 2.

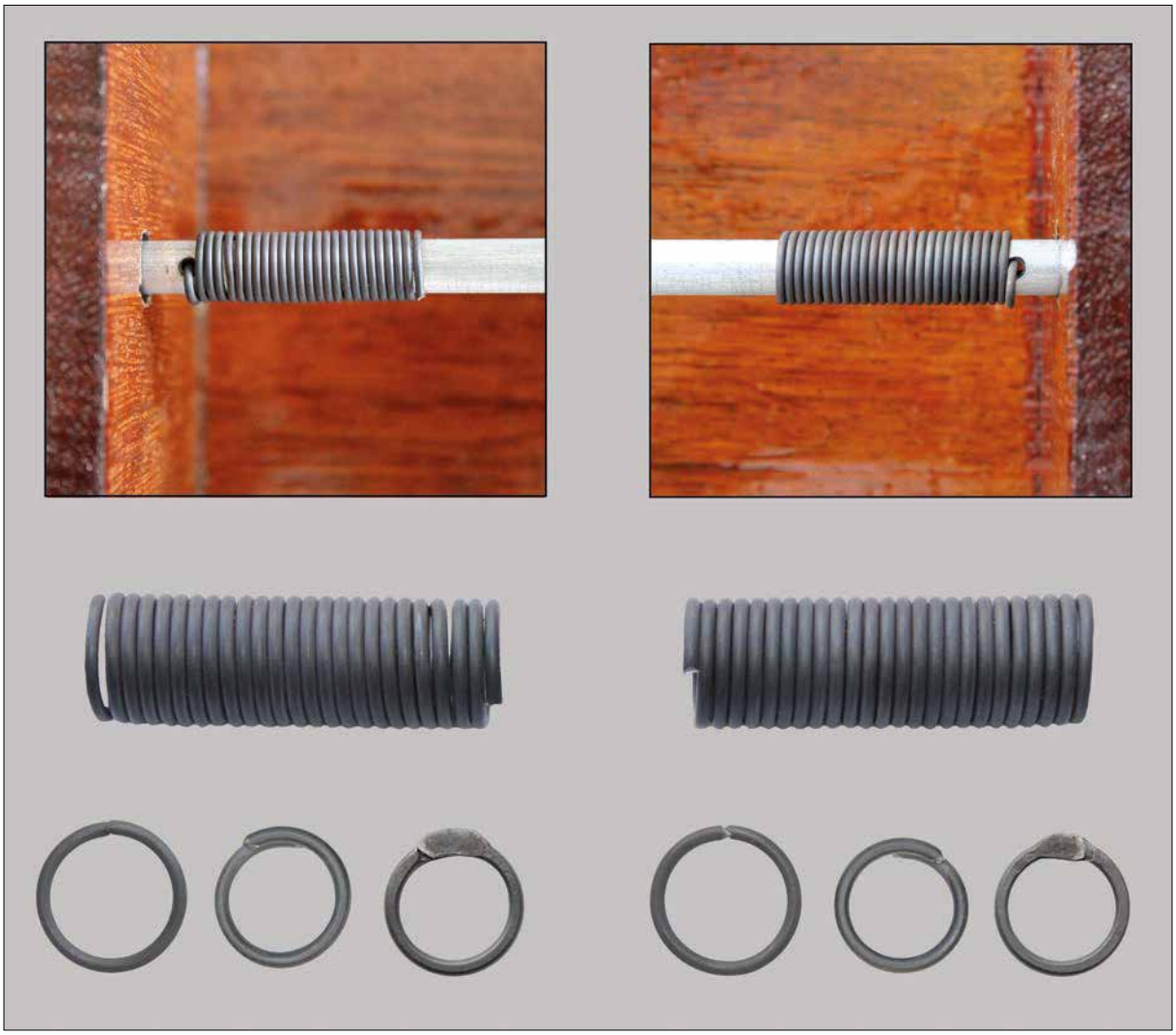


Fig. 11.13. The direction of the overlap depends on the direction in which the coil is wound. Top and middle: when wire is wound from left to right on the mandrel, the result is anti-clockwise rings. When wound from right to left, the rings are clockwise. Subsequently, the coil is clipped into loose rings. Bottom: the ends of the rings are slightly out of line, which facilitates them sliding on top of each other. Next, the overlaps are flattened (photograph M.A. Wijnhoven).

hard surface, like an anvil, and tapping on them lightly with a hammer. With practise, it is easy to make an overlap while leaving the outline of the ring more or less round.

The only factor that actually compels the direction of the overlap is the direction in which the metal wire is coiled. One will notice that when the coil is cut into loose rings, the ends of each ring (seen from the side) are slightly out of line (fig. 11.13, bottom). This is essential for making the overlap as it allows the ring ends to slide onto each other with very little force. Contrastingly, rings with perfectly aligned ends will only butt together when tapped on from the side or pushed through a tapering hole, but will not overlap.

The direction of the coil thus directly determines the direction of the overlap: clockwise coils make for clockwise rings. Given the number of rings that a mail maker produced in a lifetime, in all likelihood a specialised tool was employed to coil wire, probably a mandrel. A basic mandrel can be made of parallel wooden blocks mounted on a base, with a rod inserted between them. A reconstruction made by the author is shown in figure 11.12. It has two small holes that engage the wire with the rod, facilitating the

coiling action. The direction of the coil is determined by the starting point. When winding from right to left, the coil and the rings will be clockwise; when the coil is wound from left to right, both will turn up in anti-clockwise direction (fig. 11.13). Therefore we can conclude that Roman mail makers coiled from right to left, whereas in medieval times the coil was from left to right.

The best explanation for the consistency of the coil direction may be found in the flow of the mail making process itself. Once a ring overlap has been flattened and pierced, it must be reopened to insert the ring into the mail fabric. When the direction of the overlap is the same in all rings, these can be inserted into one another by the mail maker using the same motion over and over again, in a repeating and almost automated fashion. However, if the direction changes from ring to ring, the mail maker needs to be alert and adjust his movements accordingly. This is because clockwise and anti-clockwise rings differ in the angle the mail maker needs to use to weave them into the other rings. Since a single mail coat contains tens of thousands of rings, the advantages of rings with same-direction overlap become apparent. Using the same direction throughout saves time and makes it possible to do the work without too much effort. It is therefore probable that the coil direction was instructed from master to apprentice over generations.

In principle, each workshop could have followed their own pattern, but the archaeological evidence shows otherwise. This suggests that coiling direction was an important part in the 'proper' process of manufacturing mail within the craft tradition, resulting in its long-term preservation.

CONCLUSIONS

The direction of the overlap on riveted rings alongside the types of rings found in a mail garment can reveal much about its antiquity and provenance. This section presents insights that serve as a strong criterion for distinguishing Roman and medieval mail. Simply put, Roman mail has clockwise riveted rings, whereas medieval mail contains anti-clockwise rings. This allows for a classification of mail variants according to age and provenance as presented in table 11.3.

DIRECTION OVERLAP VARIANT	AGE AND PROVENANCE
Variant 1: – clockwise riveted rings – solid rings	3rd century BC – 5th century AD – the most prevalent variant during Iron Age – the only variant found in Roman mail from Augustus to the 5th century AD – dominant variant in mail from outside of the Empire during the Roman period
Variant 2: – anticlockwise riveted rings – solid rings	1st century BC – mid-1st century AD Not present in Roman mail – possibly present outside the Roman Empire from c. 4th century AD 6th century AD – 18th century AD – the only variant found in Europe and adjacent areas for the entire Middle Ages and Early Modern period
Variant 3: – anticlockwise riveted rings – no solid rings	250-150 BC? – concerns a single unprovenanced find 1st century AD – 11th century AD – limited to Northern Europe – also found in the Byzantine Empire during 10th-11th century – uncertain if or how long this tradition continues

Table 11.3. Age and provenance of mail based upon the direction of the overlap and the ring type.

11.4 CROSS-SECTION OF RIVETED RINGS

The cross-section of the riveted rings was determined in 122 cases of mail dating between the 3rd century BC and the 10th century AD (fig.11.14). The literature includes the cross-section of another 40 finds, but it does not specify whether it corresponds to riveted or solid rings. For that reason, the latter were not included in the analysis.

In the period of interest, the cross-sections of the riveted rings display three possible shapes:

- Shape 1: round cross-section.
- Shape 2: oval cross-section.
- Shape 3: flat cross-section.

These are not sharply demarcated categories, but rather a gradual scale from round, to oval, to flat. In each case, the shape that best fit one of the three descriptions was recorded. For example, a slightly flattened oval cross-section was noted as oval; while a somewhat oval flattened one was labelled as flat.

This ring feature is also informative. As discussed below, the cross-section of the riveted rings makes it possible to differentiate mail from the Principate and the Late Roman Empire.

THE MAIL MAKER'S TECHNIQUE

Like the direction of the overlap, the shape of the cross-section is a side-effect of the maker's process, in this case related to flattening the overlap of the riveted rings. The metal wire that serves as the raw material for the riveted rings always has a round cross-section, since this is easier to coil on a mandril than wire of any other shape.

Flattening the overlap is a prerequisite for piercing and subsequently inserting the rivet through, as attempts to pierce an unflattened overlap will mostly fail. In the author's experience, the overlap can be successfully flattened in two steps using a hammer. First, the ring is placed on a hard surface, such as an anvil, giving it a soft tap with the hammer in order to 'set the overlap'. This is followed by a second, harder strike with the hammer, which actually flattens the overlap. If the first step is omitted, the overlapping ends will tend to slide off, rendering the ring useless. Thus, setting the overlap substantially increases the success rate of the flattening action.

The final cross-section of the wire will be shaped by the strength and location of the setting- and flattening strikes. Riveted rings with a round cross-section have been struck only at the overlap, allowing the wire on the remainder of the ring to retain its original round shape. In an oval cross-section, the whole ring has received the first setting tap, but only the overlap has taken the forceful second strike. Lastly, rings with a flattened cross-section have been hit in their entirety during both actions. All three procedures render well-functioning riveted rings, but of a different visual appearance.

Another method for flattening the overlap of riveted rings is using a pair of tongs, instead of a hammer.[29] The force needed for this technique prescribes that it can only be applied to small or medium-sized thin rings. Annealing the rings prior to flattening will make the operation easier.

The cross-section of riveted rings should be preferably recorded at the opposite side of the overlap. Even a soft, localised tap or strike to the overlap can affect the adjacent areas of the ring, so the opposite point will give the best reading for the shape of the cross-section.

[29] Simkins 1979, 20; pers. comm. Alfredo Mellace, 2020.

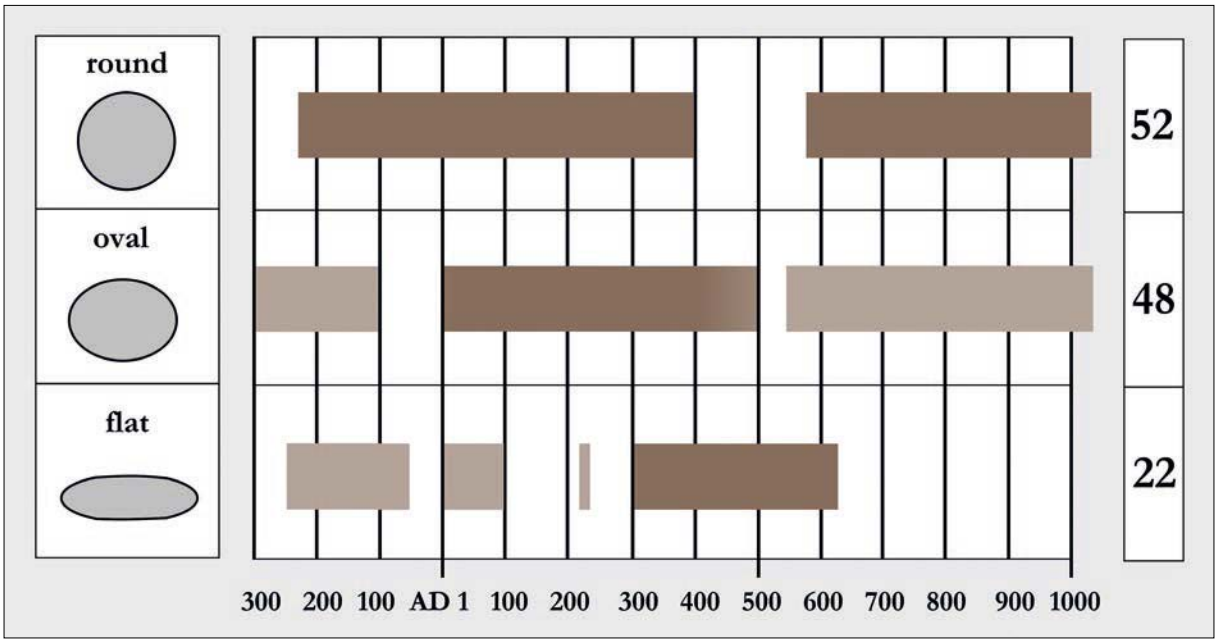


Fig. 11.14. The shape of the cross-section of riveted rings through time. Dark brown: several finds of known provenance. Light brown: single find or several finds of unknown provenance.

3RD TO 1ST CENTURY BC

There is a total of 16 finds that (partially) date from this period. The round cross-section is the most prevalent (n=9) and is observed from 220 BC onwards. The 16 cases include three Roman finds, all from the Early Imperial period. During the centuries BC, the oval cross-section is only present in a single riveted ring from the Iron Age mail found in Fluitenberg, The Netherlands, which has been dated to 300-115 BC (fig. 11.8).[30]

Five finds include riveted rings with a flat cross-section. Unfortunately four of them lack provenance and can only be tentatively assigned to the centuries BC, based on characteristics shared with finds from that period (e.g. shape of the overlap or type of rivet). The earliest possible occurrence comes from the piece of mail (unprovenanced 1 from Bulgaria) that was attached to a medieval helmet in the Veliko Tarnovo Museum of Archaeology.[31] The only provenanced mail find with flat cross-section riveted rings comes from the funerary chamber of a local ruler from Piquía, Spain (fig. 11.10). It dates from the first half of the 1st century BC.[32] In sum, flat riveted rings occurred with certainty in the 1st century BC, and perhaps as early as the mid-3rd century BC.

The cross section in this period follows a similar pattern as the direction of the overlap. Although there is a dominant form, the round shape, there still is much room for variation. All other cross-section shapes occur as well, albeit with different frequencies, suggesting little standardisation in the mail making process during this period.

[30] Wijnhoven 2010.

[31] Dimitrov 2009/2010.

[32] Quesada Sanz *et al.* 2018.

The majority of cases in which the cross-section of the riveted rings could be determined (n=53) is Roman, dating between the 1st and 5th centuries AD. Throughout this period, Roman mail includes all three cross-section shapes but with varying frequencies over time (fig. 11.15). During the 1st to 3rd centuries AD, riveted rings in Roman mail have a round or oval cross-section. Only two finds (one round and one oval) have a slightly later date, one from Weiler-la-Tour in Luxembourg and the other from Sarry in France (fig. 11.19).[33] Both come from graves dated to the 4th century on the basis of the style of the grave goods.

Roman riveted rings with a flat cross-section are absent from the 1st to the 3rd century, except for two examples. One is a 1st century AD strip of mail consisting of copper alloy rings from Vindonissa 1 in Switzerland.[34] The other is a small fragment of flexible mail, of no more than a few interconnected rings, from the site of the battle of Harzhorn in Germany, which is thought to have taken place around AD 235.[35] All other Roman mail with flat riveted rings comes from the 4th century AD onwards. Moreover, there is a significant difference between the flat rings from Harzhorn and Vindonissa and those that are later. While the first have an outer ring diameter of some 6 mm, the others are much larger, usually double that size.

The shape of the cross-section of riveted rings offers another criterion for determining the age of mail artefacts. Roman mail with round or oval riveted rings usually belongs to the Principate, and possibly the (early) 4th century AD. Roman mail with riveted rings of a flat cross-section and a larger diameter is from the 4th century AD or later. The rule of thumb is: large flat Roman rings are from Late Antiquity and round or oval Roman rings are from the Principate.

Interestingly, the transition from round/oval to large flat rings coincides with an important change in the production of Roman military equipment. The late 3rd to early 4th century saw the introduction of large state factories (*fabricae*) that took over the manufacture of military items, which formerly had relied in large part on the labour of the (ex-)soldiers themselves at the frontiers.[36]

During the first three centuries AD, Roman and non-Roman mail both have riveted rings with similar cross-sections (fig. 11.15), either round or oval. At this time outside the Roman Empire there are no examples of rings with a flat cross-section. Unfortunately the number of mail finds with a distinguishable cross-section from the 4th and 5th centuries is very limited. The 4th century has five observations, and the 5th only has two, one from Kerch 2 in the Crimean Peninsula and one from Ogultsy in the Ukraine.[37] That makes it difficult to draw solid conclusions about this period.

Despite this limitation, it is interesting to note that there are no finds with a flat cross-section outside the Roman Empire, except for Ogultsy (AD 380-420), which is a mail fragment of probable Roman manufacture. In addition to its large flat rings, like those from the Late Roman Empire, it has other telling features, such as the shape of the overlap and the cross-section of the solid rings (discussed below). Moreover, the Ogultsy find is a hoard that includes items of Roman (35 *denarii*) as well as non-Roman origin (brooches).

Overall, the cross-section is also a possible criterion for identifying the provenance of mail of the Late Roman period: riveted rings with a flat cross-section are probably Roman, and rings with a round or oval cross-section probably come from outside the Roman Empire.

[33] Chew 1993, 313; Waurick 1982, 111, 121.

[34] Unz/Deschler-Erb 1997, 63, pl. 83.

[35] Geschwinde 2013, 313, fig. 18; Geschwinde/Lönne 2013, 277, fig. 7.

[36] Bishop/Coulston 2006, 233-240; James 1988.

[37] Shaposhnik 2010.

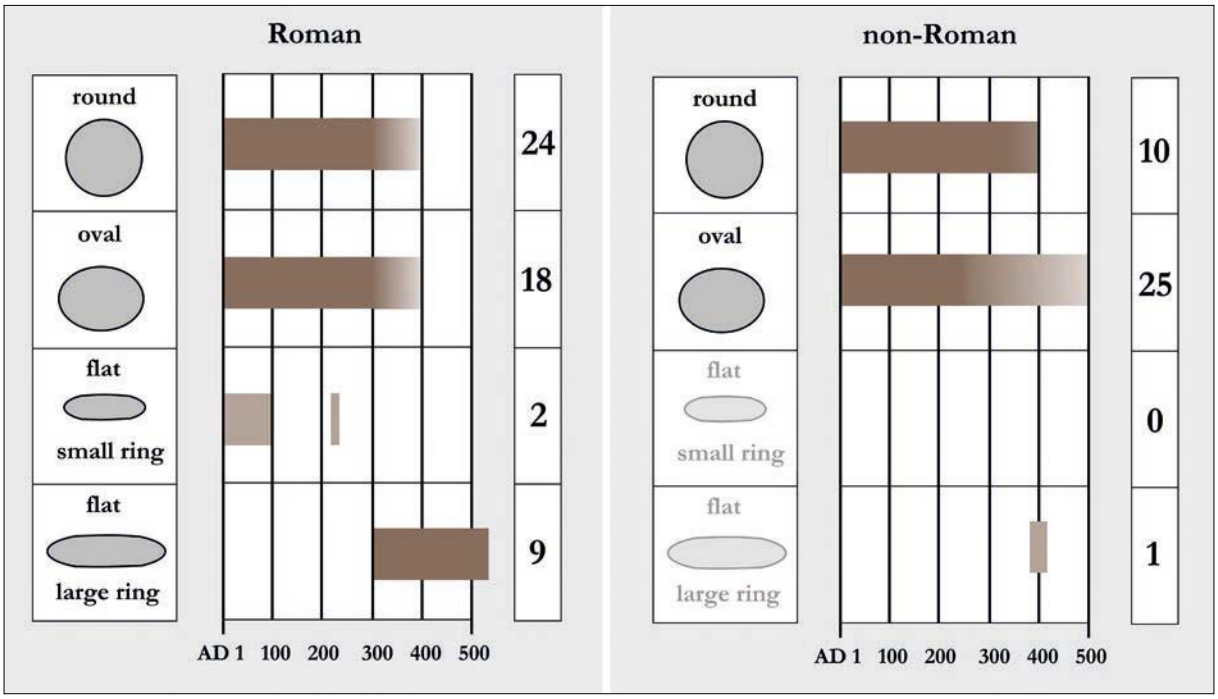


Fig. 11.15. The cross-section of riveted rings for Roman and non-Roman mail. During Late Antiquity, Roman mail changes from round/oval sectioned rings to large flat rings. Dark brown: several finds of known provenance. Light brown: single find or several finds of unknown provenance.

6TH TO 10TH CENTURY AD

The number of finds between the 6th and 10th centuries is smaller (n=23) than in the previous period. One notable change is that mail with riveted rings of a round cross-section reappears after having vanished from Roman contexts in the 4th century in favour of large flat rings. Among non-Roman finds, this pattern is less clear. There, round sectioned mail is found until the 4th century too, but the scarcity of examples from the 5th century on makes it difficult to say whether it continued or disappeared as well. In any case, by AD 575 mail with round cross-sectioned riveted rings is present again and becomes the most prevalent (n=12) from then until the 10th century, and later.

Oval cross-sectioned rings are uncommon, with only three cases from Scandinavia; Rickeby in Sweden (AD 550-790), and Smedenga i Ullensaker (AD 600) and Gjermundbu (AD 900-1000, fig. 11.39) in Norway. Despite the regional connection, the number of finds is too small to rule out coincidence, but could imply a local mail making tradition.

The large riveted rings with a flat cross-section, typical of the Late Roman Empire, continue into the Middle Ages, and are also observed in the 6th and the early 7th century AD. Many are found in mail neck guards, or aventails, that were attached to helmets. Examples come from St. Vid in Croatia (AD 480-610), Planig in Germany (c. AD 510, fig. 11.36), Batajnica in Serbia (500-600 AD), Vézeronce in France (AD 480-610), and the previously mentioned unprovenanced example from Egypt (AD 395-700).[38] In the case of Planig, a complete mail coat was recovered alongside the helmet with mail aventail. All of these cases involve *Spangenhelme*, except the one from Egypt. It is thought that a substantial part of all surviving *Spangenhelme* was produced in Byzantine workshops. This suggests that the Late Roman mail making tradition of using large flattened riveted rings did not end with the Western Roman Empire, but continued in the Byzantine Empire.

[38] Grancsay 1949, 276; Hilgner 2010; Vogt 2006, 37-38, 195, 257, 271.

ROMAN PRINCIPATE – RING CHARACTERISTICS

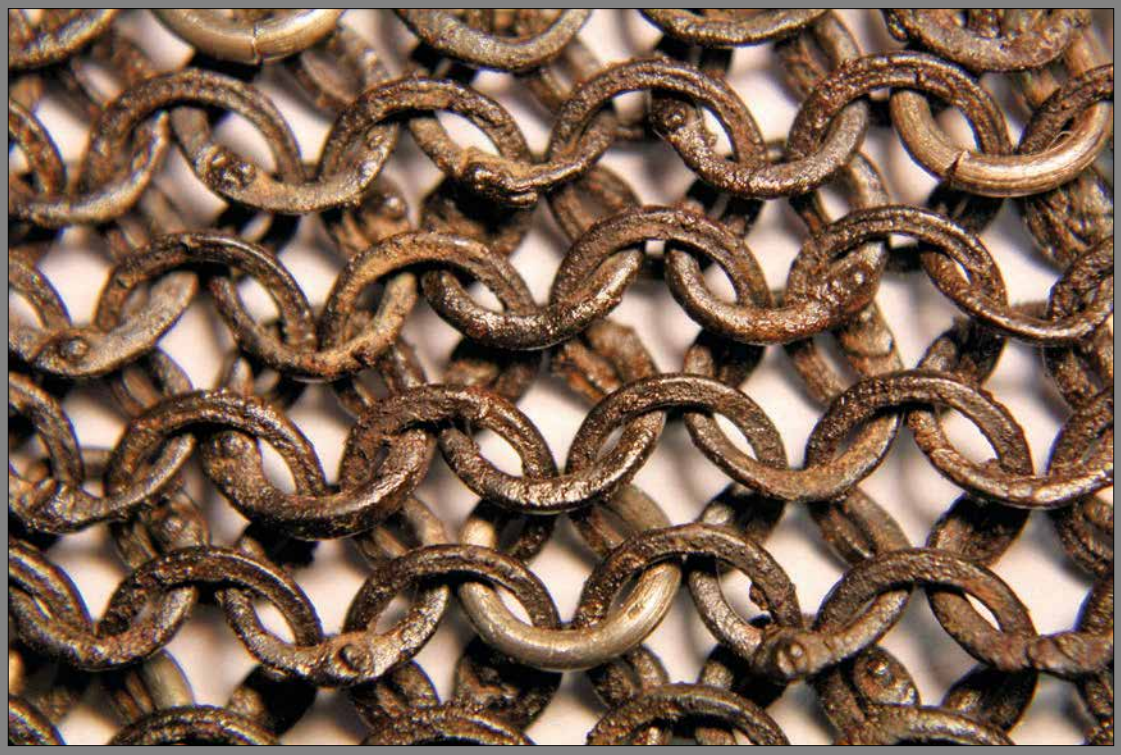
Fig. 11.16. Xanten 2, Germany (1st - early 2nd century AD). Roman mail could have very small rings in the Early Empire. This specimen has c. 4 mm riveted rings and 3 mm solid rings, similar to rings in hybrid armour, and may be called 'miniature mail'. The direction of the overlap is clockwise (variant 1). The overlap looks relatively large, but is in fact small and stump-like (variant 2). Due to the small size of the rings, the overlap and adjacent areas are flattened, giving the appearance of a larger overlap. The rivets have a round head on both sides (variant 1). The cross-section of the wire is round (shape 1). The solid rings have been made by punching them out of sheet metal. Their cross-section is rectangular (variant 1) and they have been deformed during manufacture into a conical shape (photograph M.A. Wijnhoven; drawing A. Moskvin and M. Moskvina).

The occurrence of the large flat riveted rings associated with the Late Roman Empire is at odds with the overlap in a clockwise direction. The latter disappeared with the end of the Western Roman Empire, giving the impression that a completely new mail making tradition had been established. However, the continuity of the large flat riveted rings until the early 7th century AD,[39] reveals a more complex mosaic-like phenomenon, in which some aspects of mail making fell out of use, while others prevailed.

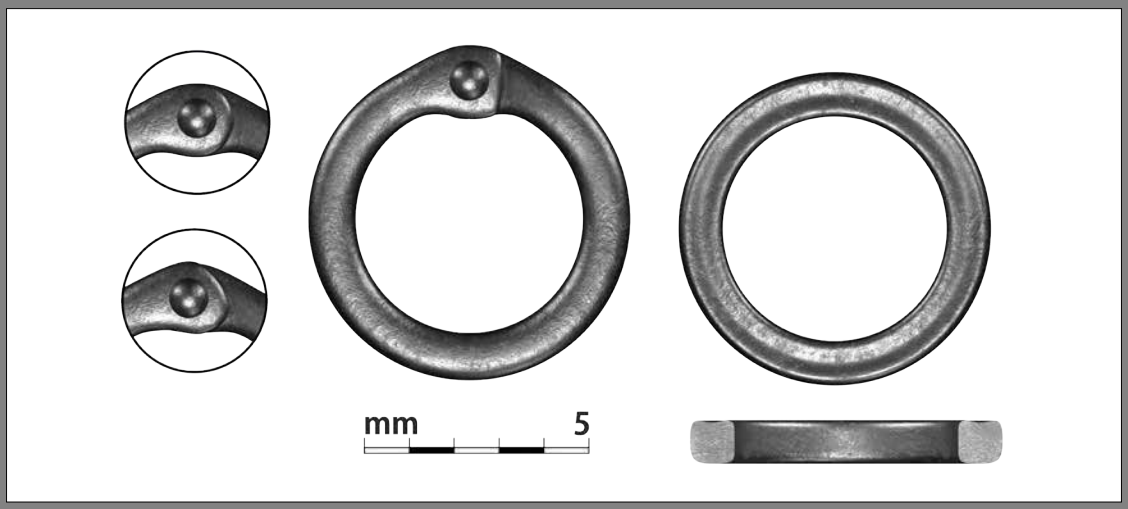
CONCLUSIONS

The cross-section of the riveted rings confirms that during the centuries BC different mail making traditions coexisted. Within the Roman Empire, the cross-section serves to distinguish mail rings from the Principate and the Late Roman period. The latter tradition continues into the Early Middle Ages probably through the influence of the Byzantine Empire. Mail from outside the Roman Empire was made from round or oval rings, and the occasional flat specimen was likely a Roman import. Table 11.4 sums up the main results of the analysis of the cross-section of riveted rings.

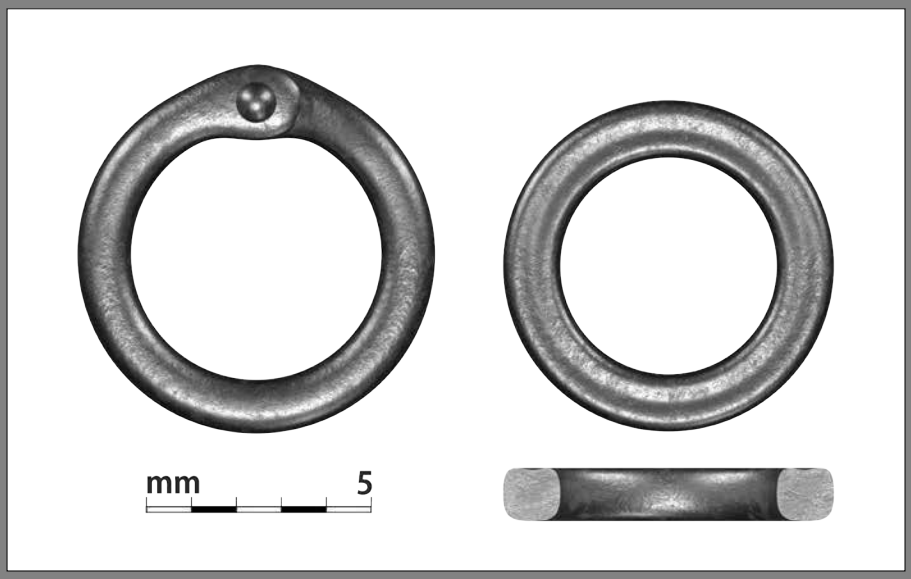
[39] During the Late Middle Ages and Early Modern period flat riveted rings are observed again, particularly in mail from Germany and Russia. Examples can be seen in: Krogh 2016; Schmid 2003; Wood *et al.* 2013.

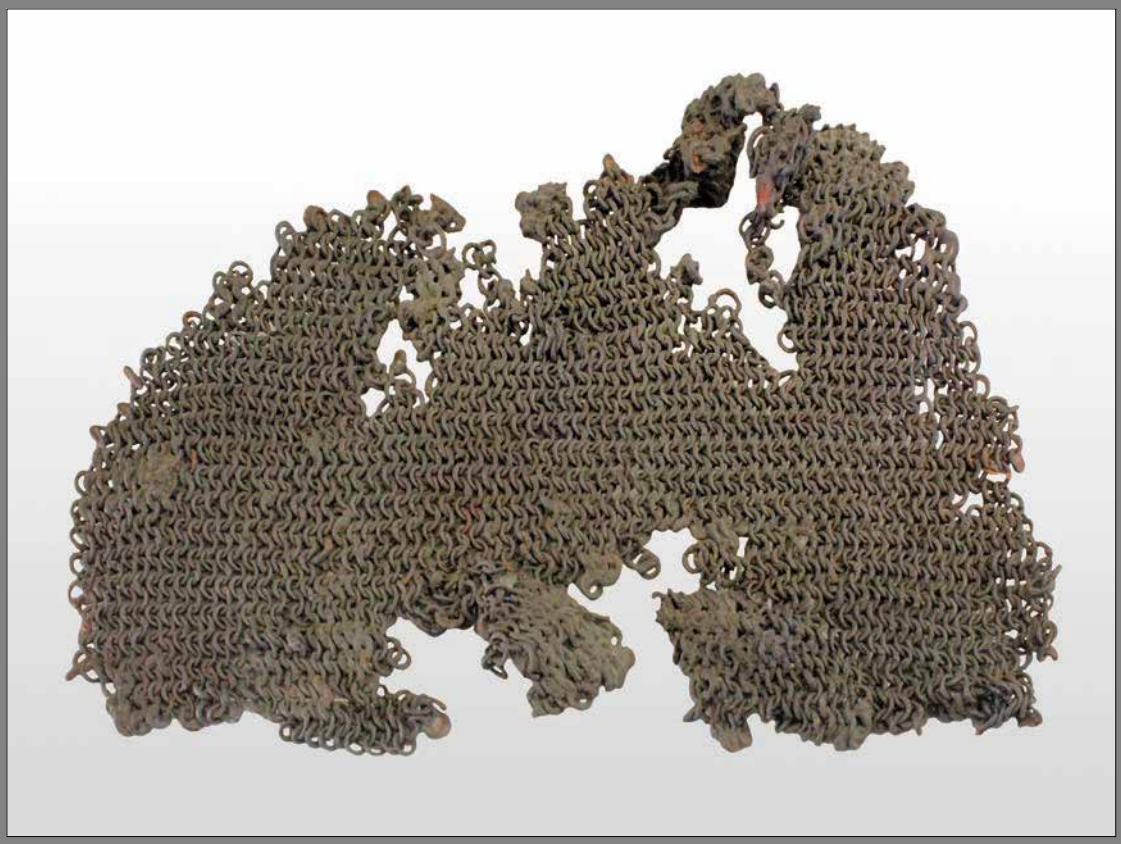


↑↓ Fig. 11.17. Carlingwark Loch, United Kingdom (AD 80-200). This find has the typical characteristics of Roman mail from the Principate. The rings are relatively small; riveted rings are just over 7 mm in diameter and solid rings are just below. The overlap is placed clockwise (variant 1) and is stumpy-shaped (variant 2). The actual shape can vary from a straight end to more rounded or pointed endings. This has to do with the tool used to cut the rings. A straight end indicates a chisel, which generated more shapes as it turned blunt. The rivet has a rounded head on both sides of the overlap (variant 1). The cross-section of the wire in the riveted rings is oval (shape 2). The solid rings have a square cross-section (variant 2) with slightly rounded corners. The latter were made by punching from sheet metal, as evidenced by ridges on the inner and outer edges on one side of the rings. The metal rings were deformed during the punching action and were not reworked afterwards (photograph M.A. Wijnhoven; drawing A. Moskvin and M. Moskvina).



↑↓ Fig. 11.18. Künzing 4, Germany (mid-3rd century AD). The riveted rings in this specimen measure 8.2 mm in diameter and the solid rings, 7.4 mm. The overlap is clockwise (variant 1) and the shape of the overlap is stump-like (variant 2). The rivet heads are round on both sides (variant 1). The small fragment in the photograph shows several badly executed rivet heads that are not nice and round, but too long and became squashed when the rings were closed. Roman mail from the Principate often contained similarly misshapen rings, so long as they were functional. The cross-section of the wire in the riveted rings is oval (shape 2). The solid rings are square-sectioned (variant 2) with slightly rounded corners. Some of the rings still have burrs and, like the specimen from Carlingwark Loch, the inner and outer edges on one side of the solid rings have a ridge formed when punching from sheet without further reworking (photograph M.A. Wijnhoven; drawing A. Moskvin and M. Moskvina).





↑↓ Fig. 11.19. Sarry, France (4th century AD). These mail remnants were part of a burial. The rings display characteristics of Roman mail from the Principate, but were assigned a slightly later date based on a ceramic vessel found among the grave goods. It has the latest observed occurrence of an oval cross-section for the wire of the riveted rings (shape 2) and of the stumpy-shaped overlap (variant 2). These attributes place the mail find at the start of the 4th century. Alternatively, the find already had some age to it when deposited. As is usual for Roman mail the fragment consists of alternating rows of riveted and solid rings (variant 1). The solid rings are square-sectioned (variant 2) and some still have burrs on their inner edge. The solid rings have been reworked on the outside and have a multi-faceted appearance. Reworking of solid rings is not common in Roman mail but is customary outside the Roman Empire (photograph M.A. Wijnhoven).

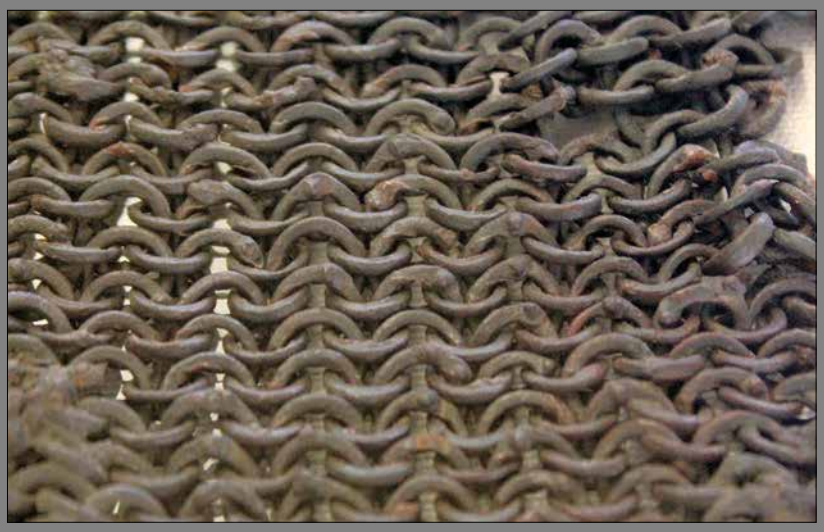


Fig. 11.20. Ouddorp, The Netherlands (AD 75-200). Rings in hybrid armour are very small. The diameter is c. 4 mm in the riveted rings and just over 3 mm in the solid rings. The riveted rings have a clockwise overlap (variant 1), are stumpy-shaped (variant 2) and measure less than 1.8 mm in length. The rivets are square-sectioned (shape 2) and have a domed head on the side of the ring facing the wearer, and protrude on the other side (variant 2b). The cross-section of the wire of the riveted rings is perfectly round (variant 1), although the small size of the rings makes the flattening of the overlap affect the adjacent area. The cross-section of the solid rings is rectangular (variant 1) and they have not been reworked, as seen from their conical warping after being punched from sheet metal (photograph M.A. Wijnhoven).

Fig. 11.21. Newstead 4, United Kingdom (AD 138-161). As all hybrid armour, the rings in this example are small and measure approximately the same as in the Ouddorp armour. The weave is made from alternating rows of riveted clockwise rings and solid rings (variant 1). The riveted rings have a round cross-section (shape 1) and the shape of the overlap is stumpy (variant 2). The rivet shanks have a rectangular cross-section (shape 2), and a round head on one side, while protruding on the other (variant 2b). The solid rings have a rectangular section (variant 1). They have not been reworked after punching from sheet metal as evidenced by their conical shape and the presence of burrs (photographs M.A. Wijnhoven).

SHAPE CROSS-SECTION	AGE AND PROVENANCE
Shape 1: round	non-Roman mail: 3rd century BC – 10th century AD – physical evidence is lacking for AD 400-575 Roman mail: Augustan – 3rd century AD (possibly 4th century AD)
Shape 2: oval	non-Roman mail: 3rd century BC – 10th century AD – most date to 1st – 5th century AD – only one find for 3rd –1st century BC – only three finds for 6th – 10th century AD; all from Scandinavia Roman mail: 1st century – mid-3rd century AD (possibly 4th century)
Shape 3a: flat – small – mid-size rings (diameter ≤ 9 mm)	non-Roman mail: 3rd – 1st century BC – mostly from unprovenanced finds Roman mail: limited evidence for the Principate – two finds from 1st century AD and c. AD 235
Shape 3b: flat – large rings (diameter > 9 mm)	Roman mail: 4th century AD – 5th century AD medieval mail: 6th – early 7th century AD – likely a continuation of the Late Roman tradition through the Byzantine Empire

Table 11.4. Age and provenance of mail based upon the cross-section of the riveted rings.

11.5 RIVET CHARACTERISTICS

A mail ring can be riveted shut in various manners and using different kinds of rivets. The dataset contains specific information on three elements: the shape of the rivet shank, the shape of the rivet hole, and the type of rivet head.

SHAPE OF THE RIVET SHANK

The rivet shank has three variants, each corresponding to a specific manufacture technique:

- Shape 1: round or oval rivet shank.
- Shape 2: square or rectangular rivet shank.
- Shape 3: wedge-shaped shank.

Rivets with a round shank are made from metal wire produced with a drawplate or by strip drawing on a finishing die (chapter 8.2). An oval shape is the result of distortion during the riveting process. In contrast, square or rectangular rivet shanks are made from sheet metal cut into strips. And lastly, the wedge-shaped shank can come from both, round wire that is flattened, or from rectangular strips of sheet metal cut diagonally to create triangular or wedge-shaped rivets.

Since rivet shanks are not exposed, but well embedded into the mail rings, their shape was observed only in a few finds (n=17),[40] for example in damaged or opened rings and rings that have been exam-

[40] Square: Brokær, Denmark, AD 150-200; unprovenanced 1, Egypt, AD 395-700; unprovenanced 1 & 2, unprovenanced country, Iron Age. Square in hybrid armour: Nijmegen 3, The Netherlands, 19 BC-AD 125; Oud-dorp, The Netherlands, AD 75-200; Newstead, United Kingdom, AD 138-161; unprovenanced 5, possibly Bal-

ined with metallography. Despite the small sample, it is clear that wedge-shaped rivets do not occur in the period under discussion. This type of rivet is well known from European historical mail from the Late Middle Ages and Early Modern period,[41] but must have been introduced after the period of study. For our period, only square and round rivet shanks are found. Although the number of observations is too small to draw conclusions concerning their distribution or usage through time, square shanks occur more often in pre-medieval times, while round shanks are mostly limited to medieval Scandinavia. The only exception is Roman hybrid armour, which appears to be made consistently with square-rectangular rivets (figs. 11.20-21).

SHAPE OF THE RIVET HOLE

Three types of hole shapes are observed at the overlap of riveted rings, where the rivet is inserted:

- Shape 1: round rivet hole.
- Shape 2: square rivet hole.
- Shape 3: slit-like rivet hole.

The shape of the rivet hole takes after the shape of the implement used to pierce the overlap. For example, an awl with a round cross-section makes a round hole. Alternatively to an awl and hammer, the mail maker sometimes used a specialized tool, similar to a pair of pliers, to pierce the overlap vertically. In this case, the hinging and closing motion of the pliers pierce the overlap under a slight angle, resulting in a slit-like rivet hole.

The shape of the rivet hole is not easily observed (n=12) as this requires the rivet to become dislodged and fall out of the ring. Ideally, this should not happen in a mail garment, as its integrity depends greatly on the rivets securing the rings.

Slit-like rivet holes go with wedge-shaped rivets. Because there are no finds of the latter dating between the 3rd century BC and the 10th century AD, no slit-like rivet holes are observed. In this period all rivet holes are round, with the exception of one mail fragment from Czaszkowa in Poland dated to AD 250-320, which employs square rivet holes. The old saying that 'you cannot fit a square peg in a round hole' does not apply to mail and there are definitively square shanked rivets fitted in round holes.

TYPE OF RIVET HEAD

There is much more information on the rivet heads, which can be observed on the outside of the mail rings. Among the 105 cases with information on this characteristic, there are three variants:

- Variant 1: round rivet heads on both sides of the ring.
- Variant 2: round rivet head on one side and the rivet protruding from the other side.
- Variant 3: round rivet head on one side and a flush surface on the other side.

kans, 20 BC-AD 200. Round: Öremölla, Sweden, AD 70-220; Vendel 2-5, Sweden, AD 520-850; York, United Kingdom, AD 770; Slite and Tuna 1, Sweden, Viking period?; Gjermundbu, Norway, AD 900-1000.

[41] E.g. Burgess 1953a, 53; 1957, 200; 1958, 198; Reid/Burgess 1960, 51; Schmid 2003, 3, 6, 8, 12-14.

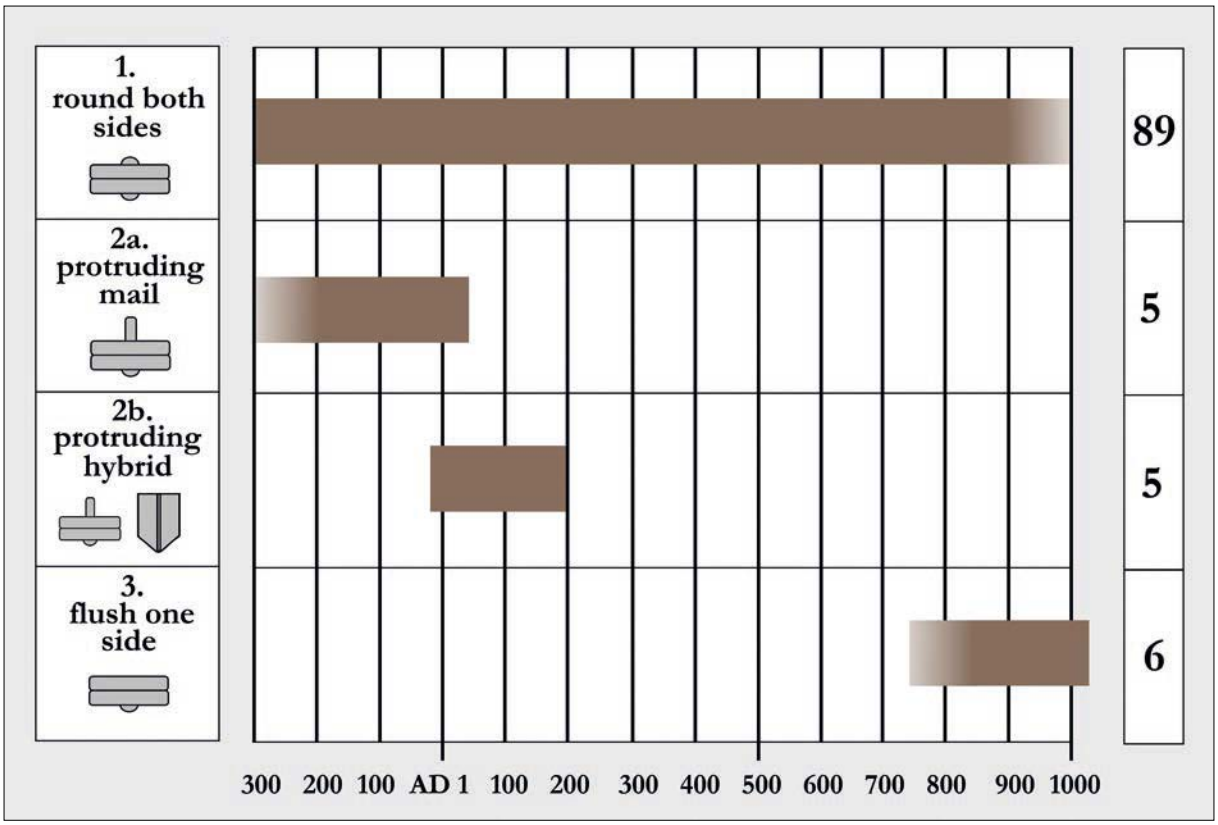


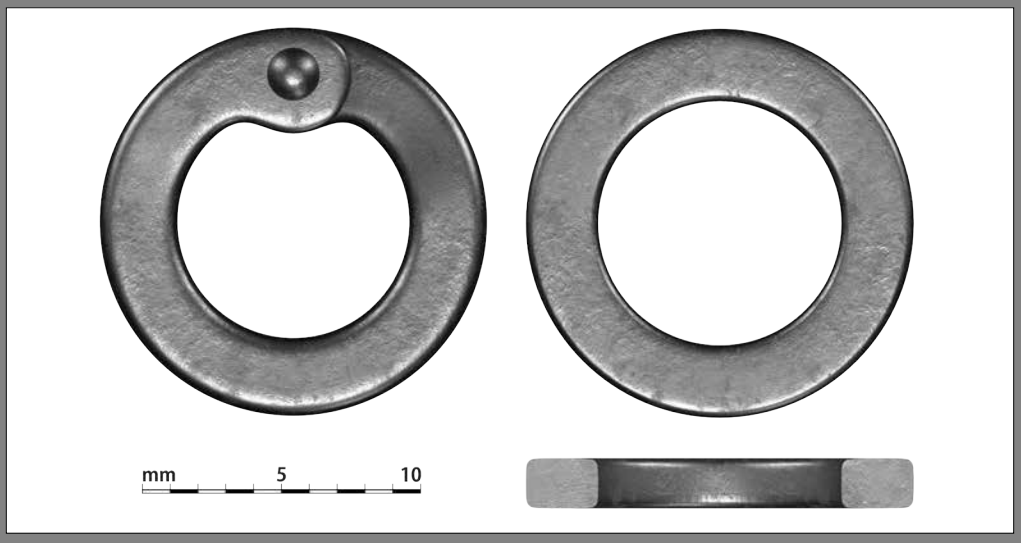
Fig. 11.22. The occurrence of different types of rivet heads. Up to the 9th or 10th century, rivet heads can be found on both sides of the rings. From *circa* the mid-8th century AD, and probably up to the demise of mail, European mail rivets have only one head and are flush on the other side. Protruding rivets only occur in mail during the Iron Age or in hybrid armour during the Roman period. Dark brown: several finds of known provenance. Light brown: single find.

Figure 11.22 shows the three variants through time. Variant 1, with round rivet heads placed on both sides, is the most prevalent with 89 mail finds. The other two variants are much less frequent; ten specimens have protruding rivets and six examples have the rivet flush on one side.

Rivets with round heads on both sides are found throughout the entire period. In fact, from the 1st to 7th century AD there is no other variant in mail, both from Roman and non-Roman contexts.[42] The size of the rivet heads varies, mainly according to the size of the rings; larger rings tend to have larger rivet heads.

The second variant of rivets has a domed head on one side with the rivet protruding a few millimetres on the other side. After insertion, the rivets are set and slightly bent. Not only do these rivets close the rings, but they also affect the way the mail weave behaves. Regular riveted rings can rotate in the mail fabric, meaning that the overlap of each ring will face a different direction. Here, the protruding shanks prevent the riveted rings from spinning, stabilising the mail mesh and making all the overlaps point in the same direction. Moreover, these rivets make for a denser and stiffer mesh.

[42] One of the many mail fragments found at Gurzuf Saddle Pass has been described as having uncut rivets of 5 mm in length. Although uncertain, this may refer to protruding rivets, which would make it the only find of variant 2 from the Roman period that is not hybrid armour. Novichenkova 2009; 2011.



↑↓ Fig. 11.23. Stari Jankovci, Croatia (4th-5th century AD). Roman mail can have very large rings during Late Antiquity. This specimen has 14 mm rings, with alternating rows of clockwise riveted rings and solid rings (variant 1). Clockwise rings are found up to the end of the 5th century and disappear afterwards. Mail in the Late Roman period is often made of heavy rings with a flat appearance. The cross-section of thesse riveted rings is also severely flattened (shape 3b) and the rivet heads are present on both sides of the rings (variant 1). The overlap is paddle-shaped (variant 3), although it is not as pronounced in this specimen as in others. The reason being that the wire in this example is exceptionally wide. The cross-section of the solid rings is rectangular and resembles a washer (variant 1) (photograph M.A. Wijnhoven; drawing A. Moskvin and M. Moskvina).

Fig. 11.24. Sisak 1, Croatia (4th-5th century AD). This mail fragment has relatively large rings, with the riveted links measuring almost 12 mm and the solid ones about 10 mm, befitting the Late Roman period. The riveted rings have a clockwise overlap (variant 1) and a flat cross-section (shape 3b). The overlap is a good example of the paddle shape (variant 3) found during the Late Roman period and the Early Middle Ages. The rivet has a large round head on both sides of the rings (variant 1). The cross-section of the solid rings is rectangular (variant 1) (photograph M.A. Wijnhoven).

Fig. 11.25. Sisak 3, Croatia (4th-5th century AD). This site rendered the remains of several mail coats, some from the Principate and others from the Late Roman period. The rings are large; riveted links can measure over 14 mm, and the solid ones over 12 mm. The riveted rings have a clockwise overlap (variant 1) and a flat cross-section (shape 3b). The cross-section of the solid rings is rectangular and very flat, resembling a washer. The flat appearance for the riveted and solid rings is typical of the Late Roman period. The riveted rings have a paddle-shaped overlap (variant 3), although some have been affected by corrosion. The rivets have large heads on both sides (variant 1). Some rings have rivet heads made of copper alloy; a decorative technique also associated with the Late Roman period (photograph M.A. Wijnhoven).

Protruding rivets are found in two contexts. They are seen in Iron Age mail, among the finds from Fluitenberg (300-115 BC; fig. 11.8),[43] Huneduora (100-1 BC)[44] and Hedegård (50 BC-AD 50),[45] and in two occurrences of unprovenanced finds (1 and 2; fig. 11.9) in which the presence of this feature and the shape of the overlap (see below) suggest an Iron Age origin.

The other context in which protruding rivets are observed is Roman hybrid armour (figs. 11.20-21). The rivets have a square-rectangular section in this type of armour. The domed rivet heads face the wearer, while the protruding rivets face out and are covered by scales. Given the minute size of all the elements in hybrid armour and the large quantity of rings it includes, having rivets that can be secured with a slight bent seems an efficient strategy. However, not all hybrid mail contains protruding rivets. For example, the find from Nijmegen 3 has 'regular' rivets with a round rivet head on both sides.[46]

The third variant has a rivet head on one side of the ring and is flush on the other side. This is accomplished by piercing the overlap with a tapering awl, resulting in a tapering hole. The rivet, made from a piece of metal wire with an even cross-section, is then inserted and pushed down with force until one side is flush. On the other side, the protruding rivet is set with a special pair of pliers that have a small depression on the inside of the beak, which shapes the final rivet head.

This type of rivet is observed in Europe from the 8th century AD onwards, and seems to have remained in use throughout the Middle Ages until the Early Modern period. These rivets are found in historical mail until the demise of this type of armour.

CONCLUSIONS ON RIVET CHARACTERISTICS

The rivets employed in mail offer additional criteria for assessing age and provenance. Mail from the Roman period has rivet heads on both sides (variant 1), with the exception of hybrid armour. Protruding rivets (variant 2) are only observed in the centuries BC, except in Roman hybrid armour. And lastly, rivets that are flush on one side date from the 8th century AD or later. Table 11.5 sums up the main conclusions from this section.

RIVET SHANK	AGE AND PROVENANCE
Shape 1: round-oval	3rd century BC – 10th century AD – observed more often in medieval Northern Europe
Shape 2: square-rectangular	3rd century BC – 10th century AD – observed more often in pre-medieval times found consistently in hybrid armour – c. 20 BC – AD 200
Shape 3: wedge-shaped	not observed from the 3rd century BC – 10th century AD – very common in the Late Middle Ages and Early Modern period in Europe

[43] Wijnhoven 2010, 148.

[44] Sîrbu *et al.* 2007a, fig. 5.

[45] Kalsbøll Malfilâtre 1993, 16.

[46] Wijnhoven 2016a, 79.

RIVET HOLE	AGE AND PROVENANCE
Shape 1: round	3rd century BC – 10th century AD – the dominant shape during this period and probably beyond
Shape 2: square	AD 250 – 320 – concerns a single find
Shape 3: Slit	not observed from the 3rd century BC – 10th century AD – very common in the Late Middle Ages and Early Modern period in Europe

RIVET HEAD	AGE AND PROVENANCE
Variant 1: round on both sides	3rd century BC – 9th or 10th century AD (and probably does not continue) – the most prevalent during this period – the only variant in mail armour from the 1st – 7th century AD
Variant 2a: protruding	in mail armour: 3rd – 1st century BC
Variant 2b: protruding	in hybrid armour: 20 BC – AD 200
Variant 3: flush on one side	AD 750 – 10th century AD (and probably continues in Europe until the demise of mail armour in the Early Modern period)

Table 11.5. Age and provenance of mail based upon the rivet characteristics.

11.6 SHAPE OF THE OVERLAP IN RIVETED RINGS

During our period of interest there is a lot of variation in the overlap of riveted rings, as many steps in the mail making process can influence its final shape. The most relevant features that can be indicative of a certain period have been clustered together into the following variants:

- Variant 1: oval-shaped overlap.
  - 1a: large oval
  - 1b: triangle-shaped
  - 1c: mid-sized oval
  - 1d: reshaped oval
  - 1e: other
- Variant 2: stumpy-shaped overlap.
- Variant 3: paddle-shaped overlap.

There are three main shapes of overlap. In addition, the oval-shaped overlaps have been divided into five subcategories. Box 11.2 describes each of them.

The characteristics of the overlap were recorded in 92 cases from the database. The occurrence of the variants and subcategories differs through time as demonstrated in figure 11.26. The overlap shape turns out to be very informative and helps distinguish Iron Age from Roman period mail. It also allows us to identify mail from the Roman Principate and the Late Roman period, and mail from outside the Roman Empire.

MAIL MAKER'S STEPS TO SHAPE THE OVERLAP

The shape of the overlap is the result of five factors during the production process, all of which influence its final features. The first is the tool used to separate the rings from the coil. A pair of snippers, for example, will cut the metal wire from two sides simultaneously, in a scissor-like motion. The blades are angled at one edge, forming basically two triangles that bite into the wire in unison. Instead of a clean cut, the wire is pinched from two sides making it somewhat pointy. When flattened, this results in an overlap that is partially pointed or rounded at its ends. In contrast, a sharp chisel will make a clean cut, resulting in an overlap that ends in a straight line,[47] while a blunt chisel will tear off the rings instead of cutting them loose, forming overlaps of different shapes in the same mail garment.

The second factor is the execution of the cut. Whatever tool is chosen, if the wire is cut at a 90-degree angle the end of the overlap will stop abruptly. However, if the metal wire is cut at a 45-degree angle with the same tool, the shape of the overlap will be more elongated or pointy.

Third is how much the ends of the ring overlap. The mail maker can choose to make a short overlap, or can opt to use more material and create a long overlap. This can result in big differences, with some overlaps being no more than 2 mm, and others as long as 8 mm.

The fourth factor concerns the flattening of the overlap. Done with simple tools (for example a hammer and anvil), the overlap can expand horizontally in all directions creating an oval or rounded shape. The shape of the overlap can also be created by the use of specialised flattening tools,[48] which may be as simple as a depression on an anvil, a striker tool, or both, to receive the overlap when flattened. Such specialised tools limit horizontal expansion and direct the overlap into a predetermined shape that will consistently be achieved.

Last is the setting of the rivet, during which the rivets are closed, forming the rivet head(s). The overlap can be further shaped during this step. In that case the riveting tool has not only a depression that forms the rivet head, but also a special depression that shapes the overlap. The so-called watershed overlap (fig. 11.11 left), observed frequently in medieval and early-modern mail, is a good example of mail treated in this manner, which has great consistency. The reshaping of the entire overlap together with the rivet is not merely aesthetic, it also strengthens the overlap and makes it harder to open with or without rivet.

3RD TO 1ST CENTURY BC

There are twelve finds from this period. The large oval-shaped overlap (variant 1a) is the most prevalent (n=7), followed by the triangle-shaped variant (n=3) (variant 1b). The latter three finds, from Fluitenberg (fig. 11.8), Hedegård, and Hunedoara, are very similar.[49] Besides the triangle-shaped overlap, they all have

[47] The findings using a chisel are based upon practical experiments by Alfredo Mellace (pers. comm. 2019/2020).

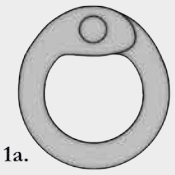
[48] E.g. Kalsbøll Malfilâtre 1993, 31-37, fig. 44.

[49] Malfilâtre 1993; Sîrbu *et al.* 2007a, 158-160, fig. 5-6, 12; Wijnhoven 2010.

BOX 11.2 THE SHAPE OF THE OVERLAP IN RIVETED RINGS

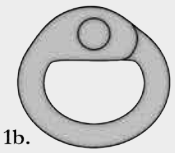
VARIANT 1: OVAL-SHAPED OVERLAP

The key characteristic is that the overlap is substantially longer than it is wide. It is thus larger to the left and right of the rivet than to its top and bottom. The width of the overlap is also broader than the wire. Other features of this variant are incorporated into five subcategories.


1a.

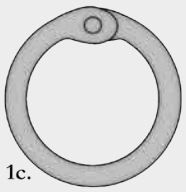
1a: large oval-shaped

The overlap is large in comparison to the size of the ring. The overlap is relatively long, even for the oval-shaped variant, and is substantially wider than the wire of the rings. Factors that determine its shape: 1) rings are cut from the coil with a chisel or snippers; 2) wire is cut at a 90-degree angle; 3) a long overlap; 4) heavy flattening with unobstructed expansion horizontally; 5) no reshaping of overlap during riveting.


1b.

1b: triangle-shaped

The overlap resembles a triangle with rounded corners and is relatively big in comparison to the ring size, both in length and width. The overlap is heavily flattened. The expansion of the overlap during the flattening is directed outwards of the ring, which gives it its triangular form. Factors that determine its shape: 1) wire is cut with a chisel or snippers; 2) wire is cut at a 45-degree angle; 3) a long overlap; 4) heavy flattening with obstructed expansion; 5) no reshaping of overlap during riveting.


1c.

1c: mid-sized oval-shaped

The overlap is smaller compared to the ring size, unlike the former two subcategories. The length is large enough to still create an oval shape, and although the width is often less than in the former two, some still have a relatively wide overlap. Factors that determine its shape: 1) wire is cut with a chisel or snippers; 2) wire is cut at a 90-degree angle; 3) a relatively long overlap; 4) mild to heavy flattening with unobstructed expansion; 5) no reshaping of overlap during riveting.

1d: reshaped oval

The most salient feature of this overlap is the fact that it has been reshaped during the riveting stage. The overlap itself somewhat resembles the triangle-shaped, although it is not as big in comparison to the ring. The initial flattening to prepare the overlap for piercing and subsequent reshaping during riveting causes the final overlap to be heavily flattened. So much so, that the thickness of the overlap is less than the wire's. Factors that determine its shape: 1) wire is cut with a snippers; 2) wire is cut at a 45-degree angle; 3) a relatively long overlap; 4) flattening with unobstructed expansion; 5) reshaping of overlap during riveting.

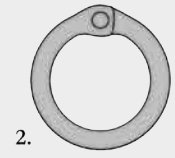

1d.

1e: other

Two finds comply with the general definition of an oval overlap, but not with any of the subcategories. The first is the complete coat of mail from Vimose 1 in Denmark (fig. 11.30). Its shape approaches an elongated point, with an exceptionally long overlap. The other find concerns the mail aventail from Coppergate in the United Kingdom (fig. 11.38). The length of the overlap is comparable to the mid-sized ones, however remarkably slim, barely wider than the ring wire. This could be the result of the overlap being reshaped while the rivet heads are being set.

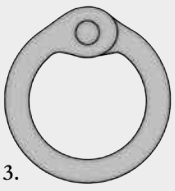
VARIANT 2: STUMPY-SHAPED OVERLAP

The overlap is short and stumpy. The overlap is often substantially wider than the width of the wire indicating that it has been heavily flattened. Among mail with stumpy-shaped overlap there are rings with overlaps that end in a straight line, indicating that they were cut with a chisel. Factors that determine its shape: 1) rings are cut from the coil with a chisel; 2) wire is cut at a 90-degree angle; 3) a short overlap; 4) heavy flattening with unobstructed expansion horizontally; 5) no reshaping of overlap during riveting.


2.

VARIANT 3: PADDLE-SHAPED OVERLAP

This overlap resembles the shape of a table tennis paddle. The overlap is substantially wider than the wire of the rings. The length is relatively short when compared to its width, albeit not as much as in the stumpy-shaped variant. Most paddle-shaped overlaps end in a nice curve, although occasionally there is mail with rings that end in a straight line. Factors that determine its shape: 1) wire is cut with snippers or chisel; 2) wire is cut at a 90-degree angle; 3) a mid-length overlap; 4) heavy flattening with unobstructed expansion horizontally; 5) no reshaping of overlap during riveting.


3.

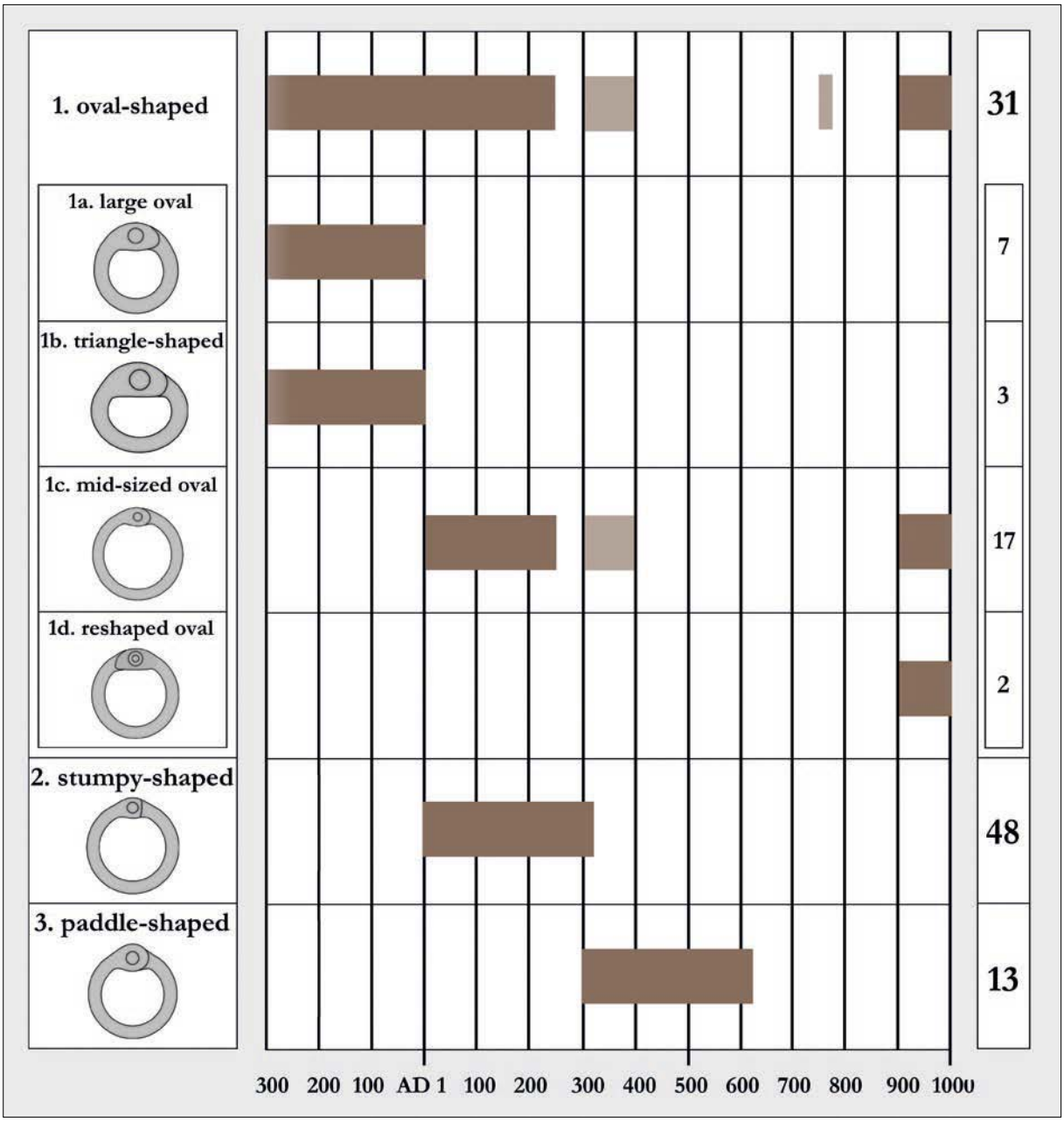


Fig. 11.26. The shape of the overlap in riveted rings divided in their variants and subcategories. Dark brown: several finds of known provenance. Light brown: single find.

protruding rivets, and are relatively small in diameter for the Iron Age, measuring between 5 and 6.8 mm in diameter.

Two finds have a stumpy overlap (variant 2): a river find from Pontoux 2 in France, and one from a cremation burial in Mala Kopanya in Ukraine.[50] Neither are accurately dated, but stem from between the 1st century BC and the 1st century AD. However, since stumpy-shaped overlaps are found exclusively during the Roman Imperial period, as discussed below, they likely date to the 1st century AD. The fact that the mail fragment from Pontoux 2 is made of copper alloy rings, a material associated with the Imperial Roman army (chapter 6), supports this interpretation.

[50] Boube-Piccot 1994, 55; Kotyhoroshko 2015, 211, fig. 41.19-20.

[51] Croom 1998; 2001.

[52] Chew 1993, 313; Waurick 1982, 111, 121.

Riveted rings from the 3rd to the 1st centuries BC therefore appear to all have oval overlaps (variant 1), most large oval and some triangle-shaped. Moreover, both subcategories are meticulously executed and the overlaps are uniform in appearance, with very few misshapen rings. Given the many steps that it takes to make a riveted ring, and how this process influences the shape of the overlap, a lot can go wrong. It can result in functional, but malformed rings. For this period, such imperfect rings seem to have been discarded and are not found in the final mail garments. This is in line with what we know about the role of mail armour in Iron Age society (chapter 3), as it was a carefully crafted luxury item for the higher classes of society.

1ST TO 5TH CENTURY AD

The stumpy-shaped overlap (variant 2) is the most prevalent variant among the Roman finds, recorded 37 times (fig. 11.27). All accurately dated examples of this variant fall between the 1st and the 3rd centuries AD, which must be the height of its popularity. Only two finds seem to have a slightly later date. The first is a complete coat of mail from South Shields 1 in the United Kingdom, found in a burnt down barrack thought to date to the late 3rd or early 4th century.[51] The second find, previously discussed in section 11.5, is a large mail fragment from a burial in Sarry, France, dated to the 4rd century based on the grave goods (fig. 11.19).[52] However, according to both the shape of the overlap and the characteristics of the cross-section of the riveted rings, this fragment appears to be earlier. It more likely comes from the beginning of the 4th century, making it one of the last occurrences of these traits, common in previous centuries. Alternatively, it might have been already old when deposited. The incidence of the stumpy-shaped overlap relatively coincides with the Roman Principate, during which a substantial part of the production of military items, including mail, took place at the Roman *limes*, either made by Roman (ex-) soldiers themselves or under their supervision.

Roman mail from the Principate has the characteristics of a mass produced item. In contrast to the Iron Age, when mail was carefully crafted, here we often find defects. These can be flawed or misshapen rings that are still serviceable. For example, the overlap sometimes has moved during the flattening and does not align well, or the riveting is sloppy with partly bent over and irregularly squashed rivet heads.

Another possible sign of mass production is the very short overlap in this variant, since a shorter overlap saves raw material. Nonetheless, the main advantage of the short overlap may be that it can be created while omitting steps in the mail making process. Normally, individual rings freshly cut from a coil have no overlap, but it can be created either by pinching together the ends of the rings after cutting or by opening the coil so that the rings can be cut with an overlap included (fig. 11.28 left). Both options require an extra step. The rings with a short stumpy overlap can however be created without an additional step,[53] simply by cutting the wire from the inside of the coil with a small chisel (fig. 11.28 right). This will leave an overlap of approximately 2 mm; larger overlaps are impossible due to the curvature of the rings. The short stumpy overlap constitutes an ingenious shortcut to making mail without compromising the functionality of the riveted rings, even if the overlap does not appear as sturdy as the other variants.

There are also nine Roman finds with a paddle shaped-overlap (variant 3). The well-dated examples of this variant indicate that they belong to Late Antiquity. Paddle-shaped overlaps are observed from the 4th century AD onwards, and extend into the Early Middle Ages. The paddle-shaped variant corresponds to a period when state-run *fabricae* began to play an important role in the manufacture of Roman *militaria*. Apparently, moving the production of armour from the borders during the Principate to state factories in Late Antiquity involved changes in the way mail was made. The span of the paddle-shaped variant into the Early Middle Ages probably represents a continuation of this tradition into the Byzantine Empire.

[53] Pers. comm. Alfredo Mellace, 2020.

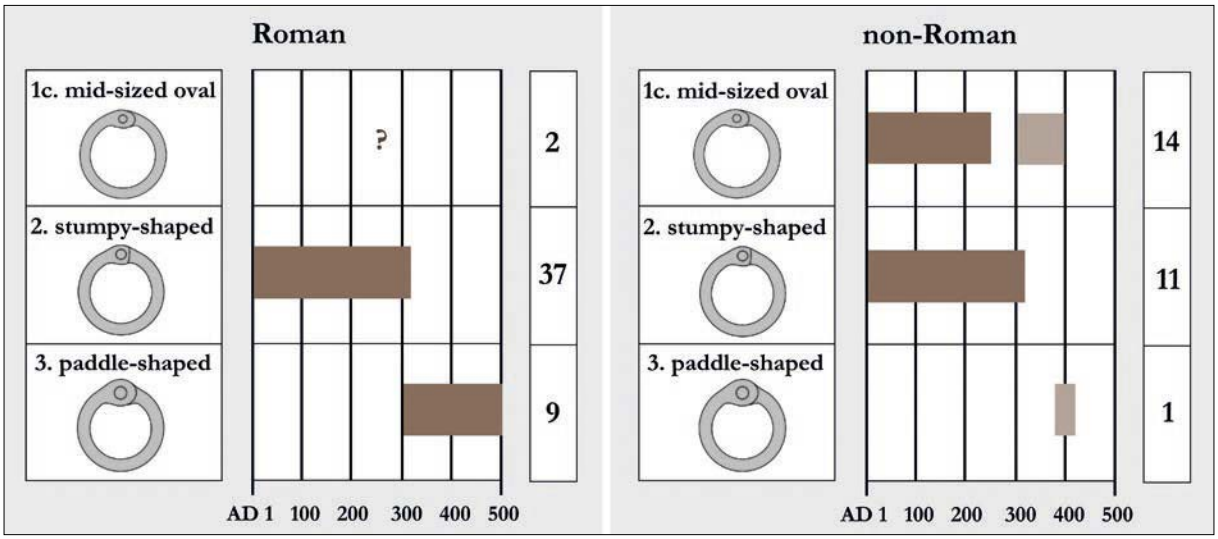


Fig. 11.27. The occurrence of overlap shape in Roman and non-Roman mail. Stumpy-shaped overlaps are found mainly during the Roman Principate, while paddle-shaped overlaps belong to the Late Roman period and continue into the Early Middle Ages. In non-Roman mail, mid-sized oval overlaps are commonly found and are likely of indigenous production, while mail with stumpy-shaped overlaps are probably of Roman origin. Dark brown: several finds of known provenance. Light brown: single find.

The oval-shaped overlap (variant 1c) is only observed twice in (probable) Roman mail. Both finds come from unknown contexts thought to date from the Roman period. The first was recovered in Mlakvena Grada, Croatia, in the 19th century and donated to the Archaeological Museum in Zagreb in 1900.[54] The second is an unprovenanced find possibly from The Netherlands (fig. 6.4).[55] Thus, mail with mid-size overlaps did not play an important role in the Roman context, if at all.

The shape of the overlap provides yet another good criterion to differentiate Roman mail of the Principate from that of Late Antiquity. The former has stumpy-shaped overlaps, while the latter contains paddle-shaped overlaps.

Outside the Roman Empire, the oval-shaped overlap (variant 1) is the most common variant (n=15). Of these, 14 finds include the mid-size oval shape (variant1c) and only the complete coat from Vimose 1 has variant 1e (fig. 11.30).[56] The rings in this garment have a very elongated overlap ending in a sharp point.

The mid-size oval variant is found in the Barbaricum from the 1st to at least the mid-3rd century AD and perhaps afterwards, but there are no well-preserved examples from this region between the 4th and 5th centuries, so no conclusions can be drawn for this period. The 4th-century unprovenanced find from Bulgaria, described above as the earliest evidence of anti-clockwise overlap variant 2, is the one possible non-Roman find of a mid-size oval overlap of a later date. The apparent absence of the mid-size oval overlap in the Roman Empire and its prevalence outside of it further strengthen the idea of an autonomous non-Roman mail production.

Mail with a stumpy overlap, prevalent during the 1st to 3rd centuries in the Roman Empire, is also found beyond the Roman Empire. There are 11 finds that share this feature and whose dates correspond with those from Roman contexts, between the 1st and the early 4rd century AD. These finds may be products of Roman manufacture; not only do they share the stumpy overlap, but also four out of the 11 finds include copper alloy rings, typical of mail associated with the Roman army. Furthermore, the

[54] Hoffiller 1912, 45.

[55] Wijnhoven 2017, 185, 193, fig. 2.

[56] Wijnhoven 2015a.

Fig. 11.28. Alfredo Mellace demonstrates here how rings can be cut from the coil with a small chisel. This method results in rings with an overlap shape found in the Roman mail of the Principate. The chisel, when sharp, will cut clean through the metal wire making an overlap with straight ends. As the chisel blunts, the end shape of the overlap changes to more rounded or pointed. During the Principate, mail has a very short stumpy overlap, probably due to how the rings were cut from the coil. On the left, the coil is opened in order to insert the chisel and make the overlap. In this manner, the length of the overlap can be as long or short as one desires. On the right, the links are cut without opening the coil. This is faster, as it omits a step, but has the disadvantage that it cuts down the length of the overlap to 2 mm, at most. The curvature of the rings does not allow a longer overlap with this method (photographs A. Mellace).

average diameter of these 11 finds, at 7.7 mm, is substantially smaller than that of mail with oval-shaped overlaps, at 10.7 mm. Earlier in this chapter it was explained that, on average, Roman rings have a smaller diameter than their contemporary non-Roman counterparts.

There also is a single occurrence of the paddle-shaped overlap outside the Roman Empire. It concerns a hoard found by a metal detectorist at Ogultsy, in the Ukraine,[57] Dated to the late 4th or early 5th century AD, the hoard included 35 Roman *denarii*, among other things. The Roman coins, together with the observation that all other contemporaneous finds with a paddle-shaped overlap come from the Roman Empire, strongly suggest this piece of mail is of Roman origin.

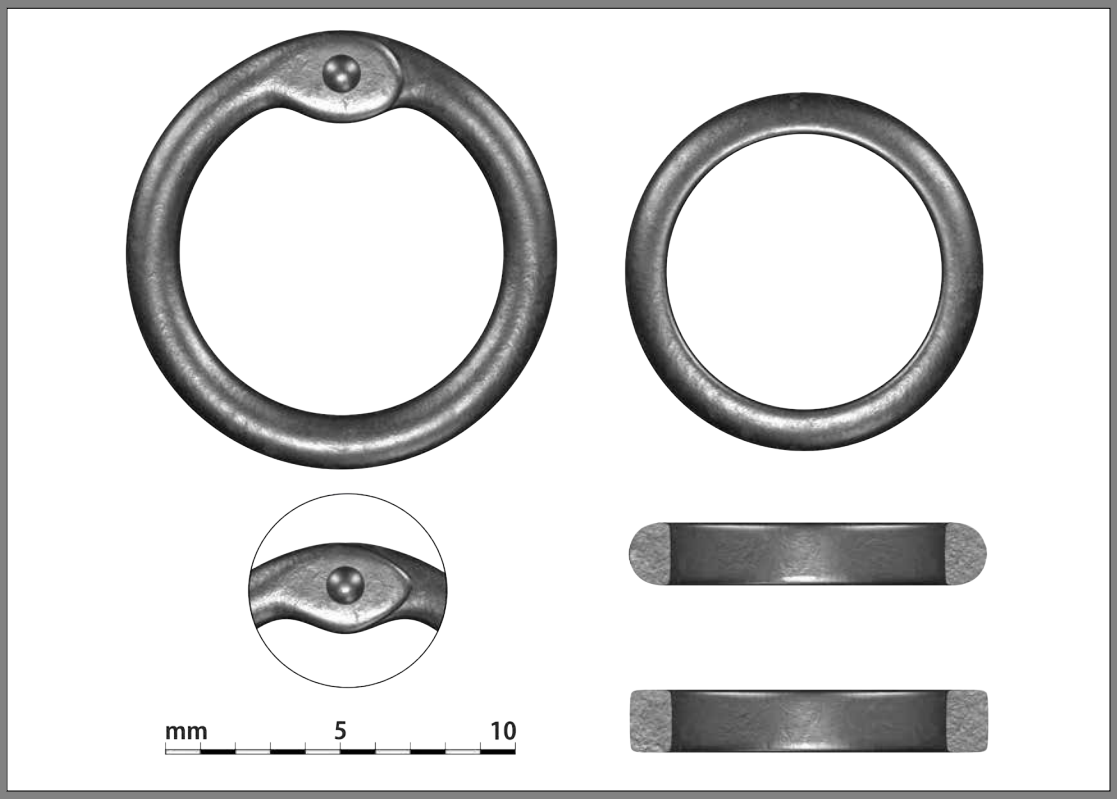
The shape of the overlap provides an additional condition to differentiate between Roman and non-Roman mail during the Principate. Roman mail has stumpy-shaped overlaps, while rings with mid-size oval overlaps are dominant outside the Empire. In Late Antiquity, Roman mail has paddle-shaped overlaps.

6th to 10th century AD

Among the finds in which the shape of the overlap was identified, only ten (partially) date to the Middle Ages. Half of them belong to the Early Middle Ages, the 6th or early 7th century, and have paddle-shaped oval overlaps. These constitute a continuation of the same mail making tradition seen during Late Antiquity, probably under the Byzantine Empire. The possible latest occurrences of the paddle-shaped overlap

[57] Shaposhnik 2010.

NON-ROMAN (1ST - 4TH CENTURY AD) – RING CHARACTERISTICS



↑↓ Fig. 11. 29. Vimose 2 mail belt, Denmark (AD 100-200). Mail from outside the Roman Empire usually has larger rings than contemporaneous examples from the Empire. The riveted rings are 12.5 mm in diameter and the solid rings measure over 10 mm. The rows of riveted rings with clockwise overlap and solid rings (variant 1) alternate throughout the item. The shape of the overlap is a mid-sized oval (variant 1c), which is the most common among non-Roman finds from this period. The overlap shape is not uniform and can differ slightly from rounded to more pointed examples. There are rivet heads on both sides of the rings (variant 1). The cross-section of the riveted rings is round (shape 1) and in some rings oval (shape 2). Two variants of solid rings are also found. The majority has a D-shaped cross-section (variant 3), but there are some rings unreworked and left rectangular (photograph M.A. Wijnhoven; drawing A. Moskvin and M. Moskvina).

NON-ROMAN (1ST - 4TH CENTURY AD) – RING CHARACTERISTICS

Fig. 11.30. Vimose 1 coat of mail, Denmark (AD 150-220). The riveted rings measure around 13 mm in diameter and the solid ones are only a fraction smaller. The riveted rings have a clockwise overlap (variant 1) whose shape is an elongated point (variant 1e). The cross-section of the riveted rings is oval (shape 2), which is the most recurrent shape during this period among non-Roman finds. The rivets have a round rivet head on both sides of the ring (variant 1), which is the norm for mail up to the 9th or 10th century AD. The cross-section of the solid rings is rectangular (variant 1). The thickness of the solid rings is larger than their width, which is a characteristic found in mail from the Barbaricum between the 1st and mid-3rd century AD. The solid rings have been reworked on the outside, possibly with a file, giving the rings a faceted appearance (drawing A. Moskvin and M. Moskvina).

Fig. 11.31. Unprovenanced 1 from Bulgaria (4th century AD). This is possibly the earliest occurrence of anti-clockwise riveted rings combined with solid rings (variant 2) during the Roman period. The rings are relatively small for the time, riveted rings measure c. 7 mm and the solid rings are slightly larger. The cross-section of the riveted rings is round (shape 1). Its overlap is mid-sized oval (variant 1c) with a rivet head on both sides (variant 1). The solid rings have a rectangular cross-section and are more wide than thick (variant 1). These rings have not been reworked after punching and are slightly conical as the result of being punched out of sheet metal (photograph M.A. Wijnhoven).

NON-ROMAN (1ST - 4TH CENTURY AD) – RING CHARACTERISTICS

Fig. 11.32. Thorsberg 10, Germany (AD 200-250). Despite the ring loss, it is clear that the mail coat is made from alternating rows of clockwise riveted- and solid rings (variant 1). The ring diameter is larger than average in the Roman Empire. Riveted rings measure c. 10 mm and the solid ones are slightly smaller. The cross-section of the wire for the riveted rings is oval (shape 2). The shape of the overlap fits the typical mid-sized oval (variant 1c). The rings are iron, but the rivets are made from a copper alloy (possibly bronze), giving a subtle contrast. The rivet heads are nicely shaped and can be observed on both sides of the rings (variant 1). The solid rings are predominantly D-shaped in cross-section (variant 3), but some of them are rectangular (thicker than wide) with a faceted surface on the outside. These rings have also been reworked but not to the extent of the D-shaped rings (photograph M. Höflinger, Museum für Archäologie Schloss Gottorf, Stiftung Schleswig-Holsteinische Landesmuseen Schloss Gottorf, Schleswig).

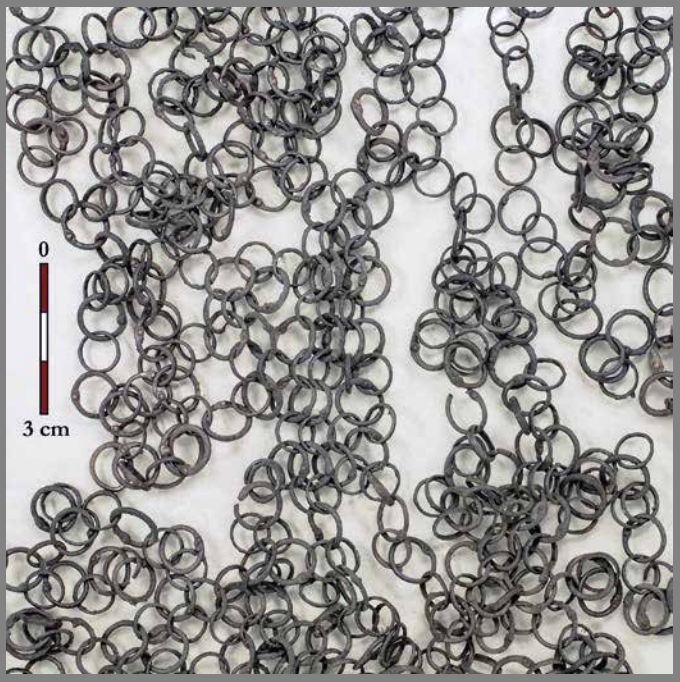


Fig. 11.33. Thorsberg 14, Germany (AD 200-250). All-riveted anti-clockwise rings (variant 3) are exclusively found in mail from Northern Europe during the Roman Iron Age, such as this specimen from the war booty site of Thorsberg. It constitutes an indigenous mail making tradition that stretches for centuries. With rings of an average diameter of 9.5 mm, they are larger than usually observed in contemporary Roman mail. The rivet heads are visible on both sides of the rings (variant 1) and vary from nicely domed to relatively flat in some rings. The shape of the overlap is mid-sized oval (variant 1c) and the cross-section of the wire is oval (shape 2) (photograph M. Höflinger, Museum für Archäologie Schloss Gottorf, Stiftung Schleswig-Holsteinische Landesmuseen Schloss Gottorf, Schleswig).

come from two finds that cannot be dated accurately. The first is a mail aventail attached to a banded helmet from Egypt, already discussed, which is thought to belong between the 4th and 7th century AD.[58] The second is a small fragment of mail from a cremation burial at Helgö in Sweden, dated to the Vendel period, approximately AD 550-790. [59] Given the date of the other paddle-shaped oval finds, both are unlikely to postdate the early 7th century, although a later date cannot be excluded.

There is no evidence for the shape of the overlap from the 7th to the 9th century, except for the mail aventail of the Coppergate helmet found at York, in the United Kingdom, dated to AD 750-775 (fig. 11.38).[60] This includes an as yet unique overlap shape (variant 1e), which can best be described as narrow oval. Future finds or careful examination of other finds of similar age could clarify whether this shape is representative for the period.

Four finds date to the 10th century AD and contain two cases of mid-size oval overlap shape (variant 1c) and two of reshaped oval (variant 1d). The former was popular outside the Roman Empire during the 1st to 3rd centuries AD. Its absence from the 4th to 9th centuries makes it impossible to determine if it is a continuation or a case of 'convergent evolution'. In the 10th century it is observed in many of the loose rings and small fragments from Birka 1 in Sweden, and in a coat of mail attributed to St. Wenceslas, now in the St. Vitus Cathedral in Prague.[61] The other two finds have a reshaped oval overlap. One is the mail coat from Gjermundbu in Norway, which uses a variant of rivets that is flush on one side and has a conical rivet head on the other side (fig. 11.39). The other is the Byzantine coat from Milhailovo in Bulgaria, of possible Northern European origin (see above),[62] which also contains conical rivet heads.

CONCLUSIONS

The shape of the overlap is the result of various steps in the mail making process and can lead to a variety of shapes. This means that this characteristic can also be diagnostic for a certain period or place of manufacture. The shape of the overlap makes it possible to identify Iron Age mail and differentiate it from Roman Imperial material. Roman mail is relatively uniform and the shape of the overlap differs between the Principate and Late Antiquity. The overlap shape also points to an autonomous mail production outside of the Roman Empire, although mail of Roman production is also found there. The Roman mail making tradition of Late Antiquity continues into the Early Middle Ages, probably through Byzantine workshops. Table 11.6 sums up the main conclusions.

58 Grancsay 1949, 276; Vogt 2003, 11, 29; 2006, 37-38, 271.

59 Fredman 1992, 23, 28, 44. These should be taken with caution, as the shape of the overlap was assessed from a drawing of the mail rings.

60 O'Connor 1983; Tweddle 1992, 929-935, 999-1009, 1057-1081.

61 Checksfield *et al.* 2012; Ehlton 2002/2003.

62 Petrov *et al.* 2015, 575-576; Vike 2000, 8-18; Zlatkov 2014.

SHAPE OVERLAP	AGE AND PROVENANCE
Variant 1a: large oval	3rd – 1st century BC
Variant 1b: triangle-shaped	3rd – 1st century BC
Variant 1c: mid-sized oval	non-Roman mail: 1st – mid-3rd century AD (and probably longer) – only one find from 4th century AD
Variant 1d: reshaped oval	10th century AD (and possibly longer)
Variant 2: stumpy-shaped	Roman mail: 1st – early 4th century AD
Variant 3: paddle-shaped	Roman mail: 4th – 5th century AD medieval mail: 6th – early 7th century AD – probably made in Byzantine workshops

Table 11.6. Age and provenance of mail based upon the shape of the overlap in riveted rings.

11.7 CROSS-SECTION OF SOLID RINGS

The shape of the cross-section of solid rings was determined on 99 finds from the database.[63] The following types of cross-section were observed:

- Variant 1: rectangular
- Variant 2: square
- Variant 3: D-shaped
- Variant 4: round (oval)

Figure 11.34 illustrates the frequency of the four cross-section shapes over time.

MAKING AND REWORKING SOLID RINGS

The shape of the cross-section of a solid ring is the result of manufacture and reworking. As discussed in chapter 8.3, rings punched from sheet metal were sometimes reworked by filing, grinding, hammering or swaging. This is most evident on rings with a D-shaped cross-section, where the belly of the D faces outwards. This profile is formed when a square or rectangular punched ring is reworked on the outside

[63] This is less than the number of riveted rings (n=117), as some mail consists entirely of riveted rings. Additionally, in some cases it became possible to determine the cross-section of only one ring type, not both.

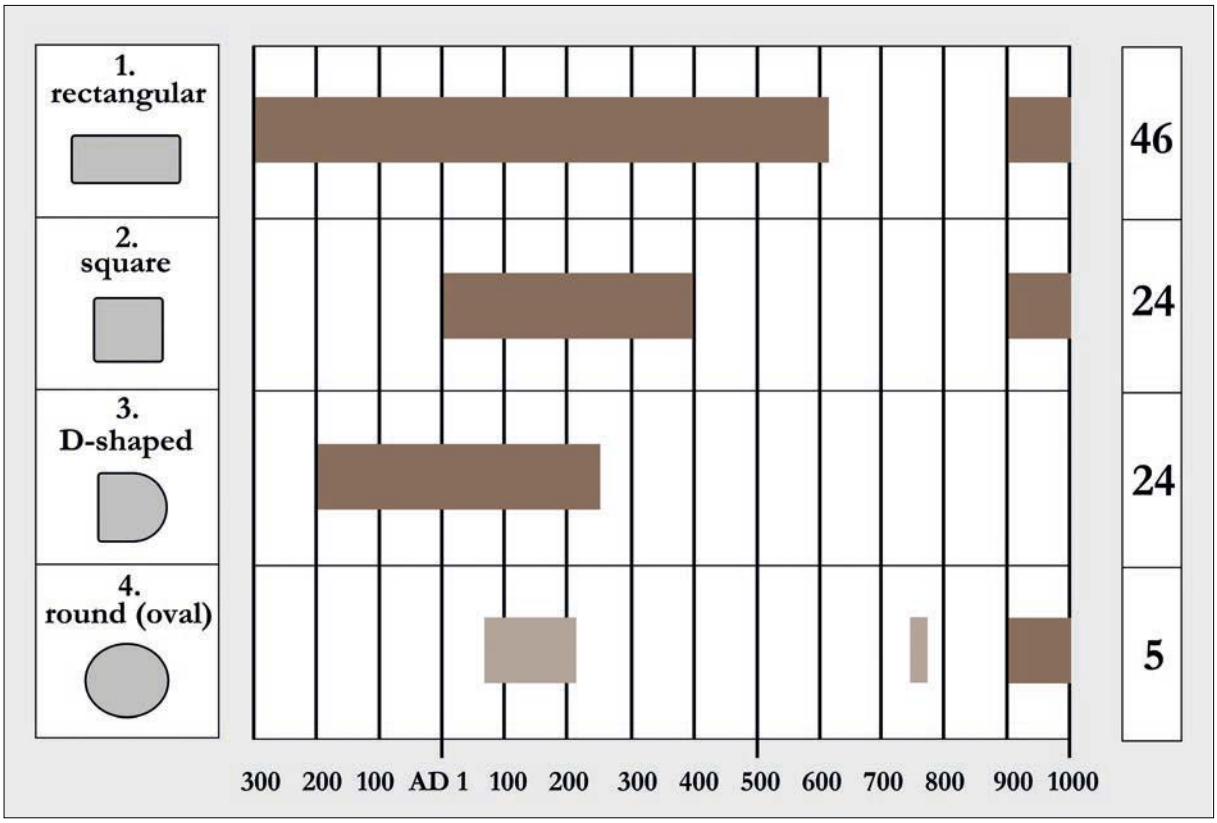


Fig. 11.34. The cross-section of the solid rings. Round-sectioned rings do not occur much during the period under discussion, although this starts to change during the 10th century. Dark brown: several finds of known provenance. Light brown: single find.

to remove sharp corners and burrs, leaving a smooth surface. D-shaped rings often retain signs of the original punching from sheet, such as leftover small burrs or metal deformations on the inside of the shank, which do not cause harm or get caught on fabric.

Rectangular and square-sectioned rings were usually not reworked after punching, which can be deduced from various preserved characteristics. First, the outer edges of these solid rings have coarse burrs. Second, the punching action has at times deformed the rings into a conical shape, especially when made from a thin metal sheet. Third, even when made of a thick sheet of metal, the rings may still get deformed at the inner and outer edges, leaving a slight ridge along one side. Burrs on the outer edges, conical deformation, and ridges are all by-products of punching from sheet metal which indicate that the rings did not undergo reworking. In some cases, rectangular and square-sectioned rings may have been lightly reworked to remove rough outer burrs and to smooth the corners, but not as extensively as to acquire a D-shape. However, wear can also soften the edges of the rings, making it hard to determine whether the shape was created by reworking or use.

The round or oval cross-section can be acquired by any of the four reworking techniques mentioned above. In addition, this profile can also be created by making a solid ring from metal wire, instead of punching, and welding it shut. It should be warned that oxidation of the edges can make square or rectangular rings look like round or oval rings, hindering identification in rings that are not well preserved.

3RD TO 1ST CENTURY BC

The cross-section of the solid rings was determined just in eight finds from this period. The majority are either rectangular (n=4) or D-shaped (n=3). Half of the finds show signs of reworking, which is self-evident in the D-shaped examples, but the rectangular solid rings of the mail from Fluitenberg also appear to have been reworked to obtain more rounded corners (fig. 11.8).[64] The rectangular solid rings from this period somewhat resemble washers, being much wider than they are thick.

The find from Faschendorf is the only one with a square cross-section, and its date is uncertain.[65] It consists of two fragments of mail recovered from a disturbed area in a Roman cemetery, located on a former La Tène D burial site. They were retrieved close to a La Tène sword, but neither were *in situ* and lack context. It has been commonly assumed that the sword and mail are contemporaneous, but the characteristics of the solid mail rings, square and unreworked, are found almost exclusively during the Roman Principate, as discussed below. On this basis, it is possible to assign a Roman provenance and date to the mail.

1ST TO 5TH CENTURY AD

The cross-section of the solid rings has been identified in 51 examples from the Roman Empire (fig. 11.35). Some of the rings have slightly rounded corners which appear to be regular wear, but reworking cannot be excluded. Only in three cases there are strong indications of reworking. The mail remains from Xanten 1, Germany, have solid rings with a D-shaped cross-section,[66] making it the only clear specimen of this variant found in a Roman context (fig. 8.18). As discussed below, D-shaped rings are much more frequent outside the Roman Empire. The other two finds with evidence of reworking come from Mlakvena Greda in Croatia and Sarry in France (fig. 11.19).[67] Both have square-sectioned solid rings reworked on the outside, probably with a file to remove burrs, giving them a somewhat faceted appearance.

Reworking the solid rings after punching them from sheet metal was certainly not the norm among the Romans. Out of 51 examples, 41 had at least one of the three characteristics of unreworked rings (outer burrs, conical deformation, and ridges). The overall impression from these rings is that they were mass-produced, with no place or time to perfect them as long as they were functional.

The most common cross-section among solid rings used by the Roman army had a rectangular profile (n=29), followed by rings with a square profile (n=21). Square-sectioned rings are observed from the 1st to the 4th century AD, while the rectangular variant is present during the entire time. In Late Antiquity, the latter can become substantially more flat than thick, resembling washers. The most extreme example is Sisak 3 with solid rings 1.1 mm thick and 2.9 mm wide (fig. 11.26). These washer-like, flat rings are not found during the Roman Principate.

The cross-section of the solid rings offers therefore a criterion to distinguish mail from the Roman Principate from that of Late Antiquity. When the rings from the Roman Empire are square-sectioned they belong to the Principate or possibly at the latest to the 4th century. When they are rectangular, they can come from the entire period. The exception are the flat washer-like and often large solid rings which date to Late Antiquity.

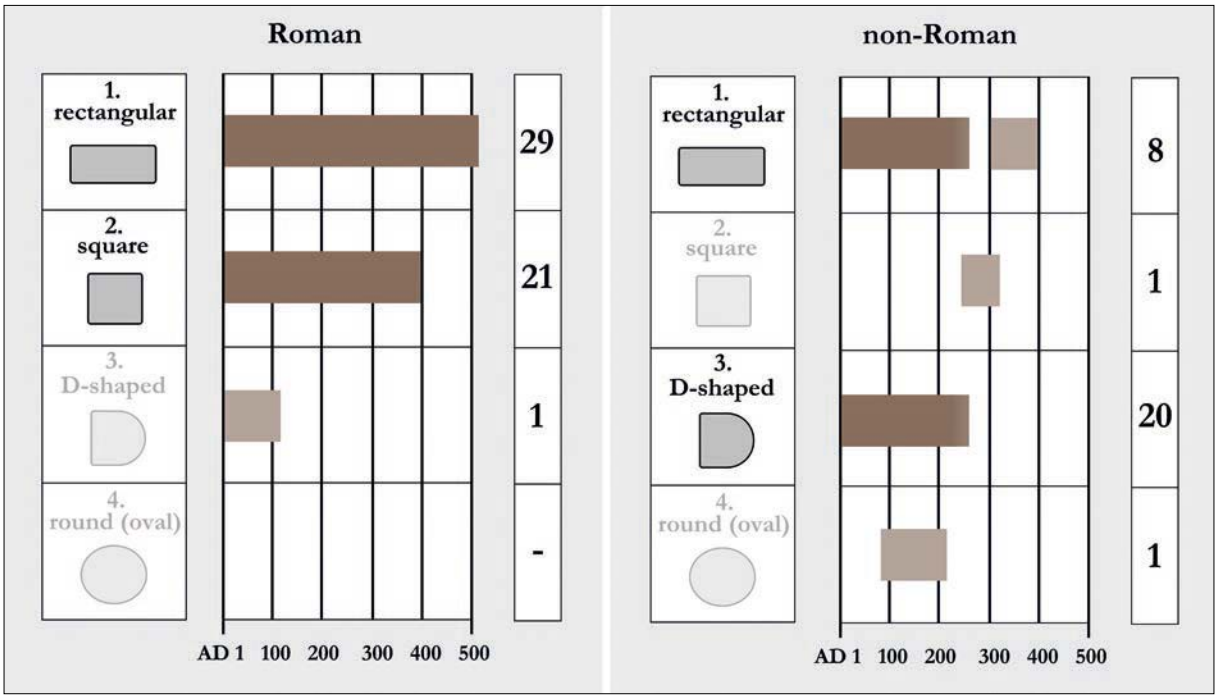
Outside the Roman Empire, the cross-section of the solid rings differs substantially. Out of a total of 30 finds, 21 have evidence of having been reworked. Although the majority concern D-shaped rings (n=20), the rectangular rings in the complete coat from Vimose 1 also show reworking in the form of

64 Wijnhoven 2010.

65 Polleres/Artner 2004, 93-94.

66 Lenz 2006, 19-20, pl. 17-18.

67 Chew 1993, 313, pl. 3.3, 4.3; Hoffiller 1912, 45.



Fig, 11.35. Comparison of the cross-section of solid rings in Roman and non-Roman mail. Rectangular and square cross-sections are found in Roman mail and are usually unreworked. In non-Roman mail, the D-shaped cross-section is the most common variant. Oval-sectioned solid rings do not occur, with one exception. Dark brown: several finds of known provenance. Light brown: single find.

file strokes that give them a faceted appearance (fig. 11.30).[68] This is in stark contrast to the unreworked Roman rings, strengthening the idea that outside the Empire, mail was a luxury product reserved for the upper layers of society. In this context the extra step of perfecting the rings, although it adds nothing to the functionality of the armour, was well worth the effort.

Interestingly, some of the finds contain solid rings of two profiles, such as the hinged mail belt from Vimose 2,[69] which mainly consists of D-shaped rings but includes unreworked rings scattered throughout the fabric (fig. 11.29). Finds from outside the Empire also contain rectangular rings (n=8) that differ from the Roman ones in one specific aspect. Roman rectangular rings are invariably wider than thick, but outside the Empire, ring thickness can exceed width, turning out cylindrical-shaped rings.

A single non-Roman example has a round cross-section. This find from Sörup 1 in Germany was discussed in chapter 8.3 as the sole metallographic evidence for welded rings during the Roman period.[70] Manufacture by welding would in fact explain the round cross-section. There is also just one find of a square cross-section, from Czaszkowa in Poland.[71] This variant is much more common among Roman finds. Moreover, the small ring diameter of 4-5 mm, the stumpy-shaped overlap in the riveted rings, and the copper alloy material all point to Roman manufacture.

D-shaped rings are found in the Barbaricum up to the mid-3rd century AD, after which there are no mail finds of good enough condition to determine the cross section. Only two non-Roman finds

68 Wijnhoven 2015a, 84.

69 Engelhardt 1869, 12, pl. 4.4.

70 Drescher 1981, 186-190.

71 Nowakiewicz/Rzeszotarska-Nowakiewicz 2012, 62-63, 128-129.

inform us of the 4th and the early 5th century: the unprovenanced 1 from Bulgaria (fig. 11.31) and the presumed Roman find from Ogultsy,[72] both mentioned before in this chapter. The earlier has unreworked rectangular rings which preserve a conical shape, and the latter has large washer-like solid rings that are common in Roman mail during Late Antiquity.

The solid rings give another criterion to distinguish Roman mail from that outside of the Empire. Square-sectioned and rectangular washer-like solid rings circulate in a Roman context and are often left without reworking. Outside the Empire solid rings are often reworked and D-shaped rings are almost exclusively found here.

6TH TO 10TH CENTURY AD

There are only twelve finds for this period, most of which (n=7) belong to the Early Middle Ages. All have a rectangular profile, demonstrating a continuity of the Late Roman tradition. Five of them may be even described as washer-shaped, with a very wide shank in proportion to thickness. The rectangular shape remains present until the early 7th century AD.

In the following centuries evidence is very slim, with only one find from the mail aventail of the Coppergate helmet (fig. 11.38). The cross-section is round and metallographic studies of this 8th century aventail have indicated that the rings were probably made by welding.[73]

Four finds belong to the 10th century, three of which have predominantly round or oval rings. Oval rings were prevalent at a workshop in Birka 1, but rectangular solid rings have also been found there.[74] St. Wenceslaus' mail coat, in Prague, has mainly round-oval sectioned solid rings, some with a clearly welded overlap, and some rings with a square section that appear to have been reworked by a file, as suggested by their faceted appearance.[75] The mail coat from Gjermundbu also has reworked square rings (fig. 11.39).[76] In this specimen, however, metallography demonstrated that the rings were punched from sheet metal and subsequently swaged to soften their corners.

From this small sample it can be concluded that the Late Roman tradition of punched, unfinished rings continued up to the beginning of the 7th century. The Coppergate find and the evidence from the 10th century show a break with this tradition and the use of round-oval sectioned rings that could be made by welding. Punching does not disappear as corroborated by the Gjermundbu coat and possibly the square sectioned rings from the St. Wenceslaus' mail coat, but the rings are now reworked.

CONCLUSIONS

The cross-section of the solid rings proves highly informative and allows to differentiate among mail making traditions. It enables Roman mail to be distinguished from its non-Roman counterpart. It also provides clues as to whether a Roman find belongs to the Principate or to Late Antiquity. Lastly, it throws light on the introduction of new mail making methods after the start of the 7th century AD. The main conclusions are summed up in table 11.7.

[72] Shaposhnik 2010.

[73] O'Connor 1992a, 1003-1009.

[74] Ehlton 2002/2003.

[75] Checksfield *et al.* 2012, 234-235.

[76] Vike 2000, 8-18.

CROSS-SECTION	AGE AND PROVENANCE
Variant 1: rectangular	3rd century BC – early 7th century AD 10th century AD
when washer-like then..	3rd – 1st century BC (may be reworked) Roman mail: 4th – 5th century AD (unreworked) medieval mail: 6th – early 7th century AD (unreworked)
when thicker than wide then...	non-Roman mail: 1st – mid-3rd century AD
Variant 2: square	Roman mail: 1st – 4th century AD (unreworked, incidentally reworked) 10th century AD (reworked)
Variant 3: D-shaped	2nd – 1st century BC non-Roman mail: 1st – mid-3rd century AD
Variant 4: round (oval)	non-Roman mail: single find AD 70-220 8th – 10th century AD

Table 11.7. Age and provenance of mail based upon the cross-section of the solid rings.

11.8 RING CHARACTERISTICS TYPOLOGY

As this chapter demonstrates, a single mail ring can be highly informative and reveal a lot about the original artefact. The small details observed in a finished ring are the result of a series of steps undertaken by the mail maker. Even when accounting for personal variation, we have shown that it is certainly possible to identify specific mail making workshop traditions. These reflect centuries of instruction from master mail makers to apprentices who learned to execute the manufacturing steps in a certain way, with certain tools, preserving this technical knowledge over generations.

The systematic examination of ring characteristics allows these mail making traditions to be recognised, providing important clues as to the age or provenance of a mail artefact. It can also offer glimpses of the role that mail armour played in society. Mail from the Iron Age and from peoples outside the Roman Empire during the Roman period (i.e. Roman Iron Age) usually displays signs of having been crafted with much care. The overlap and riveting of the rings are well executed and the sharp edges of the solid rings have been removed. This conforms with the function of mail as a high status product, accessible only to the elites. In contrast, Roman mail, particularly during the Principate, has all the signs of mass-production. The rings are roughly shaped and riveted. It is not uncommon to find deformed but functional rings, and the solid rings were seldom finished and often left crude.

To summarize, we can identify several mail making traditions in Europe. The first, during the 3rd to 1st centuries BC, shows a lot of variation, akin to a relatively new craft and especially one that catered to the elite. It alludes to the possibility of mail makers as travelling craftspeople or a small group sponsored by members of the upper layers of Iron Age society.

In contrast, the mail making tradition during the Roman Principate is very much defined by a standardisation befitting mass-production. The evidence points to the production of mail at the Roman border, probably by (ex-)Roman soldiers themselves, or workshops in the military *vici* or *canabae*. In Late

MIDDLE AGES (6TH - 10TH CENTURY AD) – RING CHARACTERISTICS

Fig. 11.36. Planig, Germany (c. AD 510). The Late Roman mail making tradition continues into the Early Middle Ages, as seen in this example and the one from Gammertingen. The only change is that the riveted rings no longer overlap clockwise but anti-clockwise (variant 2), as in all mail from the 6th century AD onwards. Otherwise it has similar features as previous mail, such as large 14 mm flattened riveted rings (shape 3b), a rivet head on both sides of the ring (variant 1), and a paddle-shaped overlap (variant 3). The solid rings have a rectangular cross-section (variant 1) and are relatively large at 10 mm (photograph M.A. Wijnhoven).

Antiquity there is a break from this tradition. Both the written sources and the archaeological evidence coincide that by then, mail armour, along with much of the military equipment, was being produced in centralised, state-governed *fabricae* located throughout the Empire.

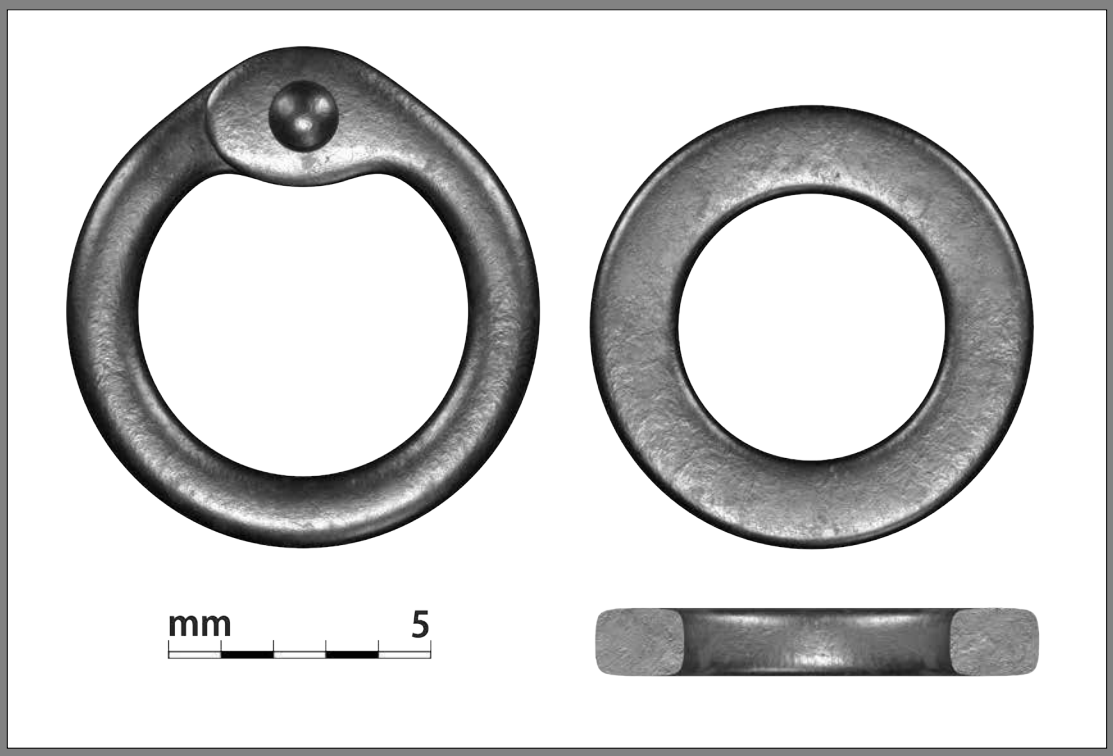
Contrary to expectations, the end of the Western Empire did not spell the end of this tradition. Around the 6th century we do see a change in the direction of the overlap of the riveted rings, suggesting some new non-Roman influences. However, most ring characteristics point to a continuation of the Late Roman tradition well into the medieval period until the start of the 7th century. This can be attributed to the influence of the Byzantine Empire, whose influence in Europe appears to dwindle at that point.

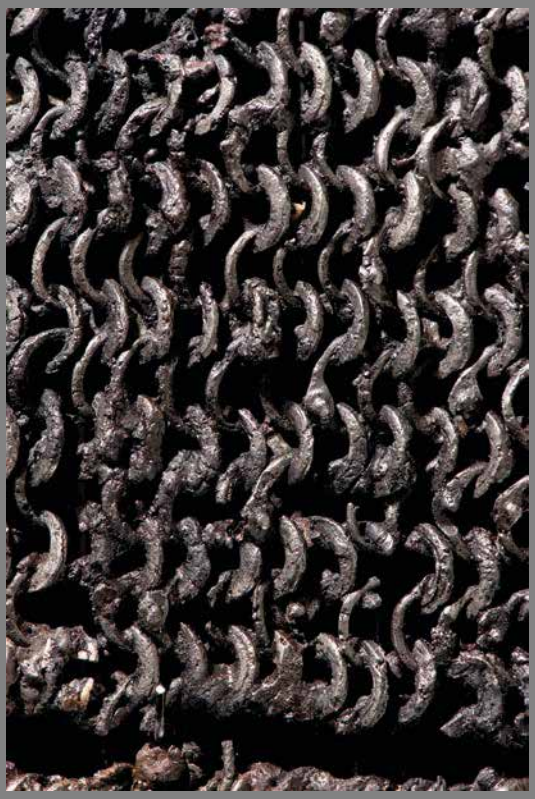
After the start of the 7th century mail finds become rare, partly due to the change in burial practices under Christianity. This makes it hard to draw conclusions for the following centuries. The scant evidence we do have seems to point towards a break and the introduction of new mail making traditions. This becomes clear in the 10th century AD, for which there are more surviving examples to inform us, but it probably started as early as the 7th or 8th century AD.

During the Roman period but outside the Empire, ring characteristics clearly indicate that not all mail was produced by the Romans. There is an autonomous indigenous mail making tradition that can be distinguished from the Roman tradition. It is interesting to note that very few finds from the Roman Empire show features of non-Roman production. This means mail garments from outside the Empire very seldom made their way into the Roman realm, whereas the opposite is not the case. In addition to indigenous production, many garments of the Roman tradition are found outside the Empire. Most likely, these can be interpreted as imports through trade, war booty, and returning veterans.

Finally, this chapter has refrained from giving a traditional typology of types and subtypes of mail rings, but instead focusses on individual characteristics. Although a traditional typology could be generated with the information here presented, it would add little to, and perhaps even obstruct, the discussion. Typologies tend to be either highly simplified for easy application, or very detailed and convoluted. Also,

MIDDLE AGES (6TH - 10TH CENTURY AD) – RING CHARACTERISTICS



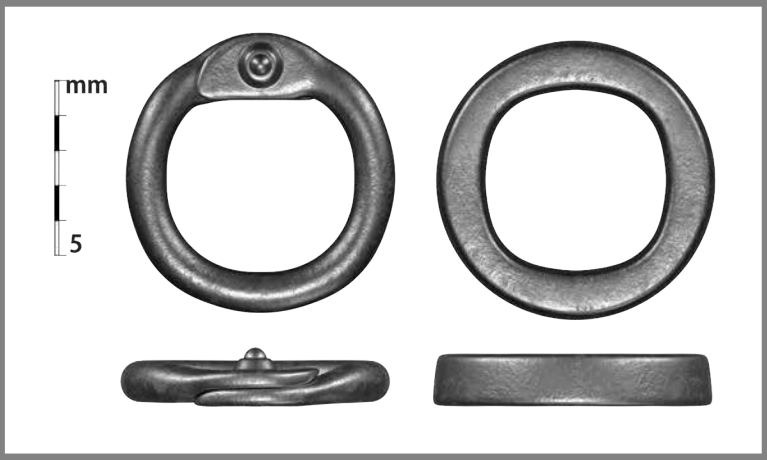


←↑ Fig. 11.37. Gammertingen, Germany (c. AD 570). The rings in this mail coat preserve many elements from the Late Roman tradition. Nonetheless, the direction of the overlap of the riveted rings is now anti-clockwise (variant 2). The size of the rings is also relatively small for the period; the riveted rings measure 9.2 mm and the solid rings 8.5 mm. The riveted rings have an oval cross-section (shape 2) somewhat flattened. Round rivet heads are found on both sides of the rings (variant 1), and the shape of the overlap is a good example of the paddle-shape (variant 3). The cross-section of the solid rings is rectangular (variant 1) with slightly rounded corners, probably the result of wear, although light reworking cannot be excluded (drawing A. Moskvin and M. Moskvina; photograph Landesmuseum Württemberg, H. Zwietasch).

MIDDLE AGES (6TH - 10TH CENTURY AD) – RING CHARACTERISTICS

← Fig. 11.38. Coppergate, York, United Kingdom (AD 750-775). Close-up of the rings of the mail neck guard, or aventail, associated to an Anglo-Saxon helmet. Small part of the helmet and cheek guard can be seen in the photograph. This is one of the few finds that informs us on the characteristics of mail rings during the 8th century AD. It clearly shows a break with the Late Roman – Early Medieval mail making tradition. The fabric is made from alternating rows of riveted anti-clockwise and solid rings (variant 2), both relatively small for the period at c. 8 mm for both types of rings. The riveted rings are no longer flattened in their entirety, giving them a round cross-section (shape 1). The overlap is oval-shaped and slim (variant 1e). The rivet heads are almost flush with the rings, and it may be an early example of variant 3 rivets that are flush on one side. The cross-section of the solid rings is round (variant 4) and metallography has indicated that they were probably made by welding (photograph York Museum Trust).

↓ Fig. 11.39. Gjermundbu, Norway (c. 10th century AD). This mail coat consists of anti-clockwise riveted rings and solid rings (variant 2). Both types are of similar size and measure approximately 8 mm in their outer diameter. The riveted rings have a round cross-section (shape 1). The shape of the overlap is a reshaped oval (variant 1d) in which the entire overlap was reshaped as a final step of riveting. The overlap is thinner than the adjacent areas of the round sectioned ring. The rivets are very pronounced. They are flush on one side of the ring (variant 3), with rivet heads of a conical shape on the other side. The conical shape is partly made from the overlap itself and partly from the rivet. The solid rings have been punched and reworked by swaging and have a square cross-section (variant 2). The mail coat must have been used intensively or for a long period. All the rings are heavily worn, which is most obvious in the squaring of the original round inner outline of both ring types (drawing A. Moskvin and M. Moskvina).



it is often difficult to decide how new evidence fits into an already existing framework, or even which typology to follow. A good example of these problems is the typology of Roman helmets and debates between followers of the British Robinson and those of the continental site-name system.[77] In mail rings, as we have seen, a change in one trait, like the direction of the overlap in the 6th century, does not prescribe change in any other traits, such as the cross-section of the rings. Traditional typologies do not usually allow for such fluidity. Moreover, a strong argument in favour of a classification of independent ring characteristics is that it can be applied even to mail with not a single well-preserved ring. As long as one or two ring characteristics can still be observed, something can be said about the armour. This inclusive approach is fit for mail as an artefact group.

The proposed framework based on ring characteristics will likely be modified and refined with new finds and more detailed information from known finds. The current structure leaves more than enough room for such adaptations.

[77] E.g. Robinson 1975, 11-144; Fischer 2019, 101-125; Junkelmann 2000; Klumbach 1974.

12 Final considerations

'The past is over, completed, and so much of it is lost in the distance. There are still traces with us, the problem is how to use these to enable us to see the past, to visit the distant past. The traces of the past which we find in the present 'belong' to time other than the present. The problem is how to relate to this otherness.'
Michael Shanks & Christopher Tilley[1]

12.1 INSIGHTS

This study has aimed to lay down a solid foundation for mail armour research which can be built upon and expanded in the future. The systematic analysis of the evidence for mail through a multi-dimensional approach has proven very productive. It has contributed to our understanding of this type of armour in much more depth and rendered the following insights concerning the four main topics of this study:

ORIGIN AND DISPERSION

There have been several suggestions concerning the predecessors of mail armour. These forerunners all have in common that they are made of (interwoven) metal rings. However, examination of these ringed artefacts demonstrates that they differ in many key aspects from mail armour. Therefore, the supposed predecessors have been called into question.

The invention of mail armour has been attributed to various archaeological cultures during the last two centuries of research. Analysis of the archaeological-, iconographical-, and written evidence makes it possible to assign its origin to the Celts (La Tène culture) around the turn of the 4th to 3rd century BC. Within La Tène society mail pertains to the elite and it is their mobility and far-reaching networks that are responsible for the rapid geographical dispersion of this new technology. Within less than a century after its invention it can be found in many parts of Europe and even beyond. This rapid dispersion makes it impossible to pinpoint the origin of mail to a single region. The earliest finds are all found more or less along the Rhine-Danube corridor, a well-known 'highway' of contact between Western and Eastern Europe from prehistory onwards.

During the 2nd century BC mail becomes somewhat more abundant in the archaeological record. It is also found outside of Europe, notably in Asia Minor and Northern Africa. It is probably also during this century that the Roman army adopted the mail coat. The 1st century BC demonstrates a steady increase in the number of finds in Iron Age societies, indicating that its use must have become slightly less exclusive.

[1] Shanks/Tilley 1992, 9.

WEARING AND NAMING

The design of the mail coat can be traced through time by looking at the representational and archaeological records. The early mail coat resembled the tube-and-yoke cuirass. This design contained two shoulder guards that as an extension of the back were fastened to the chest. Iconography shows many variants of this model, and surviving specimens of mail indeed affirm the presence of shoulder guards and fasteners. From the second half of the 1st century AD this design was increasingly abandoned and by the end of that century it finally fell out of use. From then onwards the design of all mail coats include sleeves. Initially these are relatively short, but from the 3rd century there is archaeological and iconographical evidence for full-length sleeves. During the Late Roman period the coat of mail covers a large portion of the human body, being relatively long and wide. This period also saw the introduction of a new garment, the mail coif, which protected the entire head except for the face.

Our modern idea of the coat of mail is mainly as a mere functional piece of equipment, but in reality there is more to them than sheer practicality. Many of the iron mail coats include copper alloy rings as a decorative feature. The earliest evidence for such decoration stems from the later part of the 1st century BC. The origin of the decorative use of contrasting copper alloy rings must be sought in the Roman army. The archaeological record demonstrates that especially the Roman army frequently invested in this type of embellishment.

The use of a padded garment underneath metal armour is well-established practice for medieval times, but less acknowledged for the Roman period and the Iron Age. The combined insights from (experimental) archaeology, iconography and written sources demonstrate that such padded garments were also common in antiquity. This garment could be worn separately underneath the mail coat, but could also be integrated by sewing it to the mail rings. The available evidence indicates that a variety of materials was used to create these garments, such as felt, quilted textiles and leather.

Lastly, various terms found in classical written sources have been proposed to refer to mail armour. The most popular of these, *lorica hamata*, is nowadays understood as *the* ancient term for a mail coat. An analysis of the occurrence of this term, the type of sources and its contextual consistency indicates that *lorica hamata* was not a standard expression. It must rather be understood as a loose description, mainly found in poetical works to highlight a certain characteristic of an armour. This could be mail, but in many cases could also be interpreted as scale armour. It appears that in antiquity there either was no standardised term for mail armour, it was never written down, or the written sources with the appropriate term(s) simply didn't survive into modernity.

TECHNICAL DETAILS

Sources that inform us about the craft of early mail making are few and far between. For antiquity, there is not even a single text or depiction of mail manufacture. Therefore, we must look at other periods that offer more information such as the Late Middle Ages and the Early Modern period. Piecing together this evidence makes it possible to get an idea of the tools used in a mail workshop and understand the *chaîne opératoire* from raw material to finished rings.

Iron wire production has been widely discussed, particularly whether and how it was possible to draw iron prior to the Late Middle Ages. A systematic analysis shows that almost all wire employed in mail armour is made either made by wire-drawing or by strip-drawing. Throughout history, the two traditions existed side by side. The co-existence of these traditions could be due to a divergent scale of production with smaller workshops relying more on strip-drawing that required rudimentary tools, while larger or more specialised workshops were be able to invest in the mechanical aids needed for iron wire drawing.

Another point of discussion has been the manner in which solid rings are produced. Two methods have been suggested in the past: punching from sheet metal and forge welding. This study concludes that both traditions co-existed, although the dominant tradition in Europe was the punched method, also during antiquity. Just as with wire-making, the choice of one over the other is likely related to the size and level of specialisation of the workshop. Larger and more specialised workshops can afford the specialised tools needed for punched rings, while smaller and less specialised workshops would opt for producing solid rings through forge welding.

The literature describes besides riveted and solid rings, the use of butted rings. These rings are simpler to make, but structurally weak. Especially Iron Age mail has often been considered butted, considering the evolution of mail from simple butted rings towards more complex riveted and solid rings. A reassessment of the finds described as butted proves that this notion is incorrect. From the start onwards mail always consisted of riveted and solid rings. There are three exceptions where butted mail is found: as decorative elements without structural function; as repairs; and as imitations of desirable objects when the knowledge to make true mail armour was still limited.

Metal rings can be woven together in many ways to form a mesh and the possibilities are almost limitless. Nevertheless, mail in Europe is almost exclusively woven in a 4-in-1 pattern. This pattern is able to stretch with the wearer making it comfortable to wear. The 4-in-1 pattern offers a good balance between the protection, weight, and unobstructed mobility, which explains why this pattern has been so prevalent throughout the centuries.

Besides the weaving pattern, mail makers can use constructional techniques to tailor the mail coat. Our understanding of these techniques and their application is much better for well-preserved mail from the Late Middle Ages onwards. It is clear that by then mail garments contained a wide variety of construction techniques to tailor them. However, the examination of mail from the Late Iron Age and Roman period shows that most of these techniques are absent in antiquity. This should not be understood as a lack of ability or knowledge, but the result of the cultural context in which the mail coat was created. The design of the mail coat reflects that of civilian textile clothing throughout history. Since clothing during the Late Iron Age and Roman period had little to no tailoring, this is also absent in mail armour. By looking at the development of textile clothing it is possible to make predictions of the moment of introduction of constructional techniques in mail armour.

The steps taken by the mail maker and the tools he uses will result in mail rings with slightly different characteristics. Many of these prove to be diagnostic for a certain period or region, which is especially useful for finds without a context. The ring characteristics allow us to identify different mail making traditions. The first, during the 3rd to 1st centuries BC, shows a lot of variation, akin to a new craft. In contrast, the mail making tradition during the Roman Principate is very much defined by standardisation, befitting mass production. In the Late Roman period there is a break from this tradition. Both written sources and the archaeological evidence coincide that by then much of the mail armour was being produced in centralised state-governed factories located throughout the Empire. Contrary to expectations the end of the Western Empire did not mean the end of this tradition. The Late Roman tradition continues into the Early Middle Ages, probably through the Byzantine Empire, until the start of the 7th century AD. From here on mail becomes scarce in the archaeological record. The few finds point to a break from the Late Roman tradition. Returning to the Roman period, but outside the Empire, ring characteristics clearly indicate the presence of an autonomous indigenous mail making tradition that can be distinguished from the Roman one.

During the Iron Age mail is most often found in a funerary context, especially in Eastern Europe. The grave inventories indicate that the practice of depositing mail in burials was not for everyone, but exclusive to an elite. Mail armour was part of a set of high-status grave goods that identified a deceased individual as a warrior from the top social strata. The fact that the accompanying grave goods were quite uniform all across Europe reinforces the idea of long-distance networks and high mobility among the upper layers of society.

Mail armour finds are mostly absent for the Roman Republic. The low number of finds should not be taken for an absence of armour, but rather the absence of deposition practices that would have allowed mail to become more visible in the archaeological record. Insights into these practices, combined with written sources and iconography indicate the use of mail armour. While it was still an exclusive item of *militaria* in the 2nd century BC, this was no longer so during the 1st century BC.

From the Early Principate onwards the archaeological evidence of mail becomes very abundant. This is due to an unique combination of factors. There is the location of permanent military forts along the northern Roman border, located far away from traditional production centres. In order to mitigate this the Roman army became self-sufficient in the production of military equipment, including mail armour. It is clear that (ex-) soldiers played an essential role in this production, providing its main labour force. Mail armour of the Principate was mass-produced and hence accessible to all soldiers in the Roman army with a tactical function that required (mail) armour. The army not only produced, but also recycled the military equipment when no longer serviceable. The disposal of scrap metal upon abandonment of a military fort accounts in large part for the observed abundance of military equipment in the archaeological record.

The traditional view is that the heavily armoured infantrymen of the Principate were replaced by lightly armoured foot soldiers in Late Antiquity. There are indeed much less finds of mail armour for this period. However, the distribution and contexts of Late Roman mail suggest that the processes behind the deposition differed substantially from previous centuries. These changes also explain the marked decline in the number of finds. Large part of the military equipment was now produced in central state factories in the hinterland of the Roman Empire. Mail continues to be mass-produced and accessible to many in the Roman army.

The idea that all mail from the Barbaricum must be of Roman production has long predominated. Only recently has the all-Roman provenance of mail been questioned, and the possibility of autonomous native Germanic manufacture been reconsidered. The collective evidence presented in this study, indeed, demonstrates that there was an indigenous mail production in the Barbaricum.

The grand majority of mail found outside the Roman Empire comes from burials. And although mail is commonly associated with men, the archaeological record offers many examples where mail is found in burials of women or children. These burials do not have a martial character: their grave inventories do not contain any other item of *militaria* and the mail remains only concern one or several small fragments and not a complete garment. These small fragments must probably be understood as apotropaic objects to deter danger or evil in life or in (the journey towards) the afterlife. It then seems that mail armour had transcended its status as an actual protective object and took on a symbolic protective function in the social and ritual spheres as well.

The case of the female and infant graves clearly shows that the presence of mail does not necessarily mark the deceased out as a warrior. This also applies to male burials. Analysis of the grave goods in male burials demonstrates that it had two main manifestations. The first resembles the burials of women and infants, and involves graves of a non-martial character. These weaponless graves normally contain only one or a handful of small mail fragments. Contrarily, in the second manifestation the body is accompanied by various military objects, often forming a complete warrior's panoply. These grave goods portray the deceased as a military man and the mail garment is almost always complete when placed in the grave.

The weapon graves with mail indicate that this piece of military equipment pertained only to the socio-economic elite. All burials are richly furnished, often both the quantity and the quality of the objects accompanying the body are very high. However, the weaponless graves with one or several small mail fragments appear to belong to a different social tier. Taken together, the grave goods can still represent a considerable value, but they do not reach the levels of the average weapon grave. The practice of accompanying the deceased with one or several fragments of mail in weaponless graves is clearly aimed at a different social stratum than the weapon graves.

12.2 PROSPECTS

Several lines of investigation remain relatively unexplored and may prove fruitful eventually. This study introduces a new standard for the description and examination of mail armour, which should prove useful for future research.

Although the scope of this work is wide, it has focused on Europe and its adjacent regions up to the 10th century AD. Consequently, it has omitted the long period from the 11th century until the demise of mail armour in the Early Modern period and, it has said little about non-European societies where mail also played an important role. So, in spite of the present effort to integrate all the information currently available for our topic, a systematic analysis of mail from other periods and/or societies is still lacking.

Similarly, mail studies have yet to make the most of the application of scientific techniques, especially for archaeological mail in a condition that does not allow for direct visual clues. These techniques can reveal much about the *chaîne opératoire* of mail production across times and geographies, and about the characteristics of the armour itself. Such tools therefore have the potential to broaden our perception of mail armour and the societies in which it was made and used.

Most contemporary mail makers produce garments for historical re-enactment, educational purposes, or out of personal interest. There is much we can learn from their knowledge and skill to widen our scientific understanding of mail. However, to harness this information we need to develop a theoretical framework that can take it from the sphere of recreation to the level of experimental archaeology.[2]

Two relatively new avenues for the examination of archaeological artefacts are digital reconstruction and computer simulation (fig. 12.1). When done accurately, using available archaeological data, three-dimensional reconstructions allow us not only to visualise what an object would have looked like originally, but also to test it in a virtual environment in order to assess its physical and mechanical properties.[3] The fragility and state of conservation of archaeological artefacts make it impossible to carry out physical and mechanical tests on the actual objects. A virtual environment offers a good alternative to discover aspects of the artefact that would otherwise remain unknown. The first attempts to apply these technologies to mail armour are promising.[4]

12.3 METHODOLOGICAL POTENTIAL

Since corroded or fragmented mail does not make for an aesthetically pleasing object, particularly compared to artefacts like swords or helmets, it does not feature prominently in museum displays and non-scientific publications. In addition, archaeological mail has conventionally been deemed relatively

2 Cf. Koepfer *et al.* 2011.

3 Such virtual tests are being increasingly applied in the fashion industry prior to production.

4 Wijnhoven/Moskvin 2020; Wijnhoven *et al.* 2020.

Fig. 12.1. Digital reconstruction of a Germanic warrior from the 2nd to 4th centuries AD wearing the coat of mail from Vimose. Each of the 19,123 rings originally present in the coat of mail has been recreated and digitally woven into a mesh. In order to understand the coat and its performance, a complete warrior panoply was reconstructed using archaeological data. The warrior wears a tunic and trousers from Thorsberg, shoes from Obenaltendorf, and a belt with personal objects from Illerup Ådal. Underneath his armour there is a padded felt garment made according to specifications from the Byzantine military manual *Peri strategias* (digital reconstruction A. Moskvin/M. Moskvina).

uninformative. This is partly due to the fact that many specimens are in such bad condition that they indeed can give very little information about, for instance, stylistic traits of the overall object, which is what historical studies usually focus on.

The study of arms and armour has traditionally revolved around historical artefacts from the European High Middle Ages and after, which are often in good condition and lend themselves well to stylistic analyses. Even in archaeological studies of military equipment, where it is usual to deal with incomplete or damaged artefacts, the predominant interest is on style, as revealed by the heavy focus on typology. Often, these kinds of studies do not go beyond the description and classification of artefact groups, failing to situate them in a broader context.

While relevant in themselves, stylistic and typological studies are but a first step in the scientific process and should not be the *sole* strategy to research archaeological mail armour, or any other artefact group for that matter. The present volume has demonstrated that there is a lot to be inferred and explained by applying a multi-dimensional methodology to the study of mail. This approach can yield a wealth of information through the systematic analysis of all the available sources[5] over a long period of time and across different cultures at various scales. It has also shown that to gain new insights on this material we do not need new evidence, but only looking at the abundance of existing data in a detailed and structured manner can already suffice.

Therefore, the multi-dimensional approach presented here holds much potential for archaeological and historical research, especially in material studies. It is certainly not limited to the realm of military equipment studies and may be applied to any artefact category. It is my hope that this book will serve as an example of its potential.

[5] E.g. archaeological, iconographic, written, experimental, scientific, and even ethnographic.

Bibliography

CLASSICAL, MEDIEVAL AND EARLY MODERN SOURCES

Aldhelm, *Enigmata*, transl. M. Lapidge/J.L. Rosier, 1985: *Aldhelm. The poetic works*, Woodbridge.

Ammianus Marcellinus, *Res gestae*, ed. and transl. J.C. Rolfe, 1950: *Ammianus Marcellinus. History. Volume I: books 14-19*, Cambridge.

Arrian, *Tactica*, ed. and transl. K. Brodersen, 2017: *Arrianos/Asklepiodotos. Die Kunst der Taktik*, Berlin.

Beowulf, transl. S. Heaney, 2000: *Beowulf. A new verse translation*, New York.

Biringuccio, V., *De la pirotechnia*, transl. C.S. Smith/M.T. Gnudi, 1942: *The pirotechnia of Vannoccio Biringuccio*, New York.

Cassius Dio, *Historia Romana*, eds and transl. E. Cary/H.B. Foster, 1927: *Dio Cassius. Roman history. Volume IX: books 71-80*, Cambridge.

Caesar, *Commentarii de bello civili*, ed. and transl. A.G. Peskett, 1957: *Caesar. The civil wars*, London.

Claudian, *In Rufinum*, ed. and transl. J.-L. Charlet, 2000: *Claudien Ouvres* vol. 2, Paris; ed. and transl. M. D'Hane-Scheltema, 2008: *Claudius Claudianus verzamelde gedichten*, Amsterdam.

Claudian, *Panegyricus*, ed. and transl. J. Henderson, 1911: *Claudian I*, Cambridge.

Cornelius Nepus, *Iphicrates*, ed. and transl. J.C. Rolfe, 1929: *Cornelius Nepus. On great generals. On historians*, Cambridge.

De rebus bellicis, ed. and transl. R. Ireland, 1979: *De rebus bellicis. Part 2: the text*, Oxford; ed. and transl. R. Schneider, 1908: *Anonymi. De rebus bellicis*, Berlin.

Diodorus Siculus, *Bibliotheca historica*, ed. and transl. C.H. Oldfather, 1939: *Diodorus Siculus. Library of history. Volume III: books 4.59-8*, Cambridge.

Fronto, *Ad verum imperator*, ed. and transl. C.R. Haines, 1920: *Fronto. Correspondence* vol. 2, Cambridge.

Isidore of Seville, *Origines*, ed. and transl. M. Chassignet, 1986: *Caton. Les origines. Fragments*, Paris.

Josephus, *Antiquitates Iudaicae*, ed. and transl. R. Marcus, 1934: *Josephus. Jewish antiquities. Volume III: books 7-8*, Cambridge.

Kiel, C., 1632 [1599]: *Etymologicum teutonicae linguae*, Amsterdam.

Lucan, *Bellum civile*, ed. and transl. A. Bourgery, 1948: *Lucain. La guerre civile (La Pharsale)* vol. 2, Paris; ed. and transl. P.H. Schrijver, 2013: *Lucanus. Burgeroorlog*, Amsterdam.

Mancini, D., *De occupatione regni Anglie per Riccardum tercium*, ed. and transl. C.A.J. Armstrong, 1936: *The usurpation of Richard the third. Dominicus Mancinus ad angelum catonem de occupatione regni Anglie per Riccardum tercium libellus*, Oxford.

Martianus Capella, *De nuptiis Philologiae et Mercuri*, ed. and transl. W.H. Stahl/R. Johnson/E.L. Burge, 1971-1977: *Martianus Capella and the seven liberal arts*, New York.

Maurice, *Strategikon*, ed. and transl. G.T. Dennis, G.T., 1981: *Das Strategikon des Maurikios*, Wien; 1984: *Maurice's Strategikon. Handbook of Byzantine military strategy*, Philadelphia.

Notitia dignitatum, ed. O. Seeck, 1876: *Notitia dignitatum*, Berlin.

Paternus, *Digesta seu Pandectae*, ed. and transl. H. Hulot, 1805: *Les cinquante livres du Digeste* vol. 7, Paris.

Pausanias, *Graeciae descriptio*, ed. and transl. H.L. Jones, 1935: *Pausanias. Description of Greece. Volume IV: books 8.22-10*, Cambridge.

Peri strategias, ed. and transl. G.T. Dennis, 1985: *Three Byzantine military treatises*, Washington.

Pliny, *Naturalis historia*, ed. and transl. H. Rackham, 1956, 1961: *Pliny. Natural history* vol. 3 and 5, London.

Polybius, *Historiae*, ed. and transl. W.R. Paton, 1960, 1966: *Polybius. The histories* vols. 3 and 6, Cambridge.
Procopius, *De bello Vandalico,* ed. and transl. H.B. Dewing, 1916: *Procopius. History of the wars, volume II: books 3-4 (Vandalic war)*, Cambridge.
Sachs, H./J. Amman, 1568: *Eygentliche Beschreibung aller Stände auff Erden, hoher und nidriger, geistlicher und weltlicher, aller Künsten, Handwerken und Händeln, etc. vom grösten biß zum kleinesten, auch von ihren Ursprung, Erfindung und Gebreuchen*, Frankfurt.
Scriptores historiae augustae, ed. and transl. D. Magie, 1921, 1924, 1932: *Historia augusta* vol. 1-3, Cambridge.
Sidonius Apollinaris, *Carmina*, ed. and transl. W.B. Anderson, 1963: *Sidonius. Poems and letters* vol. 1, London; ed. and transl. A. Loyen, 1960: *Sidoine Apollinaire* vol. 1, Paris.
Silius Italicus, *Punica*, ed. and transl. Duff, 1927: *Silius Italicus. Punica* vol. 1, London; ed. and transl. P. Miniconi, 1979-1981: *Silius Italicus. La guerre Punique*, Paris; ed. F. Spaltenstein, 1986: *Commentaire des Punica de Silius Italicus (livres 1 à 8)*, Lausanne.
Statius, *Thebaid*, ed. and transl. D.R. Shackleton Bailey, 2003a: *Statius. Thebaid, Books 1-7*, Cambridge.
Statius, *Achilleid*, ed. and transl. D.R. Shackleton Bailey, 2003b: *Statius. Thebaid, Books 8-12 Achilleid*, Cambridge.
Strabo, *Geographica*, ed. and transl. H.L. Jones, 1923: *Strabo. Geography. Volume II: books 3-5*, Cambridge.
Suetonius, *De vita caesarum*, ed. and transl. J.C. Rolfe, 1914: *Suetonius. Lives of the caesars*, vols. 1 and 2, Cambridge.
Tacitus, *Annales*, transl. J.C. Yardley, 2008: *The Annals. The reigns of Tiberius, Claudius and Nero*, Oxford.
Tacitus, *Germania*, transl. A.R. Birley, 1999: *Tacitus. Agricola and Germany*, Oxford.
Theophilus, *De diversis artibus*, transl. J.G. Hawthorne/C.S. Smith, 1979: *Theophilus on divers arts. The foremost medieval treatise on painting, glassmaking and metalwork*, New York.
Valerius Flaccus, *Argonautica*, ed. and transl. P. Dräger, 2003: *C. Valerius Flaccus. Argonautica/Die Sendung der Argonauten*, Frankfurt am Main; ed. and transl. J.H. Mozley, 1963, *Valerius Flaccus*, Cambridge.
Varro, *De lingua Latina*, ed. and transl. J. Collart, 1954: *Varron. De lingua latina livre V*, Paris; ed. and transl. R.G. Kent, 1967: *Varro on the Latin language*, London.
Vegetius, *De re militari*, transl. J. Clarke, 2013 [1767]: *Flavius Vegetius Renatus. On Roman military matters*, St. Petersburg; transl. N.P. Milner, 1996: *Vegetius. Epitome of military science* (2nd ed.), Liverpool.
Virgil, *Aeneid*, ed. and transl. H.R. Fairclough, 1999-2000: *Virgil. Aeneid*, London; N. Horsfall, 2006: ed. and transl. *Virgil. Aeneid 3. A commentary*, Leiden; ed. and transl. J. Perret, 1977-1978: *Virgile. Énéide*, Paris.
Weigel, C., 1698: *Abbildung der gemeinnützlichen Hauptstände von denen Regenten und ihren so in Friedens- als Kriegszeiten zugeordneten Bedienten an, biß auf alle Künstler und Handwercker*, Regensburg.

MODERN SOURCES

Abrahams, E.B., 1908: *Greek dress. A study of the costumes worn in ancient Greece, from the pre-Hellenistic times to the Hellenistic age*, London.
Absolon, T., 2017: *Samurai armour. Volume I: the Japanese cuirass*, Oxford.
Abwegg-Wigg, A./A. Rau (eds), 2008: *Aktuelle Forschungen zu Kriegsbeuteopfern und Fürstengräbern im Barbaricum*, Neumünster.
Adams, N., 2010: Rethinking the Sutton Hoo shoulder clasps and armour, in C. Entwistle/N. Adams (eds), *'Intelligible beauty'. Recent research on Byzantine jewellery*, London, 83-112.
Adler, W., 1993: *Studien zur germanischen Bewaffnung. Waffenmitgabe und Kampfesweise im Niederelbegebiet und im übrigen Freien Germanien um Christi Geburt*, Bonn.
Agre, D., 2006: Royal grave from the mid-4th century B.C. from a tumulus near the village of Malomirovo-Zlatinitsa, Yambol Region, in M. Reho/P. Ilieva (eds), *Thracian treasures from Bulgaria*, Czech Republic, 179-183.

Agre, D., 2011: *The tumulus of Golyamata Mogila near the villages of Malomirovo and Zlatinitsa*, Sofia.
Ahmad, N., 2017: The Sogdian heavy cavalryman. Traded wealth, *Ancient Warfare* 11 (1), 24-25.
Akerraz, A./S. Camporeale/E. Papi (eds), 2013: *Sidi Ali Ben Ahmed – Thamusida 3. I materiali*, Roma.
Aldrete, G.S./S. Bartell/A. Aldrete, 2013: *Reconstructing ancient linen body armor. Unraveling the linothorax mystery*, Baltimore.
Alexander, D.G., 1985: Decorated and inscribed mail shirts in the Metropolitan Museum, *Waffen- und Kostümkunde. Zeitschrift der Gesellschaft für historische Waffen- und Kostümkunde* 27 (1), 29-36.
Alexander, D.G., 2015: *Islamic arms and armor in the Metropolitan Museum of Art*, New York.
Alexandrescu, C.-G., 2010: *Blasmusiker und Standartenträger im römischen Heer. Untersuchungen zur Benennung, Funktion und Ikonographie*, Cluj-Napoca.
Alfs, J., 1941: Der bewegliche Metallpanzer im römischen Heer. Die Geschichte seiner Herkunft und Entwicklung, *Zeischrift für historische Waffen- und Kostümkunde* (Neue Folge) 7, 69-126.
Allason-Jones, L., 2009: The small finds, in A. Rushworth (ed.), *Housesteads Roman fort – the grandest station. Excavation and survey at Housesteads, 1954-95 by Charles Daniels, John Gillam, James Crow and others*, Swindon, 430-487.
Allason-Jones, L./M.C. Bishop, 1988: *Excavations at Roman Corbridge. The hoard*, Nottingham.
Amborn, H., 1976: *Die Bedeutung der Kulturen des Niltals für die Eisenproduktion im subsaharischen Afrika*, Wiesbaden.
Anderson, A.S., 1984: *Roman military tombstones*, Aylesbury.
Androshchuk, F.O., 2013: Essays on contact along the road to Byzantium (800-1100), Uppsala.
Appels, A./S. Laycock, S., 2007: *Roman buckles and military fittings*, Essex.
Arentzen, W., 2005: *Janssiana I. De verzameling van L.J.F. Jansen*, Utrecht.
Arik, R.O./J. Coupri, 1935: Les tumuli de Karalar et la sépulture du roi Déiotaros II, *Revue Archéologique* 6, 133-151.
Arkell, A.J., 1956: The making of mail at Omdurman, *Kush. Journal of the Sudan Antiquity Service* 4, 83-85.
Arnold, J., 1993: The jupon or coat-armour of the Black Prince in Canterbury Cathedral, *Journal of the Church Monuments Society* 8, 12-24.
Arnswald, T., 2004: Einige Betrachtungen zum Arbeitsablauf und über die benötigten Werkzeuge zur Herstellung von Ringpanzerzeug des Spätmittelalters, *Waffen- und Kostümkunde. Zeitschrift der Gesellschaft für Waffen- und Kleidungsgeschichte* 46 (1), 37-40.
Arntz, M./M. Lewis (eds), 2020: *The chaîne opératoire. Past, present and future*, Cambridge.
Articus, R., 2004: *Das Urnengräberfeld von Kasseedorf, Lkr. Ostholstein. Die Entwicklung des südöstlichen Schleswig-Holstein während der jüngeren römischen Kaiserzeit*, Rahden.
Arwidsson, G., 1934: A new Scandinavian form of helmet from the Vendel-time, *Acta Archaeologica* 5, 243-257.
Arwidsson, G., 1942: *Valsgärde 6. Die Gräberfunde von Valsgärde I*, Uppsala.
Arwidsson, G., 1954: *Valsgärde 8. Die Gräberfunde von Valsgärde II*, Kopenhagen.
Arwidsson, G., 1977: *Valsgärde 7. Die Gräberfunde von Valsgärde III*, Uppsala.
Askew, G.N./F. Formenti/A.E. Minetti, 2012: Limitations imposed by wearing armour on medieval soldiers' locomotor performance, *Proceedings of the Royal Society B: Biological Sciences* 279, 640-644.
Atanassov, G., 1992: Съоръжения от III-II в. пр. н. е. от околностите на с. Кълново, Шуменско, *Jahrbuch des Historischen Museums Schumen* 7, 5-44.
Aubert, A., 1857: *Monographie de la commune de Juvigny*, Châlons-sur-Marne.
Aurrecoechea Fernández, J., 2006: Talleres dedicados a la producción de equipo militar en los campamentos romanos de León, con especial referencia a los restos de lorica segmentata, in Á. Morillo (ed.), *Arqueología militar romana en Hispania II. Producción y abastecimiento en el ámbito militar*, León, 309-334.
Aurrecoechea Fernández, J., 2010: Las armaduras romanas en Hispania. Protectores corporales para la infantería y la caballería, *Gladius* 30, 79-98.

Baatz, D., 1963/1964: Die Grabungen im Kastell Echzell 1962, *Saalburg Jahrbuch* 21, 32-58.
Bader, T., 2000/2001: Geschichte und Stand der Forschung der Bronzezeit und Eisenzeit, in M. Rotea/T. Bader (eds), *Thraker und Kelten beidseits der Karpaten*, Eberdingen, 11-20.
Bader, T., 2012: Meine Begegnungen mit den Keltenfürsten. Am Beispiel der Fürstengräber von Ciumeşti und Hochdorf, in S. Berecki (ed.), *Iron Age rites and rituals in the Carpathian Basin. Proceedings of the International Colloquium from Târgu Mureş: 7-9 Oktober 2011*, Târgu Mureş, 279-292.
Bailly, A., 1978: Des armes romaines dans le lit de la Saône, *Archéologia* 122, 52-56.
Bakker, L., 1985: Militärische Funde aus Augusta Vindelicum, in *Die Römer in Schwaben. Jubiläumausstellung 2000 Jahre Augsburg*, München, 90-94.
Barbour, J., 1906/1907: Notice of a stone fort near Kirkandrews in the parish of Borgue, Kirkcudbright, recently excavated by James Brown, *Proceedings of the Society of Antiquaries of Scotland* 41, 68-80.
Bârcă, V., 2006: *Istorie şi civilizaţie. Sarmaţii în spaţiul Estcarpatic (sec. I a. Chr. – începutul sec. II p. Chr)*, Cluj-Napoca.
Bârcă, V./O. Symonenko, 2009: *Călăreţii stepelor. Sarmaţii* în *spaţiul nord-Pontic*, Cluj-Napoca.
Barril Vicente, M./E. Manso Martín/V. Salve Quejido, 1998: Tejidos de mallas celtibéricos en las necrópolis de Almaluez (Soria) y Clares (Guadalajara), *Boletín del Museo Arqueológico Nacional* 16 (1/2), 65-80.
Barruol, G., 1996: La statue du guerrier de Vachères (Alpes-de-Haute-Provence), *Revue archéologique de Narbonnaise* 29 (29), 1-12.
Bartolini, G. (ed.), 1980: *Materiali dell'età del bronzo finale e della prima età del ferro*, Firenze.
Bate, L.F., 1998: *El proceso de investigación en arqueología*, Barcelona.
Bauchhenß, G., 1978: *Germania inferior. Bonn und Umgebung. Militärische Grabdenkmäler*, Mainz.
Baudry, F./L. Ballereau, 1873: *Puits funéraires gallo-romains du Bernard (Vendée)*, La Roche-sur-Yon.
Baumgartl, H., 2009: *Bestattungen in römischen Importgefäßen in der Germania Magna während der römischen Kaiserzeit*, Wien (BA thesis, Universität Wien).
Bazovský, I./R. Čambal/K. Hladíková/J. Rajtár, 2019: Nové funerálne nálezy z doby rímskej zo Závodu (predbežná správa), *Zborník Slovenského Národného Múzea Archeológia* 29, 263-267.
Beard, M., 2007: *The Roman triumph*, Cambridge.
Bechert, T., 1974: *Asciburgium – Ausgrabungen in einem römischen Kastell am Niederrhein*, Duisburg.
Beck, F./H. Chew, 1991: *Masques de fer. Un officier romain du temps de Caligula*, Paris.
Beilke-Voigt, I., 1992: Zur statistischen Auswertung der Miniaturgeräte als Grabbeigabe bei den Germanen der späten Kaiserzeit, *Archäologische Informationen* 15, 82-89.
Beilke-Voigt, I., 1994: Miniatursymbole unter dem Aspekt der Amulettdeutung. Typologisch-chronologische Studien zu Miniaturbeigaben im mittel- und osteuropäischen Raum unter Einschluss des angelsächsischen Gebietes von Christi Geburt bis 6. Jh. n. Chr., *Ethnographisch-Archäologische Zeitschrift* 24, 603-612.
Beltrán Fortes, J./A.R. Menéndez Arguín, 1999: New evidence on the use of armour by Roman soldiers of the fourth century AD, *Journal of Roman Military Equipment* 10, 21-26.
Benadík, B./E. Vlček/C. Amros, 1957: *Keltské pohrebiská na juhozápadnom slovensku*, Bratislava.
Bender, H., 2008: *Befunde und Funde der römischen Zeit aus Passau*, Rahden.
Bennett, J./A.L. Goldman, 2009: A preliminary report on the Roman military presence at Gordion, Galatia, in A. Morillo/N. Hanel/E. Martin (eds), *Limes XX. XXth International Congress of Roman Frontier Studies*, Madrid, 1605-1616.
Benoit, F., 1948: Le bas-relief de Saint-Julien-lès-Martigues (Bouches-du-Rhône), *Gallia* 6 (1), 171-175.
Benoit, F., 1981: *Entremont. Capitale celto-ligure des Salyens de Provence*, Paris.
Berecki, S., 2010: Two La Tène bronze discs from Târgu Mureş, Transylvania, *Marisia. Studii şi materiale* 30, 69-75.
Berger, F., 1995: Kalkriese – Ort der Varusschlacht? Römer im Osnabrücker Land, in J.-S. Kühlborn (ed.), *Germaniam pacavi - Germanien habe ich befriedet*, Münster, 145-169.
Bernhard, H., 1981: Untersuchungen im frührömischen Rheinzabern, *Archäologisches Korrespondenzblatt*

11, 127-137.
Beronius Jörpeland, L. (ed.), 2017: *Föremålskatalog. Utbyggnad av Ostkustbanan genom Gamla Uppsala*, Uppsala.
Besuijen, G., 2008: *Rodanum. A study of the Roman settlement at Aardenburg and its metal finds*, Leiden.
Beutler, F./C. Farka/C. Gugl/F. Humer/G. Kremer/E. Pollhammer (eds), 2017: *Der Adler Roms. Carnuntum und die Armee der Cäsaren*, Mainz.
Bianco, S./G. Greco/E. Pica/A. Russo/M. Tagliente, 1998: Catalogue, in *Treasures from the south of Italy. Greeks and indigenous people in Basilicata*, Milan, 215-235.
Biborski, M./P. Kaczanowski, 2017: Die Frage des Einflusses der Markomannenkriege auf die Bewaffnung und Ausrüstung der Bevölkerung des Barbaricums, *Študijné Zvesti Archeologického Ústavu SAV* 62, 171-180.
Bieber, M., 1928: *Griechische Kleidung*, Berlin.
Biek, L., 1963: *Archaeology and the microscope. The scientific examination of archaeological evidence*, London.
Birley, A., 1997: *Security. The keys and locks*, Greenhead.
Bishop, M.C., 1985: The military fabrica and the production of arms in the Early Principate, in M.C. Bishop (ed.), *Production and distribution of Roman military equipment. Proceedings of the second Roman Military Equipment Research Seminar*, Oxford, 1-42.
Bishop, M.C., 1986: The distribution of military equipment within Roman military forts of the first century A.D, in *Studien zu den Militärgrenzen Roms III. 13. Internationaler Limeskongress Aalen 1983: Vorträge*, Stuttgart, 717-723.
Bishop, M.C., 1987: The evolution of certain features, in M. Dawson (ed.), *Roman military equipment. The accoutrements of war. Proceedings of the third Roman Military Equipment Research Seminar*, Oxford, 109-139.
Bishop, M.C., 1989a: A new mail hook, *Arma* 1 (1), 11-12.
Bishop, M.C., 1989b: The composition of some copper alloy artefacts from Longthorpe, *Arma* 1 (2), 20-24.
Bishop, M.C., 1989c: Naming the parts. Did the Roman army use technical terminology?, *Exercitus* 2 (6), 102-103.
Bishop, M.C., 1989d: O Fortuna. A sideways look at the archaeological record and Roman military equipment, in C. van Driel-Murray (ed.), *Roman military equipment. The sources of evidence. Proceedings of the fifth Roman Military Equipment Conference*, Oxford, 1-11.
Bishop, M.C., 1991: Soldiers and military equipment in the towns of Roman Britain, in V.A. Maxfield/M.J. Dobson (eds), *Roman Frontier Studies 1989. Papers presented to the 15th International Congress of Roman Frontier Studies*, Exeter, 21-27.
Bishop, M.C., 1995: Aketon, thoracomachus, and lorica segmentata, *Exercitus* 3 (1), 1-3.
Bishop, M.C., 2001: The Newstead 'lorica segmentata', *Journal of Roman Military Equipment Studies* 10, 27-43.
Bishop, M.C., 2002: *Lorica segmentata. Volume I: a handbook of articulated Roman plate armour*, Duns.
Bishop, M.C., 2015a: Inevitable corollaries? Lorica segmentata from Eining und Zugmantel, *Journal of Roman Military Equipment Studies* 14/15, 15-28.
Bishop, M.C., 2015b: Von Groller's Waffenmagazin, *Arma* 14 (1), 4-8.
Bishop, M.C., 2015c: Body armour, in Y. Le Bohec (ed.), *The encyclopedia of the Roman army*, Chichester, 98-106.
Bishop, M.C., 2017: Military equipment, in C. Ambrey/D. Fell/R. Fraser/S. Ross/G. Speed/P.N. Wood (eds), *A Roman roadside settlement at Healam Bridge. The Iron Age to Early Medieval evidence* vol. 2, Barnard Castle, 151-155.
Bishop, M.C., 2018: Grim realism. Analyzing the Mainz column bases, *Ancient Warfare* 7 (4), 46-50.
Bishop, M.C./J.C.N. Coulston, 2006: *Roman military equipment. From the Punic Wars to the fall of Rome*, Oxford (2nd edition).

Bishop, M.C./J.N. Dore, 1988: *Corbridge. Excavations of the Roman fort and town, 1947-80*, London.
Bitner-Wróblewska, A./A. Rzeszotarska-Nowakiewicz, 2016: The Balt societies in Poland, 1-500 AD, in A. Rzeszotarska-Nowakiewicz (ed.), *The past societies. Polish lands from the first evidence of human presence to the Early Middle Ages* 4, Warsaw, 258-306.
Bivar, A.D.H., 1964: *Nigerian panoply. Arms and armour of the northern region*, Lagos.
Bivar, A.D.H., 1972: Cavalry equipment and tactics on the Euphrates frontier, *Dumbarton Oaks Papers* 26, 271-291.
Blair, C., 1958: *European armour. Circa 1066 to circa 1700*, London.
Blair, C., 1996: How to interpret brasses. Armour and the study of brasses, in J. Bertram (ed.), *Monumental brasses as art and history*, Gloucestershire, 37-40.
Blair, C., 2005: A 16th century reference to the making of a coat of mail, *Journal of the Arms and Armour Society* 18 (3), 105-107.
Blake, J., 1999: *The tools*, Greenhead.
Blanc, O., 1997: Le pourpoint de Charles de Blois. Une relique de la fin du Moyen Âge, *Bulletin de Centre Internationale d'Étude des Textiles Anciens* 74, 65-82.
Blankenfeldt, R., 2015: *Das Thorsberger Moor, 2. Die persönlichen Ausrüstungen*, Schleswig.
Blell-Tüngen, 1877: Römisches Panzergeflecht von Bingerbrück, *Annalen des Vereins für Nassauische Altertumskunde und Geschichtsforschung* 14, 416-417.
Blöndal, S., 2007: *The Varangians of Byzantium. An aspect of Byzantine military history* (transl. B.S. Benedikt), Cambridge.
Bochnak, T., 2009: Die Militaria der vorrömischen Eisenzeit aus dem Archiv von Józef Kostrzewski, *Barbaricum* 8, 7-32.
Bochnak, T./P. Harasim, 2012: Interregional and multidirectional contacts of local elites. A case of scabbards with crossbars decorated with three or more S-figures in northern Poland, *Archaeologia Baltica* 18, 59-82.
Bogaers, J.E./J.K. Haalebos, 1992: Opgravingen op het terrein van het voormalige Canisiuscollege, 1990, *Jaarboek Numaga. Vereniging tot beoefening van de Geschiedenis van Nijmegen en Omgeving* 39, 7-23.
Böhme, H.W., 1975: Archäologische Zeugnisse zur Geschichte der Markomannenkriege (166-180 n. Chr.), *Jahrbuch des Römisch-Germanischen Zentralmuseums* 22, 153-217.
Bohn, R., 1885: *Das Heiligtum der Athena Polias Nikephoros*, Berlin.
Böhner, K., 1994: *Die frühmittelalterlichen Spangenhelme und die nordischen Helme der Vendelzeit*, Mainz.
Bóna, I./M.Nagy/J. Cseh, 2005: *Gepidische Gräberfelder im Theissgebiet II*, Budapest.
Bonfante, L., 1975: *Etruscan dress*, Baltimore.
Bonnamour, L./A. Dumont, 1996: Les armes romaines de la Saône. État des découvertes données récentes de fouilles, *Journal of Roman Military Equipment Studies* 5, 141-154.
Bonnamour, L./O. Gros/A.-C. Gros/M. Feugère, 2001/2002: Une étonnante découverte d'armes romaines effectuée à Ouroux-sur-Saône (Saône-et-Loire) à la fin du XIXe siècle, *Revue Archéologique de l'Est* 51, 481-487.
Boppert, W., 1992: *Militärische Grabdenkmäler aus Mainz und Umgebung*, Mainz.
Boppert, W., 1998: *Römische Steindenkmäler aus Worms und Umgebung*, Mainz.
Boppert, W., 2001: *Römische Steindenkmäler aus dem Landkreis Bad Kreuznach*, Mainz.
Borangic, C., 2011a: Războinici Nord-Dunăreni în armuri de zale (sec. II a. Chr.-sec. II p. Chr.) – Partea I, *Terra Sebus. Acta Musei Sabesiensis* 3, 171-227.
Borangic, C., 2011b: Armuri de zale, meşteri şi ateliere în Dacia preromană, *Acta Mvsei Porolissensis* 33, 123-146.
Borangic, C., 2012: Războinici Nord-Dunăreni în armuri de zale (partea A II-A). Reprezentările Antichităţii, *Terra Sebus. Acta Musei Sabesiensis* 4, 179-209.
Borangic, C./A. Bădescu, 2014: *Civilizaţia geto-dacică (I). Arme şi echipamente din patrimoniul Muzeului Naţional de Istorie a României*, Bucureşti.

Borangic, C./S. Paliga, 2013: Note pe marginea originii şi a rolului armurilor geto-dacilor în ritualurile funerare, *Acta Centri Lucusiensis* 1, 5-23.
Borisenko, A./K. Tabaldiev/O. Soltobaev/Y. Chudjakov, 2006: Die Bewaffnung der alten Turkvölker, der Gegner der Sasaniden, in M. Mode/J. Tubach (eds), *Arms and armour as indicators of cultural transfer. The steppes and the ancient world from Hellenistic times to the Early Middle Ages*, Wiesbaden, 107-128.
Boschung, D., 2012: Bildquellen des römischen Militärs, in T. Fischer (ed.), *Die Armee der Caesaren. Archäologie und Geschichte*, Regensburg, 32-61.
Bosman, A.V.A.J., 1997: *Het culturele vondstmateriaal van de vroeg-Romeinse versterking Velsen 1*, Amsterdam (PhD thesis, Universiteit van Amsterdam).
Bottin, M., 1821: Mémoire, *Mémoires de la Société Royale des Antiquaires de France* 3, 453-474.
Bottini, A./M. Tagliente, 1984: Nuovi documenti sul mondo indigeno della Val d'Agri in età arcaica. La necropoli di Alianello, *Bolletino d'Arte* 24, 111-116.
Bottomley, I./H. Bowstead Stallybrass, 2000: Galvanized Indian mail, *Royal Armouries Yearbook* 5, 133-138.
Boube-Piccot, C., 1994: *Les bronzes antiques du Maroc. VI. L'équipement militaire et l'armement*, Paris.
Boucher, J.-P.,1977: Circonscription de Rhône-Alpes, *Gallia* 35 (2), 473-494.
Boutell, C., 1870: *Arms and armour in Antiquity and the Middle Ages*, New York.
Bowman, A.K./J.D. Thomas, 1983: *Vindolanda. The Latin writing tablets*, London.
Bradley, R., 1990: *The passage of arms. An archaeological analysis of prehistoric hoards and votive deposits*, Cambridge.
Brailsford, J.W., 1962: *Hod Hill. Antiquities from Hod Hill in the Durden collection* vol. 1, London.
Brailsford, J.W., 1975: The Polden Hill hoard, Somerset, *Proceedings of the Prehistoric Society* 41, 222-234.
Brandenburgh, C.R./W.A.M. Hessing, 2005: *Matilo – Rodenburg – Roomburg. De Roomburgpolder: van Romeins castellum tot moderne wijk*, Leiden.
Bravermanová, M., 2012: The so-called armour of St. Wenceslaus. A historical introduction, *Acta Militaria Mediaevalia* 8, 213-220.
Brewer, M., 2002: *The art of mail armour. How to make your own*, Colorado.
Bridoux, V., 2008: Les établissements de Maurétanie et de Numidie entre 201 et 31 av. J.-C. Synthèse de connaissances, *Mélanges de l'École française de Rome – Antiquité* 120 (2), 369-426.
Brilliant, R., 1967: *The arch of Septimius Severus in the Roman Forum*, Rome.
Brink-Kloke, H., 1999: Römisches Kettenhemd, *Archäologie in Deutschland* 1999 (1), 47.
Brinkmann, V./H. Breider, 2006: *Kleur! Bij Grieken en Etrusken*, Amsterdam.
Britton, D., 1971: The Heathery Burn cave revisited. An essay towards the reconstruction of a well-known archaeological discovery, *The British Museum Quarterly* 35 (1), 20-38.
Bruce-Mitford, R., 1978: *The Sutton Hoo ship-burial. Volume 2: arms, armour and regalia*, London.
Bruckner, A./R. Marichal, 1979: *Chartae Latinae antiquiores* vol. 10, Zürich.
Brüggler, M./M. Drechsler, 2012: Das neue Auxiliarlager Till-Steincheshof, Bedburg-Hau, Kreis Kleve, in P. Henrich (ed.), *Der Limes von Niederrhein bis an die Donau. 6. Kolloquium der Deutschen Limeskommission*, Stuttgart, 29-37.
Brunaux, J.-L./B. Lambot, 1987: *Guerre et armement chez les Gaulois. 450-52 av. J.-C.*, Paris.
Brunsting, H., 1943: Brandheuvels bij Fluitenberg, gem. Ruinen, *Nieuwe Drentsche Volksalmanak* 61, 98-101.
Buchsenschutz, O./K. Gruel/T. Lejars, 2012: The golden age of the Celtic aristocracy in the fourth and third centuries BC, *Annales. Histoire, Sciences Sociales* 67 (2), 187-215.
Buchwald, V.F., 2005: *Iron and steel in ancient times*, Copenhagen.
Budinský-Krička, V., 1967: Východoslovenské mohyly, *Slovenská Archeológia* 15 (2), 277-388.
Budinský-Krička, V./M. Lamiová-Schmiedlová, 1990: A late 1st century B.C. – 2nd century A.D. cemetery at Zemplín, *Slovenská Archeológia* 38 (2), 245-344.
Bujna, J., 1982: Spiegelung der Sozialstruktur auf latènezeitlichen Gräberfeldern im Karpatenbecken, *Pamatky Archeologické Praha* 73 (2), 312-431.

Bull, S., 2007: *Triumphant rider. The Lancaster Roman cavalry stone*, Lancaster.
Buora, M., 2001: Militaria in Aquileia, *Gesellschaft Pro Vindonissa. Jahresbericht* 2001, 41-52.
Burandt, B.A.N., 2017: *Die Ausrüstung der römischen Armee auf der Siegessäule des Marcus Aurelius in Rom. Ein Vergleich zwischen der skulpturalen Darstellung und den archäologischen Bodenfunden*, Oxford.
Burandt, B.A.N., 2019: *Der römische Legionär. Kleidung, Ausrüstung und Waffen in der Zeit von Augustus bis Domitian*, München.
Burchianti, F., 2013: *Museo Etrusco Guarnacci. 100 masterpieces*, Ospedaletto.
Burgess, E.M., 1953a: The mail-maker's technique, *The Antiquaries Journal* 33, 48-55.
Burgess, E.M., 1953b: Further research into the construction of mail garments, *The Antiquaries Journal* 33, 193-202.
Burgess, E.M., 1955: Technical note on the fragment of iron mail from Carlingwark Loch (C.74), *Proceedings of the Society of Antiquaries of Scotland* 87, 50.
Burgess, E.M., 1957: The mail shirt from Sinigaglia, *The Antiquaries Journal* 37, 199-205.
Burgess, E.M., 1958: A mail shirt from the Hearst Collection, *The Antiquaries Journal* 38, 197-204.
Burgess, E.M., 1960: A reply to Cyril Stanley Smith on mail making methods, *Technology and Culture* 1 (2), 151-155.
Burgess, E.M./H.R. Robinson, 1956: A 14th century mail hood in the Scottish Museum, Edinburgh, *Journal of the Arms and Armour Society* 2, 59-65.
Burmeister, S./H. Derks (eds), 2009: *2000 Jahre Varusschlacht. Konflikt*, Stuttgart.
Burnham, B.C./J.L. Davies (eds), 2010: *Roman frontiers in Wales and the Marches*, Aberystwyth.
Burnham, B.C./F. Hunter/A.P. Fitzpatrick/S. Worrel/M.W.C. Hassall/R.S.O. Tomlin, 2006: I. Sites Explored, *Britannia* 37, 369-428.
Burns, M., 2005: *The cultural and military significance of the south Italic warrior's panoply from the 5th to the 3rd centuries BC*, London (PhD thesis, University College London).
Burns, M., 2015: Pompeii under siege. A missile assemblage from the Social War, *Journal of Roman Military Equipment Studies* 14/15, 1-9.

Caldwell, D.H./W.F. Cormack/T. Gabra-Sanders, 2005: A mail garment from the medieval church at Barhobble, *Transactions of the Dumfriesshire and Galloway Natural History and Antiquarian Society* 79, 95-100.
Canestrelli, G., 2018: Gallica. Mail armour of the Celts, *Ancient Warfare* 12 (3), 20-21.
Capwell, T., 2003: A fragment of Scottish mail, *The Journal of the Mail Research Society* 1 (1), 21-24.
Capwell, T., 2015: *Armour of the English knight - 1400-1450*, London.
Capwell, T., 2017: Mail and the knight in renaissance Italy. Part I, *Armi Antiche. Bollettino dell'Accademia di San Marciano – Torino* 2017, 9-84.
Carroll, D.L., 1972: Wire drawing in Antiquity, *American Journal of Archaeology* 76 (3), 321-323.
Caumont, O., 2011: *Dépôts votifs d'armes et d'équipements militaires dans le sanctuaire gaulois et gallo-romain des Flaviers à Mouzon (Ardennes)*, Montagnac.
Cavell, M., 2016: The woven mail-coat, in *Weaving words and binding bodies. The poetics of human experience in Old English literature*, Toronto, 47-67.
Černenko, E.V., 2006: *Die Schutzwaffen der Skythen*, Stuttgart.
Cessford, C., 1994: The Borgue armour and the Dumfriesshire Spangenhelm, *Transactions of the Dumfriesshire and Galloway Natural History and Antiquarian Society* 69, 73-80.
Chabot, L., 1983: L'oppidum de la Cloche aux Pennes-Mirabeau (Bouches-du-Rhône). Synthèse des travaux effectués de 1967 à 1982, *Revue Archéologique Narbonnaise* 16, 39-80.
Chapman, E.M., 2005: *A catalogue of Roman military equipment in the National Museum of Wales*, Oxford.
Chapman, M.D., 2004: The construction and metallurgy of a late fifteenth century mail sleeve, *Journal of the Arms and Armour Society* 18 (2), 41-62.

Charles, M.B., 2003: Vegetius on armour. The pedites nudati of the epitoma rei militaris, *Ancient Society* 33, 126-167.
Charles, M.B., 2004: Imperial cuirasses in Latin verse. From Augustus to the fall of the West, *L'Antiquité Classique* 73, 127-148.
Charles, M.B, 2007: Heads and chests unprotected. Vegetius and Late Roman infantry armour? *Ancient Warfare* 1 (3), 8-10.
Checksfield, N./D. Edge/A. Williams, 2012: Examination and assessment of the Wenceslaus mail hauberk, *Acta Militaria Mediaevalia* 8, 229-242.
Chew, H., 1993: Une sépulture militaire de l'époque tardive à Sarry (Marne), in F. Vallet/M. Kazanski (eds), *L'armée romaine et les barbares du IIIe au VIIe siècle*, Saint-Germain-en-Laye, 313-321.
Christensen, A.E., 2005: The Roman Iron Age tools from Vimose, Denmark, *Acta Archaeologica* 76 (2), 59-86.
Christie, N., 1991: Longobard weaponry and warfare, A.D. 1-800, *Journal of Roman Military Equipment Studies* 2, 1-26.
Ciafaloni, D./G. Della Rocca de Candal, 2011: Sasanian traditions in Sogdian paintings. Hunting and figthing scenes, *Parthica* 13, 111-189.
Collar, A., 2011: Military networks and the cult of Jupiter Dolichenus, in E. Winter (ed.), *Von Kummuh nach Telouch. Historische und archäologische Untersuchungen in Kommagene, Dolichener und Kommagenische Forschungen* 4, Bonn, 217-245.
Connolly, P., 1990: *Las legiones romanas*, Madrid.
Connolly, P., 1998, *Greece and Rome at war*, London.
Cosma, C., 2018: *Graves of Avar military chiefs in Transylvania*, Cluj-Napoca.
Coulston, J.C.N., 1983: Arms and armour in sculpture, in M.C. Bishop (ed.), *Roman military equipment. Proceedings of a seminar held in the Department of Classical Archaeology at the University of Sheffield, 21st March 1983*, Sheffield, 24-26.
Coulston, J.C.N., 1988: *Trajan's column. The sculpting and relief content of a Roman propaganda monument*, Newcastle (PhD thesis, University of Newcastle upon Tyne).
Coulston, J.C.N., 1989: The value of Trajan's column as a source for military equipment, in C. van Driel-Murray (ed.), *Roman military equipment. The sources of evidence. Proceedings of the fifth Roman military equipment conference*, Oxford, 31-44.
Coulston, J.C.N., 1990: Later Roman armour, 3rd-6th centuries AD, *Journal of Roman Military Equipment Studies* 1, 139-160.
Coulston, J.C.N., 1991a: The 'draco' standard, *Journal of Roman Military Equipment Studies* 2, 101-114.
Coulston, J.C.N., 1991b: Two representations of 3rd century AD equipment from Cumbria, *Arma* 3 (1), 2-6.
Coulston, J.C.N., 2002: Arms and armour of the Late Roman army, in D. Nicolle (ed.), *Companion to medieval arms and armour*, Woodbridge, 2-24.
Coulston, J.C.N., 2013: Late Roman military equipment culture, in A. Sarantis/N. Christie (eds), *War and warfare in Late Antiquity*, Leiden, 463-492.
Craddock, P.T. 1978: The composition of copper alloys used by the Greek, Etruscan and Roman civilizations. 3. The origins and early use of brass, *Journal of Archaeological Science* 5, 1-16.
Crişan, I. H., 1971: În legătură cu datarea necropolei celtice de la Ciumeşti, *Marmaţia* 2, 55-74.
Croom, A.T., 1998: Spectacular find of a Roman iron ring-mail suit at Arbeia Roman fort, *Minerva. The International Review of Ancient Art and Archaeology* 9 (2), 7.
Croom, A.T., 2000: The wear and tear of third century military equipment, *Journal of Roman Military Studies* 11, 129-134.
Croom, A.T., 2001: A ring mail shirt from South Shields Roman fort, *The Arbeia Journal* 6/7, 55-60.
Croom, A.T., 2010: *Roman clothing and fashion*, Stroud.

Croom, A.T./W.B. Griffiths, 1996: A fragment of ring-mail from Chesters, *Arma* 8 (1-2), 3-4.
Crowfoot, E./F. Pritchard/K. Staniland, 1992: *Textiles and clothing: c. 1150- c. 1450*, London.
Crummy, N., 1987: Things they left behind. Some recent finds in Colchester or Roman arms and armour, *The Colchester Archaeologist* 1987 (1), 6-9.
Crummy, P./J. Bayley/T.W. Cook, 1992: *Excavations at Culver Street, the Gilberd School, and other sites in Colchester*, Colchester.
Csallány, D., 1972: Avarkori páncélok a Kárpát-medencében, *A Nyíregyházi Jósa András Múzeum Évkönyve* 7/8 (1969-1971), 7-44.
Cunliffe, B., 2018: *The ancient Celts*, Oxford (2nd edition).
Curle, J., 1911: *A Roman frontier post and its people. The fort of Newstead in the Parish of Melrose*, Glasgow.
Curle, J., 1931/1932: An inventory of objects of Roman and provincial Roman origin found on sites in Scotland not definitely associated with Roman constructions, *Proceedings of the Antiquaries of Scotland* 66, 77-397.
Czarnecka, K., 1996: The re-use of Roman military equipment in barbarian contexts. A chain-mail souvenir? *Journal of Roman Military Equipment Studies* 5, 245-258.
Czarnecka, K., 2013: Warriors in this world and the afterlife. Przeworsk culture graves containing weapons, in M. Sanader/A. Rendić-Miočević/D. Tončinić/I. Radman-Livaja (eds), *XVII Roman Military Equipment Conference Zagreb 2010, 24th-27th May, 2010*, Zagreb, 163-175.

Daehnhardt, R., 1988: The Ghost King's armour. An extraordinary child's armour discovered, *Man at Arms Magazine* 1988 (September/October), 10-15.
D'Agostino, B. 1998: Greeks and indigenous people in Basilicata from the 8th to the 3rd century B.C., in *Treasures from the south of Italy. Greeks and indigenous people in Basilicata*, Milan, 24-57.
Dahm, M., 2012: A decorated ivory box from Ephesus. Opening the lid, *Ancient Warfare Magazine* 5 (6), 40-41.
Dalewicz-Kitto, S./F. McLaughlan/E. Schmuecker/J. Hood, 2013: Japanese armour and the conservation of a Sakakibara family armour at the Royal Armouries, *Journal of the Institute of Conservation* 36 (1), 35-52.
Daly, G., 2005: *Cannae. The experience of battle in the second Punic War*, London.
D'Amato, R., 2011a: Adaptations in Roman armour during the Trajanic era. The miles legionis of the last age of conquest, *Ancient Warfare* 6 (2), 16-18.
D'Amato, R., 2011b: *Roman centurions. 753-31 BC*, Oxford.
D'Amato, R., 2012a: *Roman centurions. 31BC-AD 500*, Oxford.
D'Amato, R., 2012b: *Byzantine imperial guardsmen 925-1025. The tághmata and imperial guard*, Oxford.
D'Amato, R./A.E. Negin, 2017: *Decorated Roman armour. From the age of the kings to the death of Justinian the Great*, Yorkshire.
D'Amato, R./G. Sumner, 2009: *Arms and armour of the imperial Roman soldier. From Marius to Commodus. 112 BC – AD 192*, London.
D'Andrea, M., 2014: Schede di catalogo 1-1104, in M. Cerzoso/A. Vanzetti (eds), *Museo dei Brettii e degli Enotri. Catalogo dell'esposizione*, Soveria Mannelli, 97-370.
Daubigney, A./P. Barral/S. Canet, 2007: Le dépôt laténien et romain de Champdivers dans la basse Vallée du Doubs (Jura), in Association française pour l'étude de l'Age du Fer and P. Barral (eds), *L'Age du Fer dans l'arc jurassien et ses marges. Dépôts, lieux sacrés et territorialité à l'Age du Fer. Actes du XXIXe colloque international de l'AFEAF, Bienne, canton de Berne, Suisse, 5-8 mai 2005*, Besançon, 405-424.
Dautova-Ruševljan, V./M. Vujović, 2006: *Roman army in Srem*, Novi Sad.
Davis, H./J.R. Travis, 2011: *Roman body armour*, Stroud.
Dawson, T., 2013: *Armour never wearies. Scale and lamellar armour from the Bronze Age to the 19th century*, Gloucestershire.
Day, R., 1878: On a hauberk of chain mail, and silvered badge, found in the Phoenix Park, Dublin, *The Journal of the Historical and Archaeological Association of Ireland* 4 (3), 494-498.

De Blois, L./E. Lo Cascio (eds), 2007: *The impact of the Roman army (200 BC – AD 476). Economic, social and cultural aspects*, Leiden.
De Boone, W.J., 1970/1971: An early-medieval grave field on the Beumelerberg near Garderen, *Berichten van de Rijksdienst voor het Oudheidkundig Bodemonderzoek* 20/21, 249-292.
De Bonstetten, G., 1860: *Supplément au recueil d'antiquités suisses*, Lausanne.
De Bruin, J., 2020: *Romeinen langs de Rijn*, Leiden.
De Bruin, J./G. Besuijen/H. Siemons/J. van Zoolingen, 2012: *Goedereede-Oude Oostdijk. Een havenplaats uit Romeinse tijd*, Leiden.
Dechezleprêtre, T., 2008: Présence de militaria sur quelques oppida de l'est de la Gaule, in M. Poux (ed.), *Sur les traces de César. Militaria tardo-républicains en contexte gaulois*, Bibracte, 93-102.
De Cosson, C.A./W. Burges, 1880: Catalogue of the exhibition of ancient helmets and examples of mail, *The Archaeological Journal* 37, 455-593.
Dedyulkin, A.V./N.F. Shevchenko, 2017: Доспех из погребения рубежа эр могильника Мезмай-1. Кольчуги на Северо-Западном Кавказе, *Stratum Plus* 2017 (4), 47-56.
Demarsin, B./S. Derwael, 2019: *Dacia felix. Het roemrijke verleden van Roemenië*, Gent.
Demierre, M., 2012: La cotte de mailles, in M. Poux (ed.), *Corent. Voyage au coeur d'une ville gauloise*, Paris, 166-167.
Demierre, M., 2015: Mobilier métalique, in M. Poux/M. Demierre (eds), *Le sanctuaire de Corent (Puy-de-Dôme, Auvergne). Vestiges et rituels*, Paris, 138-230.
Demierre, M./M. Poux, 2012: Du culturel au profane. Essai d'analyse taphonomique et spatiale des petits mobiliers du sanctuaire de Corent et de ses abords, in O. de Cazanove/P. Méniel (eds), *Étudier les lieux de culte de Gaule romaine*, Montagnac, 209-227.
De Moor, A./I. van den Berghe/M. van Strydonck/M. Boudin/C. Fluck, 2010: Radiocarbon dating and dye analysis of Roman linen tunics and dalmatics with purple coloured design, *Archaeological Textiles Newsletter* 51, 34-47.
Depeyrot, G., 2008: *Légions romaines en campagne. La colonne Trajane*, Paris.
Deschieter, J., 2016: Two shield bosses from the Roman vicus at Velzeke. Evidence of a countryside in peril…? *Journal of Roman Military Equipment Studies* 17, 61-68.
Deschler-Erb, E., 1991: Römische Militaria des 1. Jahrhunderts aus Kaiseraugst. Zur Frage des frühen Kastells, in E. Deschler-Erb/M. Peter/S. Deschler-Erb (eds), *Das frühkaiserzeitliche Militärlager in der Kaiseraugster Unterstadt*, Augst, 9-81.
Deschler-Erb, E., 1996: Die Kleinfunde aus Edelmetall, Bronze und Blei, in *Beiträge zum römischen Vitudurum - Oberwinterthur 7: Ausgrabungen im Unteren Bühl. Die Funde aus Metall. Ein Schrank mit Lararium des 3. Jahrhunderts*, Zürich, 13-139.
Deschler-Erb, E., 1999: *Ad arma! Römisches Militär des 1. Jahrhunderts n. Chr. in Augusta Raurica*, Augst.
Deschler-Erb, E., 2012: *Römische Militärausrüstung aus Kastell und Vicus von Asciburgium*, Duisburg am Rhein.
Deschler-Erb, E./R. Fellmann Brogli/T. Kahlau, 2004: Ein 'Fellhelm' aus Vindonissa, *Jahresbericht der Gesellschaft Pro Vindonissa* 2004, 3-12.
Dieudonné-Glad, N./M. Feugère/M. Önal, 2013: *Zeugma V. Les objets*, Lyon.
Dillon, S./K.E. Welch (eds), 2009: *Representations of war in ancient Rome*, Cambridge.
Dimitrov, S., 2009/2010: Преоткрита елинистическа ризница от експозицията на РИМ – В. Търново, *Proceedings of the Regional Museum of History – Veliko Tarnovo* 24/25, 95-106.
Dimitrova, D., 2017: Die goldene Maske aus dem Grabhügel von Svetica, in S. Haag/C. Popov/B. Horejs/S. Alexandrov/G. Plattner (eds), *Das erste Gold. Ada Tepe: das* älteste *Goldbergwerk Europas*, Vienna, 157-159.
Dixon, K.R./P. Southern, 1992: *The Roman cavalry from the first to the third century AD*, London.
Dobat, A.S., 2008: *Werkzeuge aus kaiserzeitlichen Heeresausrüstungsopfern. Mit besonderer Berücksichtigung der Fundplätze Illerup* Ådal *und Vimose*, Kopenhagen.

Dobos, A., 2015: Weapon and weapon depositions in the late row-grave cemeteries in Transylvania, in C. Cosma (ed.), *Warriors, weapons and harness from the 5th–10th centuries in the Carpathian Basin*, Cluj-Napoca, 57-88.

Dobres, M.-A., 1999: Technology's links and chaînes. The processual unfolding of technique and technician, in M.-A. Dobres/C.R. Hoffman (eds), *The social dynamics of technology. Practice, politics and words views*, Washington DC, 124–146.

Dobres, M.-A., 2009: Archaeologies of technologies, *Cambridge Journal of Economics* 34, 103-114.

Dolenz, H., 1998: *Eisenfunde aus der Stadt auf dem Magdalensberg*, Klagenfurt.

Domaradski, M., 1984: *Келтите на Балканския полуостров: IV-I в.ир.н.е*, Sofia.

Doroshko, B.B., 2016: Защитное вооружение из раскопок византийского херсона, in V.V. Mikeo/T.Y. Yasheava (eds), *Materials of the first and second International Scholarly Conferences „St. Vladimir's Readings"*, Kaliningrad, 61-72.

Dorow, W., 1826: *Römische Alterthümer in und um Neuwied am Rhein*, Berlin.

Dove, S./R. Goldstraw, 1992: Lifting the Kirkburn mail tunic, in R. Payton (ed.), *Retrieval of objects from archaeological sites*, Denbigh, 51-59.

Downey, S.B., 2006: Arms and armour as social coding in Palmyra, the Palmyrène, and Dura-Europos, in M. Mode/J. Tubach (eds), *Arms and armour as indicators of cultural transfer. The steppes and the ancient world from Hellenistic times to the Early Middle Ages*, Wiesbaden, 321-355.

Drescher, H., 1981: Untersuchung des Ringgeflechts aus Sörup, Grab K 10, in K. Raddatz (ed.), *Sörup I. Ein Gräberfeld der Eisenzeit in Angeln*, Neumünster, 186-190.

Drechsler, M., 2017: Das römische Auxiliarkastell Steineshof und der niedergermanische Limes zwischen Xanten und Nimwegen, *Bonner Jahrbücher* 217, 131-305.

Driehaus, J.: 1968: Die Panzer von Augsburg und Vize (Thrakien). Zwei Meisterwerke antiker Brünnenmacherkunst, *Mitteilungen der Berliner Gesellschaft für Anthropologie, Ethnologie und Urgeschichte* 2 (1), 14-16.

Driehaus, J./C. Raub/L. Bakker, 2012: Die Panzer von Augsburg und Vize. Eine Untersuchung zur Metalltechnologie im 1. Jahrhundert n. Chr., *Bericht der Römisch-Germanischen Kommission* 91 (2010), 339-409.

Dungworth, D. 1997: Roman copper alloys. Analysis of artefacts from northern Britain, *Journal of Archaeological Science* 24, 901-910.

Dungworth, D./R. Wilkes, 2007: An investigation of hammerscale, *English Heritage Research Department Report* 26, 1-36.

Dupras, N., 2012: *Armourers and their workshops. The tools and techniques of late medieval armour production*, Leeds (PhD thesis, University of Leeds).

Duval, A./C. Lyon-Caen, 1994: *Vercingétorix et Alésia. Saint-Germain-en-Laye Musée des Antiquités Nationales, 29 mars–18 julliet 1994*, Paris.

Eckhart, L., 1967: Ein römischer Legionär des 4. Jahrhunderts n. Chr. aus Lentia-Linz/Donau, *Jahrbuch des Oberösterreichischer Musealvereines* 112, 25-33.

Edge, D., 2001: The construction and metallurgy of mail armour in the Wallace Collection, *Acta Metallurgica Slovaca* 7, 227-234.

Edge, D., 2004: Problems and pitfalls in the identification of European mail, *London Park Lane Arms Fair* (spring 2004), 16-25.

Edge, D. /J.M. Paddock, 1988: *Arms and armour of the medieval knight*, London.

Ehlton, F., 2002/2003: *Ringväv från Birkas garnison. Dokumentation, preparering och analys*. Stockholm (MA Thesis, Stockholm University).

Eimermann, E., 2009: *Cananefaatse boeren op de noordelijke oeverwal van de Gantel. Een archeologische opgraving aan de Juliahof te Wateringen, gemeente Westland*, Amersfoort.

Elliott, S., 2019: The battle of Lugdunum, AD 197. Clash of the titans, *Ancient Warfare* 13 (3), 26-35.
Elsner, J., 2000: From the culture of spolia to the cult of relics. The arch of Constantine and the genesis of Late Antique forms, *Papers of the British School at Rome* 68, 149-184.
Engelhardt, C., 1863: *Thorsbjerg Mosefund*, København.
Engelhardt, C., 1866: *Denmark in the early Iron Age*, London.
Engelhardt, C., 1869: *Vimose Fundet*, København.
Engström, J., 1992: Skandinaviskt krigsväsen under mellersta järnåldern, *Meddelande från Armémuseum* 52, 14-72.
Erdkamp, P. (ed.), 2007: *A companion to the Roman army*, Oxford.
Erdrich, M., 2002: *Corpus der römischen Funde im europäischen Barbaricum* vol. 4 Deutschland, Bonn.
Erdrich, M., 2004: Waffen im mitteleuropäischen Barbaricum. Handel oder Politik, *Journal of Roman Military Equipment Studies* 5, 199-209.
Everson, T., 2004: *Warfare in ancient Greece. Arms and armour from the heroes of Homer to Alexander the Great*, Stroud.
Ewing, T., 2006: *Viking clothing*, Gloucestershire.

Faber, A., 1994: *Das römische Auxiliarkastell und der Vicus von Regensburg-Kumpfmühl*, München.
Fabian, M., 2018: Herr der Kettenringe. Der römische Soldat und das Kettenhemd, in C. Pause (ed.), *Römer zum Anfassen. Mythos und Fakten*, Neuss, 39-43.
Fabre, G., 1943: Contribution à l'étude du protohistorique du sud-ouest de la France, *Gallia* 1 (1): 43-79.
Fabricius, E./O. von Sarwey, 1906: *Der Obergermanisch-raetische Limes des Römerreiches. B72: Das Kastell Weißenburg*, Heidelberg.
Falkenstein, F., 2004: Anmerkungen zur Herkunftsfrage des Gundestrupkessels, *Praehistorische Zeitschrift* 79 (1), 57-88.
Fenn, T.R./D.J. Killick/J. Chesley/S. Magnavita/J. Ruiz, 2009: Contacts between West Africa and Roman North Africa. Archaeometallurgical results from Kissi, northeastern Burkina Faso, in S. Magnavita/L. Koté/P. Breunig/O.A. Idé (eds), *Crossroads/Carrefour Sahel. Cultural and technological developments in first millennium BC/AD West Africa*, Bielefeld, 119-146.
Fernández Ibáñez, C., 2010: Restos del armamento de la Legio IIII Macedonica hallados en su campamento de Herrera de Pisuerga (Palencia, España), *Gladius* 30, 99-116.
Fernández Ibáñez, C., 2015: Las armas del enemigo. Militaria romana de metal en la guerra cantábrica de Augusto, in J. Camino Mayor/E.J. Peralta Labrador/J.F. Torres Martínez (eds), *Las guerras Astur-Cántabras*, Gijón, 323-344.
Fernández Reyes, P.A., 2014: *Metallurgical characterisation of 1st and 2nd century AD Roman copper-alloy military equipment from north-western Europe*, Liverpool (PhD thesis, University of Liverpool).
Ferris, I., 2008: *Hate and war. The column of Marcus Aurelius*, Gloucestershire.
Ferrua, A., 1960: *Le pitture della nuova catacomba di Via Latina*, Roma.
Feugère, M., 1993: *Les armes des romains. De la République à l'Antiquité tardive*, Paris.
Feugère, M., 1996: L'armement du Haut-Empire, in M. Reddé/J. Bénard, J. (eds), *L'armée romaine en Gaule*, Paris, 115-131.
Feugère, M. (ed.), 1997: *Journal of Roman Military Equipment* 8.
Feugère, M., 2002: *Weapons of the Romans*, Stroud.
Feugère, M., 2006: Roman militaria from Zeugma, in R. Ergeç (ed.), *International symposium on Zeugma: from past to future 20-22 mai 2004 - Gaziantep*, Gaziantep, 91-95.
Feugère, M./M. Poux, 2001: Gaule pacificée, Gaule liberée? Enquête sur les militaria en Gaule civile, *Gesellschaft Pro Vindonissa Jahresbericht* 2001, 79-95.
Ffoulkes, C., 1909: *Armour and weapons*, Oxford.
Ffoulkes, C., 1912: *The armourer and his craft from the XIth to the XVIth century*, London.

Fields, N., 2012: *Roman republican legionary. 298-105 BC*, Oxford.
Filmer-Sankey, W., 1996: The 'Roman emperor' in the Sutton Hoo ship burial, *Journal of the British Archaeological Association* 149 (1), 1-9.
Fingerlin, G., 1986: *Dangstetten I. Katalog der Funde (Fundstellen 1 bis 603)*, Stuttgart.
Fingerlin, G., 1998: *Dangstetten II. Katalog der Funde (Fundstellen 604 bis 1358)*, Stuttgart.
Fingerlin, G., 1997: Kirchen und Kirchengräber in der frühmittelalterlichen Alamannia Südwestdeutschlands, *Denkmalpflege in Baden-Württemberg* 26 (2), 44-53.
Fischer, T., 2001: Waffen und militärische Ausrüstung in zivilem Kontext. Grundsätzliche Erklärungsmöglichkeiten, *Jahresbericht der Gesellschaft Pro Vindonissa* 2001, 13-18.
Fischer, T., 2002: Zu einer römischen Soldatendarstellung aus Lentia/Linz an der Donau, in K. Kuzmová/K. Pieta/J. Rajtár (eds), *Zwischen Rom und dem Barbarikum. Festschrift für Titus Kolník zum 70. Geburtstag*, Nitra, 89-96.
Fischer, T., 2004: Bemerkungen zu Grab 622 von Kemnitz, Kreis Potsdam in Brandenburg, in H. Friesinger/A. Stuppner (eds), *Zentrum und Peripherie. Gesellschaftliche Phänomene in der Frühgeschichte*, Vienna, 131-141.
Fischer, T., 2011: Teile von römischen Waffen und militärischer Ausrüstung aus den Grabungen auf dem Dülük Baba Tepesi in den Jahren 2004-2009, in E. Winter (ed.), *Von Kummuḫ nach Telouch. Historische und archäologische Untersuchungen in Kommagene*, Bonn, 105-119.
Fischer, T., 2012: *Die Armee der Caesaren. Archäologie und Geschichte*, Regensburg.
Fischer, T., 2019: *Army of the Roman emperors. Archaeology and history* (transl. M.C. Bishop), Oxford.
Fitzpatrick, A.P., 1989: *Cross channel relations in the British Later Iron Age*, Durham (PhD thesis, Durham University).
Florschütz, B., 1890: Die Giganten-Säule von Schierstein, *Nassauische Annalen* 22, 119-134.
Fölting, H., 2008: Een Romeins dorpje onder het Statenkwartier? *Statenkoerier. Orgaan van het wijkoverleg Statenkwartier* 30 (maart), 7.
Foster, J., 1986: *The Lexden tumulus. A re-appraisal of an Iron Age burial from Colchester, Essex*, Oxford.
Fox, C., 1958: *Pattern and purpose. A survey of early Celtic art in Britain*, Cardiff.
Frangioni, L., 1978: Una cotta di maglia milanese a Firenze sulla fine del Trecento, in L. De Rosa (ed.), *Studi in memoria di Frederigo Melis* vol. 2, Firenze, 479-495.
Franke, R., 2009: *Römische Kleinfunde aus Burghöfe 3. Militärische Ausrüstungsgegenstände, Pferdegeschirr, Bronzegeschirr und –Gerät*, Rahden.
Fransen, L./A. Nørgaard/E. Østergård, 2010: *Medieval garments reconstructed. Norse clothing patterns*, Aarhus.
Franzius, G., 1995: Die römischen Funde aus Kalkriese 1987-95 und ihre Bedeutung für die Interpretation und Datierung militärischer Fundplätze der augusteischen Zeit im nordwesteuropäischen Raum, *Journal of Roman Military Equipment Studies* 6, 69-88.
Fredman, P.-O., 1992: *Ringväv. Om ringbrynjor och liknande föremålstyper från förhistorisk tid och medeltid*, Uppsala (BA thesis, Uppsala University).
Freeden, U. von, 2009: Die frühmittelalterlichen Adelsgräber von Straubing St. Peter, *Jahresbericht des Historischen Vereins für Straubing und Umgebung* 110, 79-157.
Frere, S.S./ J.K.S. Joseph, 1974: The Roman fortress at Longthorpe, *Britannia* 5, 1-129.
Frey, O.-H., 1991: *Eine Nekropole der frühen Eisenzeit bei Santa Maria d'Anglona*, Galatina.
Friederichs, C., 1871: Panzerfragment eines römischen Ketten- und Schuppenpanzers von Eisen, in *Geräthe und Broncen im Alten Museum. Kleinere Kunst und Industrie im Alterthum II*, Düsseldorf, 230.
Fuhrmann, I., 1942: Zum Moorgewand von Reepsholt, *Prähistorische Zeitschrift* 32-33, 339-365.
Fulford, M./D. Sim/A. Doig/J. Painter, 2005: In defence of Rome. A metallographic investigation of Roman ferrous armour from northern Britain, *Journal of Archaeological Science* 32, 241-250.

Gabelmann, H., 1973: Römische Grabmonumente mit Reiterkampfszenen im Rheingebiet, *Bonner Jahrbücher* 173, 132-200.

Gansser-Burckhardt, A., 1942: *Das Leder und seine Verarbeitung im römischen Legionslager Vindonissa*, Basel.

Garbsch, J., 1978: *Römische Paraderüstungen*, München.

Garbsch, J., 1984: Ein römisches Paradekettenhemd von Bertoldsheim, Ldkr. Neuberg-Schrotenhausen, *Neuburger Kollektaneenblatt* 136, 239-253.

Garbsch, J. 2000: Verschlußsache. Panzer, Kettenhemden und kimmerische Gewänder, *Bayerische Vorgeschichtblätter* 65, 109-124.

García Sánchez, L./R. Sánchez Salcedo/G.W. Queirós Mugas/A.J. Criado Martín/F. Penco Valenzuela/J.M. Gómez de Salazar y Caso de los Cobos/A.J. Criado Portal, 2017: Study of a 12th century fragment of hauberk with black magnetite patina, *International Journal of Recent Scientific Research* 8 (10), 21277-21281.

Garlan, Y., 1972: *La guerre dans l'antiquité*, Paris.

Gaspari, A., 2010: *Beginnings of the Roman town of Colonia Iulia Emona*, Ljubljana.

Gerresheim, T./H.G. Horn/H. Langguth/W. Maslankowsky/A. Steiner, 1979: Zur Konservierung und Restaurierung der Funde von Es Soumâa, in H.G. Horn/C.B. Rüger (eds), *Die Numider. Reiter und Könige nördlich der Sahara*, Köln, 345-362.

Geschwinde, M., 2013: Die dolabra vom Kahlberg, in H. Pöppelmann/K. Deppmeyer/W.-D. Steinmetz (eds), *Roms vergessener Feldzug. Die Schlacht am Harzhorn*, Stuttgart, 311-316.

Geschwinde, M./P. Lönne, 2013: Relikte einer Schlacht. Die Funde vom Harzhorn, in H. Pöppelmann/K. Deppmeyer/W.-D. Steinmetz (eds), *Roms vergessener Feldzug. Die Schlacht am Harzhorn*, Stuttgart, 272-284.

Geschwinde, M./P. Lönne/M. Meyer, 2013: Die Archäologie einer römisch-germanischen Konfrontation im 3. Jh. n. Chr., in H. Pöppelmann/K. Deppmeyer/W.-D. Steinmetz (eds), *Roms vergessener Feldzug. Die Schlacht am Harzhorn*, Stuttgart, 294-310.

Giddens, A., 1979: *Central problems in social theory. Action, structure and contradiction in social analysis*, London.

Gilles, K.J., 1985: Die römische Villa von Mehring, *Funde und Ausgrabungen in Bezirk Trier* 17, 33-39.

Gilliver, C.M., 1993: *The Roman art of war. Theory and practice: a study of the Roman military writers*, London (PhD thesis, University College London).

Gilliver, K., 2007: The Augustan reform and the structure of the imperial army, in P. Erdkamp (ed.), *A companion to the Roman army*, Oxford, 183-200.

Gilmour, B.J., 1997: Iron Age mail in Britain, *Royal Armouries Yearbook* 2, 26-35.

Gilmour, B.J., 1999: The mail shirt, in R. Niblett (ed.), *The excavation of a ceremonial site at Folly Lane, Verulamium*, London, 159-166.

Ginoux, N./D. Robcis/M. Leroux/F. Dussere, 2014: Metal craft and warrior elites in the third century BC. New sights from the Carpathian Basin to Gaul, in S. Berecki (ed.), *Iron Age crafts and crafsmen in the Carpathian Basin*, Târgu Mureş, 9-18.

Ginoux, N.C./P.C. Ramsl, 2014: Art and craftsmanship in elite-warrior graves. From Boii to Parisii and back again…, in C. Gosden, S. Crawford, K. Ulmschneider (eds), *Celtic art in Europe. Making connections*, Oxford, 284-295.

Glad, D., 2009: *Origine et diffusion de l'équipement défensif corporel en Méditerranée orientale (IVe-VIIIe s.). Contribution à l'étude historique et archéologique des armées antiques et médiévales*, Oxford.

Glassman, R.M., 2017: *The origins of democracy in tribes, city-states and nation-states* vol. 1, Cham.

Gleba, M., 2012: Linen-clad Etruscan warriors, in M.-L. Nosch (ed.) *Wearing the cloak. Dressing the soldier in Roman times*, Oxford, 45-55.

Gobkalo, O.V./V.S. Tyliščak, 2010: Римские импорты из металла на могильнике Чернелив-Русский, in O.A. Seglova/M. Kazanski/W. Nowakowski/O.A. Radus/K.N. Skvorcov (eds), *Germania – Sarmatia 2*, Kaliningrad, 79-95.

Godłowski, K., 1980: Zur Frage des Miniaturgeräts in der Przeworsk-Kultur, in T. Krüger/H.-G. Stephan (eds), *Beiträge zur Archäologie Nordwestdeutschlands und Mitteleuropas*, Hildesheim, 85-100.
Goldsworthy, A., 2003: *The complete Roman army*, London.
Gorelik, M., 2002: Arms and armour in south-eastern Europe in the second half of the first millennium AD, in D. Nicolle (ed.), *A companion to medieval arms and armour*, Woodbridge, 127-147.
Gorgues, A./M. Schönfelder, 2008: Militaria d'époque césarienne à Boé (Lot-et-Garonne) et à Toulouse (Haute-Garonne), in M. Poux (ed.), *Sur les traces de César. Militaria tardo-républicains en contexte gaulois*, Bibracte, 251-264.
Goroncharovski, V.A., 2006: Some notes on defensive armament of the Bosporan cavalry in the first centuries AD, in M. Mode/J. Tubach (eds), *Arms and armour as indicators of cultural transfer. The steppes and the ancient world from Hellenistic times to the Early Middle Ages*, Wiesbaden, 445-451.
Grancsay, S.V., 1928: Notes on European chain mail, *Bulletin of the Metropolitan Museum of Art* 23 (3), 82-85.
Grancsay, S.V., 1949: A barbarian chieftain's helmet, *The Metropolitan Museum of Art Bulletin* 7 (10), 272-281.
Grancsay, S.V., 1963: A Sasanian chieftain's helmet, *The Metropolitan Museum of Art Bulletin* 21 (8), 253-262.
Grandin, L., 2008: Ringar från en ringväv. Metallografisk och kemisk analys. Gotland, Tofta socken, Tofta kyrka, *UV Uppsala Rapport, Riksantikvarieämbetet, Avdelningen för arkeologiska undersökningar, Geoarkeologisk Undersöking* 22, 1-25.
Grane, T., 2007: Southern Scandinavia foederati and auxiliarii?, in T. Grane (ed.), *Beyond the Roman frontier. Roman influences on the northern Barbaricum*, Rome, 83-104.
Grane, T., 2015: South Scandinavian foederati and auxiliarii?, *Journal of Roman Military Equipment Studies* 16, 69-80.
Grane, T., 2017: Modern perceptions of Roman-Scandinavian relations. Research history and interpretations, in S. González Sánchez/A. Guglielmi (eds), *Romans and barbarians beyond the frontiers. Archaeology, ideology and identities in the North*, Oxford, 83-104.
Granger-Taylor, H., 1982: Weaving clothes to shape in the ancient world. The tunic and the toga of the Arringatore, *Textile History* 13 (1), 3-25.
Granger-Taylor, H., 2011: Fragments of linen from Masada, Israel - the remnants of pteryges? - and related finds in weft- and warp-twining including several slings, in M.-L. Nosch (ed.), *Wearing the cloak. Dressing the soldier in Roman times*, Oxford, 56-84.
Green, M., 1992: *Symbol and image in Celtic religious art*, London.
Greiner, B.A., 2006: Zur Herstellungsweise römischer Kettenhemden (lorica hamata), in H.U. Nuber/G. Seitz (eds), *Im Dienste Roms. Festschrift für Hans Ulrich Nuber*, Remshalden, 199-204.
Greiner, B.A., 2008: Kettenpanzer (lorica hamata), in *Rainau-Buch II. Der römische Kastellvicus von Rainau-Buch (Ostalbkreis). Die archäologischen Ausgrabungen von 1976 bis 1979*, Stuttgart, 97-101.
Gröbbels, I.W., 1905: *Der Reihengräberfund von Gammertingen*, München.
Grömer, K., 2010: *Prähistorische Textilkunst in Mitteleuropa. Geschichte des Handwerkes und Kleidung vor den Römern*, Wien.
Grose, F., 1786: *A treatise on ancient armour and weapons*, London.
Grotowski, P.Ł., 2010: *Arms and armour of the warrior saints. Tradition and innovation in Byzantine iconography (843-1261)* (transl. R. Brzezinski), Leiden.
Grunwald, L., 1998: *Grabfunde des Neuwieder Beckens von der Völkerwanderungszeit bis zum frühen Mittelalter. Der Raum von Bendorf und Engers*, Rahden.
Grunwald, L./A. Tröller-Reimer, 1997: Ein Kettenhemd des 8. Jahrhunderts n. Chr. aus Rullstorf, Ldkr. Lüneburg, *Berichte zur Denkmalpflege in Niedersachsen* 17, 171-174.
Gschwind, M., 2004: *Abusina. Das römische Auxiliarkastell Eining an der Donau vom 1. bis 5. Jahrhundert n. Chr.*, München.

Guillaud, L., 2019: *Militaria de Lugdunum. Étude de l'armement romain et de l'equipement militaire à Lyon (Ier s. av. – IVe s. ap. J.-C.)*, Drémil Lafage.

Guillement, J.-P./A. Lefort/C. Marcigny, 2016: *Le PCR «Etude de la plaine fermée de Port-en-Bessin. De l'Age du Bronze au début de l'Antiquité» et la fouille programmée du Mont Castel à Port-en-Bessin/Commes*, Cesson-Sévigné.

Gushchina, I.I./I.P. Zasetskaia, 1989: Погребения зубовско-воздвиженского типа из раскопок Н. И. Веселовского в Прикубанье (1 в. до н. э. - начало II в. н. э.), *Археологические исследования на юге Восточной Европы* 70, 71-123.

Gut, M., 2009: Die historisch belegten Flechttechniken von Kettenhemden und ihre Eigenschaften, *Mittelalter. Zeitschrift des Schweizerischen Burgenvereins* 14 (3), 65-90.

Haalebos, J.K., 1994: Review. Eckhard Deschler-Erb, Markus Peter und Sabine Deschler-Erb: Das frühkaiserzeitliche Militärlager in der Auguster Unterstadt, *Bonner Jahrbücher des Rheinischen Landesmuseums in Bonn* 194, 703-705.

Haalebos, J.K., 2002: Die früheste Belegung des Hunerberges in Nijmegen, in P. Freeman/J. Bennett/Z.T. Fiema/B. Hoffmann (eds), *Limes XVIII. Proceedings of the XVIIIth International Congress of Roman Frontier Studies held in Amman, Jordan (September 2000)*, Oxford, 403-414.

Haas, F./F. Firbas, 1930: Kastell Feldberg, *Saalburg Jahrbuch* 7, 79-91.

Hagedoorn, S., 2013: Uitrusting, in P. Bakker/W. Bron (eds), *Gered uit de grond. Romeinse vondsten van castellum Albaniana*, s.l., 49-62.

Hald, M., 1946: Ancient textile techniques in Egypt and Scandinavia. A comparative study, *Acta Archaeologica* 17, 49-98.

Hald, M., 1980: *Ancient Danish textiles from bogs and burials. A comparative study of costume and Iron Age textiles*, Copenhagen.

Haldon, J., 2002: Some aspects of Early Byzantine arms and armour, in D. Nicolle (ed.), *A companion to medieval arms and armour*, Woodbridge, 65-79.

Hanel, N., 2006: Fabricae, Werkstätten und handwerkliche Tätigkeiten des Militärs in den Nordprovinzen des römischen Reiches, in Á Murillo Cerdán (ed.), *Producción y abestecimiento en el ámbito militar. Arqueología militar romana en Hispania II*, León, 19-32.

Hansen, L., 2003: *Die Panzerung der Kelten. Eine diachrone und interkulturelle Untersuchung eisenzeitlicher Rüstung*, Kiel.

Harhoiu, R., 2008: Das gepidische Gräberfeld von Galații Bistriței, *Revista Bistriței* 22, 183-241.

Härke, H., 2014: Grave goods in early medieval burials. Messages and meanings, *Mortality* 19 (1), 41-60.

Harlow, M./M.-L. Nosch, 2014: Weaving the threads. Methodologies in textile and dress research for the Greek and Roman world – the state of the art and the case for cross-disciplinarily, in Harlow, M./M.-L. Nosch (eds), *Greek and Roman textiles and dress. An interdisciplinary anthology*, Oxford, 1-33.

Harnecker, J., 2008: *Kalkriese 4. Katalog der römischen Funde vom Oberesch. Die Schnitte 1 bis 22*, Mainz am Rhein.

Harnecker, J., 2011: *Kalkriese 5. Die römischen Funde vom Oberesch. Die Schnitte 23 bis 39*, Mainz am Rhein.

Hatt, J.-J., 1953: Les fouilles de la ruelle Saint-Médard à Strasbourg, *Gallia* 11 (2), 225-248.

Hawkes, C.F.C./M.R. Hull, 1947: *Camulodunum. First report on the excavation at Colchester 1930-1939*, Oxford.

Haynes, I. 2013: *Blood of the provinces. The Roman auxilia and the making of provincial society from Augustus to the Severans*, Oxford.

Haynes, S., 2000: *Etruscan civilization. A cultural history*, Los Angeles.

Hazenberg, T., 2000: *Leiden-Roomburg 1995-1997. Archeologisch onderzoek naar het kanaal van Corbulo en de vicus van het castellum Matilo*, Amersfoort.

Hebert, J.E., 1990: Les deux phiales à inscriptions ibériques du tumulus no III de la lande „Mesplède" à Vielle-Aubagnan (Landes), *Bulletin de la Société de Borda* 417, 1-40.

Hellman, T., 1995: *Ringbrynjehuvor från massgravarna vid Korsbetningen. Några frågor rörande deras konstruktion samt en jämförelse med en i England återfunnen, som äkta betraktad ringbrynjehuva*, Stockholm (MA thesis, Stockholm University).
Hencken, H., 1968: *Tarquinia, Villanovans and early Etruscans*, Cambridge.
Herramhof, S./F.-R. Herrmann/H. Koschik/D. Rosenstock/L. Wamser, 1986/1987: *Archäologische Funde und Ausgrabungen in Mittelfranken. Fundchronik 1970-1985*, Ansbach.
Herrmann, F.-R., 1972: *Die Ausgrabungen in dem Kastell Künzing/Quintana*, Stuttgart.
Hessing, W./R. Polak/V. Wouter/I. Joosten, 1997: *Romeinen langs de snelweg. Bouwstenen voor Vechtens verleden*, Abcoude.
Hewitt, J., 1860: *Ancient armour and weapons in Europe. From the Iron period of the northern nations to the end of the thirteenth century*, Oxford.
Hewitt, J., 1867: Mail-maker of the fifteenth century, from an illumination in the British Museum, *The Archaeological Journal* 24, 318.
Hiddink, H.A., 2018: *De opgravingen van 1989-1991 op De Werf bij Empel*, Amsterdam.
Higgins, R.A., 1980: *Greek and Roman jewellery*, Berkeley.
Hilgner, A., 2010: Das Prunkgrab von Planig. Neubearbeitung eines Altfundes, *Mainzer Zeitschrift. Mittelrheinisches Jahrbuch für Archäologie, Kunst und Geschichte* 105, 41-86.
Himmler, F., 2011: ‚On the road again' - Ergebnisse zweier Erprobungsmärsche in den Jahren 2004 und 2008, in C. Koepfer/F.W. Himmler/J. Löffl (eds), *Die römische Armee im Experiment*, Berlin, 173-191.
Hobley, B., 1969: A Neronian-Vespasianic military site at 'The Lunt', Baginton, Warwickshire, *Transactions of the Birmingham Archaeological Society* 83.
Hobley, B., 1973: Excavations at 'The Lunt' Roman military site, Baginton, Warwickshire: 1968-71. Second Interim Report, *Transactions of the Birmingham Archaeological Society* 85.
Hodgetts, F., 1883: Some remarks on chain mail, *The Antiquary* 7 (39), 89-93.
Hodgson, N., 2003: *The Roman fort at Wallsend (Segedunum). Excavations in 1997-8*, Newcastle upon Tyne.
Hoffiller, V. 1911/1912: *Oprema rimskoga vojnika u prvo doba carstva. S osobitim obzirom na material pohranjen u hrv. narodnom muzeju*, Zagreb.
Hölscher, T., 2009: The transformation of victory into power. From event to structure, in S. Dillon/K.E. Welch (eds), *Representations of war in ancient Rome*, Cambridge.
Holzer, V., 2008: Der keltische Kultbezirk in Roseldorf/Sandberg, Niederösterreich, in C. Eggl/P. Trebsche/I. Balzer/J. Fries-Knoblach/J.K. Koch/H. Nortmann/J. Wiethold (eds), *Ritus und Religion in der Eisenzeit. Beiträge zur Sitzung der AG Eisenzeit während der Jahrestagung des Mittel- und Ostdeutschen Verbandes für Altertumsforschung e. V. in Halle an der Saale 2007*, Langenweissbach, 125-134.
Horedt, K., 1973: Interpretări arheologice II, *Studii şi Cercetări de Istorie Veche şi Arheologie* 24 (2), 299-310.
Horn, H.G./C.B. Rüger (eds), 1979: *Die Numider. Reiter und Könige nördlich der Sahara*, Köln.
Hoss, S., 2008: Metaal en metaalbewerking, in E. Blom/W.K. Vos (eds), *Woerden-Hoochwoert. De opgravingen 2002-2004 in het Romeinse castellum Laurium, de vicus en van het schip de 'Woerden 7'*, Amersfoort, 235-261.
Hoss, S., 2011: The Roman military belt, in M.-L. Nosch (ed.), *Wearing the cloak. Dressing the soldier in Roman times*, Oxford, 29-44.
Hoss, S., 2014*: Cingulum militare. Studien zum römischen Soldatengürtel des 1. bis 3. Jh. n. Chr.*, Leiden (PhD thesis, Leiden University).
Houston, M.G., 1996 [1939]: *Medieval costume in England and France. The 13th, 14th and 15th centuries*, Mineola.
Hrubý, V., 1959: Ein Ringpanzer der Hallstattzeit, *Sborník Prací Filozofické Fakulty Brněnské Univerzity E* 8, 33-37.
Huber, A./P. Ettmayer/J. Garcia/M. Pfaffenbichler, 2004: Vom Kettenpanzer zum Saitendraht. Untersuchungen zum Saitenmaterial von Musikinstrumenten des 14. und 15. Jahrhunderts, *Kunsthistorisches Museum. Technologische Studien* 1/2004, 32-51.

Hulit, T.D., 2002 *Late Bronze Age scale armour in the Near East. An experimental investigation of materials, construction, and effectiveness, with a consideration of socio-economic implications*, Durham (PhD thesis, University of Durham).

Hulsebos, G.A., 1890: *Vervolg benevens wijzigingen en toevoegsels op den catalogus der archeologische verzameling van het Provinciaal Utrechtsch Genootschap van Kunsten en Wetenschappen*, Utrecht.

Hummelberger, W., 1961: Die Ordnungen der Wiener Plattner und Sarwürcher, *Waffen- und Kostümkunde. Zeitschrift der Gesellschaft für historische Waffen- und Kostümkunde* 3 (2), 91-107.

Hunter, F./M. Goldberg/J. Farley/I. Leins, 2015: In search of the Celts, in J. Farley/F. Hunter (eds), *Celts. Art and identity*, 19-35.

Iaia, C., 2007: Identità e comunicazione nell'abbigliamento femminile dell'area circumadriatica fra IX e VII secolo a.C., in P. von Eles (ed.), *Le ore e i giorni delle donne. Dalla quotidianità alla sacralità tra VIII e VII secolo a.C.*, Verucchio, 25-36.

Ignatov, V./K. Gospodinov, 2013: Eine reiche Bestattung eines thrakischen Aristokraten aus dem 1. Jh. n. Chr. bei Karanovo, Kreis Nova Zagora, Südbulgarien, *Archaeologia Bulgarica* 17 (1), 27-47.

Ilkjær, J., 1990: *Illerup Ådal 1-2. Die Lanzen und Speere*, Højbjerg.

Ilkjær, J., 2001: Unterschiede zwischen Moorfunden und Waffengräbern in der jüngeren römischen Kaiserzeit, in B. Storgaard (ed.), *Military aspects of the aristocracy in Barbaricum in the Roman and Early Migration periods*, Copenhagen, 87-93.

Ilkjær, J., 2003: Danish war booty sacrifices, in L. Jørgensen/B. Storgaard/L. Gebauer Thomson (eds), *The spoils of victory. The North in the shadow of the Roman Empire*, Copenhagen, 44-65.

Ilkjær, J./R. Birch Iversen, 2009: Untergegangen. Germanische Heeresverbände und skandinavische Kriegsbeuteopfer, in S. Burmeister/H. Derks (eds), *2000 Jahre Varusschlacht. Konflikt*, Stuttgart, 140-147.

ILRUV, 2012: *La casona de Puerta de Castillo y el solar de Santa Marina*, León.

Istenič, J. 2016: Non-ferrous metals on Late Republican and Early Principate Roman military metalwork found in the River Ljubljanica (Slovenia), *Journal of Roman Military Equipment Studies* 17, 279-285.

Istenič, J./Z. Šmit, 2007: The beginning of the use of brass in Europe with particular reference to the southeastern Alpine region, in S. La Niece/D.R. Hook/P.T. Craddock (eds), *Metal and mines. Studies in archaeometallurgy,* London, 140-147.

Ivčević, S., 2013a: First-century military gear from Salona, in M. Sanader/A. Rendić-Miočević/D. Tončinić/I. Radman-Livaja (eds), *XVII Roman Military Equipment Conference Zagreb 2010, 24th-27th May, 2010*, Zagreb, 299-316.

Ivčević, S., 2013b: Project Tilurium – Roman military equipment, in M. Sanader/A. Rendić-Miočević/D. Tončinić/I. Radman-Livaja (eds), *XVII Roman Military Equipment Conference Zagreb 2010, 24th-27th May, 2010*, Zagreb, 435-453.

Jacques, A./G. Prilaux, 2008: Arras – Les fouilles Actiparc (62). Le mobilier à caractère militaire découvert dans un vaste complexe césaro-tibérien, in M. Poux (ed.), *Sur les traces de César. Militaria tardo-républicains en contexte gaulois*, Bibracte, 47-62.

Jähns, J., 1880: *Handbuch einer Geschichte des Kriegswesens von der Urzeit bis zur Renaissance*, Leipzig.

James, S., 1986: Evidence from Dura Europos for the origins of Late Roman helmets, *Syria* 63, 107-134.

James, S., 1988: The fabricae. State arms factories of the Later Roman Empire, in J.C. Coulston (ed.), *Military equipment and the identity of Roman soldiers. Proceedings of the fourth Roman Military Equipment Conference*, Oxford, 257-331.

James, S., 1990: *The Arms and armour from Dura-Europos, Syria. Weaponry recovered from the Roman garrison town and the Sassanid siegeworks during the excavations, 1922-37*, London (PhD thesis, University College London).

James, S., 2004: *Excavations at Dura-Europos 1928-1937. Final Report VII: the arms and armour and other military equipment*, London.
Janssen, L.J.F., 1836: *Gedenkteekenen der Germanen en Romeinen aan den linker oever van den Neder-Rijn*, Tiel.
Jarva, E., 1995: *Archaiologia on archaic Greek body armour*, Rovaniemi.
Jensen, J., 1989: The Hjortspring boat reconstructed, *Antiquity* 63, 531-535.
Jeremić, G., 2009: *Saldum. Roman and Early Byzantine fortification*, Belgrade.
Johns, C., 1996: *The jewellery of Roman Britain. Celtic and classical traditions*, Ann Arbor.
Jones, D., 2014: Arrows against mail armour, *Journal of the Society of Archer-Antiquaries* 57, 62-70.
Jöns, H./A. Nieuwhof/A. Siegmüller/E. Strahl/W. van der Sanden, 2013: Von Reichen und Armen. Eliten im archäologischen Befund, in J.F. Kegler (ed.), *Land der Entdeckungen. Die Archäologie des friesischen Küstenraums*, Aurich, 219-233.
Jope, E.M., 1957: A fragment of chain-mail from the Romano-British temple site at Woodeaton, *Oxoniensia* 22, 106-107.
Jørgensen, L./B. Storgaard/L.G. Thomsen (eds), 2003: *The spoils of victory. The North in the shadow of the Roman Empire*, Copenhagen.
Jouttijärvi, A., 1995: Technische Untersuchung der kaiserzeitlichen Ringbrünne von Brokaer, *Acta Archaeologica* 66, 102-105.
Jouttijärvi, A., 1996: The manufacture of chain-mail, in H. Lyngstrøm (ed.), *Early iron. Netvaerk for tidlig jernteknologi*, Copenhagen, 53-60.
Juncher, K.L., 2016: Lorica hamata or Germanic crafts? Ring-mail finds from the Early Iron Age in a southern Scandinavian context, *Journal of Roman Military Equipment Studies* 17, 95-100.
Junkelmann, M., 1986: *Die Legionen des Augustus. Der römische Soldat im archäologischen Experiment*, Mainz am Rhein.
Junkelmann, M., 1991: *Die Reiter Roms: Teil II. Der militärische Einsatz*, Mainz am Rhein.
Junkelmann, M., 1992: *Die Reiter Roms. Teil III. Zubehör, Reitweise, Bewaffnung*, Mainz am Rhein.
Junkelmann, M., 1996: *Reiter wie Statuen aus Erz*, Mainz am Rhein.
Junkelmann, M., 2000: *Römische Helme*, Mainz am Rhein.
Junkelmann, M., 2008: *Gladiatoren. Das Spiel mit dem Tod*, Mainz.

Kaczanowski, P., 1994: Aus den Forschungen an der territorialen Differenzierung des Zustroms römischer Waffenimporte im Barbaricum, in C. von Carnap-Bornheim (ed.), *Beiträge zu römischer und barbarischer Bewaffnung in den ersten vier nachchristlichen Jahrhunderten: Akten des 2. Internationalen Kolloquiums in Marburg a.d. Lahn, 20. Bis 24. Februar 1994*, Marburg, 207-222.
Kaenel, G./F. Lanthemann, 2016: Les vestiges pré- et protohistoriques, in D. Paunier/T. Luginbühl (eds), *La villa romaine d'Orbe-Boscéaz. Genèse et devenir d'un grand domaine rural. Environnement, histoire et développement du bâti* vol. 1, Lausanne, 69-95.
Kalee, C.A., 1989: Roman helmets and other militaria from Vechten, in C. van Driel-Murray (ed.), *Roman military equipment. The sources of evidence. Proceedings of the fifth Roman Military Equipment Conference*, Oxford, 193-226.
Kalsbøll Malfilâtre, M., 1993 *Ringbrynjen fra Hedegård. Fremstillingsteknik og metode*, København (MA thesis, Konservatorskolen Det Kongelige Danske Kunstakademi).
Kaminskaja, I.V./V.P. Kaminskij/A.V. P'jankov, 1985: Сарматское погребение у ставицы Михайловской (Закубанье), *Sovetskaya Archeologija* 4, 228-234.
Karamian, G./K. Farrokh/A. Kubik/M. Taheri Oshterinani, 2017: An examination of Parthian and Sasanian military helmets (2nd century BC – 7th century AD), in K. Maksymiuk/G. Karamian (eds), *Crowns, hats, turbans and helmets. Headgear in Iranian history. Volume I: Pre-Islamic period*, Siedlce, 121-163.
Karlova, E./A. Pastukhov/A. Popov/E. Uspenskaya, 2015: *Mortal beauty. Arms and armour of India and China. Exibition catalogue*, Moscow.

Karwowski, M., 2014: The dragon from Oberleiserberg, in C. Gosden/S. Crawford/K. Ulmschneider (eds), *Celtic art in Europe. Making connections*, Oxford, 234-238.

Kaul, F., 2003a: The Hjortspring find, in O. Crumlin-Pedersen/A. Trakadas (eds), *Hjortspring. A pre-Roman Iron Age warship in context*, Roskilde, 141-153.

Kaul, F., 2003b: The Hjortspring find. The oldest of the large Nordic war booty sacrifices, in L. Jørgensen/B. Storgaard/L. Gebauer Thomson (eds), *The spoils of victory. The North in the shadow of the Roman Empire*, Copenhagen, 212-223.

Kavur, B., 2014: *Vse stvari štejejo (v majhnih količinah)…*, Koper.

Kazakevich, G., 2012: Celtic military equipment from the territory of Ukraine. Towards a new warrior identity in the pre-Roman Eastern Europe, in M. Fomin/V. Blažek/P. Stalmaszczyk (eds), *Transforming traditions. Studies in archaeology, comparative linguistics and narrative*, Łódz, 177-212.

Kazanski, M., 1995: Les tombes des chefs alano-sarmates au IVe siècle dans les steppes pontiques, in F. Vallet/M. Kazanski (eds), *La noblesse romaine et les chefs barbares du IIIe au VIIe siècle*, Saint-Germain-en-Laye, 189-205.

Kazanski, M., 1999: L'armement slave du Haut Moyen-Âge (Ve-VIIe siècles). A propos des chefs militaires et des guerriers professionnels chez les anciens slaves, *Přehled výzkumů* 39 (1995-1996), 197-236.

Kazanski, M., 2002: *La nécropole gallo-romaine et mérovingienne de Breny (Aisne). D'après les collections et les archives du Musée des Antiquités Nationales*, Montagnac.

Kazanski, M., 2007: The armament, horsemen's accoutrements, and riding gear of Long Barrow Culture (fifth to seventh centuries), *Archaeologia Baltica* 8, 238-253.

Kazanski, M., 2012: Les armes et les techniques de combat des guerriers steppiques du début du Moyen Âge. Des Huns et Avars, in S. Lazaris (ed.), *Le cheval dans les sociétés antiques et médiévales*, Turnhout, 193-199, 289-299.

Kazanski, M., 2013: Barbarian military equipment and its evolution in the Late Roman and Great Migration periods (3rd-5th C. A.D.), in A. Sarantis/N. Christie (eds), *War and warfare in Late Antiquity*, Leiden, 493-521.

Kazanski, M./A. Mastykova, 2003: *Les peuples du Caucase du Nord. Le début de l'histoire (Ier-VIIe siècle apr. J.-C.)*, Paris.

Kebric, R.B., 2015: The Portonaccio sarcophagus' Roman cavalry charge, *Athens Journal of History* 1 (3), 175-193.

Kelly, F. M., 1931: "Chain mail", *Apollo. A Journal of the Arts* 14, 264-270.

Kelly, F.M., 1934: Römisch-romanische Ringelpanzer, ihre Darstellung in der gleichzeitigen Kunst, *Zeitschrift für historische Waffen- und Kostümkunde. Neue Folge* 4, 204-210.

Kelly, T.D., 2013: The tailoring of the pourpoint of King Charles VI of France revealed, *Waffen- und Kostümkunde* 55 (2), 153-180.

Kemkes, M./J. Scheuerbrandt, 1997: *Zwischen Patrouille und Parade. Die römische Reiterei am Limes*, Stuttgart.

Kemkes, M./J. Scheuerbrandt/N. Willburger, 2006: *Der Limes. Grenze Roms zu den Barbaren*, Ostfildern.

Kérdő, K./A. Verebes/L. Költő/M. Kis-Varga, 2007: An assemblage of bronze objects found in the territory of the 1st century vicus in Aquincum-Víziváros, in *2nd International Conference on Archaeometallurgy in Europe 2007. Aquileia, Italy, 17-21 June, 2007*, 1-10 (online publication).

Kerkhoven, N.D., 2012: Metaal, in A.C. Aarts (ed.), *Scherven, schepen en schoeiingen. LR62: archeologisch onderzoek in een fossiele rivierbedding bij het castellum van De Meern*, Utrecht, 133-160.

Khazanov, A.M., 1971: Очерки военного дела сарматов, Moscow.

Khomchyk, M./Y. But, 2017: Фрагменти римських кольчуг I–II ст. в зібранні нміу (нові надходження), Науковий вісникНаціонального музею історії України 2, 24-28.

Kiernan, P., 2009: *Miniature votive offerings in the north-west provinces of the Roman Empire*, Mainz.

Kirby, M., 2020: Excavations at Musselburgh Primary Health Care Centre. Iron Age and Roman discoveries to the north of Inveresk Roman Fort, East Lothian, *Scottish Archaeological Internet Reports* 89.

Kitov, G., 1996: The Thracian valley of the kings in the region of Kazanluk, *Balkan Studies* 37 (1), 6-34.
Kitov, G., 2003: *The valley of the Thracian rulers*, Slavena.
Kitov, G., 2007: Tombs of the Thracian kings in the region of Kazanluk, in M. Stefanovich/C. Angelova (eds), *Prae. In Honorem Henrieta Todorova*, Sofia, 215-277.
Klee, M., 1989: *Der Limes zwischen Rhein und Main. Vom Beginn des obergermanischen Limes bei Rheinbrohl bis zum Main bei Großkrotzenburg*, Stuttgart.
Klein, J., 1891: Die kleineren inschriftlichen Denkmäler des Bonner Provinzialsmuseums, *Bonner Jahrbücher* 90, 13-48.
Klumbach, H., 1974: *Römische Helme aus Niedergermanien*, Köln.
Koepfer, C./F.W. Himmler/J. Löffl, (eds), 2011: *Die römische Armee im Experiment*, Berlin.
Köhne, E./C. Ewigleben, 2000: *Gladiators and caesars. The power of spectacle in ancient Rome*, London.
Kokkotidis, K.G./U. Wittwer-Backofen/S. Schlager/C. Knipper, 2019: *Der Mann mit dem Goldhelm. Das frühmittelalterliche "Fürstengrab" aus Gammertingen, Kreis Sigmaringen*, Stuttgart.
Komoróczy, B., 2013: *New Roman military finds from the Germanic territory to the north of the middle Danube and their contribution to knowledge of the Roman military equipment and weaponry development of the 2nd half of the 2nd century AD* (conference poster, Roman Military Equipment Conference 18, Copenhagen).
Kopf, J., 2015: Von Spitzgräben und Gürtelblechen… Neue Grabungsergebnisse zur frühkaiserzeitlichen Militärpräsenz in Brigantium (Bregenz, Österreich), in L.F. Vagalinski/N. Sharankov (eds), *Limes XXII. Proceedings of the 22nd International Congress of Roman Frontier Studies, Ruse, Bulgaria, September 2012*, Sofia, 111-118.
Kopf, J., 2016: New military equipment from the area of the Early Imperial forts at Brigantium (Bregenz, Austria), *Journal of Roman Military Equipment Studies* 17, 243-250.
Kopf, J., 2018: The function of Brigantium (Bregenz, Austria) on the Augustan and Tiberian Rhine frontier line, in C.S. Sommer/S. Matešić (eds), *Limes XXIII. Proceedings of the 23rd International Congress of Roman Frontier Studies Ingoldstadt 2015*, Mainz, 932-939.
Kotyhoroshko, V., 2015: *The sacred centre of the upper Tisa region of the Late La Tène period*, Satu Mare.
Krekovič, E., 1996: Military equipment on the territory of Slovakia, *Journal of Roman Military Equipment Studies* 5, 211-225.
Kröger, H./W. Best, 2014: *Porta Westfalica-Barkhausen. Ein Gang durch die Jahrtausende* (Grabungsbrochüre), Porta Westfalica.
Krogh, I., 2016: *Mail tailoring in Late Medieval and Renaissance Germany. A study of the mail garments in Veste Coburg*, Lund (MA thesis, Lunds Universitet).
Kubarev, G.V., 1997: Der Panzer eines alttürkischen Ritters aus Balyk-Sook, *Zeitschrift für Archäologie Eurasiens* 3, 629-645.
Kubarev, G.V./V.D. Kubarev, 2003: Noble Turk grave in Balyk-Sook (Central Altai), *The Metal Ages and Medieval period. Archaeology, Ethnology and Anthropology of Eurasia* 4 (16), 64-82.
Kubik, A.L., 2016: Introduction to the studies on Late Sasanian protective armour. The Yarysh-Mardy helmet, *Historia I* Świat 5, 77-105.
Kubik, A., 2017: Sasanian lamellar helmets, in K. Maksymiuk/G. Karamian (eds), *Crowns, hats, turbans and helmets. Headgear in Iranian history. Volume I: Pre-Islamic period*, Siedlce, 195-210.
Künzl, E., 2001: Wasserfunde römischer Gladii. Votive oder Transportverluste?, in R. Bedon/A. Malissard (eds), *La Loire et les fleuves de la Gaule romaine et des régions voisines*, Limoges, 547-575.
Künzl, E., 2002: Der römische Schuppenpanzer (lorica squamata). Importwaffe und Prunkgrabelement, in J. Peška/J. Tejral (eds), *Das germanische Königsgrab von Mušov in Mähren* vol. 1, Mainz, 127-140.
Künzl, E., 2008: *Unter den goldenen Adlern. Der Waffenschmuck des römischen Imperiums*, Regensburg.
Künzl, E., 2010: *Ein Traum vom Imperium. Der Ludovisisarkophag. Grabmal eines Feldherrn Roms*, Mainz.

Lacombe, P., 1868: *Les armes et les armures*, Paris.

Laharnar, B., 2011: Roman lead slingshots (glandes plumbae) in Slovenia, *Arheološki Vestnik* 62, 339-374.
Laking, G.F., 1920: *A record of European armour and arms through seven centuries* vol. 2, London.
Lamm, J.P., 1962: Ett Vendeltida gravfynd från Spelvik, *Fornvännen. Journal of Swedish Antiquarian Research* 1962, 277-299.
Lantier, R., 1951: L'équipement militaire des «héros» celtiques d'Entremont (Bouches-du-Rhône), *Comptes-rendus des séances de l'Académie des Inscriptions et Belles-Lettres* 95 (3), 276-279.
Lanting, J.N./J. Van der Plicht, 2005/2006: De ^{14}C-chronologie van de Nederlandse pre- en protohistorie V. Midden- en Late IJzertijd, *Palaeohistoria. Acta et Communicationes Instituti Archaeologici Universitatis Groninganae* 47/48, 214-428.
La Rocca, D.J., 1995: Notes on the mail chausse, *Journal of Arms and Armour Society* 15 (2), 69-84.
Laser, R./R. Leineweber, 1991: Die römischen Importfunde der Altmark, *Jahresschrift für mitteldeutsche Vorgeschichte* 74, 191-282.
Lau, N., 2010: Zum Ritus der Opferung von Kriegsbeute in der jüngeren römischen Kaiserzeit. Spuren ritueller Zerstörungen an Pferdgeschirren aus dem Thorsberger Moorfund, in A.W. Busch and H.-J. Schalles (eds) *Waffen in Aktion. Akten der 16. internationalen Roman Military Equipment Conference*, Mainz am Rhein, 137-152.
Laver, P.G., 1927: The excavation of a tumulus at Lexden, Colchester, *Archaeologia or Miscellaneous Tracts Relating to Antiquity* 76, 241-254.
Lazer, T., 2011: "Srednjeveške" verižne rokavice. Verižnina kot pojav dolgega trajanja, *Argo. Journal of the Slovene Museums* 54 (1), 84-90.
Lazer, T., 2018: A steel skin hammered out by master armourers, in G. Oitzl (ed.), *The past under the microscope. Scientific analyses in museums*, Ljubljana, 103-108.
Lazerov, L., 2010: The Celtic Tylite state in the time of Cavarus, in L. Vagalinski (ed.), *In search of Celtic Tylis in Thrace (III C BC). Proceedings of the interdisciplinary colloquium arranged by the National Archaeological Institute and the Museum at Sofia and the Welsh Department, Aberystwyth University held at the National Archaeological Institute and Museum Sofia: 8 May 2010*, Sofia, 97-113.
Lee, M.M., 2015: *Body, dress, and identity in ancient Greece*, New York.
Lehmann, H., 1885: *Brünne und Helm im angelsächsischen Beowulfliede*, Leipzig.
Lehmann, K., 1953: Samothrace. Sixth preliminary report, *Hesperia. Journal of the American School of Classical Studies at Athens* 22, 1-24.
Lehner, H., 1904: Die Einzelfunde von Novaesium, *Bonner Jahrbücher* 111/112, 243-418.
Lejars, T., 1998: Des armes celtiques dans un contexte cultuel particulier. Le "charnier" de Ribemont-sur-Ancre (Somme), *Revue Archéologique de Picardie* 1/2, 233-244.
Lejars, T., 2007: Caractères originaux de l'armement celtique. Contraintes idéologiques et choix techniques, in P. Sauzeau/T. van Compernolle (eds), *Les armes dans l'antiquité. De la technique à l'imaginaire*, Montpellier, 145-182.
Lejars, T., 2011: L'armement celtique en fer, in C. Giardino (ed.), *Archeometallurgia della conoscenza alla fruizione*, Bari, 133-147.
Lendering, J., 2009: Varus' defeat in narrative sources. Four misrepresentations, *Ancient Warfare* special issue 2009, 4-9.
Lendering, J./A. Bosman, 2012: *Edge of the empire. Rome's frontier on the Lower Rhine*, Rotterdam.
Lenz, E.E., 1902: Описание оружия, найденнаго в 1901 г. в Кубанской области, *Известия Императорской археологической комиссии* 4, 120-131.
Lenz, E., 1919: Datierte Panzerhemden und verzierte Panzerringe, *Zeitschrift für historische Waffenkunde* 8 (7), 193-197.
Lenz, K.H., 2006: *Römische Waffen, militärische Ausrüstung und militärische Befunde aus dem Stadtgebiet der Colonia Ulpia Traiana (Xanten)*, Bonn.
Leroi-Gourhan, A., 1964: *Le geste et la parole I. Technique et langage*, Paris.

Leveau, P., 2016: Sculpture funéraire et présence des élites gallo-romaines dans les campagnes de la cité romaine d'Aquae Sextiae, in V. Gaggadis-Robin/P. Picard (eds), *La sculpture romaine en Occident: Nouveaux regards. Actes des rencontres autour de la sculpture romaine 2012*, Arles, 223-235.

Liberati, A.M., 1997: L'esercito di Roma nell'età delle guerre puniche. Ricostruzioni e plastici del Museo della Civilità Romana di Roma, *Journal of Roman Military Equipment Studies* 8, 25-40.

Lichtenstein, L., 2006: Középavar kori magányos női temetkezés Orosházáról, *A Szántó Kovács Múzeum Évkönyve* 8, 147-156.

Lindenschmit, L., 1858: *Die Alterthümer unserer heidnischen Vorzeit*, Mainz.

Lloyd-Morgan., G., 1987: Professor Robert Newstead and finds of Roman military metalwork from Chester, in M. Dawson (ed.), *Roman military equipment. The accoutrements of war. Proceedings of the third Roman Military Equipment Research Seminar*, Oxford, 85-97.

Logdacheva, E./Y. Vinogradov/S. Shvemberger/N. Borisov, 2011: 3D reconstructions of Cimmerian Bosporus painted crypts, in S. Dunn/J. Bowen/K. Ng (eds), *EVA London 2011. Electronic Visualisation and the Arts. Proceedings of a conference held in London 6-8 July,* Swindon, 197-202.

Longaurová, M./S. Longaur, 1990: Structural analysis of a scabbard and a ring mail from Zemplín, *Slovenská Archeológia* 38 (2), 349-355.

Lőrinczy, G./P. Somogyi, 2018: Archäologische Aussagen zur Geschichte der Großen ungarischen Tiefebene östlich der Theiss im 6. und 7. Jahrhundert. Grab 33 des frühawarenzeitlichen Gräberfeldes von Szegvár-Oromdűlő, in J. Drauschke/E. Kislinger/K. Kühtreiber/T. Kütreiber/G. Scharrer-Liška/T. Vida (eds), *Lebenswelten zwischen Archäologie und Geschichte. Festschrift für Falko Daim zu seinem 65. Geburtstag,* Mainz, 231-249.

Luik, M., 2002: *Die Funde aus den römischen Lagern um Numantia im Römisch-Germanischen Zentralmuseum*, Mainz/Bonn.

Luik, M., 2010: Los hallazgos de armas en los campamientos romanos alrededor de Numancia, *Gladius* 30, 61-78.

Lund Hansen, U., 2007: Barbarians in the north. The greatest concentration of Roman weaponry in Europe, in T. Grane (ed.), *Beyond the Roman frontier. Roman influences on the northern Barbaricum*, Rome,105-130.

Luttwak, E., 1976: *Grand strategy of the Roman Empire. From the first century AD to the third*, Baltimore.

Lysenko, A., 2013: Das Heiligtum Eklizí-Burún in römischer Zeit, in S. Müller (ed.), *Die Krim. Goldene Insel im Schwarzen Meer. Griechen – Skythen – Goten*, Darmstadt, 276-283.

MacDowall, S., 1994: *Late Roman infantryman. AD 236-565*, Oxford.

MacDowall, S., 1995: *Late Roman cavalryman. AD 236-565*, Oxford.

MacDowall, S., 1996: *Germanic warrior. 236-568 AD*, London.

MacGregor, M., 1962: The Early Iron Age metalwork hoard from Stanwick, N.R. Yorks, *Proceedings of the Prehistoric Society* 28, 17-57.

Macháček, J./M. Gregerová/M. Hložek/J. Hošek, 2007: Raně středověká kovodělná výroba na Pohansku u Břeclavi, *Památky Archeologické* 98, 129-184.

MacIntosh Turfa, J., 2005: *Catalogue of the Etruscan gallery of the University of Pennsylvania Museum of Archaeology and Anthropology*, Philadelphia.

MacMullen, R., 1960: Inscriptions on armor and the supply of arms in the Roman Empire, *American Journal of Archaeology* 64 (1), 23-40.

Madsen, O., 1997: Hedegård – a rich village and cemetery complex of the Early Iron Age on the Skjern river, *Journal of Danish Archaeology* 13 (1), 57-93.

Maguer, P., 2015: Thropées guerriers à la porte du sanctuaire. Le cas de l'enclos celtique de Grand-Champ-Est à Bessines (Deux-Sèvres), in S. Lemaître/C. Batigne Vallet (eds), *Abécédaire pour un archéologue Lyonnais. Mélanges offerts à Armand Desbat*, Autun, 81-86.

Maier, F., 1973: Keltische Altertümer in Griechenland, *Germania* 51, 459-477.
Măndescu, D., 2012: Killing the weapons. An insight on graves with destroyed weapons in Late Iron Age Transylvania, in S. Berecki (ed.), *Iron Age rites and rituals in the Carpathian Basin. Proceedings of the International Colloquium from Târgu Mureş: 7-9 Oktober 2011*, Târgu Mureş, 343-356.
Măndescu, D., 2013: Două posibile piese de inventar funerar din situl geto-dacic de la Cetăţeni, păstrate în colecţiile Muzeului Judeţean Argeş, *Argesis. Serie Istorie* 22, 9-15.
Manning, W.H./J. Price/J. Webster, 1995: *Roman small finds. Report on the excavations at Usk 1965-1976*, Cardiff.
Manojlovic, R./J. Trpcevska/O. Petrov/B. Rizov, 2017: Analysis of medieval mail armour. Archaeological remains from the Prilep Monastery Treskavec, *International Journal of Engineering Research and Development* 13 (2), 40-47.
Mansel, A.M., 1939: Grabhügelforschung in Ostthrakien, *Bulletin de l'Institut d'Archéologie Bulgare* 13, 154–188.
Mansel, A.M., 1940: Les fouilles de Thrace, *Belleten* 4 (13), 115–316.
Mansel, A.M., 1941: Grabhügelforschung im Östlichen Thrakien, *Jahrbuch des Deutschen Archäologischen Instituts* 56, 119–187.
Marinov, I., 2008: *Les monuments funéraires thraces. Catalogue raisonné et analyse architecturale*, Montréal (PhD thesis, Université de Montréal).
Maspoli, A.Z., 2014: *Römische Militaria aus Wien. Die Funde aus dem Legionslager, den Canabae legionis und der Zivilsiedlung von Vindobona*, Wien.
Mataloto, R., 2014: A propósito de um conjunto de glandes plumbeae. O Castelo da Juntas (Moura) no contexto do episódio Sertoriano das Guerras Civis na margen esquerda do Guadiana, in C. Fabião/J. Pimenta (eds), *Atas Congresso Conquista e Romanização do Vale Do Tejo. Cira Arqueologia 3*, Vila Franca de Xira, 343-384.
Matešić, S., 2008: Militaria im Thorsberger Moorfund. Zeugnisse römisch-germanischer Kontakte, in A. Abegg-Wigg/A. Rau (eds), *Aktuelle Forschungen zu Kriegsbeuteopfern und Fürstengräbern im Barbaricum*, Neumünster, 85-104.
Matešić, S., 2015: *Das Thorsberger Moor, 3. Die militärischen Ausrüstungen*, Schleswig.
Mathieu, F., 2005: Nouvelles propositions sur la suspension des épées laténiennes, *Instrumentum* 22, 24-29.
Mattern, M., 1999: *Römische Steindenkmäler des Stadtgebiets von Wiesbaden und der Limesstrecke zwischen Marienfels und Zugmantel*, Mainz.
Mattern, M., 2001: *Römische Steindenkmäler vom Taunus- und Wetteraulimes mit Hinterland zwischen Heftrich und Grosskrotzenburg*, Mainz.
Mauss, M., 1979 [1934]: *Sociology and psychology. Essays of Marcel Mauss* (transl. B. Brewster), London, 97-123.
McGhee, L., 2016: Conserving a late eighteenth - early nineteenth century Indian helmet. A technical study, *Arms and Armour* 13 (2), 157-176.
Médard, F., 2015: Les restes textiles. Analyse des vestiges en matière organique de la cotte de mailles, in M. Poux/M. Demierre (eds), *Le sanctuaire de Corent (Puy-de-Dôme, Auvergne). Vestiges et rituels*, Paris, 498-502.
Meer, van der, L.B., 1978: *Etruscan urns from Volterra. Studies on mythological representations I-II*, Groningen (PhD thesis, University of Groningen).
Megaw, J.V.S., 2004: In the footsteps of Brennos? Further archaeological evidence for Celts in the Balkans, in B. Hänsel/E. Studeníková (eds), *Zwischen Karpaten und* Ärgäis. *Neolithikum und* ältere *Bronzezeit. Gedenkschrift für Viera Němejcová-Pavúková*, Rahden, 93-107.
Meller, H. (ed.), 2009: *Schlachtfeldarchäologie – Battlefield archaeology. 1. Mitteldeutscher Archäologentag vom 09. bis 11. Oktober 2008 in Halle (Saale)*, Halle.
Mengarelli, R., 1902: *La necropoli barbarica di Castel Trosino*, Roma.

Merchant, J., 1760: *A new complete English dictionary*, London.
Metcalf, S., 2005: The treatment of mail on an arm guard from the armoury of Shah Shuja. Ethical repair and in situ documentation in miniature, *Journal of the Armour Research Society* 1, 49-54.
Metzler, J., 1995: *Das treverische Oppidum auf dem Titelberg (G.-H. Luxemburg). Zur Kontinuität zwischen der spätkeltischen und der frührömischen Zeit in Nord-Gallien* vol. 1, Luxembourg.
Metzler, J./C. Gaeng/P. Meniel, 2016: *L'espace public du Titelberg*, Bertragne.
Meyrick, S.R., 1821: On the lorica catena of the Romans, *Archaeologia* 19, 336-352.
Meyrick, S.R., 1824: *A critical inquiry into antient armour. As it existed in Europe, but particularly in England, from the Norman conquest to the reign of King Charles II*, London.
Meyrick, S.R., 1846: Remarks on chain mail, *The Journal of the British Archaeological Association* 1, 141-142.
Meyrick, S.R., 2007: [1842]: Roman armour, in *Meyrick's medieval knights and armour*, New York, 39-52.
Mielczarek, M., 1993: *Cataphracti and clibanarii. Studies on the heavy armoured cavalry of the ancient world* (transl. M. Abramowicz), Lódz.
Migotti, B., 2008: Fragments of a chain mail as amulets in the Late Roman cemetery at Štrbinci near Đakovo, *Contributions of Institute of Archaeology in Zagreb* 24, 203-212.
Migotti, B., 2015: Pagans, christians and barbarians at the Late Roman cemeteries of Štrbinci and Zmajevac (NE Croatia), in L.F. Vagalinski/N. Sharankov (eds), *Limes XXII. Proceedings of the 22nd International Congress of Roman Frontier Studies, Ruse, Bulgaria, September 2012*, Sofia, 671-680.
Miks, C., 2007: *Studien zur römischen Schwertbewaffnung in der Kaiserzeit*, Rahden.
Miks, C., 2008: *Vom Prunkstück zum Altmetall. Ein Depot spätrömischer Helmteile aus Koblenz*, Mainz.
Miks, C., 2009: Relikte eines frühmittelalterlichen Oberschichtgrabes? Überlegungen zu einem Konvolut bemerkenswerter Objekte aus dem Kunsthandel, *Jahrbuch des Römisch-Germanischen Zentralmuseums* 56, 395-538.
Miks, C., 2014: *Ein spätrömischer Depotfund aus Koblenz am Rhein. Studien zu Kammhelmen der späten Kaiserzeit*, Mainz.
Miks, C., 2015: Eine späteisenzeitliche spatha in des Kaisers Diensten. Zur Wechselwirkung der Schwerttraditionen am Beginn der Kaiserzeit, in P. Heinrich/C. Miks/J. Obmann/M. Wieland (eds), *Non solum… sed etiam. Festschrift für Thomas Fischer zum 65. Geburtstag*, Rahden, 285-299.
Miletić, Ž., 2010: Burnum – a military centre in the province of Dalmatia, in I. Radman-Livaja/M. Ilkić/T. Bilić (eds), *Finds of the Roman military equipment in Croatia*, Zagreb, 33-176.
Miller, M., 1956: *Archaeology in the U.S.S.R.*, New York.
Minns, E.H., 1913: *Scythians and Greeks. A survey of ancient history and archaeology on the north coast of the Euxine from the Danube to the Caucasus*, Cambridge.
Möller-Wiering, S., 2011: *War and worship. Textiles from 3rd to 4th century AD weapon deposits in Denmark and northern Germany*, Oxford.
Montelius, O., 1888: *The civilisation of Sweden in heathen times*, London.
Montelius, O., 1895: *La civilisation primitive en Italie depuis l'introduction des métaux* vol. 1, Stockholm.
Montfaucon, B. de, 1722a: *L'antiquité expliquée et représentée en figures* vol. 4, Paris.
Montfaucon, B. de, 1722b: *Antiquity explained and represented in sculptures by the learned father Montfaucon* vol. 4 (transl. D. Humphrets), London.
Moralejo Ordax, J., 2011: *El armamento y la táctica militar de los galos. Fuentes literarias, iconográficas y arqueológicas*, Vitoria Gasteiz.
Mordvintseva, V.I./N.F. Shevchenko/Y.P. Zaïtsev, 2012: Princely burial of the Hellenistic period in the Mezmay burial-ground (north-western Caucacus), *Ancient Civilizations from Scythia to Siberia* 18, 281-339.
Mordvintseva, V./Y. Zaytsev, 2015: The elite military necropolis in Scythian Neapolis (I-II century AD), *Journal of Roman Military Equipment Studies* 16, 157-168.
Morris, J., 1934: Ring-mail, *The Journal of English and Germanic Philology* 33, 194-204.

Morsella, E./C.A. Godwin/T.K. Jantz/S.C. Krieger/A. Gazzaley, 2016: Homing in on consciousness in the nervous system. An action-based synthesis, *Behavioural and Brain Sciences* 39 (1), 1-70.
Mortimer, P., 2011: *Woden's warriors. Warriors and warfare in 6th-7th century northern Europe*, s.l.
Mráv, Z., 2012: Kora császárkori militaria a Budaörs-Kamaraerdei-Dűlői vicus terűletéről, in K. Ottományi (ed.), *Római vicus Budaörsön. Régészeti tanulmányok*, Budapest, 529-552.
Müller, F., 1986: Das Fragment eines keltischen Kettenpanzers von der Tiefenau bei Bern, *Archäologie der Schweiz* 9 (3), 116-123.
Müller, F., 1991: The votive deposit at Tiefenau near Berne, in S. Moscati (ed.), *The Celts*, Milan, 526-527.
Müller, F., 2011: Ein latènezeitlicher Zierknopf im plastischen Stil, *Archäologisches Korrespondenzblatt* 41, 521-529.
Müller, M., 2002: *Die römischen Buntmetallfunde von Haltern*, Mainz.
Müller, R., 2003: Rüstung, in J. Hoops (ed.), *Reallexikon der Germanischen Altertumskunde* vol. 25, Berlin, 429-449.
Muller, S., 1895: Verslag over de opgravingen van Romeinsche oudheden te Vechten, gedaan op kosten van het PUG in de jaren 1892-1894, in *Verslag van het verhandelde in de Algemeene Vergadering van het P.U.G. gehouden den 25 juni 1895*, Utrecht, 122-169.
Müller-Karpe, H., 1959: *Beiträge zur Chronologie der Urnenfelderzeit nördlich und südlich der Alpen*, Berlin.
Mylius, H., 1936: *Die römischen Heilthermen von Badenweiler*, Berlin.

Narloch, K., 2012: The cold face of battle. Some remarks on the function of Roman helmets with face masks, *Archäologisches Korrespondenzblatt* 42, 377-386.
Nash-Williams, V.E., 1932: The Roman legionary fortress at Caerleon in Monmouthshire. Report on the excavations carried out in the Prysg Field, 1927-9, part II, *Archaeologia Cambrensis* 87, 48-104.
Nefedkin, A., 2006: Sarmatian armour according to narrative and archaeological data, in M. Mode/J. Tubach (eds), *Arms and armour as indicators of cultural transfer. The steppes and the ancient world from Hellenistic times to the Early Middle Ages*, Wiesbaden, 433-444.
Negin, A.E., 1998: Sarmatian cataphracts as prototypes for Roman equites cataphractarii, *Journal of Roman Military Equipment Studies* 9, 65-75.
Negin, A.E., 2010: Позднеримские шлемы с продольным гребнем, *Germania—Sarmatia* 2, 343-357.
Negin, A.E./R. D'Amato, 2018: *Roman heavy cavalry (1). Cataphractarii & clibanarii, 1st century BC-5th century AD*, Oxford.
Negin, A.E./M. Kamisheva, 2018: Armour of the cataphractarius from the "Roshava Dragana" burial mound, *Archaeologia Bulgarica* 22 (1), 45-70.
Neiss, R., 1985: Circonscription de Champagne-Ardenne, *Gallia* 43 (2), 357-377.
Nemeti, I., 1975: Weitere Angaben über die keltischen Gräberfelder von Ciumeşti und Sanislău (Kreis Satu Mare), *Dacia. Revue d'archéologie et d'histoire ancienne: nouvelle série* 19, 243-248.
Newbury, B./M. Notis, 2004: The history and evolution of wiredrawing techniques, *JOM Journal of the Minerals, Metals and Materials Society* 56 (2), 33-37.
Newton, S.M., 1980: *Fashion in the age of the Black Prince. A study of the years 1340-1365*, Woodbridge.
Niblett, R., 1985: *Sheepen. An Early Roman industrial site at Camulodunum*, London.
Niblett, R., 1992: A Catuvallaunian chieftain's burial from St Albans, *Antiquity. A Quarterly Review of World Archaeology* 66 (253), 917-929.
Nicklasson, P., 1989: *Ringväv och sårsvett. Om tillverkning och användning av ringbrynjor*, Lund (MA Thesis, Lunds Universitets).
Nicklasson, P., 1991: Att tillverka en brynja. En kilometer järntråd och 1000 arbetstimmar, *Populär Arkeologi* 9 (1), 20-22.
Nicolay, J., 2007: *Armed Batavians. Use and significance of weaponry and horse gear from non-military contexts in the Rhine Delta (50 BC to AD 450)*, Amsterdam.

Nicolay, J., 2014: *The splendour of power. Early medieval kingship and the use of gold and silver in the southern North Sea area*, Groningen.
Nicolle, D., 1992: *Romano-Byzantine armies 4th-9th centuries*, Oxford.
Nicolle, D., 2017: One-piece Sasanian and early Islamic helmets, in K. Maksymiuk/G. Karamian (eds), *Crowns, hats, turbans and helmets. Headgear in Iranian history. Volume I: Pre-Islamic period*, Siedlce, 223-253.
Nizzo, V., 2007: Le produzioni in bronzo di area Medio-Italica e Dauno-Lucana, in M.G. Benedettini (ed.), *Il Museo delle Antichità Etrusche e Italiche. II. Dall'incontro con il mundo greco alla romanizzazione*, Roma, 327-359.
Nockert, M., 1991: *The Högom find and other Migration period textiles and costumes in Scandinavia*, Umeå.
Norris, H., 1999 [1927]: *Medieval costume and fashion*, Mineola.
Novichenkova, M., 2009: О римской кольчуге из святилища у перевала Гурзуфское Седло в Горном Крыму, in *Пятая Кубанская археологическая конференция. Материалы конференции*, Krasnodar, 283-286.
Novichenkova, M., 2011: Римская кольчуг a lorica hamata 1 в. до н.э. -1 в. н.э. из ритуального комплекса святилища у перевала гурзуфское седло, in в. до н.э. – *I в. н.э. из ритуального комплекса святилища у перевала Гурзуфское Седло*, Kerch, 271-297.
Nowakiewicz, T./A. Rzeszotarska-Nowakiewicz, 2012: *Lake Nidajno near Czaszkowo in Masuria. A unique sacrificial site from Late Antiquity*, Warsaw.
Nowakiewicz, T./A. Rzeszotarska-Nowakiewicz, 2013: *Antiquities of Mrągowo Lake District. An archaeological guide*, Mrągowo.

O´Connor, S.A., 1983: The missing link, *Bulletin of the York Archaeological Trust* 9 (3), 30-37.
O'Connor, S.A., 1992a: Technology and dating of the mail, in D. Tweddle (ed.), *The Anglian helmet from Coppergate*, London, 1060-1085.
O'Connor, S.A., 1992b: Catalogue of Scandinavian mail, in D. Tweddle (ed.), *The Anglian helmet from Coppergate*, London, 1183-1187.
Oakeshott, E., 1974: *Dark Age warrior*, London.
Oakeshott, E., 2000: *European weapons and armour. From the Renaissance to the Industrial Revolution*, Woodbridge.
Oddy, A., 1977: The production of gold wire in Antiquity. Hand-making methods before the introduction of the draw-plate, *Gold Bulletin* 10 (3), 79-87.
Oddy, W.A./A.E.A. Werner, 1978: Report on scientific examination of fragments of the mail coat, in R. Bruce-Mitford (ed.), *The Sutton Hoo ship-burial. Volume 2: arms, armour and regalia*, 240.
Oldenstein, J., 1976: Zur Ausrüstung römischer Auxiliareinheiten. Studien zu Beschlägen und Zierrat an der Ausrüstung der römischer Auxiliareinheiten des obergermanisch-raetischen Limesgebietes aus dem zweiten und dritten Jahrhundert n. Chr., *Bericht der Römisch-Germanischen Kommission* 57, 51-284.
Oldenstein, J., 1990: Two Roman helmets from Eich, Alzey-Worms District, *Journal of Roman Military Equipment Studies* 1, 27-37.
Olivier, S., 2004: Nieuw leven voor vondsten "De Oude Stee". Romeinse oudheden na 100 jaar terug op Goeree, *De Oude Waerelt. Historisch Tijdschrift voor Goeree-Overflakkee* 4 (10), 4–8.
Onurkan, S., 1978: Vize-A tümülüsünden bir zirh gömlek, *Güney-Doğu Avrupa Araştirmalari Dergisi* 6/7, 47-55.
Oorthuys, J., 2012: Reconstructing a soldier from finds. Imperial Roman legionary, Flavian era, *Ancient Warfare* 5 (6), 6-7.
Opreanu, C.H., 2011: Precizări cu privire la cronologia şi originea unor accesorii şi podoabe din necropola de la Bârlad-Valea Seacă, *Acta Musei Porolissensis* 33, 221-230.
Östenberg, I., 2009: *Staging the world. Spoils, captives, and representation in the Roman triumphal procession*, Oxford.

Özşen, I./F. Willer, 2016: Gezogener antiker Draht? Zur Drahtproduktion des Kettenpanzers aus Zemplín, *Restaurierung und Archäologie* 9, 85-102.

Patterson, A., 2009: *Fashion and armour in Renaissance Europe. Proud looks and brave attire*, London.

Pauli Jensen, X., 2003: The Vimose find, in L. Jørgensen/B. Storgaard/L. Gebauer Thomson (eds), *The spoils of victory. The North in the shadow of the Roman Empire*, Copenhagen, 224-238.

Pauli Jensen, X., 2008: *Våpen fra Vimose. Bearbejdning og tolkning af et gammelkendt fund*, København (PhD thesis, University of Copenhagen).

Pauli Jensen, X., 2009: From fertility rituals to weapon sacrifices. The case of the south Scandinavian bog finds, in U. von Freeden/H. Friesinger/E. Wamers (eds), *Glaube, Kult und Herrschaft. Phänomene des Religiösen im 1. Jahrtausend n. Chr. in Mittel- und Nordeuropa*, Bonn, 53-64.

Pauli Jensen, X. 2011: Friend or foe. Alliances and power structures in southern Scandinavia during the Iron Age, *Lund Archaeological Review* 17, 35-47.

Pauli Jensen, X./L. Jørgensen/U. Lund Hansen, 2003: The Germanic army. Warriors, soldiers and officers, in L. Jørgensen/B. Storgaard/L. Gebauer Thomson (eds), *The spoils of victory. The North in the shadow of the Roman Empire*, Copenhagen, 310-328.

Paulsen, P., 1967: *Alamannische Adelsgräber von Niederstotzingen (Kreis Heidenheim)*, Stuttgart.

Pausch, M., 2003: *Die römische Tunika. Ein Beitrag zur Peregrinisierung der antiken Kleidung*, Augsburg.

Perevalov, S.M., 2003: The Sarmatian lance and the Sarmatian horse-riding posture, *Anthropology and Archaeology of Eurasia* 41 (4), 7-21.

Pérez Rubio, A., 2012: Celtic cavalry at war. Making Epona proud, *Ancient Warfare* 6 (3), 15-19.

Pérez Rubio, A., 2015: Trouble comes in threes. From chariot to cavalry in the 'Celtic' world, in G. Lee/H. Whittaker/G. Wrightson (eds), *Ancient warfare. Introducing current research* vol. 1, Cambridge, 172-190.

Pérez Rubio, A., 2017: Fabio Píctor y el doble Breno, *Mélanges de l'École française de Rome – Antiquité* 129 (2), 373-398.

Péri, B., 2019: David and the chain mail. A traditional telmîh ('allusion') in Ottoman poetry, in P. Fodor/N.E. Kovács/B. Péri (eds), *Şerefe. Studies in honour of prof. Géza Dávid on his seventieth birthday*, Budapest, 39-56.

Pernet, L., 2010: *Armement et auxiliaires gaulois (IIe et Ier siècles avant notre ère)*, Montagnac.

Pernet, L./M. Poux, M./W.-R. Teegen, 2008: Militaria gaulois et romains sur l'oppidum de Bribracte, Mont Beuvray, in M. Poux (ed.), *Sur les traces de César. Militaria tardo-républicains en contexte gaulois*, Bibracte, 103-139.

Petculescu, L., 2006: Armamentul roman în Dacia la începutul secolului II d. Chr., in E.S. Teodor/O. Tentea (eds), *Dacia Augusti Provincia: crearea provinciei. Actele simpozionului desfăşurat în 13-14 octombrie 2006 la Muzeul Naţional de Istorie a României, Bucureşti*, Bucureşti, 441-458.

Petér, M., 2014: *Avar kori védőfegyverek a Kárpát-mendencében*, Pécs (MA thesis, University of Pécs).

Peterson, D., 1992: *The Roman legions recreated in colour photographs*, Ramsbury.

Petrov, M./S. Kainov, 2019: Доспешная мастерская XII века на территории Славенского конца средневекового Новгорода (по материалам раскопа Посольский-2006), *Новгород и Новгородская земля. История и археология* 32, 243-254.

Petrov, O./R. Manojlović/J. Trpčevska, 2015: Mail from Treskavec. Contribution to the study of medieval mail armour, *Folia Archaeologica Balkanica* 3, 569-584.

Petry, F., 1976: Circonscription d'Alace, *Gallia* 34 (2), 379-411.

Pfaffenbichler, M., 1992: *Armourers*, London.

Pfahl, S.F./M. Reuter, 1996: Waffen aus römischen Einzelsiedlungen rechts des Rheins. Ein Beitrag zum Verhältnis von Militär und Zivilbevölkerung im Limeshinterland, *Germania* 71 (1), 119-167.

Phelps, J.J., 1909: The Ellesmere collection of Roman antiquities found at Castlefield, Manchester, in F.A. Bruton (ed.), *The Roman fort at Manchester*, Manchester, 144-179.

Picard, C., 1935: Découverte de la sépulture du roi Déjotaros, à Karalar en Asie Mineure, *Comptes rendus des séances de l'Académie des Inscriptions et Belles-Lettres* 79 (1), 42-44.
Picard, C., 1943: Le bas-relief funéraire de Saint-Julien-lès-Martigues, *Comptes rendus des séances de l'Académie des Inscriptions et Belles-Lettres* 87 (3), 439-458.
Piggott, S., 1955: Three metal-works hoards of the Roman period from southern Scotland, *Proceedings of the Society of Antiquaries of Scotland* 87, 1-50.
Piggott, S., 1965: *Ancient Europe from the beginnings of agriculture to Classical Antiquity. A survey*, Chicago.
Pind, L.H., 2012: Ringbrynje fra Aarhus, *KUML. Årbog for Jysk Arkæologisk Selskab* 2012, 171-183.
Pleiner, R., 2006: *Iron in archaeology. Early European blacksmiths,* Prague.
Pleiner, R., 2012: Mail of St. Wenceslaus. Metallography of rings, *Acta Militaria Mediaevalia* 8, 221-228.
Ployer, R., 2013: *Der norische Limes in Österreich*, Wien.
Pogorzelski, R., 2014: *Die Trajanssäule im Rom. Dokumentation eines Krieges in Farbe*, Mainz am Rhein.
Polak, M./R.P.J. Kloosterman/R.A.J. Niemeijer, 2004: *Alphen aan den Rijn – Albaniana 2001-2002*, Nijmegen.
Polenz, H., 1988: *Katalog der merowingerzeitlichen Funde in der Pfalz*, Stuttgart.
Polleres, J./W. Artner, 2004: Einige exzeptionelle Fundstücke aus dem römischen Grabbezirk von Faschendorf, *Rudolfinum. Jahrbuch des Landesmuseums für Kärnten* 2003, 91-95.
Ponting, M. 2002a: Keeping up with the Romans? Romanisation and copper alloys in First Revolt Palestine, *Journal of the Institute of Archaeometallurgical Studies* 22, 3-6.
Ponting, M. 2002b: Roman military copper-alloy artefacts from Israel. Questions of organisation and ethnicity, *Archaeometry* 44 (4), 555-571.
Ponting, M. 2012: The potential of scientific analysis of Roman military equipment. The case of Syria-Palaestina, in E. Schrufer-Kolb (ed.), *More than just numbers? The role of science in Roman archaeology*, Portsmouth, 163-176.
Poppe, E., 2004: A Virgilian model for lúirech thredúalach?, *Ériu* 54, 171-177.
Post, P., 1944: Ein neuer Rekonstruktionsvorschlag zum Panzerfund von Valsgärde. Ein Beitrag zur frühmittelalterlichen Schutzbewaffnung, *Zeitschrift für historische Waffen- und Kostümkunde* 8 (5/6), 98-123.
Potratz, H., 1942: *Das Moorgewand von Reepsholt, Kr. Wittmund (Ostfriesland)*, Hildesheim.
Poux, M., 2008: L'empreinte du militaire tardo-républicain dans les faciès mobiliers de La Tène finale. Caractérisation, chronologie et diffusion de ses principaux marqueurs, in M. Poux (ed.), *Sur les traces de César. Militaria tardo-républicains en contexte gaulois*, Bibracte, 301-432.
Poux, M./P.-Y. Milcent/A. Pranyies/R. Lauranson/N. Dubreu/A. Chorin/M. Evrard/C. Hemard/S. Mader/R. Philibeaux/A. Tramon/P. Valfort/H. Duchamp/M. Demierre/A. Crausaz/K. Gruel, 2015: *Corent. Veyre-Monton (63). Fouille pluriannuelle 2014-2016. Rapport intermédiaire 2015*, s.l.
Poux, M./S. Robin, 2000: Les origines de Lutèce, *Gallia* 57, 181-225.
Price, B.R., 2000: *Techniques of medieval armour reproduction. The 14th century*, Colorado.
Price, J.E., 1880: *On a bastion of London wall. Or, excavations in Camomile Street, Bishopsgate*, London.
Price, P., 1983: An interesting find of lorica plumata from the Roman fortress at Usk, in M.C. Bishop (ed.), *Roman military equipment. Proceedings of a seminar held in the Department of Ancient History and Classical Archaeology at the University of Sheffield, 21th of March 1983*, Sheffield, 12-13.
Pritchard, F., 2006: *Clothing culture. Dress in Egypt in the first millennium AD. Clothing from Egypt in the Collection of the Whitworth Art Gallery*, Manchester.
Przybyła, M.J., 2010: Bemerkungen zu einigen lokalen Formen der Schwertgürtelschließen von sog. Balteus-Typ aus dem Barbaricum, *Recherches archéologiques. Nouvelle Série* 2, 93-184.
Przybyła, M.J., 2016: Eine Insel der Pazifisten im Meer der Krieger? Anmerkungen zu einem Grabinventar von Aasø, Seeland, *Praehistorische Zeitschrift* 91 (1), 149-201.
Pyhrr, S.W./F. Negroli/J.-A. Godoy/S. Leydi, 1998: *Heroic armor of the Italian Renaissance. Filippo Negroli and his contemporaries*, New York.

Quesada Sanz, F., 2010: *Armas de la antigua Iberia. De Tartesos a Numancia*, Madrid.
Quesada Sanz, F., 2011: The Braganza brooch warrior and his weapons. The peninsular context, in A. Parea (ed.), *La fibula Braganza*, Madrid, 137-165.
Quesada Sanz, F./M.A. Lechuga Chica/A. Ruiz Rodríguez/M. Molinos Molinos/C. Rísquez Cuenca/M. Gener Moret, 2019: La primera cota de malla en la península ibérica en la antigüedad. La tumba de Piquía (Arjona, Jaén), in B. Vallori Márquez/C. Rueda Galán/J.P. Bellón Ruiz (eds), *Accampamenti, guarnigioni e assedi durante la Seconda Guerra Punica e la conquista romana (secoli III-I aC). Prospettive archeologiche*, Roma, 155-174.
Quesada Sanz, F./C. Rueda Galán, 2017: Las armas y el contexto del guerrero de "Las Atalayuelas" (Jaén). Una escultura de época ibérica tardía/romano republicana, *Gladius* 37, 7-51.

Rabovyanov, D., 2018: Защитно въоръжение от османския периодот фонда нарим-габро, *Actei Musei Varnaensis* 10 (2), 63-76.
Rabovyanov, D./S. Dimitrov, 2017: Western European armour from medieval Bulgaria (12th-15th centuries), *Acta Militaria Mediaevalia* 13, 37-53.
Raddatz, K., 1959/1961a: Römische Äxte aus dem freien Germanien, *Offa* 17/18, 17-25.
Raddatz, K., 1959/1961b: Ringknaufschwerter aus germanischen Kriegergräbern, *Offa* 17/18, 26-55.
Raddatz, K., 1969: Miniaturgerät als Grabbeigabe, in K.-H. Manegold (ed.), *Wissenschaft, Wirtschaft und Technik. Studien zur Geschichte*, München, 11-22.
Raddatz, K., 1981: *Sörup I. Ein Gräberfeld der Eisenzeit in Angeln*, Neumünster.
Raddatz, K., 1987: *Der Thorsberger Moorfund. Katalog: Teile von Waffen und Pferdegeschirr, sonstige Fundstücke aus Metall und Glas, Ton- und Holzgefäße*, Steingeräte, Neumünster.
Radman-Livaja, I., 2004: *Militaria Sisciensia. Nalazi rimske vojne opreme iz Siska u fundusu Arheološkog Muzeja u Zagrebu*, Zagreb.
Rajtár, J., 1996: Waffen und Ausrüstungteile aus dem Holz-Erde-Lager von Iža, *Journal of Roman Military Equipment Studies* 5, 83-95.
Ramsl, P.C., 2010: The La Tène age cemetery of Mannersdorf am Leithagebirge, Flur Reinthal Süd, Lower Austria and the connections to other parts of the middle european corridor, in S. Berecki (ed.), *Iron Age communities in the Carpathian Basin. Proceedings of the International Colloquium from Târgu Mureş: 9-11 Oktober 2009*, Cluj-Napoca.
Randsborg, K., 1995: *Hjortspring. Warfare and sacrifice in early Europe*, Oxford.
Rankov, B., 1999: The ban on the export of weapons to the Barbaricum. A misunderstanding, *Journal of Roman Military Equipment Studies* 10, 26-55.
Rapin, A., 1993: Destructions et mutilations des armes dans les nécropoles et les sanctuares du Second Âge du Fer. Réflexions sur les rituels et leur descriptifs, in D. Cliquet (ed.), *Les Celtes en Normandie. Les rites funéraires en Gaule (III*ème*e-Ier siècle avant J.-C.). Actes due 14*ème*e colloque de l'association française pour l'étude de l'Âge du Fer, Evreux, mai 1990*, Rennes, 291-298.
Rapin, A., 1996: Les armes des Celtes. Des messages enfouis sous la rouille, *Mélanges de l'École française de Rome – Antiquité* 108 (2), 505-522.
Rapin, A., 1999: L'armement celtique en Europe. Chronologie de son évolution technologique du Ve au 1er s. av. J.-C., *Gladius* 19, 33-67.
Rasmussen, B.M., 1995: Brokær. Ein Reichtumszentrum der römischen Kaiserzeit in Südwestjütland, *Acta Archaeologica* 66, 39-101.
Rebuffat, R., 1977: *Thamusida III. Fouilles du service des antiquités du Maroc*, Paris.
Reddé, B.-R./K. Gruel, 2004: Le sanctuaire de Mars Mullo chez les Aulerques Cénomans (Allonnes, Sarthe) Ve s. av. J.-C. – IVe s. apr. J.-C. Etat de recherches actuelles, *Gallia* 61, 291-386.
Reid, W./E.M. Burgess, 1960: A habergeon of Westwale, *The Antiquaries Journal* 40, 46-57.

Restauro, 1997: Alamanisches Kettenhemd gereinigt. Das Fürstengrab von Gammertingen, *Restauro. Zeitschrift für Kunsttechniken, Restaurierung und Museumfragen* 103 (1), 7.
Richardson, T., 1999: The Archibald hauberk, *Royal Armouries Yearbook* 4, 29-31.
Richmond, I.A., 1967: Adamklissi, *Papers of the British School at Rome* 35, 29-39.
Richter, D., 2010: *Das römische Heer auf der Trajanssäule. Propaganda und Realität. Waffen und Ausrüstung. Marsch, Arbeit und Kampf*, Wiesbaden.
Riemer, E., 2017: *Die Römer im Landtag. Die Steinhalle im Landesmuseum Mainz*, Regensburg.
Riemer, E./P. Heinrich, 1997: Zur Restaurierung der Funde aus dem „Fürstengrab" von Gammertingen, *Denkmalpflege in Baden-Württemberg* 26 (2), 54-60.
Ritchie, W.F./J.N.G. Ritchie, 1997: *Celtic warriors*, Aylesbury.
Rivera, A., 2013: Roma contra Cartago, arqueología de la batalla de Baécula, *El País* (17.03.2013).
Robinson, E.G.D., 1995: South Italian bronze armour, in A. Cambitoglou/E.G.D. Robinson, *Classical art in the Nicholson Museum*, Mainz, 145-165.
Robinson, H.R., 1967: *Oriental armour*, New York.
Robinson, H.R., 1975: *The armour of imperial Rome*, London.
Rodgers, B.A., 2004: *The archaeologist's manual for conservation. A guide to non-toxic, minimal intervention artifact stabilization*, New York.
Röhrer-Ertl, O., 1971: *Untersuchungen am Material des Urnenfriedhofes von Westerwanna, Kreis Land Hadeln. Ein Beitrag zur Typologie und Chronologie des Weser-Elbe-Mündungsgebietes in der Eisenzeit*, Hamburg.
Ronzitti Orsolini, G., 1971: *Il mito die sette a Tebe nelle urne Volterrane*, Firenze.
Rose, W., 1897: Die Verzierungen auf orientalischen Panzerhemden, *Zeitschrift für historische Waffenkunde* 1 (6/7), 142-144, 166-167.
Rose, W., 1902: Die Verzierung alt-orientalischer Panzerringe, *Zeitschrift für historische Waffenkunde* 3 (1), 8-15.
Rose, W., 1906: Römisch-germanische Panzerhemden, *Zeitschrift für historische Waffenkunde* 4 (1-2), 1-8, 40-55.
Rose, W., 1929: Behördliche Beschau-, Sarwürcher- und Eigentümermarken auf okzidentalischen Maschenpanzern, *Zeitschrift für historische Waffen- und Kostümkunde. Neue Folge* 3 (4/5), 77-84, 99a-104.
Rosenberg, G., 1937: *Hjortspringfundet*, København.
Rost, A./S. Wilbers-Rost, 2010: Weapons at the battlefield of Kalkriese, *Gladius* 30, 117-136.
Rost, A./S. Wilbers-Rost, 2016: Post-battle display and distribution of booty in Kalkriese, *Journal of Roman Military Equipment Studies* 17, 185-190.
Roux, D./A. Coffyn, 1987: Le tumulus nº 3 de la lande Mesplède à Vielle dans les Landes, in *Les relations entre le Sud-Ouest et la péninsule ibérique. Actes du XXXVIIIe Congrès tenu à Pau les 5 et 6 Octobre 1985*, Biarritz, 35-44.
Roymans, N., 1996: The sword or the plough. Regional dynamics in the Romanisation of Belgic Gaul and the Rhineland area, in N. Roymans (ed.), *From the sword to the plough. Three studies on the earliest Romanisation of northern Gaul*, Amsterdam, 9-126.
Roymans, N., 2004: *Ethnic identity and imperial power. The Batavians in the Early Roman Empire*, Amsterdam.
Rueda Galán, C./I. Grau Mira, 2017: Edad, ritos de paso y memoria. Símbolos de indicación en la cerámica ática del espacio religioso ibero, in X. Aquilué/P. Cabrera/M. Orfila (eds), *Homenaje a Glòria Trias Rubiés. Cerámicas griegas de la Península Ibérica. Cincuenta años despues (1967-2017)*, Barcelona, 318-327.
Ruprechtsberger, E.M., 2004: Miszelle zum „spätantiken Soldatenrelief" aus Lentia, *Jahrbuch des Oberösterreichischen Musealvereines* 149 (1), 179-189.
Rustoiu, A., 1996: *Metalurgia bronzului Daci (sec. II î. Chr. - sec. I d. Chr.). Technici, ateliere şi produse de bronz*, Bucureşti.
Rustoiu, A., 2005: The Padea-Panagjurski Kolonii group in south-western Transylvania (Romania), in H. Dobrzańska/V. Megaw/P. Poleska (eds), *Celts on the margin. Studies in European cultural interaction. 7th century BC - 1st century AD. Dedicated to Zenon Woźniak*, Krakow, 109-119.

Rustoiu, A., 2006: A journey to Mediterranean. Peregrinations of a Celtic warrior from Transylvania, *Studia Universitatis Babeş-Bolyai. Historia* 51 (1), 42-85.
Rustoiu, A., 2008: *Războinici şi societate* în *area celtică Transsilvăneană*, Cluj-Napoca.
Rustoiu, A., 2009: A late bronze situla (Eggers type 20) from Cugir (Alba County), Romania, *Instrumentum* 29, 33-34.
Rustoiu, A., 2012a: The grave with a helmet from Ciumeşti – 50 years from its discovery. Comments on the greaves, *Ephemeris Napocensis* 22, 159-171.
Rostoiu, A., 2012b: The Celts and indigenous populations from the southern Carpathian Basin. Intercommunity Communication Strategies, in S. Berecki (ed.), *Iron Age rites and rituals in the Carpathian Basin. Proceedings of the International Colloquium from Târgu Mureş: 7-9 Oktober 2011*, Târgu Mureş, 357-390.
Rustoiu, A., 2013: Wandering warriors. The Celtic grave from "Silivaş" (Transylvania) and its story, *Terra Sebus. Acta Musei Sabesiensis* 5, 211-226.
Rustoiu, A./S. Berecki, 2014: Celtic elites and craftsmen. Mobility and technological transfer during the Late Iron Age in eastern and south-eastern Carpathian Basin, in S. Berecki (ed.), *Iron Age crafts and craftsmen in the Carpathian Basin*, Târgu Mureş, 249-278.
Rustoiu, G.T./M. Ciută, 2015: An Avar warrior's grave recently discovered at Unirea-Vereşmort (Alba Couty), in C. Cosma (ed.), *Warriors, weapons and harness from the 5th–10th centuries in the Carpathian Basin*, Cluj-Napoca, 107-127.
Rusu, M., 1969: Das keltische Fürstengrab von Ciumeşti in Rumänien, *Bericht der Römisch-Germanischen Kommission* 50, 267-300.
Rusu, M./O. Bandula, 1970: *Mormântul unei căpetenii celtice de la Ciumeşti*, Bucureşti.

Sanader, M./A. Rendić-Miočević/D. Tončinić/I. Radman-Livaja (eds), *XVII Roman Military Equipment Conference Zagreb 2010, 24th-27th May, 2010*, Zagreb.
Sanader, M./D. Tonočinić, 2010: Gardun – the ancient Tilurium, in I. Radman-Livaja/M. Ilkić/T. Bilić (eds), *Finds of the Roman military equipment in Croatia*, Zagreb, 33-111.
Sanader, M./D. Tonočinić/Z. Šimić Kanaet/S. Ivčević/Z. Buljević/T. Šeparović/I. Milograv, 2017: *Tilurium IV. Archeologška istraživanja 2007-2010 godine*, Zagreb.
Savić, M., 2017: *Налази оружја и војне опреме у погребним контекстима од I века до половине V века у римским провинцијама на територији Србије*, Belgrade (MA thesis, University of Belgrade).
Scalini, M., 1996: *The armoury of the Castle of Churburg*, Udine.
Schamper, J., 2015: *Studien zu Paraderüstungsteilen und anderen verzierten Waffen der römischen Kaiserzeit*, Rahden.
Schimmer, F., 2005: Zum Beginn des frühkaiserzeitlichen Brigantium (Bregenz). Zivilsiedlung oder Militärlager? in Z. Visy (ed.), *Limes XIX. Proceedings of the XIXth International Congress of Roman Frontier Studies held in Pécs, Hungary, September 2003*, Pécs, 609-622.
Schlabow, K., 1976: *Textilfunde der Eisenzeit in Norddeutschland*, Neumünster.
Schleiermacher, M., 1984: *Römische Reitergrabsteine. Die kaiserzeitlichen Reliefs des triumphierenden Reiters*, Bonn.
Schmid, E.D., 2003: Details from articles of mail in the Wallace Collection, *The Journal of the Mail Research Society* 1(1), 2-20.
Schmid, E.D., 2009: Details of lorica hamata squamataque manufacture, *The Journal of the Mail Research Society* 2 (1), 67-76.
Schmidt-Colinet, A., 2000: Einleitung, in A. Schmidt-Colinet (ed.), *Die Textilien aus Palmyra*, Mainz am Rhein, 1-7.
Schmuecker, E./R. Lees/T. Richardson, 2011: The examination and conservation of a 17th century Indian horse armour, *Metal* 2010, 82-88.

Schmuhl, Y., 2013: Symbole des römischen Sieges. Tropaeum und Victoria, in H. Pöppelmann/K. Deppmeyer/W.-D. Steinmetz (eds), *Roms vergessener Feldzug. Die Schlacht am Harzhorn*, Stuttgart, 365.
Schnee, S., 2010: *Gut gerüstet. Kettenhemd und -Rüstung selbst gemacht*, Braunschweig.
Schönberger, H., 1963/1964; Römerkastell Künzing, Grabung 1962, *Saalburg Jahrbuch* 21, 59-89.
Schönfelder, M., 2002: *Das spätkeltische Wagengrab von Boé (Dép. Lot-et-Garonne). Studien zu Wagen und Wagengräbern der jüngeren Latènezeit*, Mainz.
Schránil, J., 1934: O zbroji sv. Václava, in, *Svatováclavský sborník. Na památku 1000 výročí smrti knížete Václava Svatého*, Praze, 159-172.
Schrickel, W., 1969: *Die Funde vom Wartberg in Hessen*, Marburg.
Schulten, A., 1927: *Die Lager des Scipio*, München.
Schultze-Forster, J., 2002: *Die latènezeitlichen Funde vom Dünsberg*, Marburg (PhD thesis, Philipps-Universität Marburg).
Scott, M. 2011: *Fashion in the Middle Ages*, Los Angeles.
Scott, I.R., 1985: First century military daggers and the manufacture and supply of weapons for the Roman army, in M.C. Bishop (ed.), *The production and distribution of Roman military equipment. Proceedings of the second Roman Military Equipment Research Seminar*, Oxford, 160-213.
Scott, W., 1822: *The fortunes of Nigel*, Edinburgh.
Seebold, E., 1995: *Etymologisches Wörterbuch der deutschen Sprache*, Berlin.
Selkirk, A., 1992: A royal burial at St Albans, *Current Archaeology* 132, 484-488.
Sellet, F., 1993: Chaîne opératoire. The concept and its applications, *Lithic Technology* 18 (1-2), 106-112.
Selzer, W., 1988: *Römische Steindenkmäler. Mainz in Römischer Zeit. Katalog zur Sammlung in der Steinhalle*, Mainz.
Shanks, M./C. Tilley, 1992: *Re-constructing archaeology. Theory and practice*, London.
Shaposhnik, V., 2010: Комплекс черняховской культуры из Харьковской области, *Домонгол* 2010 (1), 147-148.
Shchukin, M./M. Kazanski/O. Sharov, 2006: *Des Goths et Huns. Le Nord de la mer Noire au Bas-Empire et à l'époque de Grandes Migrations*, Oxford.
Short, W.R., 2009: *Viking weapons and combat techniques*, Yardley.
Siddorn, K., 2005: *Viking weapons and warfare*, Stroud.
Siegmund, F., 1999: Gürtel, sub. 2b: Jüng. Epoche, *Reallexikon der Germanischen Altertumskunde* vol. 13, Berlin, 166-175.
Sievers, S., 2010: *Die Waffen aus dem Oppidum von Manching*, Wiesbaden.
Sim, D., 1997: Roman chain-mail. Experiments to reproduce the techniques of manufacture, *Britannia* 28, 359-371.
Sim, D./J. Kaminski, 2011: *Roman imperial armour. The production of Early Imperial military armour*, Oxford.
Sim, D./I. Ridge, 2002: *Iron for the eagles. The iron industry of Roman Britain*, Stroud.
Simkins, M., 1979: *The Roman army from Hadrian to Constantine*, Oxford.
Simkins, M., 1984: *The Roman army from Caesar to Trajan*, Oxford.
Simonenko, A.V., 2001: Bewaffnung und Kriegswesen der Sarmaten und späten Skythen im nördlichen Schwarzmeergebiet, *Eurasia Antiqua. Zeitschrift für Archäologie Eurasiens* 7, 187-327.
Simonenko, A.V., 2010: Сарматские всадники Северного, St. Petersburg.
Simpson, G., 2000: *Roman weapons, tools, bronze equipment and brooches from Neuss – Novaesium excavations 1955-1972*, Oxford.
Simpson, J.A./E.S.C. Weiner, 1989: *The Oxford English dictionary*, Oxford (2nd edition).
Sirago, V.A., 1961: *Galla Placida e la transformazione politica dell'Occidente*, Louvain.
Sîrbu, V./S.A. Luca/C. Roman, 2007a: Tombs of Dacian warriors (2nd-1st C. BC) found in Hunedoara-Grădina Castelului (Hunedoara County), *Acta Terrae Septemcastrensis* 6 (1), 155-177.

Sîrbu, V./S.A. Luca/C. Roman, 2007b: *The Dacian vestiges in Hunedoara*, Alba Iulia.
Slofstra, J., 2002: Batavians and Romans on the Lower Rhine. The Romanisation of a frontier area, *Archaeological Dialogues* 9 (1), 16-38.
Smith, C.S., 1959: Methods of making chain mail (14th to 18th centuries). A metallographic note, *Technology and Culture* 1 (1), 60-67.
Smith, C.S., 1960: Reply to Mr. Martin Burgess on mail-making methods, *Technology and Culture* 1 (3), 289-291.
Smith, R.D., 2004: *Heavy metal. Focus on European armour*, Delft.
Soressi, M./J.-M. Geneste, 2011: The history and efficacy of the chaîne opératoire approach to lithic analysis. Studying techniques to reveal past societies in an evolutionary perspective, *Paleoanthropology* 2011 (special edition), 334-350.
Southern, P./K.R. Dixon, 1996: *The Late Roman army*, London.
Speidel, M.P., 2004: *Ancient Germanic warriors. Warrior styles from Trajan's column to Icelandic Sagas,* London.
Speidel, M.P., 2007: The missing weapons at Carlisle, *Britannia* 38, 237-239.
Speidel, M., 2011: Dressed for the occasion. Clothes and context in the Roman army, in M.-L. Nosch (ed.), *Wearing the cloak. Dressing the soldier in Roman times*, Oxford, 1-12.
Spekking, W., 2011: Een klompje roest... *Jaarverslag BATO*, 6-7.
Spratling, M.G., 1981: Metalworking at the Stanwick oppidum. Some new evidence, *The Yorkshire Archaeological Journal* 53, 13-16.
Springer, C., 2010: *Armour and masculinity in the Italian Renaissance*, Toronto.
Starley, D., 1995: Hammerscale, *Historical Metallurgy Society Datasheet* 10, 1-2.
Stauffer, A., 2000: Material und Technik, in A. Schmidt-Colinet (ed.), *Die Textilien aus Palmyra*, Mainz am Rhein, 8-40.
Stead, I.M., 1988: Kirkburn. A Yorkshire chariot burial – with a coat of mail, *Current Archaeology* 111, 115-117.
Stead, I.M., 1991a: *Iron Age cemeteries in East Yorkshire. Excavations at Burton Fleming, Rudston, Garton-on-the-Wolds, and Kirkburn*, London.
Stead, I.M., 1991b: Many more Iron Age shields from Britain, *The Antiquaries Journal* 71, 1-35.
Stein, F., 2003: Die Spangenhelme von Pfeffingen und Gammertingen – Überlegungen zur Bestimmung ihrer Herstellungsräume, *Acta Praehistorica et Archaeologica* 35, 41-61.
Stephenson, I.P., 2001: *Roman infantry equipment. The Later Empire*, Gloucestershire.
Stephenson, I.P., 2006: *Romano-Byzantine infantry equipment*, Gloucestershire.
Stephenson, I.P./K.R. Dixon, 2003: *Roman cavalry equipment*, Stroud.
Steuer, H., 1997: Krieger und Bauern – Bauernkrieger. Die gesellschaftliche Ordnung der Alamannen, in K. Fuchs/M.K. Kempa (eds), *Die Alamannen*, Stuttgart, 275-287.
Stiebel, G.D., 2007: *Armis et litteris. The military equipment of Early Roman Palestine, in the light of archaeological and historical sources*, London (PhD thesis, University of London).
Stolpe, H./T.J. Arne, 1927: *La nécropole de Vendel*, Stockholm.
Stone, G.C., 1961: *A glossary of the construction, decoration and use of arms and armor in all countries and in all times*, New York.
Strobel, K., 2007: Strategy and army structure between Septimius Severus and Constantine the Great, in P. Erdkamp (ed.), *A companion to the Roman army*, Malden, 268-285.
Stuart, P. 1986: *Provincie van een imperium. Romeinse oudheden uit Nederland in het Rijksmuseum van Oudheden te Leiden*, Leiden.
Suano, M., 1986: *Sabellian-Samnite bronze belts in the British Museum*, London.
Sumner, G., 1997: *Roman army. Wars of the empire*, London.
Sumner, G. 2003: *Roman military clothing (2). AD 200-400*, Oxford.
Sumner, G., 2009: *Roman military dress*, Gloucestershire.

Sumner, G., 2010: The centurio from Colchester. Reconstructing Marcus Favonius Facilis, *Ancient Warfare* special issue 2010, 22-30.
Svihalek, D., 2018: *Rímske kúpele a Stavby podobné kúpel'om v stredodunajskom barbariku*, Trnava (MA thesis, University of Trnava).
Szabó, M., 1988: *Les celtes en Pannonie. Contribution à l'histoire de la civilisation celtique dans la cuvette des Karpates*, Paris.

Taylor, M.J. 2011: The Adamklissi monument. Close combat on the Danube, *Ancient Warfare* 6 (2): 10-12.
Taylor, M.J., 2013a: The column of Marcus Aurelius. Scenes of brutality, *Ancient Warfare* 6 (6), 34-38.
Taylor, M.J., 2013b: The Pydna monument at Delphi. Set in stone, *Ancient Warfare* 8 (6), 10-12.
Taylor, M.J., 2016: The battle scene on Aemilius Paullus's Pydna monument. A reevaluation, *Hesperia* 85, 559-576.
Teegen, W.-R./F. Fleischer, 2004: Neue Waffenfunde von der Pâture du Couvent, Bibracte – Mont Beuvray, *Leipziger online-Beiträge zur Ur- und Frühgeschichtlichen Archäologie* 15, 6-7.
Tejral, J., 1994: Römische und germanische Militärausrüstungen der antoninischen Periode im Licht norddanubischer Funde, in C. von Carnap-Bornheim (ed.), *Beiträge zu römischer und barbarischer Bewaffnung in den ersten vier nachchristlichen Jahrhunderten: Akten des 2. Internationalen Kolloquiums in Marburg a.d. Lahn, 20. Bis 24. Februar 1994*, Marburg, 27-60.
Tempelmann-Maczyńska, M., 1985: *Die Perlen der römischen Kaiserzeit und der frühen Phase der Völkerwanderungszeit im mitteleuropäischen Barbaricum*, Mainz am Rhein.
Terry, K./I. Terry, 1961: Chain mail and other exotic materials from south-central Kansas, *Plains Anthropologist* 6 (12), 126-129.
Thevenot, É., 1955: Le monument de Mavilly (Côte-d'or). Essai de datation et d'interprétation, *Latomus* 14 (1), 75-99.
Thiel, A./W. Zanier, 1994: Römische Dolche. Bemerkungen zu den Fundumständen, *Journal of Roman Military Equipment Studies* 5, 59-81.
Thomas, M.D. 2003: *Lorica segmentata. Volume II: a catalogue of finds*, Duns.
Thomas, M.D. 2010: With bodies completely protected. Roman armour of the 1st–2nd centuries AD, *Ancient Warfare* special issue (2010), 74–81.
Thompson, E.A., 2008: Early Germanic warfare, in K. Devries (ed.), *Warfare in the Dark Ages*, London, 119-146.
Thomsen, E.G./H.H. Thomsen, 1974: Early wire drawing through dies, *Journal of Engineering for Industry* 96 (4), 1216-1221.
Thomsen, E.G./H.H. Thomsen, 1976: Drawing solid wire through soft dies in Antiquity, *Journal of Engineering for Industry* 98 (1), 201-205.
Thordeman, B., 1939: *Armour from the battle of Wisby, 1361*, Stockholm.
Thursfield, S., 2001: *The medieval tailor's assistant. Making common garments 1200-1500*, Bedford.
Tiussi, C./L.Villa/M. Novello, 2013: *Costantino e Teodoro. Aquileia nel IV secolo*, Milan.
Tod, M., 2004: *The early Germans*, Oxford (2nd edition).
Toelken, E.H., 1850: *Leitfaden für die Sammlung antiker Metallarbeiten*, Berlin.
Tomlin, R.S.O., 1998: Roman manuscripts from Carlisle. The ink-written tablets, *Britannia* 29, 31-84.
Töpfer, K.M., 2011: *Signa militaria. Die römische Feldzeichen in der Republik und im Prinzipat*, Mainz.
Torbov, N., 2004: Chain-mails from northern Bulgaria (III-I C BC), *Archaeologia Bulgarica* 8 (2), 57-69.
Torbrügge, W., 1970/1971: Vor- und frühgeschichtliche Flußfunde. Zur Ordnung und Bestimmung einer Denkmälergruppe, *Bericht der Römisch-Germanischen Kommission* 51/52, 1-146.
Tourreil, M.V., 2014: *Du paganisme gallo-romain au Christianisme. Changements des pratiques funéraires à travers l'étude archéologique de la nécropole de Maule (Yvelines) (II*ème*e-VII*ème*e)*, Pontoise (MA thesis, Université de Cergy-Pontoise).

Trapp, O., 1995 [1929]: *The armoury of the Castle of Churburg*, (transl. J.G. Mann), Udine.
Travis, H./J. Travis, 2011: *Roman body armour*, Gloucestershire.
Tremmel, B., 2009: Augusteische Marschlager in Porta Westfalica-Barkhausen, *Archäologie in Westfalen-Lippe* 2009, 45-47.
Trumm, J./M. Flück, 2013: *Am Südtor von Vindonissa. Die Steinbauten der Grabung Windisch-Spielmannwiese 2003-2006 (V.003.1) im Süden des Legionslagers*, Brugg.
Turčan, V., 2012: Ein Baukomplex aus der römischen Kaiserzeit in Stupava, in G. Březinová/V. Varsik (eds), *Archeológuesaia na Prahu histórie. K životnému jubileu Karola Pietu*, Nitra, 419-427.
Tweddle, D., 1992: *The Anglian helmet from Coppergate*, London.

Ubl, H., 2006: Was trug der römische Soldat unter dem Panzer, *Bayerische Vorgeschichtsblätter* 71, 261-276.
Underwood, R., 1999: *Anglo-Saxon weapons and warfare*, Stroud.
Unz, C./E. Deschler-Erb, 1997: *Katalog der Militaria aus Vindonissa. Militärische Funde, Pferdegeschirr und Jochteile bis 1976*, Brugg.

Van der Feijst, L., 2007: Metaal, in E. Blom/L. van der Feijst (eds), *Poeldijk Westhof, vindplaats B. Een inheems-Romeinse nederzetting uit de 1e tot de 3e eeuw*, Amersfoort, 59-69.
Van der Sanden, W.A.B., 1992: Resten van een lorica hamata uit Fluitenberg, gem. Ruinen, *Nieuwe Drentse Volksalmanak* 109, 51-62.
Van der Sanden, W.A.B., 1993: Fragments of a lorica hamata from a barrow at Fluitenberg, Netherlands, *Journal of Roman Military Equipment Studies* 4, 1-8.
Van der Sanden, W.A.B., 2003/2004: Terug naar Fluitenberg. Over een maliënkolder uit de IJzertijd, *Palaeohistoria. Acta et Communicationes Instituti Archaeologici Universitatis Groninganae* 45/46, 363-375.
Van der Sanden, W.A.B., 2018: *Geschiedenis van Drenthe. Een archeologisch perspectief*, Assen.
Van der Veen, V., 2020: *Roman military equipment and horse gear from the Hunerberg at Nijmegen. Finds from the Augustan military base and Flavio-Trajanic castra and canabae legionis*, Nijmegen.
Van Enckevort, H./J. Thijssen, 2004: Sporen van een Romeinse legerplaats onder het Rooie Dorp, *Ulpia Noviomagus* 10, 1-8.
Van Ginkel, E./W. Vos, 2018: *Grens van het Romeinse rijk. De limes in Zuid-Holland*, Utrecht.
Van Ginkel, E.J./J.A. Waasdorp, 1992: *De archeologie van Den Haag. Deel 2: de Romeinse tijd*, Den Haag.
Van Roemburg, J., 2011: *Unarmed Cananefates? Roman military equipment and horse gear from non military context in the civitas Cananefatium*, Leiden (MA thesis, Leiden University).
Varsik, V., 1999: Die Notgrabung einer römischen Siedlung des 2.-3. Jahrhunderts im Hinterland des Kastells Gerulata (vorläufige Ergebnisse 1995-1997), in J. Tejral (ed.), *Das mitteleuropäische Barbaricum und die Krise des römischen Weltreiches im 3. Jahrhundert*, Brno, 215-233.
Vedeler, M./L.B. Jørgensen, 2013: Out of the Norwegian glaciers. Lendbreen – a tunic from the early first millennium AD, *Antiquity* 87 (337), 788-801.
Verhecken-Lammens, C., 2010: Piecing together a Roman linen tunic, *Archaeological Textiles Newsletter* 51, 31-33.
Verstraaten, S./J. Oorthuys, 2012: *Romans. Clothing from the Roman era in north-west Europe*, Nijmegen.
Veselovsky, N.I., 1905: Курганы Кубанской Области в период римского владычества, in Uvarova (ed.), *ТРУДЫ Двенадцатого археологического съезда В ХАРЬКОВЕ. 1902 г* vol. 1, Moscow, 341-373.
Viand, A., 2008: Les fragments de cotte de mailles de Vernon. Armure souple véliocasse ou présence romaine aux portes de l'oppidum?, in M. Poux (ed.), *Sur les traces de César. Militaria tardo-républicains en contexte gaulois*, Bibracte, 33-46.
Viand, A./L. Pernet/L.-P. Delestrée, 2008: L'armement d'époque césarienne à Ribemont-sur-Ancre (Somme), in M. Poux (ed.), *Sur les traces de César. Militaria tardo-républicains en contexte gaulois*, Bibracte, 63-92.

Vike, V., 2000: *Ring weave. A metallographical analysis of ring mail at the Oldsaksamlingen in Oslo*, Oslo (MA thesis, Oslo University).

Vilella, J.R., 1958: Examination of mail armour links from the Metropolitan Museum of Art, *United States Steel Corporation Memorandum* (924, November 10).

Vlasova, E.V., 2004: Курган Васюринская гора на Таманском полуострове, in E.N. Khoda (ed.), *Эллинистические штудии в Эрмитаже*, St. Petersburg, 158-174.

Vogel, L., 1973: *The column of Antoninus Pius*, Cambridge.

Vogt, M., 2003: Die frühmittelalterlichen Spangenhelme. Ein Überblick zu archäologischen, kunsthistorischen und herstellungstechnischen Problemen, *Acta Praehistorica et Archaeologica* 35, 9-29.

Vogt, M., 2006: *Spangenhelme. Baldenheim und verwandte Typen*, Mainz.

Voirol, A., 2000: «Etats d'armes». Les militaria d'Avenches/Aventicum, *Bulletin de l'Association Pro Aventico* 42, 7-92.

Voirol, A., 2001: «Etats d'armes». Les militaria d'Avenches/Aventicum, *Gesellschaft Pro Vindonissa, Jahresbericht* 2001, 31-40.

Völling, T., 1998: Waffenopfer und Waffenbeigabensitte in der frühgermanischen Welt, in A. Küster/A. Lang/P. Schauer (eds), *Archäologische Forschungen in urgeschichtlichen Siedlungslandschaften*, Bonn, 559-576.

Völling, T., 1999: Römische Militaria in Griechenland. Ein Überblick, *Journal of Roman Military Equipment Studies* 8, 91-103.

Von Carnap-Bornheim, C., 1997: Neue Forschungen zu den beiden Zierscheiben aus dem Thorsberger Moorfund, *Germania* 75 (1), 69-99.

Von Carnap-Bornheim, C., 2004: Römische Militaria aus dem Thorsberger Moor Fundzusammensetzung, Kontext, Interpretation, in M. Erdich/C. von Carnap-Bornheim (eds), *Corpus der römischen Funde im europäischen Barbaricum* vol. 5 Deutschland, Bonn, 15-24.

Von Carnap-Bornheim, C./J. Ilkjær, 1996: *Illerup Ådal 5-8. Die Prachtrüstungen*, Aarhus.

Von Groller, M., 1901: Römische Waffen, *Der römische Limes in Österreich* 2, 85-132.

Von Groller, M., 1908: Grabung im Legionslager Lauriacum, *Der römische Limes in Österreich* 9, 87-116.

Von Groller, M., 1910: Die Grabungen im Lager Lauriacum und dessen nächster Umgebung im Jahre 1908, *Der römische Limes in Österreich* 11, 1-60.

Von Schnurbein, S., 2009: Caesars Kampf um Alesia und die Archäologie, in H. Meller (ed.), *Schlachtfeldarchäologie – Battlefield archaeology. 1. Mitteldeutscher Archäologentag vom 09. bis 11. Oktober 2008 in Halle (Saale)*, Halle, 59-66.

Voronov, Y., 2007: *Tsibilium I. La nécropole apsile de Tsibilium. Les fouilles de 1977-1986*, Oxford.

Voß, H.-U., 1994: Römische Waffen in Meckenburg-Vorpommern. Bilanz der Materialaufnahme für das „Corpus römischer Funde", in C. von Carnap-Bornheim (ed.), *Beiträge zu römischer und barbarischer Bewaffnung in den ersten vier nachchristlichen Jahrhunderten. Akten des 2. Internationalen Kolloquiums in Marburg a.d. Lahn, 20. Bis 24. Februar 1994*, Marburg, 261-270.

Voß, H.-U., 1998: *Corpus der römischen Funde im europäischen Barbaricum* vol. 3 Deutschland, Bonn.

Voß, H.-U., 2000: Das Fürstengrab 9/1995 von Hagenow in Mecklenburg-Vorpommern, in L. Wamser (ed.), *Die Römer zwischen Alpen und Nordmeer. Zivilisatorisches Erbe einer europäischen Militärmacht*, Mainz, 197-200.

Voß, H.-U., 2007: From the Baltic to the Danube. Early Roman Iron Age warriors from Hagenow, Mecklenburg, and their relations with barbarian and Roman worlds, *Archaeologia Baltica* 8, 58-68.

Voß, H.-U., 2008: Zwischen Vannius-Reich und Vimose. Die elitären Krieger von Hagenow, in A. Abegg-Wigg/A. Rau (eds), *Aktuelle Forschungen zu Kriegsbeuteopfern und Fürstengräbern im Barbaricum*, Neumünster, 253-277.

Vujović, M.B., 2017: Ring mail from Galerius' burial rite at Gamzigrad (Romuliana), in M.B. Vujović (ed.), *Ante portam auream. Studia in honorem professoris Aleksandar Jovanović*, Belgrade, 239-250.

Vulpe, A., 1976: La nécropole tumulaire gète de Popeşti, in A. Vulpe/C. Poghirc (eds), *Thraco-Dacica.*

Recueil d'études à l'occasion du IIe Congrès International de Thracologie, Bucarest, 4-10 septembre 1976, Bucureşti, 193-215.
Vulpe, A./V. Căpitanu, 1971: Une tombe isolée de l'époque de Latène à Răcătău, *Apulum. Arheologie, Istorie, Etnografie* 9, 155-164.

Waasdorp, A., 1989: Roman military equipment from The Hague, Holland, in C. van Driel-Murray (ed.), *Roman Military Equipment. The Sources of Evidence. Proceedings of the Fifth Roman Military Equipment Conference*, Oxford, 157-166.
Waasdorp, A., 1999: *Van Romeinse soldaten en Cananefaten. Gebruiksvoorwerpen van de Scheveningseweg*, Den Haag.
Wade, W.C., 1883: Chain mail armour, *The Antiquary* 7 (41), 209-210.
Wagner, A./J. Ypey, 2011: *Das Gräberfeld auf dem Donderberg bei Rhenen. Katalog*, Leiden.
Wagner, E./Z. Drobná/J. Durdík, 2000: *Medieval costume, armour, and weapons*, Mineola.
Waller, J.G., 1904: The hauberk of chain mail, and its conventional representations, *Archaeologia* 59 (1), 57-74.
Walter, C., 2003: *The warrior saints in Byzantine art and tradition*, Hants.
Waurick, G., 1979: Die Schutzwaffen im numidischen Grab von Es Soumâa, in H.G. Horn/C.B. Rüger (eds), *Die Numider. Reiter und Könige nördlich der Sahara*, Köln, 305-332.
Waurick, G., 1982: Die römische Kettenrüstung von Weiler-la-Tour, *Hémecht. Zeitschrift für Luxemburger Geschichte* 34, 111-130.
Waurick, G., 1983: Untersuchungen zur historisierenden Rüstung in der römischen Kunst, *Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz* 30, 265-301.
Waurick, G., 1994: Zur Rüstung von frühkaiserzeitlichen Hilfstruppen und Verbündeten der Römer, in C. von Carnap-Bornheim (ed.), *Beiträge zu römischer und barbarischer Bewaffnung in den ersten vier nachchristlichen Jahrhunderten: Akten des 2. Internationalen Kolloquiums in Marburg a.d. Lahn, 20. Bis 24. Februar 1994*, Marburg, 1-25.
Weber, L.J., 1973: *Als die Römer kamen… Augusta Vindelicorum und die Besiedlung Raetiens*, Landsberg am Lech.
Wedel, W.R., 1975: Chain mail in plains archaeology, *Plains Antropologist* 20 (69), 187-196.
Weinberg, S.S., 1979: A hoard of Roman armour, *Antike Kunst* 22 (2), 82-86.
Werner, J., 1941: *Die beiden Zierscheiben des Thorsberger Moorfundes. Ein Beitrag zur frühgermanischen Kunst- und Religionsgeschichte*, Berlin.
Weski, T., 1982: *Waffen in germanischen Gräbern der älteren römischen Kaiserzeit südlich der Ostsee*, Oxford.
Wheeler, R.E.M./T.V. Wheeler, 1932: *Report on the excavation of the prehistoric, Roman, and post-Roman site in Lydney Park, Gloucestershire*, Oxford.
Wijnhoven, M.A., 2009a: Lorica hamata squamataque. A study of Roman hybrid feathered armour, *The Journal of the Mail Research Society* 2 (1), 3-29.
Wijnhoven, M.A., 2009b: The Ouddorp lorica. A case study of Roman lorica hamata squamataque, *The Journal of the Mail Research Society* 2 (1), 30-65.
Wijnhoven, M.A., 2010: Over stansen en klinken. De vervaardiging van een maliënkolder uit de ijzertijd gevonden te Fluitenberg, *Nieuwe Drentse Volksalmanak* 127, 141-156.
Wijnhoven, M.A., 2014: Geringd wapentuig. Maliënkolders uit de ijzertijd, *Kelten* 61, 12-14.
Wijnhoven, M.A., 2015a: The iron tunic from Vimose (Funen, Denmark). Further research into the construction of mail garments, *Gladius* 35, 77-104.
Wijnhoven, M.A., 2015b: Filling in the gaps. Conservation and reconstruction of archaeological mail armour, *Journal of Conservation and Museum Studies* 13 (1) 8, 1-15.
Wijnhoven, M.A, 2015c: All that glitters is not gold. Copper alloy decoration in Roman mail garments, *Arma* 14 (2), 22-28.
Wijnhoven, M.A., 2016a: Putting the scale into mail. Roman hybrid feathered armour, *Journal of Roman*

Military Equipment Studies 17, 77-86.
Wijnhoven, M.A., 2016b: La armadura romana desde Augusto hasta los Flavios, *Desperta Ferro – especial* X: la legión romana (III) – el primer siglo del imperio, 60-64.
Wijnhoven, M.A., 2017: A very Roman practice. Copper-alloy decoration in mail armour, *Journal of Roman Military Equipment Studies* 18, 183-196.
Wijnhoven, M.A., 2018: Laid out flat. Mail making in the Roman period, in C.S. Sommer/S. Matešić (eds), *Limes XXIII. Proceedings of the 23rd International Congress of Roman Frontier Studies Ingoldstadt 2015*, Mainz, 555-563.
Wijnhoven, M.A., 2019a: Der römische Kettenpanzer. 700 Jahre Schutzrüstung aus Ringgeflecht, *Der Limes. Nachrichtenblatt der Deutschen Limeskommission* 13/2019 (1), 4-9.
Wijnhoven, M.A., 2019b: A warrior's skirt made from rings. Early mail armour or a collector's vision?, *Gladius* 39, 45-70.
Wijnhoven, M.A./A. Moskvin, 2020: Digital replication and reconstruction of mail armour, *Journal of Cultural Heritage* 45, 221-233.
Wijnhoven, M.A./A. Moskvin/M. Moskvina, 2021, Testing archaeological mail in a virtual environment. 3rd century BC to 10th century AD, *Journal of Cultural Heritage* 48, 106-118.
Wild, J.P., 1979: Fourth-century underwear with special reference to the thoracomachus, in M.W.C. Hassall (ed.), *De rebus bellicis. Part 1: aspects of De rebus bellicis. Papers presented to professor E.A. Thompson*, Oxford, 105-110.
Wild, J.P., 1985: The clothing of Britannia, Gallia Belgica and Germania Inferior, in H. Temporini/W. Haase (eds), *Aufstieg und Niedergang der römischen Welt* vol. 2.12 (3), Berlin, 362-422.
Willems, W.J.H./H. van Enckevort, 2009: *Vlpia Noviomagvs. The Batavian capital at the imperial frontier*, Portsmouth.
Willemsen, A., 2016: Speelgoedzwaarden, in L. Amkreutz/A. Willemsen (eds), *Vlijmscherp verleden. Het zwaard als wapen en symbool*, Leiden.
Williams, A.R., 1980: The manufacture of mail in medieval Europe. A technical note, *Gladius* 15, 105-134.
Williams, A.R., 2003: *The knight and the blast furnace. A history of the metallurgy of armour in the Middle Ages and the Early Modern period*, Leiden.
Williams, A.R., 2009: A metallurgical study of Viking swords, *Gladius* 29, 121-184.
Williams, A.R., 2010: A note on the metallurgy of two Migration period helmets, *The Journal of the Arms and Armour Society* 20 (1), 27-35.
Wilmott, T., 1997: *Birdoswald. Excavations of a Roman fort on Hadrian's Wall and its successor settlements: 1987-92*, Swindon.
Wójcikowski, R.S., 2013: The graffito from Dura-Europos. Hybrid armor in Parthian-Sasanian Iran, *Anabasis. Studia Classica et Orientalia* 4, 233-248.
Wood, E./D. Edge/A. Williams, 2013: A note on the construction and metallurgy of mail armour exhibited in the Wallace Collection, *Acta Militaria Mediaevalia* 9, 203-229.
Woosnam-Savag, R.C./A. Hall, 2002: *Brassey's book of body armour*, London.
Wyley, S., 1995a: The Gjermundbu mail shirt, *Varangian Voice* 34, 31.
Wyley, S., 1995b: The Gjermundbu mail shirt, *Varangian Voice* 37, 27.

Yamagami, H., 1928: *Nippon katchu no shin kenkyu*, Tokyo.
Yiu-Kang, S., 2010: *Archaeological investigations of Xiongnu-Hun cultural connections*, Minnesota (MA thesis, University of Minnesota).
Yule, T., 1933/1934: Donations to the museum, *Proceedings of the Society of Antiquaries of Scotland* 68, 10-18.

Zadoks-Josephus Jitta, A.N./A.M. Gerhartl-Witteveen, 1983: *Description of the collections in the Rijksmuse-*

um G.M. Kam at Nijmegen VII. The figural bronzes: supplement 1983, Nijmegen.

Žákovský, P./J. Hošek, 2015: Kovové artefakty, in M. Plaček/M. Dejmal (eds), *Veselí nad Moravou. Středověký hrad v* říční *nivě*, Brno, 220-251.

Zandstra, M.J.M., 2019: *Miles away from home. Material culture as a guide to the composition and deployment of the Roman army in the Lower Rhine area during the 1st century AD*, Nijmegen (PhD thesis, Radboud Universiteit).

Zanier, W., 1992: *Das römische Kastell Ellingen*, Mainz am Rhein.

Zeller, K.W., 1980: Kriegswesen und Bewaffnung der Kelten, in L. Pauli (ed.), *Die Kelten in Mitteleuropa. Kultur, Kunst, Wirtschaft*, Salzburg, 111-132.

Zienkiewicz, D.J., 1986: *The legionary fortress baths at Caerleon*, Cardiff.

Zirra, V., 1991: The cemetery of Ciumeşti and the chieftain's tomb, in S. Moscati (ed.), *The Celts*, Milan, 382-383.

Zlatkov, M., 2014: Silver-coated chain mail shirt from Stara Zagora district, in L. Vagalinski (ed.), *Tsar Samuil († 1014) in battle for Bulgaria*, Sofia, 133-135.

Database

The database consists of four catalogues that complement each other. These are:

1. Catalogue of mail armour
2. Catalogue of hybrid armour
3. Catalogue of isolated finds of fasteners and fixtures
4. Finds excluded from the database

The catalogues have the same structure, but are unique. This means that each find will feature only once and never in more than one catalogue. The catalogues are arranged around the place where an artefact was found. Some places have rendered more than one find. In such case, a number is added behind the place name. The numbers continue throughout the four databases. For example, Xanten 1 and 2 concern mail and are located in appendix 1. Xanten 3 is hybrid armour and features in appendix 2, while Xanten 4 and 5 are fasteners presented in appendix 3.

An entry in the database does not necessarily equate to a single mail garment. The entries are very much the product of the level of detail available from the literature and from personal examination. For example, an entry can describe various mail coats that are mentioned together in the literature without much further information. Moreover, it is important to stress that mail is often fragmentary. When multiple fragments are found, it is not always easy to determine if these come from one single mail garment or actually represent multiple examples.

The type of information recorded in the database is elaborated upon below. Only the applicable information is included for each find.

COUNTRY

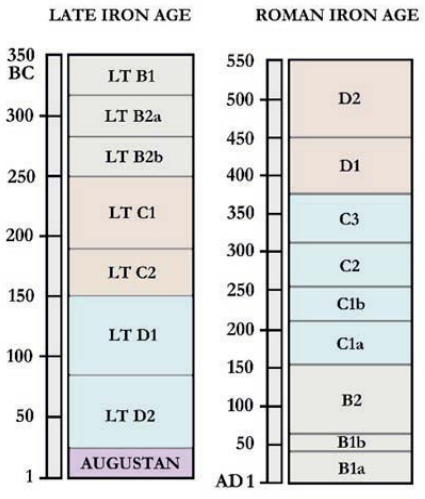
All catalogues are ordered alphabetically by country. Unprovenanced finds *with* information on their country of origin are located under that country with the name 'unprovenanced from…'. Finds without a country of origin are placed under 'Unprovenanced'.

FINDSPOT

The findspots are arranged alphabetically within each country. Some findspots are well-known in the literature for their ancient names, such as Vindonissa in modern Windisch. The use of a modern or an ancient name for findspots in the database has not been applied categorically. The choice for modern, ancient or both is mainly a reflection of the literature describing the find in question.

DATE

This concerns the age of the artefact as indicated in the literature. The date can be expressed as a period, for example 'La Tène D' (LT D) or as an absolute date, such as '1st century BC'.



Based upon the analyses done in this study, it has been possible to determine with more accuracy the date of various artefacts. In these cases a **refined date** is presented after the general date from the literature.

CONTEXT

This includes the context where the artefact was found. When known, specific information is included, for example the exact place at a site where the artefact was excavated.

DESCRIPTION

The description of the artefact is done from generic to detailed. First the artefact is identified (e.g. mail coat, mail aventail, hybrid armour, fixture), followed by an indication of its condition. Then there is specific information on the construction and the individual components of the armour. The former may include weaving patterns and the use of tailoring. The description of the mail rings follows the method presented in box 11.1. The description of scales follows that proposed in Wijnhoven 2009b. The terms 'horizontal' and 'vertical' in the description of riveted rings always refer to the ring being observed with the overlap facing North.

FIXTURE

Mail can have fixtures and fasteners. When still attached or associated to mail or hybrid armour, these are included in appendix 1 or 2. These catalogues have an extra heading labelled **fixture**. Fixtures that no longer associated to their armour are listed separately in catalogue 3. The terms 'left' and 'right' in the description of fasteners refers to that as observed by the viewer, not by the wearer.

INVENTORY

This sums up the artefacts found in the same context. It can also contain information that the closed context has been disturbed, for example by grave robbing. When the closed context is unknown or unspecified in the literature, general finds from the site in question can be mentioned here.

REMARKS

This heading contains additional relevant information. It also states whether the author has personally examined or observed the artefact.

MATERIAL

Description of the type of metal used for the armour and/or its associated fasteners and fixtures. The results of scientific analysis on the metal's components are also added here. The terms 'iron', 'copper alloy', and 'white metal' indicate that this is based upon visual examination only.

LOCATION

The current or last known location of the artefact is mentioned under this heading. When known, an inventory number (abbreviated as 'inv.') is added.

LITERATURE

This heading sums up the relevant literature consulted by the author. When the artefact is unpublished the heading is omitted entirely.

ALBANIA

Selca e Poshtme

Date: 250-200 BC.
Context: funerary - tomb 3.
Description: mail armour.
Inventory: gold earrings, necklaces, pins, rings, belt fitting, silver ornament depicting a battle scene, spearheads, 30 ceramic vessels.
Literature: Rustoiu 2006, 49.

ALGERIA

Es Soumâa

Date: *terminus ante quem* 130-118 BC.
Context: funerary.
Description: two large mail fragments measuring 59 x 15 x 6 cm and 18.5 x 17 x 4 cm. Current weight c. 5 kg. In solid corroded condition. 4-in-1. Rings: outer diameter hardly larger than 3-4 mm; X-rays indicate the presence of rings with a 7-9 mm diameter; cross-section circular.
Material: iron.
Inventory: helmet, sword, scabbard, eight spearheads, bronze bench, gilded silver medallion, silver bowl, drinking horn, silver plate, at least three *amphorae*.
Remarks: cremation remains of two individuals (c. 60 years and c. 20 years). Possibly the burial of Micipsa, king of Numidia.
Location: Musée National Cirta, Constantine.
Literature: Bridoux 2008, 410; Gerresheim *et al.* 1997, 353-354, fig. 218; Hansen 2003, 65-67, 164 (cat. no. B1); Künzl 2002, 127; Mordvintseva *et al.* 2012, 324; Müller 2003, 432; Pernet 2010, 51; Rustoiu 2006, 49; Völling 1999, 95; Waurick 1979, 318-332 (cat. no. 1).

AUSTRIA

Biberwier

Date: 4th century AD.
Context: isolated find near the Via Claudia Augusta.
Description: mail aventail, measuring 18 x 17 cm, attached to a helmet. Mail is in good condition and partly flexible. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter larger than solid rings; overlap clockwise; paddle-shaped overlap; round rivet heads; cross-section flattened. Solid rings: square cross-section; rings have burrs and deformations indicating that they were punched from sheet metal.
Material: iron.
Inventory: helmet with aventail, stored in a textile bag.
Location: Institut für Archäologien - Universität Innsbruck.
Literature: Fischer 2012, 159, fig. 194.1; 2019, 120, fig. 194.2; Miks 2008, 12-13, fig. 20; 2014, 223, pl. 70-72.

Carnuntum 1 - Bad Deutsch-Altenburg

Date: 1st century AD.
Context: Roman fort - 'Waffenmagazin'.
Description: 17 mail fragments. 4-in-1. Rings: outer diameter 5-7 mm, inner diameter 3-5 mm.
Material: iron, copper alloy.
Inventory: 121 scale armour fragments, 302 *lorica segmentata* fragments, ten armguards fragments, 62 shields fragments, 58 helmet fragments, 13 sword fragments, five dagger fragments, 38 pieces of shafted weapons, eleven pilum fragments, 40 spear butts, 209 arrowheads, 166 miscellaneous objects.
Remarks: Von Groller described one fragment as riveted, another as butted, and mentioned the possibility of welded rings. He also refers to fragments of 'wire armour' which he differentiates from mail. All the fragments are most likely regular mail armour made from riveted and solid rings.
Location: Museum Carnuntinum, Bad Deutsch-Altenburg, inv. 18469-18175.
Literature: Bishop 2015b, 6; 2015c, 2; Bishop/Coulston 2006, 265, fig. 51.2; Boube-Piccot 1994, 55; Buetler *et al.* 2017, 265-266; Burandt 2017, 41; Hansen 2003, 77, 173 (cat. no. C67); Kelly 1931, 269; 1934, 206; Matešić 2015, 211, 218; Novichenkova 2009, 285; 2011, 279; Richter 2010, 193; Robinson 1975, 171; Rusu 1969, 289; Travis/Travis 2011, fig. 31; Van der Sanden 1993, 4 (cat. no. 1); Von Groller 1901, 114, pl. 20.1-5; Wijnhoven 2015c, 25; 2017, 186, 192.

Carnuntum 2 - Bad Deutsch-Altenburg

Date: 3rd century AD.
Context: Roman fort.
Description: five mail fragments.

Material: iron.
Location: Museum Carnuntinum, Bad Deutsch-Altenburg, inv. 18476-18482.
Literature: Hansen 2003, 173 (cat. no. C68).

Carnuntum 3 **-** Bad Deutsch-Altenburg
Date: Roman period?
Context: Roman fort.
Description: seven mail rings. 4-in-1.
Material: iron.
Literature: Hansen 2003, 173 (cat. no. C69).

Enns-Lorch - Lauriacum
Date: Roman period. Refined date: end 2nd - 3rd century AD.
Context: Roman fort.
Description: two large mail fragments. 4-in-1. Rings: outside diameter 8-10 mm, inside diameter 7-9 mm. The iron rings have no longer morphological features, but the copper alloy ones do. Riveted copper alloy rings: clockwise overlap; shape overlap stumpy; round hole for rivets; round rivet heads; round cross-section wire. Solid copper alloy rings: square cross-section.
Remarks: another three mail fragments probably belonging to the same armour. These have erroneously been described by Von Groller as 'wire armour', but concern regular mail.
Material: iron, copper alloy.
Literature: Hansen 2003, 77, 173 (cat. no. C65); Matešić 2015, 211-212; Von Groller 1908, 101, fig. 45; 1910, 41, fig. 15; Wijnhoven 2015c, 25; 2017, 186, 188, 192.

Faschendorf
Date: LT D? Refined date: Roman Principate.
Context: funerary.
Description: two mail fragments. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: round cross-section. Solid rings: square cross-section; have been described as welded, but show signs of being punched from sheet metal (i.e. upstanding circles at the inner and outer edge on one side of the rings); rings have not been reworked.
Material: iron.
Remarks: the mail fragments were found in a disturbed area of a Roman cemetery. The cemetery also included older La Tène burials. The presence of a Late La Tène sword found nearby the mail remains led to the conclusion that the mail might be Iron Age. This appears incorrect and the characteristics of the solid rings point to the Roman Principate.
Literature: Polleres/Artner 2004, 93-94.

Magdalensberg 1
Date: Roman period, possibly 1st century.
Context: settlement.
Description: two mail fragments. 4-in-1. Alternating rows of riveted and solid rings. Rings: diameter 5-7 mm.
Material: iron.
Inventory: two swords, arrow- and spearheads. Inventory is incomplete.
Location: Landesmuseum Kärnten, Klagenfurt am Wörthersee, inv. TB 1987/II/74.
Literature: Dolenz 1998, 83-84 (cat. no. M203a-b); Matešić 2015, 218; Miks 2007, 660.

Roseldorf *(fig. 2.16)*
Date: LT C.
Context: sanctuary.
Description: various small corroded fragments of mail. 4-in-1. Probably alternating rows of riveted and solid rings. The presence of riveted rings is indicated through the observation of large round rivet heads. Other details are obscured by corrosion and impregnation of wax to conserve the fragments. Rings: estimated outer diameter 7 mm.
Material: iron.
Inventory: various intentionally destroyed objects, such as weapons (swords and scabbards parts, sword chains, spearheads, shield bosses), chariot parts, horse trappings, ceramic material, animal- and human bones, a so-called 'druid's crown', star-shaped amulet, numerous silver and gold coins.
Remarks: observed by the author through museum glass.
Location: Naturhistorisches Museum Wien.
Literature: Holzer 2008, 127, 129.

Vienna 1
Date: probably Roman period.
Description: mail fragment measuring 4 x 3.5 cm. 4-in-1. Alternating rows of riveted and solid rings.
Material: iron.
Location: privately owned.
Literature: Appels/Laycock 2007, 61, fig. AA6.47.

Vienna 2
Date: 1st - 3rd century AD.
Context: Roman fort - near the barracks of the 1st cohort.
Description: corroded mail fragment measuring 10 x 9 cm.
Material: iron.
Remarks: this artefact is now lost.
Literature: Maspoli 2014, 42, 81, 123, pl. 10 (cat. no. 248).

Zwentendorf
Date: 2nd half 1st century AD.
Context: Roman fort - cellar underneath the *principia*.
Description: mail fragment, broken in two and heavily corroded. The objects in the inventory adhere to the mail remains. Reported to have rings of different size, which may refer to the presence of riveted and solid rings. Rings: oval cross-section.
Material: iron.
Inventory: brooch, Trajanic coin, bronze button, cherry and plum pits, fish fin.
Literature: Hansen 2003, 173 (cat. no. C66); Ployer 2013, 80.

BELGIUM

Oudenburg 1
Date: AD 250-280 (one fragment); AD 260-280 (one fragment); AD 260-410 (one fragment); AD 325-420 (four fragments).
Context: *castellum*.
Description: seven heavily corroded mail fragments, only identified as mail after having been X-rayed. These show the presence of riveted and solid rings.
Material: seven mail fragments: iron; one fragment from AD 260-410: iron rings with copper alloy rivets.
Literature: Wijnhoven 2015c, 24, 27; 2017, 186, 192.

Oudenburg 2
Date: start 5th century AD (after abandonment of the *castellum*).
Description: four heavily corroded mail fragments, only identified as mail after having been X-rayed.
Material: one fragment: iron; three fragments iron rings with copper alloy rivets.
Literature: Wijnhoven 2015c, 24, 27.

BULGARIA

Chatalka - Stara Zagora
Date: end 1st century AD - early 2nd century AD.
Context: funerary - Roshava Dragana burial 2.
Description: small mail fragment in solid condition. 4-in-1. The fragment has the remnants of a V-shaped copper alloy object caked to it. It is uncertain whether this object formed part of the armour.
Material: iron.
Inventory: silvered face mask helmet, two shields, two swords (one with a golden pommel), scale armour, iron gorget, plate armour, splinted armour, six spearheads, 55 arrowheads, quiver, tin urn, golden wreath, pottery, bronze items, toiletries, bronze belt buckle, furniture, *candelabrum*, perfumes.
Remarks: the excavators mention that mail was found next to an iron gorget. It has therefore been reconstructed together with the gorget. However, there is no evidence that they actually belong together and are likely separate items.
Location: Regional Historical Museum, Stara Zagora.
Literature: D'Amato/Sumner 2009, 198; Künzl 2002, 136; Moralejo Ordax 2011, 294; Müller 2003, 436; Negin/D'Amato 2018, 6-9; Negin/Kamisheva 2018, 45-46, 53, 65; Stephenson 2001, 47, fig. 16; 2006, 76, fig. 60; Travis/Travis 2011, 78.

Doyrentsi *(fig. 4.6d)*
Date: 2nd - 1st century BC.
Context: funerary - *tumulus* 2.
Description: mail fragments.
Fixture: plate-like fastener that is damaged and misses one extremity. The rectangular plate has a L-shaped slit, which receives the button located on the shoulder guard. In pristine condition the fastener would have had two slits.
Material: mail: iron; plate-like fastener: copper alloy.
Remarks: from the same site, but probably not from the same *tumulus*, comes a set of S-shaped fasteners that end in what appears stylised animal heads. The fasteners are still connected to each other by a central button. Also a button from the shoulder guard survives. The iron fasteners are decorated at their base with transverse stripes of inlaid bronze strips.
Inventory: weapons, armour with gold plated figures, shield, four spearheads, sword with scabbard, three bridles, several silver objects, round shaped ornaments,

vessels. Inventory is probably incomplete.
Location: Regional Historical Museum, Lovech.
Literature: Dedyulkin/Shevchenko 2017, 52; Dimitrov 2009-2010, 101, fig. 8; Rustoiu 1996, 36, 43; 2006, 49, 51; Torbov 2004, 57, 59, fig. 4b, 5c; Van der Sanden 2003/2004, 371.

Kălnovo
Date: 220-180 BC.
Context: funerary - burial 1.
Description: coat of mail, still partly in flexible condition. 4-in-1. The presence of riveted rings has been mentioned in literature. Rings: cross-section wire round; domed rivet heads.
Fixture: three fixtures are observed among the mail remains. Two hook-like fixtures made from a triangle shaped metal plate, riveted to the mail fabric, and a hook. The other fixture corresponds to one of the former and has a similar metal plate with a triangular loop attached, which connected to the fixture with the hook.
Material: iron.
Inventory: helmet, sword, scabbard, shield boss, spearhead, torcs, horse bits, knife, shears, lamp, nails, brooch, horse bones, large number of ceramics, burnt animal bones.
Location: Regional Historical Museum, Shumen.
Literature: Atanassov 1992, 5, pl. 8; Dimitrov 2009-2010, 101; Megaw 2004, 103-104; Moralejo Ordax 2011, 292; Mordvintseva *et al*. 2012, 324; Rustoiu 2006, 49; Torbov 2004, 57, 64; Van der Sanden 2003/2004, 371.

Karanovo
Date: mid-1st century AD.
Context: funerary.
Description: mail coat folded together.
Material: iron.
Inventory: sword with scabbard, short sword with scabbard decorated with a pearl, two-handed sword, three shield bosses, ten spearheads and three spear butts, curved dagger, small knife, silver and bronze buckles, belt fixtures, part of a leather belt, ring, two silver brooches, silver plaque, three gold rings with gems, hobnails, glass vessels, silver and gold coins, bronze tripod oil lamp with molten remains of silver, bronze and glass, textile remains, chariot, two pulling horses, dog, box with lock, wooden box with toiletries, two silver embossed cups of a Roman drinking set, ceramic-, bronze- and glass vessels, key, five *strigile*, bones of more than 60 animals
Literature: Ignatov/Gospodinov 2013, 30.

Krivina - Iatrus
Date: 4th - 5th century AD.
Context: settlement.
Description: mail fragment.
Literature: Glad 2009, 43,117 (cat. no. 81).

Matochnika - Arkovna
Date: 280-200 BC.
Description: various mail fragments.
Fixture: two buttons of which one still is attached to the mail fabric. Also what looks like a buckle, still attached to the mail. Lastly, two fixtures with a hook.
Material: iron.
Inventory: bronze coins, brooches, belt parts, glass bracelets, cheek guard of a helmet, pottery.
Location: Historical Museum, Dalgopol.
Literature: Berecki 2010, 71; Lazerov 2010, 105, fig. 4.2; Rustoiu 2008, 170.

Mezdra
Date: LT D.
Context: funerary.
Description: mail fragments.
Material: mail: iron; fixture: copper alloy.
Fixture: buckle attached to the mail fabric. The tongue of the buckle has been lost.
Inventory: sword, shield boss, brooches. Inventory is incomplete.
Location: National History Museum, Sofia.
Literature: Dimitrov 2009/2010, 101; Moralejo Ordax 2011, 291-293, fig. 16.5, 16.6; Rustoiu 2006, 49; Torbov 2004, 57, 58-59, fig. 5b; Van der Sanden 2003/2004, 371.

Milhailovo
Date: 10th - 11th century AD.
Context: settlement.
Description: well-preserved mail coat that is still flexible. Length 75 cm (c. 150 ring rows); waist width c. 47 cm; sleeve length 16 cm; current weight 4.2 kg. The coat is relatively short with short sleeves and an oval head opening. The right sleeve and part of the torso are missing. 4-in-1. The coat is made with only

riveted rings: overlap anti-clockwise; shape overlap reshaped oval; rivet head is conical-shaped on one side; cross-section wire rings round. Three different gauges of rings are used. The chest and lower abdomen have a heavier gauge. Lighter rings are located at the back, the sleeves and the bottom. Intermediate rings connects the two. Heavier rings: outer diameter 4.7-5 mm; thickness 0.7-1 mm. Intermediate rings: outer diameter c. 5.8 mm. Lighter rings: outer diameter 4.5 x 5-4.8 x 5.5 mm; thickness 0.5-0.8 mm.
Material: brass covered in silver (Cu 69.16%, Ag 16.3%, Zn 11.99%, Hg 1.40%, Pl 0.85%, Ni 0.48%).
Location: National Archaeological Museum, Sofia, inv. 3245.
Literature: D'Amato 2012, 53, 56; Haldon 2002; Petrov *et al.* 2015, 576-576; Zlatkov 2014.

near **Novae** *(figs. 6.21, 10.16-18)*
Date: Roman period. Refined date: Roman Principate.
Context: river.
Description: large fragment of mail, 20 smaller fragments and some loose rings, now restored into one single fragment. The surviving part is the bottom of the mail coat, preserving the bottom hem and one of the two splits, located at the side of the coat. The hem is not straight, but stepped. No evidence for tailoring of the mail coat. The garment was made as one large panel that was folded over and closed at the sides. Evidence for this is in a straight line where the rows of riveted rings change into solid, and *vice versa*. Each side of the coat is 122 rings wide, giving a circumference of approximately 118 cm in total. The maximum depth of the splits is 45 rows (c. 18 cm), but probably less. 4-in-1. Riveted rings: outer diameter horizontal 7.5 mm; outer diameter vertical 7.1 mm; inner diameter horizontal 5.2 mm; inner diameter vertical 4.2 mm; overlap clockwise; shape overlap stumpy; overlap length c. 2.4 mm; overlap width 1.5 mm; rivet head round on both sides; rivet holes round; cross-section round; thickness wire 1 mm; width wire 1 mm. Solid rings: outer diameter 7.1 mm; inner diameter 4.9 mm; thickness 1.2 mm; width 1.1 mm; cross-section square with rounded corners; some rings still have a small ridge at the inside from being punched from sheet. In several places repairs were made with larger riveted rings: outer diameter between 8.8-9.1 mm. Repair rings do not always respect the 4-in-1 weave.
Material: iron.
Remarks: examined by the author. Artefact is said to have been found in the 1950-1960's at the Danube river, near Novae.
Location: privately owned.
Literature: Wijnhoven 2015a, 4-15; 2018, 559-562.

Panagyurski Kolonii
Date: 2nd - 1st century BC.
Context: funerary.
Description: mail armour.
Fixture: bronze fixture, probably a fastener.
Literature: Dedyulkin/Shevchenko 2017, 53 (cat. no. 4); Domaradski 1984, 136.

Ravnogor
Date: c. 50-30 BC. The *tumulus* dates to the 3rd century BC, but pottery finds indicate a re-use during the end of the Hellenistic period.
Context: funerary - *tumulus* 9.
Description: one or possibly more mail coats, all corroded.
Material: iron.
Inventory: pottery sherds. Inventory is incomplete.
Location: Regional Historical Museum, Pazardzhik.
Literature: Kitov 2007, 274; Marinov 2008, 143; Moralejo Ordax 2011, 294; Torbov 2004, 60.

Rozovets
Date: 250-150 BC.
Context: funerary.
Description: mail armour.
Material: iron.
Inventory: bronze helmet, two bronze greaves, sword, many bronze arrowheads, gold diadem, two large gilded copper vessels, gilded silver cup, bronze vessel, two silver lamps, gilded copper vase, silver dog figurine, gold ring, silver and metal objects, marble vase, ceramics, human bones.
Remarks: discovered in 1851. The iron artefacts, including the mail, were not collected.
Literature: Kitov 1996, 18-19; 2007, 274; Marinov 2008, 143, 144, 148; Torbov 2004, 61.

Rupkite
Date: late 6th - early 7th century AD.
Context: funerary - grave 82.
Description: mail aventail.

Material: iron.
Inventory: lamellar helmet. Inventory is incomplete.
Location: Regional Historical Museum, Stara Zagora, inv. 3C3-723.
Literature: Miks 2009, 501, fig. 77.60.

Sashova
Date: 200-150 BC.
Context: funerary.
Description: mail armour.
Material: iron.
Inventory: bronze helmet, sword, shield, five daggers, two spearheads, gold brooch, silver earring, silver torc, silver chain, large silver pendant, iron bracelet, hundreds of glass and bronze beads, gilded silver *phiala*, bronze vessel, ten ceramic vessels, bridle, four bronze rings, two iron rings, bronze buckle, iron buckle, nails, other metal objects, stone bed, skeleton horse.
Location: National History Museum, Sofia.
Literature: Kitov 2003, 14-17; 2007, 273-274; Marinov 2008, 188, Mordvintseva *et al.* 2012, 324; Torbov 2004, 60.

Slavchova
Date: pre-Roman.
Context: funerary.
Description: mail armour.
Literature: Kitov 2007, 274.

Smochan
Date: LT D.
Context: funerary.
Description: mail fragment. It has been interpreted as a mail neck-guard for a helmet in the past, but the presence of a fastener, points to a mail coat.
Fixture: rectangular plate-like fastener, now broken in two. The fastener is attached to the mail coat with a stud and a highly domed button located at the right. The left side of the fastener has a diagonal slit that would have received a button in order to open and close the mail coat.
Material: rings: iron; fastener: copper alloy.
Inventory: bronze helmet, swords, spearheads, silver and bronze ornaments, other valuable items, pottery. Inventory is probably incomplete.
Location: Regional Historical Museum, Lovech.
Literature: Dedyulkin/Shevchenko 2017, 52; Moralejo Ordax 2011, 292; Rustoiu 2006, 49; Torbov 2004, 57, 58, fig. 5a; Van der Sanden 2003/2004, 371.

Stara Zagora
Date: Augustan.
Context: funerary.
Description: coat of mail.
Material: iron.
Inventory: two silver *phalerae*, sword with bronze scabbard, gold ring with gem, two silver vessels, bronze sieve.
Location: Regional Historical Museum, Stara Zagora.
Literature: Falkenstein 2004, 84; Hansen 2003, 61, 166; Rustoiu 1996, 36; 2006, 49; Torbov 2004, 60, 65.

Tărnava *(fig. 4.6c)*
Date: LT D.
Context: funerary.
Description: fragments of mail, probably from a mail coat.
Fixture: rectangular plate-like fastener, broken in two. The fastener connects with a domed stud and washer at the centre to the chest area of the mail coat. The fastener has two L-shaped slits that receive the buttons located at the shoulder extensions. In addition, a small hook and an eyelet that belong together. The eyelet still has rings attached.
Inventory: sword, shield boss, brooches. Inventory is incomplete.
Location: Regional Historical Museum, Vratsa, inv. 6.
Literature: Dedyulkin/Shevchenko 2017, 52; Dimitrov 2009-2010, 101; Moralejo Ordax 2011, 291-294, fig. 16.5, 16.6; Rustoiu 1996, 36; 2006, 49; Torbov 2004, 57, 58, fig. 4a, 6a; Van der Sanden 2003/2004, 371.

Tzviatkova
Date: pre-Roman.
Context: funerary.
Description: mail armour.
Literature: Kitov 2007, 274.

Unprovenanced from Bulgaria 1 *(fig. 11.31)*
Date: c. 4th century AD.
Context: funerary.
Description: 33 fragments of mail: 30 in a solid condition and three fragments in flexible condition. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter horizontal 6.9 mm; outer diame-

ter vertical 7.4 mm; inner diameter horizontal 4.3 mm; inner diameter vertical 3.9 mm; overlap anti-clockwise; shape overlap mid-size oval; overlap length c. 3.7 mm; overlap width 2.3 mm; round rivet head on both sides of the rings; cross-section wire round; thickness wire 1.3 mm; width wire 1.3 mm. Solid rings: outer diameter 7.5 mm; inner diameter 4.5 mm; thickness 1.1 mm; width 1.7 mm; cross-section rectangular; conical deformation from punching out of sheet metal; corners of rings are rounded from wear.
Material: iron.
Inventory: helmet with nasal, horse bit, ornamented metal parts (of a scabbard?), bone fragments. Inventory probably incomplete.
Remarks: examined by the author.
Location: privately owned.
Literature: Negin/D'Amato 2018, 31, 51.

Unprovenanced from Bulgaria 2 *(fig. 4.6b)*
Date: possibly 250-150 BC.
Description: large mail fragment in flexible condition. 4-in-1. Reported to consist of all riveted rings: diameter 9 mm; overlap anti-clockwise; shape overlap large oval; cross-section wire 1 mm; rings are flattened.
Fixture: wheel-shaped fastener. Two bars extend from the central wheel and end in hooks. One of the hooks is still inserted into a mushroom shaped button with a hole in it. An identical button is found among the mail remains, but is now incomplete. In addition, there is a fixture made of two rings that sandwich the mail fabric. Three rivets secure it and the hole at its centre is left free of mail rings. The reconstruction is that the wheel-shaped fastener was attached to the chest. The two mushroom shaped buttons were placed right and left from the fastener. Each shoulder guard contained a ring fixture with a hole through which the mushroom button was pulled. This was locked into place with the hooks on the end of the central fastener.
Material: rings: iron; fixtures: iron.
Remarks: the mail armour and fixtures are nowadays attached to an unrelated medieval helmet. The fixtures point to an Iron Age date for the mail armour.
Location: Archaeological Museum, Veliko Tarnovo.
Literature: Dimitrov 2009/2010.

Varbeshnitza
Date: LT D.
Context: funerary.
Description: mail fragment. Riveted rings are observed. 4-in-1.
Inventory: sword, shield boss, brooch. Inventory is incomplete.
Location: Regional Historical Museum, Vratsa, inv. 113.
Literature: Moralejo Ordax 2011, 291-293, fig. 16.5, 16.6; Rustoiu 2006, 49; Torbov 2004, 57, fig. 6b; Van der Sanden 2003/2004, 371.

Zhelad
Date: late 3rd - 2nd century BC.
Context: funerary.
Description: mail armour?
Material: iron.
Literature: Dimitrov 2009/2010, 101; Rustoiu 2006, 49; Torbov 2004, 57, 64; Van der Sanden 2003/2004, 371.

BURKINA FASO

Kissi
Date: 2nd - 9th century AD (2σ).
Context: funerary - grave 12.
Description: several loose rings, some broken, and four still connected. Uncertain if this is mail. Rings are butted: outer diameter c. 8 mm; cross-section c. 1.5 mm; cross-section round.
Material: copper alloy with low zinc (1.2%) and minor iron, lead and arsenic contents. Metallographic, chemical and lead isotope analyses have been done. The rings are not drawn, but cast. The analyses also show that the origin of the raw material for the copper alloy rings must be sought outside West-Africa, potentially Spain or possibly Sardinia, although Britain and Morocco cannot be ruled out. This may indicate trans-Saharan contact during the Roman period.
Inventory: disturbed grave. Unknown if there were other items associated to this burial.
Literature: Fenn *et al.* 2009.

CRIMEAN PENINSULA

Eklizí-Burún
Date: Roman period.
Context: sanctuary.
Description: mail fragments.
Material: iron.

Inventory: objects cleared out from the sanctuary: ceramic vessels, glass vessels, silver vessels, bronze vessels, brooches (iron, bronze, brass, silver), belt fittings, bronze finger rings, silver arm rings, earrings (bronze, silver, gold), beads (stone, glass, metal), swords, spearheads, arrowheads, part of a helmet, horse gear, knives, needles, whetstone, lead weights, bronze weight with head of a Roman emperor, bronze snake-shaped objects with silver inlays, mirror fragments, key, iron nails, 31 coins, animal bones.
Literature: Lysenko 2013, 279.

Gurzuf Saddle Pass
Date: 30 BC-AD 50.
Context: sanctuary.
Description: 892 mail fragments and 380 loose rings, many in good condition and still retain mobility. The fragments measure usually around 3.5 x 3.5 cm, but can be as large as 35 x 15 cm. The mail has been intentionally destroyed before disposal. Some fragments still fit together, but no complete garment could be reconstructed. It is unknown how many mail coats the fragments represent, but given the variety of ring characteristics observed a minimum of twelve mail coats is expected. 4-in-1. Most fragments are made of riveted and solid rings. Some fragments have besides these also rings that simply overlap and have been left unriveted. Others have additionally butted rings. The unriveted and butted rings could be repairs. All fragments are iron, except for two that include copper alloy rings. The mail rings in some fragments have been executed with care, while others are described as sloppy and make with less care. Different ring characteristics are observed among the many fragments. Fragments vary from small rings (c. 3-4 mm diameter) to mid-size (c. 5-9 mm) to large rings (c. 10-12 mm). Most rings have a round or sometimes oval cross-section. Some fragments with 4.5-5 mm diameter rings have uncut rivets 5 mm in length.
Fixture: convex button. Also a partial fixture is embedded in the mail remains.
Material: iron, copper alloy.
Inventory: jewellery, household items, pottery, swords, scabbards, spears, javelins, arrowheads, catapult bolts, shield fragments, helmet fragments, *lorica segmentata* remains, spurs, horse harness pendants, objects of military cult and insignia, amulets, torcs, small torcs with lion heads, Roman military brooches, buckles, plates, hobnails, lanterns, tent pegs, medical instruments, tools, inkwells, razor, mirrors, boxes, keys, tableware made from bronze and silver, scales, spoons, and toiletries. Inventory is incomplete.
Location: Yalta Historic and Literature Museum.
Literature: Dedyulkin/Shevchenko 2017, 53 (cat. no. 1); Khomchyk/But 2017; Novichenkova 2009; 2011; Wijnhoven 2015c, 23, 25; 2016a, 84; 2017, 184, 186, 193.

Kerch 1 - Panticapaeum
Date: probably 7th - 9th century AD.
Description: heavily corroded mail fragment measuring 6.5 x 4 x 0.7 cm. 4-in-1. Riveted rings are observed. Rings: outside diameter c. 7 mm; thickness c. 2 mm and width c. 1.5 mm (including corrosion). There is one large ring with a diameter of 12.6 mm, which is likely a repair.
Material: iron.
Remarks: examined by the author.
Location: British Museum, London, inv. OA. 3019.

Kerch 2 - Panticapaeum
Date: 4th - 5th century AD.
Description: six mail fragments measuring 8 x 7 x 2 cm, 12 x 5.5 x 3 cm, 4.5 x 4.5 x 3 cm, 4 x 3.5 x 1.5 cm, 5.5 x 3 x 2.5 cm, 3.5 x 2.5 x 1.5 cm. Heavily corroded and treated with wax. 4-in-1. Riveted rings are observed. Rings: horizontal outside diameter 9.9-10.8 mm; vertical outside diameter 9.7-11.1 mm; horizontal inside diameter c. 5.7 mm; cross-section oval. There are several larger rings, which could be repairs. Larger rings: horizontal outside diameter 15.4-17.14 mm; vertical outside diameter 16.1-17.4 mm; horizontal inside diameter 9.4-9.9 mm; vertical inside diameter c. 9.9 mm; thickness 2.7-4.4 mm; cross-section flat.
Material: iron.
Remarks: examined by the author.
Location: British Museum, London, inv. 1857,0106.16.

Kerch 3 - Panticapaeum
Date: 2nd century AD.
Description: small fragment of mail consisting of several copper alloy rings.
Material: copper alloy.
Literature: Dedyulkin/Shevchenko 2017, 53 (cat. no. 3); Goroncharovski 2006, 446; Wijnhoven 2017, 184, 186, 193.

Neapolis

Date: late 1st - 2nd century AD.
Context: funerary.
Description: small mail fragment (4 x 5 cm), preserved as a single layer now corroded together. Outline of individual rings can still be made out. 4-in-1. Rings: outer ring diameter c. 8 mm.
Material: iron.
Inventory: silver belt buckle, golden appliqué. Uncertain if the burial also included: short sword, horse harnesses, skeletal remains of two horses, ceramics.
Literature: Dedyulkin/Shevchenko 2017, 53 (cat. no. 2); Mordvintseva/Zaytsev 2015, 162, fig. 3.

CROATIA

Mlakvena Greda
Date: Roman period.
Description: small mail fragments and several loose rings. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter horizontal 10 mm; outer diameter vertical 9.8 mm; inner diameter horizontal 7 mm; inner diameter vertical 5 mm; overlap clockwise; shape overlap mid-size oval; length overlap c. 4 mm; width overlap 3 mm; small domed rivet head on both sides; thickness 1.9 mm; width 1.9 mm; cross-section wire round. Solid rings: outer diameter 9.5 mm; inner diameter 6.2 mm; thickness 2.5 mm; width 2 mm; cross-section square; some of the solid rings have a multi-faceted outer surface.
Material: iron.
Remarks: examined by the author.
Location: Arheološki Muzej u Zagrebu, inv. 1457B.
Literature: Hoffiller 1912, 45.

Salona 1 - Tilurium
Date: Roman period.
Context: Roman fort.
Description: five connected riveted and solid mail rings: outer diameter 10 mm; cross-section wire 1 mm.
Material: iron.
Location: inv. GAR 06 PN 45.
Literature: Sanader *et al.* 2017, 269-270, pl. 3 (cat. no. 14).

Sisak 1 *(fig. 11.24)*
Date: Roman period. Refined date: AD 300-500.
Context: river.
Description: fragment of mail measuring c. 20 x 12 cm with at least one, and possibly two, straight edges. The edge may represent the hem of the garment or was cut into manageable rectangular pieces for recycling. Also two small fragments measuring 20 x 12 cm. Riveted rings: outer diameter horizontal 11.6 mm; outer diameter vertical 11.7 mm; inner diameter horizontal 8.3 mm; outer diameter vertical 7.1 mm; overlap length c. 5.8 mm; overlap width 3.8 mm; overlap clockwise; paddle-shaped overlap; rivet head round on both sides; thickness 1.5 mm; width 2.1 mm; shape cross-section wire flattened. Solid rings: outer diameter 9.9 mm; inner diameter 7 mm; thickness 1.3 mm; width 1.6 mm; shape cross-section rectangular.
Material: iron.
Remarks: examined by the author.
Location: Arheološki Muzej u Zagrebu, inv. 3132.
Literature: Dautova-Ruševljan/Vujović 2006, 42; Hansen 2003, 172 (cat. no. C56); Hoffiller 1912, 43, fig. 18; Jeremić 2009, 257; Radman-Livaja 2004, 78-79, 130, fig. 18-19 (cat. no. 133-134).

Sisak 2 *(fig. 3.14)*
Date: Roman period. Refined date: Roman Principate.
Context: river.
Description: mail fragment measuring c. 20 x 16 cm with one straight edge. 4-in-1. Alternating riveted and solid rings. Riveted rings: outer diameter horizontal 8.3 mm; outer diameter vertical 8 mm; inner diameter horizontal 6.2 mm; outer diameter vertical 5.5 mm; overlap length 2.6 mm; overlap width 2 mm; overlap clockwise; shape overlap stumpy; rivet heads on both sides of the ring; thickness wire 1.1 mm; width wire 1.6 mm; shape cross-section wire oval. Solid rings: outer diameter 8.4 mm; inner diameter 5.5 mm; thickness 1.6 mm; width 1.7 mm; shape cross-section square with rounded corners; deformation and burrs are present.
Material: iron.
Remarks: examined by the author.
Location: Arheološki Muzej u Zagrebu, inv. 3132.
Literature: Dautova-Ruševljan/Vujović 2006, 42; Hansen 2003, 172 (cat. no. C56); Hoffiller 1912, 43, fig. 18; Jeremić 2009, 257; Radman-Livaja 2004, 78-79, 130, fig. 18-19 (cat. no. 133-134).

Sisak 3 *(fig. 11.25)*
Date: Roman period. Refined date: AD 300-500.
Context: river.

Description: several mail fragments. 4-in-1. Alternating riveted and solid rings. Riveted rings: outer diameter horizontal 13.1 mm; outer diameter vertical 14.5 mm; inner diameter horizontal 8.5 mm; outer diameter vertical 8.5 mm; overlap length 6 mm; overlap width 4.8 mm; overlap clockwise; peddle shaped overlap; rivet head large and round on both sides; thickness 1.6 mm; width 2.5 mm; shape cross-section wire flattened. Solid rings: outer diameter 12.1 mm; inner diameter 7 mm; thickness 1.1 mm; width 2.9 mm; shape cross-section rectangular like a washer.
Material: iron and some of the rivet heads are copper alloy.
Remarks: examined by the author.
Location: Arheološki Muzej u Zagrebu, inv. 3132.
Literature: Dautova-Ruševljan/Vujović 2006, 42; Hansen 2003, 172 (cat. no. C56); Hoffiller 1912, 43, fig. 18; Jeremić 2009, 257; Radman-Livaja 2004, 78-79, 130, fig. 18-19 (cat. no. 133-134).

Sisak 4
Date: Roman period. Refined date: Roman Principate.
Context: river.
Description: several mail fragments. 4-in-1. Alternating riveted and solid rings. Riveted rings: outer diameter horizontal 10.8 mm; outer diameter vertical 11 mm; inner diameter horizontal 7.7 mm; outer diameter vertical 7 mm; overlap length c. 3.4 mm; overlap width 2.2 mm; overlap clockwise; shape overlap stumpy; rivet head small and round on both sides; thickness 1.4 mm; width 1.9 mm; shape cross-section wire flattened. Solid rings: outer diameter 8 mm; inner diameter 5.8 mm; thickness 1.1 mm; width 1.2 mm; shape cross-section square.
Material: iron.
Remarks: examined by the author.
Location: Arheološki Muzej u Zagrebu, inv. 3132.
Literature: Dautova-Ruševljan/Vujović 2006, 42; Hansen 2003, 172 (cat. no. C56); Hoffiller 1912, 43, fig. 18; Jeremić 2009, 257; Radman-Livaja 2004, 78-79, 130, fig. 18-19 (cat. no. 133-134).

Sotin - Cornacum
Date: Roman period.
Context: funerary?
Description: mail fragment in flexible condition, measuring 39 x 11 cm. 4-in-1. Alternating rows of riveted and solid rings. Rings: inner diameter 9 mm; thickness 2 mm.
Material: iron.
Location: Arheološki Muzej u Zagrebu (in 1912).
Literature: Dautova-Ruševljan/Vujović 2006, 42; Hansen 2003, 172 (cat. no. C57); Hoffiller 1912, 43, fig. 16; Jeremić 2009, 157.

Stari Jankovci *(figs. 11.1, 11.23)*
Date: Roman period. Refined date: AD 300-500.
Description: several large fragments of mail, some flexible, others solid that still preserve much of the ring details. The fragments have been cleaned professionally. The flexible fragments differ in ring characteristics from the solid fragments and could have come from different garments. 4-in-1. Alternating riveted and solid rings. Flexible fragments: riveted rings: outer diameter horizontal 14 mm; outer diameter vertical 14 mm; inner diameter horizontal 8.4 mm; outer diameter vertical 7.3 mm; overlap clockwise; paddle-shaped overlap; length overlap 7.4 mm; width overlap 4.3 mm; large round rivet head on both sides; thickness 1.9 mm; width 3 mm; cross-section wire highly flattened. Solid rings: outer diameter 14 mm; inner diameter 8.8 mm; thickness 1.8 mm; width 2.6 mm; cross-section rectangular and washer-like. Solid fragments: riveted rings: outer diameter horizontal 12.1 mm; outer diameter vertical 11.5 mm; inner diameter horizontal 8.1 mm; outer diameter vertical 5.5 mm; overlap clockwise; paddle-shaped overlap, length overlap 5.5 mm; width overlap 4 mm; large round rivet head on both sides; thickness 1.8 mm; width 2.8 mm; cross-section wire highly flattened. Solid rings: outer diameter 11.1 mm; inner diameter 7.5 mm; thickness 1.9 mm; width 2.2 mm; cross-section rectangular.
Material: iron.
Remarks: examined by the author.
Location: Arheološki Muzej u Zagrebu, inv. 14863.
Literature: Dautova-Ruševljan/Vujović 2006, 42; Hansen 2003, 172 (cat. no. 58); Hoffiller 1912, 43, fig. 17; Jeremić 2009, 257.

Štrbinci near Đakovo 1
Date: AD 350-450.
Context: funerary - grave 45.
Description: mail fragment wrapped into a piece of cloth. 4-in-1. Alternating rows of riveted and solid rings. Rings: outer diameter 6-8 mm.

Material: iron.
Inventory: bronze, iron and bone bracelets, tooth of a wild boar, two bronze rings, two iron rings, two bronze necklace clasps, glass and limestone beads, bronze unidentified object, pieces of amorphous glass, plate-shaped mother-of-pearl object, three glass vessels.
Remarks: grave of a 8-12 year old girl.
Literature: Migotti 2008; 2015, 676, 678, fig. 5.4.

Štrbinci near Đakovo 2
Date: AD 350-450.
Context: funerary - grave 84.
Description: five connected mail rings wrapped in a piece of textile. Rings: outer diameter c. 8 mm; cross-section flat. One ring outer diameter 13 mm. Size difference may be due to the ring type (solid and riveted).
Material: iron.
Inventory: bronze bulla, two glass pendants, beads, glazed jug, bronze bracelet, bronze coin.
Remarks: child's grave.
Literature: Migotti 2008; 2015, 676.

St. Vid - Narona
Date: AD 480-610.
Context: hoard.
Description: eight mail rings. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter 16 mm; inner diameter 10 mm; width c. 3 mm; cross-section flat. Solid rings: smaller than riveted ones; inner diameter 9 mm; cross-section rectangular and washer-shaped.
Material: iron.
Inventory: three helmets, three spearheads, fire steel, bronze brooch.
Location: Kunsthistorisches Museum Wien.
Literature: Kelly 1931, 269; 1934, 206; Rose 1906, 51-52, fig. 19; Vogt 2003, 11, 28; 2006, 37-38, 257.

CZECH REPUBLIC

Brno - Horní Heršpice
Date: D1.
Context: funerary.
Description: mail fragment measuring 7.5 x 2.5 cm, with textile remnants adhering. Rings: outer diameter 10 mm; inner diameter 6-7 mm.
Material: iron.
Remarks: a round metal disc adheres to the mail fragment.
Inventory: knife, buckle, two brooches, two glass beads.
Literature: Hansen 2003, 189 (cat. no. C218).

Mušov - Burgstall
Date: AD 171-180.
Context: Roman fort.
Description: loose rings with an outer diameter of 6-6.5 mm.
Material: copper alloy.
Literature: Burandt 2017, 41; Hansen 2003, 174 (cat. no. C78); Matešić 2015, 218; Tejral 1994, 39, fig. 6.4; Wijnhoven 2015c, 25; 2017, 186, 193.

Pasohlávky
Date: AD 150-220.
Context: settlement - bottom of a pit.
Description: coat of mail weighing 8 kg. 4-in-1. Alternating rows of riveted and solid rings. Rings: outer diameter 7.5 mm.
Material: iron.
Inventory: stone working plane.
Remarks: this settlement has rendered a large amount of Roman artefacts, including military equipment.
Literature: Komoróczy 2013.

Pohansko
Date: 9th century AD.
Context: settlement.
Description: small mail fragment and many loose rings. Rings: outer diameter varies from 6.5 mm to 14.5 mm; cross-sections show that the rings were made by strip drawing.
Material: iron.
Remarks: this context is thought to be evidence for a workshop for the production of mail.
Literature: Macháček *et al.* 2007, 178, 180-181, fig. 157d; Pleiner 2002.

Prague *(fig. 10.32)*
Date: 10th century AD.
Context: St. Vitus Cathedral.
Description: coat of mail accredited to St. Wenceslaus (AD 907-935). The coat is long and covers most of the upper legs, flairs out towards the bottom, and has long wide sleeves. Size mail coat: length 108 cm; neck to cuff 82 cm; armpit to cuff 50 cm; armpit to hem 71-72

cm; circumference 122 cm (at 36 cm below the neck); circumference cuff 43-47 cm. There is extensive damage around the neck and upper right arm. This makes it impossible determine the shape of the head opening and the coat may even have included an integrated hood. The mail coat has many repairs from different periods and there are even areas that are turned inside out. The sleeves are straight and have a three-dimensional shape, with ring rows meeting at an angle at the armpit. The coat has some tailoring: two triangular gussets (one inside the other) are placed at the front to allow movement of the legs; another triangular gusset was placed at the back. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: overlap anti-clockwise; shape overlap mid-size oval; rivet shaft round; strongly pronounced domed rivet head on one side and flush on the other side; cross-section wire round. Some rings have an overlap that has not been riveted. These are likely repairs. Solid rings: some rings show evidence of welding; other rings look like reworked punched rings and are multi-faceted on the outside. Rings: internal diameter 3.7-4.8 mm; wire thickness 0.7-1.1 mm.
Material: iron.
Inventory: helmet, sword (possibly associated), lance (lost).
Location: St. Vitus Cathedral, Prague.
Literature: Bravermanová 2012; Checksfield *et al.* 2012; Kelly 1931, 270; Edge 2004, 22; Grunwald 1998, 97; Laking 1920, 167-171; Müller 2003, 447; Pleiner 2012; Wijnhoven 2015a, 3; Williams 2003, 31.

Závist
Date: LT D1.
Context: *oppidum*.
Description: hundreds of small fragments of mail scattered throughout the settlement. Two fragments, found 750 m from each other, actually fit together. 4-in-1. Alternating rows of riveted and solid rings. Rings: diameter 6-8 mm.
Material: iron.
Literature: Canestrelli 2018, 20; Demierre 2015, 157; Hansen 2003, 40-42, 54-55, 165 (cat. no. 34); Maguer 2015, 85; Rustoiu 2006, 49-50; Viand 2008, 41.

DAGESTAN

Andreï-Aoul
Date: 2nd - 3rd century AD.
Context: funerary.
Description: fragments of mail.
Remarks: the grave was robbed.
Literature: Kazanski/Mastykova 2003, 57, 198.

Kalkni
Date: early 5th century AD.
Context: funerary - grave 3.
Description: mail aventail belonging to a lamellar helmet.
Location: Institute for Archaeology, History and Ethnography, Machatsjkala.
Literature: Kubik 2017, 202-203, fig. 6.

Tchir-Yourt
Date: 2nd half 7th - 8th century AD.
Context: funerary - *tumulus* 5 and others.
Description: several burials at this cemetery are reported to contain a mail coat. *Tumulus* 5 rendered a rolled up mail coat broken into two fragments.
Inventory: burials of local aristocracy: bows, arrows, sabres, spearheads, belts, Byzantine gold coins made into pendants, bone saddle applications with hunting scenes. *Tumulus* 5: lamellar armour, plate of a shoulder guard. Inventory is incomplete.
Literature: Glad 2009, 120 (cat. no. 99); Gorelik 2002, 133, 135, fig. XI-5.11-12; Kazanski/Mastykova 2003, 168, 207.

DENMARK

Aarhus – Bispetorv square
Date: late 10th century AD.
Context: settlement – pit house, later used as a waste pit.
Description: two small mail fragments in corroded condition. One fragment has been cleaned and reveals three copper alloy rings among the iron rings. Iron rings: outer diameter c. 8.5 mm. Copper alloy rings: outer diameter c. 7 mm.
Material: iron, copper alloy.
Inventory: spur, key, brooch, bit, beads, millstone, antler.
Location: Moesgård Museum, Højbjerg, inv. FHM 5124X1430; FHM 1463.
Literature: Pind 2012, 178, fig. 5.

Agerholm
Date: C1b-C2.

Context: funerary.
Description: much corroded small mail fragment. 4-in-1. Riveted rings are observed. Riveted rings: outer diameter c. 8.15 mm (with corrosion); overlap appears clockwise.
Material: iron.
Inventory: spearhead, shield handle, two shield bosses, gold neck ring, ladle with sieve, iron scissors, bronze fittings. Uncertain if the inventory is from a closed context.
Remarks: examined by the author.
Location: Nationalmuseet, Copenhagen, inv. adC5563-69.
Literature: Hansen 2003, 83, 175 (cat. no. C81); Ilkjaer 1990, 342 (cat. no. 2); Juncher 2016, 95, 100; Künzl 2002, 138 (cat. no. 29); Pauli Jensen 2008, 218.

Barsbøl
Date: C1b-C2.
Context: funerary.
Description: twelve mail fragments in corroded and folded condition. 4-in-1. Alternating rows of riveted and solid rings. Rings: outer diameter 4.7-9.3 mm; inner diameter 2.8-5.6 mm; round cross-section.
Material: iron.
Inventory: possible spearhead; iron kettle, iron and bronze fragments. The inventory is incomplete.
Location: Museum für Archäologie Schloss Gottorf, Schleswig, inv. K.S. 5609.
Literature: Hansen 2003, 83, 175 (cat. no. C83); Ilkjaer 1990, 343 (cat. no. 21); Künzl 2002, 136 (cat. no. 2); Pauli Jensen 2008, 218; Raddatz 1959/1961b, 52; Rasmussen 1995, 75; Rose 1906, 50; Van der Sanden 1993, 4 (cat. no. 5); Waurick 1982, 115 (cat. no. 2).

Bjergelide
Date: B2a.
Description: seven small mail fragments in corroded condition. The outlines of the rings can be observed, but the fragments preserve few details. Bone from the cremation still adheres. Mail was deposited inside a copper alloy vessel. Rings: outer diameter 9.2 mm (swollen by corrosion) and estimated 8 mm in original condition.
Material: iron.
Inventory: shield boss, shield handle, shield edge, sword, fixtures drinking horn, spurs, belt buckle, gold finger ring, chair, knife, razor, scissors, iron spoon, several vessels, including a copper alloy vessel, molten glass.
Remarks: examined by the author.
Location: Nationalmuseet, Copenhagen, inv. C1921.
Literature: Ilkjaer 1990, 344 (cat. no. 36).

Brokær
Date: transition B2 to C1.
Context: funerary - grave 1878.
Description: coat of mail. Current weight c. 12 kg, including other objects from the burial enveloped inside. 4-in-1. X-ray examination show alternating rows of riveted and solid rings. Riveted rings: overlap clockwise; length overlap 1.5-2 mm; shape overlap stumpy; round rivet holes of c. 0.8 mm; rivets made from square sectioned wire; cross-section wire for rings round. Solid rings: outer diameter 7.2 mm; thickness c. 1.1 mm; cross-section D-profile.
Fixture: four rectangular fixtures with rounded ends, measuring 30 x 7-8 mm. These were used to open and close the head opening of the mail coat.
Material: iron.
Inventory: ring-pommel sword, scabbard, spurs, gold finger ring, two silver beakers, two drinking horns, c. eight Roman bronze vessels, silver vessel, belt strap-end, knives, bone comb, bone needle, game pieces, dice, textile remains.
Location: Museet Ribes Vikinger, inv. C 3281.
Literature: Grane 2015, 71-73; Greiner 2006, 203; Hansen 2003, 83, 85, 175, fig. 27 (cat. no. C85); Ilkjaer 1990, 345-346 (cat. no. 62); Jouttijärvi 1995; 1996, 54; Juncher 2016, 95, 100; Künzl 2002, 136 (cat. no. 1); Madsen 1997, 85; Miks 2007, 552; Müller 2003, 437; Pauli Jensen 2008, 125, 217-218; Raddatz 1959/1961b, 52; Rasmussen 1995, 73-75, fig. 29; Van der Sanden 1993, 4 (cat. no. 6); Waurick 1982, 115-116 (cat. no. 1); Wijnhoven 2015b, 96, 101, fig. 16; Williams 2003, 30.

Forum
Date: Roman period.
Description: mail in fragmentary condition.
Location: Nationalmuseet, Copenhagen, inv. C. 7169.
Literature: Hansen 2003, 175 (cat. no. C86); Müller 2003, 437.

Hedegård
Date: end 1st century BC - start 1st century AD. Refined date: 1st century BC.
Context: funerary - cremation grave A 4137.

Description: coat of mail with shoulder guards. Although no longer flexible, many details can be made out. The coat has damage that appears purposely made by an axe or shears. It is estimated to have 100,000 rings. Current weight is just over 10 kg, including adhering charcoal and bone fragments. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter c. 5 mm; overlap anti-clockwise; shape overlap triangular; rivet head on one side and protruding on the other side; length rivets c. 3.5 mm; protruding rivets all face the outside of the mail fabric; ring wire thickness c. 0.95-1 mm; cross-section wire round. Solid rings: cross-section D-shaped.
Fixture: set of S-shaped fasteners located at the chest, separated by 6 cm. Each is attached with an iron button. Another fixture, a forged eyelet, is located between the fasteners. The shoulder guards had originally large buttons. These are no longer *in situ*, but one has been found among the loose items in the cremation pit.
Material: rings: iron with almost no carbon; fixtures: probably iron. Metallography demonstrates that the wire for the riveted rings was drawn and that the solid rings were punched. Analysis of the slag inclusions in the rings indicate that the iron for the mail coat came from Northern Europe, most likely North Germany, North Netherlands, Poland or possibly West Jutland.
Inventory: one-edged sword, scabbard, two long knives, spearhead, two ring brooches, pottery, burnt bones.
Location: Horsens Historiske Museum, inv. HOM 151.
Literature: Articus 2004, 97; Buchwald 2005, 192; Grane 2015, 77; Greiner 2006, 203; Hansen 2003, 83, 175 (cat. no. C82); Jouttijärvi 1995, 102-103; 1996, 54-55, 57-59; Juncher 2016, 96, 98, 100, fig. 7; Kaul 2003, 154; Madsen 1997, 85, fig. 28; Malfilâtre 1993; Matešić 2015, 218; Pauli Jensen 2008, 218; Pauli Jensen *et al.* 2003, 316; Wijnhoven 2018, 562; Williams 2003, 30.

Kastenskov
Date: Roman Iron Age.
Context: probably funerary - loose find.
Description: two small corroded mail fragments. 4-in-1. Riveted and solid rings. Rings: outer diameter c. 6 mm. Riveted rings: round cross-section; round rivet head. Solid rings: D-shaped cross-section.
Material: iron.
Remarks: examined by the author.
Location: Nationalmuseet, Copenhagen, inv. C 13527.
Literature: Greiner 2006, 203; Hansen 2003, 166; Jouttijärvi 1995, 102-103; 1996, 55; Madsen 1997, 85; Malfilâtre 1993, 2-3; Pauli Jensen 2008, 218.

Møllegårdsmarken 1
Date: C2.
Context: funerary - grave 1304.
Description: mail fragment measuring 4.6 x 2.6 cm. Rings: outer diameter 5-6 mm; inner diameter 3 mm.
Inventory: glass beaker, nine glass beads, fragments of gold foil beads, ceramic vessels, *terra sigillata*, bones.
Location: Fyns Stiftsmuseum, Odense, inv. 10934.
Literature: Hansen 2003, 176 (cat. no. C89); Juncher 2016, 99; Pauli Jensen 2008, 217-218.

Møllegårdsmarken 2
Date: C1a-C1b.
Context: funerary - grave 1322.
Description: mail fragment measuring 2.2 x 1 cm. Rings: outer diameter 8 mm; inner diameter 6 mm. One ring with outer diameter 14 mm and inner diameter 9 mm.
Material: iron.
Inventory: bronze brooch, fragments of brooches, bronze ring, vessel, at least six glass beads, bronze needle box, iron ring, ceramic vessel.
Literature: Hansen 2003, 176 (cat. no. C90); Juncher 2016, 99; Pauli Jensen 2008, 217-218.

Neder-Jerstal
Date: Roman Iron Age.
Description: mail armour?
Literature: Hansen 2003, 175 (cat. no. C84); Künzl 2002, 136 (cat. no. 3); Raddatz 1959/1961b, 52; Rasmussen 1995, 75; Van der Sanden 1993, 4 (cat. no. 8); Waurick 1982, 115 (cat. no. 3).

Vimose 1 *(figs. 9.3, 10.10-15, 11.1, 11.30, 12.1)*
Date: C1b. Refined date: 2nd century - early 3rd century AD.
Context: bog.
Description: coat of mail in excellent preservation, still mostly complete and flexible. Some ring loss throughout the garment, a large hole on the chest and two long tears. Most of this is the result of intentional damage prior to deposition. Length coat c. 100 cm; length sleeves c. 35 cm; weight 8 kg. 4-in-1. Alternating rows of riveted and solid rings. Underneath the armpit the

rows change suddenly from riveted to solid and *vice versa*. This is prove that the coat was made as one large panel. The head opening is a slit made by leaving 25 rings out of a single row. No tailoring on the body of the shirt, but each sleeve has five reductions, giving them a tapered shape. Riveted rings: outside diameter vertical 12.3 mm; outside diameter horizontal 13.2 mm; inside diameter vertical 8.3 mm; inside diameter horizontal 10.0 mm; overlap clockwise; shape overlap oval: other - elongated point; length overlap c. 8-9 mm; width overlap 2.6 mm; round rivet heads on both sides; diameter rivet head 1.2-1.7 mm; cross-section wire round and 1.6 mm. Solid rings: outer diameter 12.4 mm; inner diameter 9.8 mm; thickness 1.5 mm; width 1.3 mm; cross-section rectangular; burrs on some rings; reworked resulting in a multi-faceted outer surface.

Fixture: four fixtures located at the head opening. Two (25 x 6.3 and 25.8 x 6.1 mm) consisting of a rectangular metal plate affixed to the mail fabric with two round studs with domed heads and a rectangular washer. Two similar fixtures (22.6 x 7.3 and 22.1 x 7.6 mm) with one of the studs having a mushroom shape. The first type of fixtures held a leather strap that attached to the mushroom-stud on the other fixtures in order to open or close the head opening.

Material: iron.

Inventory: c. 5.600 objects, the majority military equipment.

Remarks: examined by the author.

Location: Nationalmuseet, Copenhagen, inv. C1078.

Literature: Bishop/Coulston 2006, 170; Bruce-Mitford 1978, 237; Boube-Piccot 1994, 55; Coulston 1990, 147; Ehlton 2002/2003, 8, fig. 11; Fredman 1992, 7, fig. 1; Gilmour 1997, 32-33; Hansen 2003, 82-83, 175 (cat. no. C87); Jouttijärvi 1995, 103; 1996, 54; Juncher 2016, 95, 98, fig. 9; Junkelmann 1992, 196; Kelly 1931, 269; Künzl 2002, 136 (cat. no. 4); Matešić 2015, 208-209, 215; Morris 1934, 194, fig. 2; Mortimer 2011, 161; Müller 2003, 438, 447; Nicklasson 1989, 30-31, 33; 1991, 20-21; Novichenkova 2011, 278-279; Pauli Jensen 2003, 234; 2008, 217; Quesada Sanz *et al.* 2019, 158; Rasmussen 1995, 74; Southern/Dixon 1996, 97; Stephenson 2001, 33; 2006, 52; Underwood 1999, 91, fig. 58; Van der Sanden 1993, 2, 4-5 (cat. no. 9); Waurick 1982, 112-113, 115-116, 121, fig. 17 (cat. no. 4); Wijnhoven 2015a, 1, 7-8, 13; 2015b; 2018, 556-562; Wijnhoven/Moskvin 2020.

Vimose 2 *(figs. 3.29 11.1, 11.29)*

Date: B2-C1b. Refined date: 2nd century AD.

Context: bog.

Description: copper alloy hinge with strips of mail to each side; probably a belt. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter horizontal 12.5 mm; outer diameter vertical 12.5 mm; inner diameter horizontal 9.2 mm; inner diameter vertical 7.9 mm; overlap clockwise; length overlap c. 4.2 mm; width overlap 3 mm; shape overlap mid-size oval; round rivet head on both sides; thickness wire 1.6 mm; width wire 1.8 mm; cross-section round. Solid rings: outer diameter 10.3 mm; inner diameter 7.7 mm; thickness 1.8 mm; width 1.2 mm; inside has burrs; majority rings D-shaped cross-section, some rings scattered throughout the fabric are not reworked and still have a rectangular cross-section.

Fixture: hinge that pivots around an iron stud with an eyelet on one end. A copper alloy ring goes through the eyelet to remove the stud from the hinge. Each half of the hinge has three rivets to secure it to the mail fabric.

Material: rings: iron; hinge: copper alloy.

Inventory: c. 5.600 objects, the majority military equipment.

Remarks: examined by the author.

Location: Nationalmuseet, Copenhagen, inv. 24223.

Literature: Engelhardt 1869, 12, pl. 4.4; Fredman 1992, 11; Hansen 2003, 83-84, 175-176 (cat. no. C88); Ilkjær 2003, fig. 10; Jouttijärvi 1996, 54; Przybyła 2016, 163-164; Voß 2008, 259; Nicklasson 1989, 3032; 1991, 21; Pauli Jensen 2008, 217.

Vimose 3

Date: B2-C1b.

Context: bog.

Description: solid mail fragment (16.5 x 7 x 3.5 cm) with the outlines of the rings still visible. Rivets are observed in some rings. Rings: outer diameter c. 7-7.5 mm. Possibly the same coat of mail as Vimose 4.

Material: iron.

Inventory: c. 5.600 objects, the majority military equipment.

Remarks: examined by the author.

Location: Nationalmuseet, Copenhagen, inv. 24219-25.

Literature: Engelhardt 1869, 12; Hansen 2003, 83-84, 175-176 (cat. no. C88); Pauli Jensen 2008, 217.

Vimose 4
Date: B2-C1b.
Context: bog.
Description: solid mail fragment (8.5 x 5 x 3.5 cm) with the outlines of the rings still visible. Rivets are observed in some rings. Rings: outer diameter c. 7-7.5 mm. Possibly the same coat of mail as Vimose 3.
Material: iron.
Inventory: c. 5.600 objects, the majority military equipment.
Remarks: examined by the author.
Location: Nationalmuseet, Copenhagen, inv. 24220-21.
Literature: Engelhardt 1869, 12; Hansen 2003, 83-84, 175-176 (cat. no. C88); Pauli Jensen 2008, 217.

Vimose 5 *(fig. 3.29)*
Date: B2-C1b. Refined date: 1st - early 2nd century AD.
Context: bog.
Description: small mail fragment, possibly from the same coat as Vimose 6. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter horizontal 7.2 mm; outer diameter vertical 7.5 mm; inner diameter horizontal 4.6 mm; inner diameter vertical 4.7 mm; overlap clockwise; shape overlap stumpy; length overlap c. 2 mm; width overlap 1.6 mm; round rivet head on both sides; thickness wire 0.9 mm; width wire 1 mm; cross-section wire oval. Solid rings: outer diameter 7 mm; inner diameter 5.1 mm; thickness 1.2 mm; width 1.1 mm; cross-section D-shaped; burrs on inside of rings.
Fixture: left S-shaped fastener of which the base survives. It is connected to the mail by a copper alloy stud with a conical head. The fastener is decorated with transverse blue lines of enamel inlay.
Material: rings: iron; fastener: iron/white metal, enamel, copper alloy, iron.
Inventory: c. 5.600 objects, the majority military equipment.
Remarks: examined by the author.
Location: Nationalmuseet, Copenhagen, inv. 24222.
Literature: Engelhardt 1869, 12; Pauli Jensen 2008, 217.

Vimose 6 *(fig. 10.9)*
Date: B2-C1b. Refined date: 1st - early 2nd century AD.
Context: bog.
Description: large mail fragment in flexible condition, measuring c. 43 x 40 cm. Possibly from the same coat of mail as Vimose 5. The fragment preserves two original edges: the bottom hem and a split at the side. No evidence for tailoring. 4-in-1. Alternating rows of solid and riveted rings. Riveted rings: outer diameter horizontal 7.4 mm; outer diameter vertical 6.9 mm; inner diameter horizontal 5.2 mm; inner diameter vertical 4.5 mm; overlap clockwise; shape overlap stumpy; length overlap c. 2.4 mm; width overlap 1.5 mm; rivet heads on both sides; thickness wire 1 mm; width wire 1.1 mm; cross-section wire oval. Solid rings: outer diameter 7 mm; inner diameter 5.1 mm; thickness 1.3 mm; width 1 mm; cross-section D-shaped, but also some scattered rings with a rectangular cross-section.
Material: iron.
Inventory: c. 5.600 objects, the majority military equipment.
Remarks: examined by the author.
Location: Nationalmuseet, Copenhagen, inv. 24219.
Literature: Engelhardt 1869, 12, pl. 4.2; Jouttijärvi 1995, 102; Pauli Jensen 2008, 217.

Vimose 7
Date: B2-C1b. Refined date: 1st - early 2nd century AD.
Context: bog.
Description: several small pieces of mail and loose rings, that based on the ring characteristics come at least from three separate garments. 4-in-1. Alternating rows of riveted and solid rings. Large rings: riveted rings: outer diameter horizontal 12.1 mm; outer diameter vertical 11.2 mm; inner diameter horizontal 8.8 mm; inner diameter vertical 7.1 mm; overlap clockwise; shape overlap mid-size oval; length overlap c. 6 mm; width overlap 2.7 mm; round rivet head on both sides; thickness wire c. 1.7 mm; cross-section wire round. Solid rings: outer diameter 12.4 mm; inner diameter 9.6 mm; thickness 2.1 mm; width 1.4 mm; cross-section D-shaped; burrs present on the inside. Smaller rings: riveted rings: outer diameter horizontal 11.7 mm; inner diameter vertical 11.4 mm; inner diameter horizontal 8 mm; inner diameter vertical 6.4 mm; overlap clockwise; shape overlap mid-size oval; length overlap c. 5 mm; width overlap 2.9 mm; round rivet head on both sides; thickness wire c. 1.7 mm; cross-section wire oval; one ring with a groove along the entire ring, which is evidence for strip drawing;

Solid rings: outer diameter 10.1 mm; inner diameter 7.5 mm; thickness 2.1 mm; width 1-1.6 mm; majority cross-section D-shaped, and some rectangular. Small rings: may have come from the same mail coat as Vimose 5, 6 and 8. Riveted rings: outer diameter horizontal 7.6 mm; outer diameter vertical 7.2 mm; inner diameter horizontal 5.4 mm; inner diameter vertical 4.4 mm; overlap clockwise; shape overlap stumpy; length overlap c. 2.4 mm; width overlap c. 1.5 mm; rivet heads on both sides; thickness wire 0.9 mm; width wire 1 mm; cross-section wire oval. Solid rings: outer diameter 7.1 mm; inner diameter 5.4 mm; thickness 1.2 mm; width 0.9 mm; cross-section D-shaped; burrs on inside of rings.
Material: iron.
Inventory: c. 5.600 objects, the majority military equipment.
Remarks: examined by the author.
Location: Nationalmuseet, Copenhagen, inv. 24219.
Literature: Engelhardt 1869, 12; Pauli Jensen 2008, 217.

Vimose 8
Date: B2-C1b. Refined date: 1st - early 2nd century AD.
Context: bog.
Description: loose mail rings, many broken. Possibly from the same mail coat as Vimose 5, 6, and 7 small rings. Riveted rings: estimated outer diameter c. 7.4 mm; overlap clockwise; shape overlap stumpy; cross-section oval; rivet heads on both sides. Solid rings: outer diameter 6.9 mm; inner diameter 5.1 mm; thickness 1.3 mm; width 0.9 mm; cross-section D-shaped.
Material: iron.
Inventory: c. 5.600 objects, the majority military equipment.
Remarks: examined by the author.
Location: Nationalmuseet, Copenhagen, inv. 24219.
Literature: Engelhardt 1869, 12; Pauli Jensen 2008, 217.

EGYPT

Deir-el-Medina
Date: Roman period?
Description: large piece of mail in flexible condition. The mail forms a large tube of unknown function (sleeve?) and is 25 rows deep. 4-in-1.
Material: iron.
Location: Museum of Ontario Archaeology, Toronto.
Literature: Kelly 1931, 269, fig. 3; 1934, 206, fig. 1.

Unprovenanced from Egypt 1
Date: late 4th - 7th century AD. Refined date: late 4th - 5th century AD, possibly later.
Description: rectangular section of mail, measuring 33 rows long and 11 rings wide. It has been attached as an aventail to a helmet, although it is uncertain if the two belonged together. Nowadays the mail is mounted incorrectly with its rows running vertically. 4-in-1. Alternating rows of riveted rings and solid rings. Riveted rings: outer diameter c. 15 mm; overlap clockwise; paddle-shaped overlap; rivet heads on both sides of the ring; rivets appear made from square sectioned wire; cross-section ring flattened. Solid rings: diameter less than riveted rings; cross-section rectangular and washer-shaped.
Material: iron.
Inventory: helmet?
Location: Brooklyn Museum, New York, inv. 37.1600E.
Literature: Grancsay 1949, 276.

Unprovenanced from Egypt 2
Date: Roman period.
Description: small mail fragment c. 8 cm in length. 4-in-1. Rings: outer diameter c. 10-13 mm.
Material: iron.
Location: Petrie Museum of Egyptian Archaeology, London, inv. UC27857ii.

FRANCE

Allonnes
Date: c. 50 BC-AD 14.
Context: sanctuary of Mars Mullo.
Description: large piece of mail broken into three fragments. Riveted rings are observed. Rings: outer diameter c. 10 mm.
Material: iron.
Inventory: sword fragment, part of a helmet, coins.
Literature: Reddé/Gruel 2004, 298, 306-307.

Arras 1
Date: 3rd - 4th century AD.
Description: coat of mail.

Inventory: sword.
Literature: Chew 1993, 314.

Arras 2 – Actiparc *(fig. 3.11b)*
Date: Caesarian - Tiberian.
Context: Roman fort.
Description: several mail rings.
Fixture: part of an S-shaped fastener.
Material: rings: iron; fastener: copper alloy.
Location: inv. E650-G78bc.
Literature: Chew 1993, 314; Jacques/Prilaux 2008, 57-58, fig. 10.12; Poux 2008, 350.

Aubagnan
Context: funerary - *tumulus* 3, grave 7.
Date: LT C1, although a silver beaker may suggest a 1st century BC date.
Description: various mail fragments, folded and corroded. 4-in-1. Some objects adhere to the mail remains. Rings: outer diameter 9-12 mm.
Fixture: three buttons may have been part of the mail coat, but could also have formed part of a helmet. The buttons are decorated with a triskele motif.
Material: iron (Fe 98.8%, Cu 0.5%, Pb 0.001%, As 0.05%, Mi 0.15%, Mn 0.5%). Earlier publications mention erroneously the presence of bronze rings.
Inventory: helmet attachment, fragment of cheek piece, sword, spearhead, shield edge?, brooches, two silver beakers with Iberian inscription, two decorated bronze plates, curved iron sheet, two fittings, three ceramic vessels, ash, charcoal.
Location: Musée Dubalen, Mont-de-Marsan.
Literature: Alfs 1941, 80; Barril Vicente *et al.* 1998, 75; Beck/Chew 1991, 35; Fabre 1943, 61-62, 70, fig. 5; Fitzpatrick 1989, 335-336; Hansen 2003, 37-39, 43-44, 47, 49, 51, 162 (cat. no. B10); Hebert 1990, 2-3, pl. 1; Nicklasson 1989, 26; Quesada Sanz/Rueda Galán 2017, 33; Quesada Sanz *et al.* 2019, 160; Roux/Coffyn, 1987, 37-39, 43, fig. 1-2; Rustoiu 2006, 49-50; Van der Sanden 1993, 4 (cat. no. 10); 2003/2004, 371; Viand 2008, 41, fig. 12; Waurick 1979, 322-223, 326 (cat. no. 3).

Baâlons-Bouvellemont
Date: 2nd half 1st century BC - 1st half 1st century AD.
Context: temple located in a *vicus*.
Description: various mail fragments.
Material: iron.
Inventory: spearheads, arrowheads, 170 miniature spearheads, -shields, and -swords, 480 coins, various metal objects, 1300 ceramic vessels.
Literature: Beck/Chew 1991, 163; Chew 1993, 314; Hansen 2003, 168-169 (cat. no. C26); Kiernan 2009, 90; Neiss 1985, 360.

Baldenheim
Date: 6th century AD.
Context: funerary.
Description: mail aventail. Rings: probably c. 15 mm diameter; c. 2 mm thickness.
Material: iron.
Inventory: helmet, shield boss, three arrowheads, iron buckle, ceramics, iron and horn plaques, horse harness.
Remarks: the mail remains have not been recovered.
Literature: Vogt 2006, 37, 193.

Le Bernard
Date: Roman period.
Context: well - no. 8.
Description: mail fragment. 4-in-1.
Inventory: 15 ceramic vessels filled with ash and charcoal, stone ball, iron chain, hook with a ring, iron spike, bone whistle, two whetstones, animal bones (poultry, rodents).
Literature: Baudry/Ballereau 1873, 74-75; Chew 1993, 314.

Bibracte
Date: c. 80 BC.
Context: *oppidum* - possibly at a metal working site.
Description: two mail fragments. 4-in-1. Rings: diameter 5 mm.
Fixture: partial button that may have belonged to a mail coat. A possible fastener found with a metal detector. In addition, a hooked-shaped fastener found a long time ago.
Material: rings: iron; stud: iron and copper alloy.
Inventory: shield boss, tools (e.g. chisel and crucible), slag remains.
Location: Musée de Bibracte, inv. B2000.9.7033.4, B2004.9.8800.5, Rolin BA 4077.
Literature: Pernet *et al.* 2008, 110-111, 123-124, 132; Poux 2008, fig. 34; Teegen/Fleischer 2004, 6-7, fig. 14.

Binson-et-Orquigny
Date: Roman period.

Context: funerary.
Description: coat of mail affected by fire.
Inventory: stone coffin. Inventory probably incomplete.
Remarks: cemetery discovered circa 1856, with mix of Gallo-Roman and local artefacts.
Literature: Chew 1993, 314.

Boé
Date: LT D2.
Context: funerary.
Description: 16 small mail fragments. 4-in-1. Alternating rows of riveted and solid rings. Rings: outer diameter 5-5.5 mm; cross-section wire 0.8 mm.
Fixture: D-shaped buckle that is possibly associated to the mail coat. Length 3.2 cm, width 2.8 cm.
Material: rings: iron; buckle: iron.
Inventory: helmet, shield parts, spear butt, drinking horn, tripod with chains, four-wheeled chariot, two *strigiles*, two fire dogs, bronze stick (*candelabra*?), case with iron fixtures, various metal objects, four ceramic lamps, at least 81 *amphorae* and 41 other pieces of pottery, lumps of glass, bone disk, animal bones of circa seven pigs. Grave was disturbed, inventory probably incomplete.
Location: Musée des Beaux-arts d'Agen.
Literature: Gorgues/Schönfelder 2008, 254-255, fig. 3; Hansen 2003, 34, 40-41, 43-44, 47-51, 162 (cat. no. B11); Pernet 2010, 233-234, pl. 151; Rustoiu 2006, 49; 2003/2004, 371; Schönfelder 2002; Van der Sanden 1993, 4 (cat. no. 11); Waurick 1979, 323, 326 (cat. no. 4).

Breny
Date: mid-5th - 7th century AD.
Context: funerary - grave 614.
Description: originally interpreted as chain, but probably mail. Deposited near the head of the deceased.
Material: iron.
Location: Musée d'Archéologie Nationale, Saint-Germain-en-Laye.
Literature: Kazanski 2002, 45, 98, pl. 5.7; 2007, 244.

Champdivers
Date: LT or Roman period.
Context: probably the backwaters of the Doubs river.
Description: coat of mail rolled up into a bundle.
Material: iron.
Location: privately owned.
Literature: Daubigney *et al.* 2007, 412-414, fig. 5.1.

Chaouilley *(fig. 3.32)*
Date: AD 527-565.
Context: funerary - grave 19.
Description: small mail fragment, now solid.
Material: iron.
Inventory: two silver brooches with garnets, necklace with amber and glass beads, two silver brooches, silver bracelet, iron belt buckle, silver ring, knife, comb, silver implement, glass bead hanging from belt, gold Byzantine coin (AD 527-565), bronze vessel, ceramic vessels, glass cup.
Remarks: burial of a woman.
Location: Musée d'Archéologie Nationale, Saint-Germain-en-Laye.

Chassenard *(fig. 3.18)*
Date: Tiberian.
Context: funerary.
Description: complete mail coat in fragmented condition and now partially stuck to a face helmet. Since its discovery parts have become lost or disintegrated. A 19th century description mentions the presence of a border of copper alloy ring of 5 mm diameter. The accuracy of this observation is uncertain, but nowadays there are no copper alloy rings among the remains. X-rays demonstrated that the mail has a 4-in-1 weave with rings of c. 4.5 mm in diameter.
Fixtures: two sets of S-shaped fasteners that end in animal heads, possibly birds. One set has two graffiti: ABLVCII and MVCI… (the latter cannot be read completely). Also various convex-shaped buttons used to attach the fasteners permanently to the mail coat and similar ones located at the shoulder guards.
Material: rings: iron; studs: iron; fasteners: brass (with 18% Zn; 0.5% Sn; 0.5% Pb and with 14% Zn; 1% Sn; 1% Pb).
Inventory: face helmet, gladius, scabbard, *strigilis*, four coin minting tools, arrowhead, belt parts, bronze torc, bronze vase, two bronze bowls, three coins, various metal objects, ceramic vessel with lid, seashells and stone tools.
Location: Musée d'Archéologie Nationale, Saint-Germain-en-Laye, inv. 50120, 50122, 50127a-c, 50129.
Literature: Beck/Chew 1991, 34-45, 163-164; Bishop/Coulston 2006, fig. 51.1; Bishop 2015c, 99; Boube-Piccot 1994, 55; Canestrelli 2018, 20; Chew 1993, 314; Deschler-Erb 1991, 140; 1996, 83; Dixon/Southern 1992, 37; Feugère 1993, 127; 2002, 101; Fischer 2012, 90; 2019, 53; Junkelmann 1986, pl. 48a-b; Künzl

2008, 8, fig. 9; Miks 2007, 65, 557; Müller 2003, 435; Pernet *et al.* 2008, 111; Poux 2008, 350, fig. 34; Hansen 2003, 72-74, 169, 211, fig. 23.5 (cat. no. C29 and cat. no. 9.37); MacGregor 1962, 28; Müller 2003, 435; Pernet 2010, 234, pl. 152-153; Van der Sanden 1993, 4 (cat. no. 12); Waurick 1982, 112; 1983, 291, fig. 13; Wijnhoven 2018, 562.

Châtelet de Gourzon
Date: 1st - 7th century AD.
Context: unknown, possibly funerary.
Description: mail armour discovered in 1783-1784. Drawing of the object shows a flexible mesh woven in a 4-in-1 pattern. Reported to consist of butted rings, but the veracity of this is doubtful.
Material: iron.
Literature: Dechezleprêtre 2008, 99, fig. 4.3; Pernet 2010, 246, pl. 196; Viand 2008, 41.

Corent 1
Date: 130-120 BC.
Context: sanctuary.
Description: coat of mail measuring over 80 cm in length. A shoulder guard can still be recognised. The coat appears to have suffered intentional destruction. Reported to be woven in a 6-in-1 pattern, but the X-rays resemble the usual 4-in-1 pattern. Alternating rows of riveted and solid rings. Rings: outer diameter 6.5-7 mm. Riveted rings: overlap clockwise; shape overlap large oval; round rivet head.
Fixture: round button attached to the mail fabric. Also a heart-shaped brace.
Remarks: the mail coat, together with the other artefacts, has been interpreted as a Gallic *tropaeum*. In two places the mail coat preserves mineralised textile made from plainly coarse woven wool. The fabric has both Z as S-spun threads, which makes it very strong. The textile may have come from a liner for the mail coat, but could also be from a garment deposited next to the mail coat.
Material: iron.
Inventory: four shield bosses, wild boar crest used probably as a standard, scabbard.
Location: Musée de la Céramique Lezoux?, inv. UF 25408-5/988.
Literature: Demierre 2012; 2015, 157-160, pl. 14; Demierre/Poux 2012, 213; Kaenel/Lanthemann 2016, 83; Médard 2015; Poux *et al.* 2015, 77, 245, 416, pl. 22.

Corent 2
Date: 150-50 BC, possibly later.
Context: sanctuary - stray find.
Description: mail fragment. Riveted rings are observed. Rings: outer diameter 8mm.
Material: iron.
Literature: Demierre 2015, 155.

Fort Louis
Date: 2nd century AD.
Context: river - gravel pit at the Rhine-bank.
Description: strip of mail attached to a metal greave. Presumably the strip was used to fasten the greave to the leg.
Inventory: partly silvered and gilded copper alloy greave. The remains of Rhine boats have been found at more or less in the same spot.
Location: Museé Historique de la Ville Haguenau, inv. 68/33.
Literature: Garbsch 1978, 81, pl. 38.5; Petry 1976, 406, fig. 27.

Grand-Champ-Est
Date: LT C2-D1a.
Context: sanctuary.
Description: various interconnected mail rings and several loose rings. Riveted and solid rings. Rings: outer diameter 9.2-10.4 mm.
Material: iron.
Inventory: human remains of at least three persons, sword, two scabbards, shield boss, sword chain, 20 copper alloy ornaments (torc, bracelet, brooch), glass bracelet, glass-, terracotta- and stone beads, iron- and stone tools, bone die, antler object, 576 ceramic vessels, 5,000 faunal remains.
Literature: Maguer 2015, 85, fig. 2.

Juvigny
Date: Roman period.
Context: funerary.
Description: mail armour? Discovered in 1850s.
Inventory: the graves are described to contain Roman armour, spearheads, javelins, *amphorae*.
Literature: Aubert 1857, 5-6; Chew 1993, 314.

Lyon 1 - Rue de Farges
Date: AD 190-220.
Context: settlement - room h - rubbish dump.

Description: complete coat of mail. The coat was stored inside a close-fitting bag that has shaped it into a rectangular bundle, now measuring 34.5 x 15.5 cm. 4-in-1.
Material: iron.
Inventory: three shield bosses, scale armour fragments, chariot elements, arrowheads, javelin, knife with ivory handle, 101 coins, brooches, rings, pendants, intaglio, glass beads, alabaster, glassware, hammer, stylus, keys, comb, handle, small instruments, *terra sigillata*, two terracotta masks, ceramic sherds, fragments of clay statuettes.
Remarks: the findspot is in an area that contained various stores with much evidence for craft industry, but not for the production of metal *militaria*. It is likely a place for recycling.
Literature: Boucher 1977, 487-488, fig. 20; Chew 1993, 314; Guillaud 2019, 82, 214, 449, pl. 20 (cat. no. 138); Hansen 2003, 169 (cat. no. C32); Novichenkova 2011, 279; Van der Sanden 1993, 4-5 (cat. no. 14); Waurick 1982, 112.

Lyon 2 - Avenue Adolphe Max
Date: AD 259/260.
Context: settlement - wooden chest at a wall corner.
Description: complete coat of mail, measuring 48 x 29 x 10 cm and placed in a wooden chest. 4-in-1. Rings: outer diameter 8-9 mm.
Material: iron.
Inventory: wooden chest, short sword, ivory buckle, two ivory buttons, gilded buckle, silver coins.
Literature: Chew 1993, 314; Guillaud 2019, 100, 214-215, 450, pl. 20 (cat. no. 140).

Lyon 3 - Rue de Farges
Date: AD 190-220.
Context: settlement.
Description: mail fragment.
Material: iron.
Literature: Guillaud 2019, 82, 214, 449, (cat. no. 139).

Lyon 4 - Place de Célestins
Date: 1st half 3rd century AD.
Context: settlement - backfill.
Description: mail measuring 61 x 47 cm. It may come from the same coat as Lyon 5. 4-in-1. Riveted rings have been observed. Rings: outer diameter 6-7 mm.
Material: iron.
Literature: Guillaud 2019, 107, 214, 449, pl. 19 (cat. no. 136).

Lyon 5 - Place de Célestins
Date: 1st half 3rd century AD.
Context: settlement - backfill.
Description: mail measuring 32 x 29 cm. It may come from the same coat as Lyon 4. 4-in-1. Rings: outer diameter c. 7 mm. There is a row of copper alloy rings.
Material: iron, copper alloy.
Literature: Guillaud 2019, 107, 214, 449, pl. 19 (cat. no. 137).

Lyon 6 - Verbe Incarné
Date: just after AD 194.
Context: funerary.
Description: mail coat broken into three fragments
Material: iron.
Inventory: sword baldric, purse with money.
Location: Musée Gallo-Romain de Fourvière.
Literature: Elliott 2019, 35; Guillaud 2019, 215.

Maule
Date: AD 485-540.
Context: funerary - grave 736.
Description: mail fragment.
Inventory: wooden coffin, pin, beaded necklace.
Remarks: burial of a woman.
Literature: Tourreil 2014, 216.

Melun
Date: 1st century AD?
Description: mail coat.
Literature: Feugère/Poux 2001, 86.

Mouzon
Date: 50 BC-AD 50/70.
Context: sanctuary.
Description: 17 mail fragments from various mail garments found at different spots at the site. 4-in-1. Alternating rows of riveted and solid rings. Rings: outer diameter of most fragments 6 mm (one fragment contains a large repair ring of 10 mm); one fragment outer diameter 14 mm. Two fragments have copper alloy and iron rings.
Material: iron, copper alloy.
Inventory: almost 1,000 military items have been found at this sanctuary, such as shields, swords, shafted

weapons, and miniature objects (shields and swords).
Remarks: the items are thought to be votif deposits by (ex-)Roman soldiers of Gallic origin.
Location: Musée de l'Ardenne, Charleville-Mézières.
Literature: Caumont 2011, 195-200; Wijnhoven 2015c, 23, 25; 2017, 183, 186, 193.

Pontoux 1
Date: 1st century BC - 1st century AD?
Context: river.
Description: heavily corroded and rolled up coat of mail, now 10 cm in diameter and 46 cm in length. Textile remains came to light upon cleaning, including traces of strings and thongs. It is thought that this could be a bag in which the mail coat was carried. Rings: outer diameter c. 10 mm, inner diameter c. 7-8 mm.
Material: iron.
Inventory: this item is mentioned together with Pontoux 2 and a sword. Unclear if these were found together.
Location: Musée Denon, Chalon-sur-Saône, inv. 69.1.39.
Literature: Bailly 1978, 56; Beck/Chew 1991, 45, 163; Bonnamour/Dumont 1996, 141, 143, 145; Boube-Piccot 1994, 55; Chew 1993, 314; Feugère 1993, 127; 2002, 101; Hansen 2003, 34, 42-43, 55, 162 (cat. no. B8); Maguer 2015, 85; Moralejo Ordax 2011, 290.

Pontoux 2
Context: river.
Date: 1st century BC - 1st century AD. Refined date: Roman Principate.
Description: complete coat of mail that was broken into parts by the discoverers. Now only one fragment survives, made of copper alloy rings. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: larger than solid rings; overlap clockwise; shape overlap stumpy; round rivet; cross-section wire round. Solid rings: cross-section square with rounded corners.
Material: copper alloy.
Inventory: this item is mentioned together with Pontoux 1 and a sword. Unclear if these were found together.
Location: Musée Denon, Chalon-sur-Saône, inv. 69.1.40.
Literature: Bailly 1978, 56; Beck/Chew 1991, 45, 163; Bonnamour/Dumont 1996, 141, 143, 145; Bonnamour *et al.* 2001/2002, 482; Boube-Piccot 1994, 55; Chew 1993, 314; D'Amato/Sumner 2009, 129; Feugère 1993, 127; 2002, 101; Hansen 2003, 34, 42-43, 55, 162 (cat. no. B9); Metzler 1995, 347; Moralejo Ordax 2011, 290; Viand 2008, 41; Wijnhoven 2015c, 23, 25; 2017, 183, 186, 193.

Port-en-Bessin-Huppain
Date: 130-50 BC.
Context: *oppidum* - structure 54.
Description: small mail fragment.
Location: inv. 54-F1.
Literature: Guillemet *et al.* 2016, 21, 142, 150, 152, 155, 263, pl. 3.1.

Ouroux-sur-Saône
Date: end 2nd century - early 3rd century AD.
Context: river.
Description: coat of mail in folded condition, now 23 cm in length. Current weight 9 kg. 4-in-1. Alternating rows of riveted and solid rings. There are copper alloy rings among the regular iron rings. Riveted rings: outer diameter 7.5 mm; overlap clockwise; shape overlap stumpy?; round rivet head; thickness wire c. 1 mm; cross-section wire oval. Solid rings: outer diameter 7 mm; thickness c. 0.8 mm; cross-section square.
Material: iron, copper alloy.
Inventory: helmet with a mail coat deposited inside.
Remarks: observed by the author through museum glass.
Location: Musée d'Archéologie Nationale, Saint-Germain-en-Laye, inv. 71442.
Literature: Beck/Chew 1991, 45; Bonnamour/Dumont 1996, 141, 145; Bonnamour *et al.* 2001/2002, 481-482, 486, fig. 1; Hansen 2003, 169 (cat. no. C 28, C30); Wijnhoven 2015c, 25; 2017, 186, 193.

Ribemont-sur-Ancre
Date: LT C1.
Context: sanctuary.
Description: small mail fragments. 4-in-1. Rings are reported to be butted. Rings: diameter 7 mm; cross-section wire 1.2 mm.
Fixture: twelve buttons come from this site that may have been used for a mail coat, but could also have served another purpose.
Material: rings: iron.
Inventory: more than 5,000 bones of human indi-

viduals, many metal objects of which 90% concerns weaponry: 175 spears, 60 shields, 52 scabbards, 49 belt elements, six swords.
Literature: Hansen 2003, 53; Lejars 1998, 239, 242, fig. 3; Poux 2008, 350, fig. 34; Viand 2008, 41, fig. 10.2, 11.4; Viand *et al.* 2008, 81, fig. 19.

Sarry *(fig. 11.19)*
Date: 4th century AD. Refined date: start 4th century AD.
Context: funerary.
Description: mail fragment in flexible condition, measuring 30 x 22 cm. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter 8.5 mm; overlap clockwise; shape overlap stumpy; round rivet head; cross-section wire oval. Solid rings: outer diameter 7 mm; thickness 1 mm; cross-section square; some rings have burrs; outside is reworked and has a multi-faceted appearance.
Material: iron.
Inventory: sword, iron saddle fixture, ceramic vessel.
Remarks: observed by the author through museum glass.
Location: Musée d'Archéologie Nationale, Saint-Germain-en-Laye.
Literature: Chew 1993, 313, pl. 3.3, 4.3; Miks 2007, 719.

Selongey
Date: mid-3rd century AD.
Description: mail fragment.
Material: copper alloy.
Inventory: objects of military equipment.
Literature: Chew 1993, 314.

Somsois
Date: Roman period?
Context: funerary.
Description: mail coat deposited on top of the deceased. Discovered in 1765.
Inventory: knife, ceramic vessel.
Literature: Chew 1993, 314.

Strasbourg
Date: end 2nd century AD.
Context: settlement - cellar.
Description: mail fragment in folded condition. 4-in-1.
Material: iron.
Inventory: of various cellars: fragments of scale armour, brooches, bronze jewellery, belt buckles, bronze appliques, unfinished/repairable metal objects.
Literature: Boube-Piccot 1994, 55; Hansen 2003, 169 (cat. no. C29); Hatt 1953, 236, fig. 9.20; Van der Sanden 1993, 4 (cat. no. 15).

Thuilet
Date: Late Roman period.
Context: *vicus*.
Description: mail.
Inventory: various objects including *terra sigillata*.
Location: Musée d'Épernay.
Literature: Chew 1993, 314, 317.

Vernon
Date: LT D2.
Context: *oppidum*.
Description: various mail fragments. 4-in-1. Rings: described as butted; diameter 4.5 mm, wire diameter 1 mm.
Fixture: X-rays revealed two metal elements: an iron fastener and a copper alloy button. The site also rendered nine buttons which may have been part of a mail coat, but could have also had another function.
Material: rings: iron; fastener: iron; button: copper alloy.
Inventory: found in a layer that contained various objects of (Roman) military equipment.
Location: inv. 635a-b.
Literature: Feugère/Poux 2001, 87; Pernet *et al.* 2008, 111; Poux 2008, 348, 350, fig. 34; Quesada Sanz/Rueda Galán 2017, 33; Viand 2008, 36-46, fig. 5.1-10, 5.27, 8, 11.

Vézelise
Date: Roman period - Early Middle Ages. Refined date: AD 300-620.
Context: funerary.
Description: coat of mail. It has been described that every ring connects to three others. This observation is probably erroneous, and the usual 4-in-1 pattern is more likely. The rings are described as welded, which may simply mean 'not-butted'. The rings are flat in cross-section.
Material: iron.
Inventory: burials from this cemetery: armour, swords, spears or an axe, most with a ceramic vessel and cup

placed next to them. Also glass and amber beads found in some burials.
Remarks: several burials found in 1816 by workers.
Literature: Bottin 1821, 459, 461, 464; Van der Sanden 1993, 4 (cat. no. 16).

Vézeronce
Date: AD 480-610.
Context: bog.
Description: mail aventail. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter 12 mm; overlap clockwise; paddle-shaped overlap; fairly large round rivet head; cross-section wire flattened; thickness wire 1.2 mm. Solid rings: outer diameter 11 mm; thickness c. 1 mm; cross-section rectangular, heavily worn towards an oval shape.
Material: iron.
Inventory: *Spangenhelme*.
Location: Musée Dauphinois, Grenoble.
Literature: Grancsay 1949, 276; Mortimer 2011, 162; Vogt 2003, 11, 29; 2006, 37-38, 271.

GEORGIA

Tsibilium 1
Date: AD 380-450.
Context: funerary - grave 267/31.
Description: three mail fragments.
Inventory: various ceramic vessels, pickaxe, two silver earrings, 44 beads (mostly glass, some amber and stone), three bronze brooches (one with silver decoration), bronze pendant, two bronze bracelets.
Remarks: burial of a woman. The mail fragments were located underneath the neck of the deceased.
Literature: Voronov 2007, 63, fig. 125.30.

Tsibilium 2
Date: AD 380-450.
Context: funerary - grave 294/8.
Description: mail fragment.
Inventory: various ceramic vessels, pickaxe, two earrings, finger ring, three bronze brooches (one with silver decoration), silver bracelet, 30 beads (mostly amber, some glass), knife.
Remarks: burial of a woman.
Literature: Voronov 2007, 68, fig. 137.11.

Tsibilium 3
Date: AD 550-551.
Context: Sassanid fort.
Description: small mail fragment.
Inventory: lamellar armour.
Literature: Adams 2010, 97; Glad 2009, 50, 120 (cat. no. 101).

Unprovencanced, probably from Georgia
Date: mid-6th century AD.
Description: several mail rings of an aventail, that now adhere to a helmet.
Material: iron.
Inventory: bought together on the art market with a helmet (in fact a marriage of two helmets), metal folding chair, sword, scabbard elements, belt fittings, silver brooch, silver vessel, coins.
Location: Römisch-Germanisches Zentralmuseum, Mainz.
Literature: Miks 2009, 398, 402, 406, 417-418, fig. 5.

GERMANY

Altendorf
Date: D.
Context: funerary - burial 59.
Description: four connected mail rings. Uncertain if this is mail armour. Rings: outer diameter c. 10 mm; inner diameter c. 7 mm; cross-section flat.
Material: iron.
Inventory: piece of hornstone, sherds.
Literature: Hansen 2003, 182 (cat. no. 147); Matešić 2015, 215.

Badenweiler
Date: late 1st - 3rd century AD.
Context: thermal springs - bath building.
Description: mail fragment of copper alloy rings, caked together with slag-like components.
Material: copper alloy.
Location: Badisches Landesmuseum, Baden-Württemberg, inv. C 614.
Literature: Alfs 1941, 78; Hansen 2003, 167-168 (cat. no. C18); Matešić 2015, 211; Wijnhoven 2015c, 25; 2017, 186, 193.

Bedburg-Hau - Steincheshof
Date: c. AD 66 - 2nd century AD.

Context: Roman fort.
Description: multiple mail fragments. Identified by X-rays.
Material: iron.
Inventory: nails and other small metal objects.
Literature: Brüggler/Drechsler 2012, 34; Dechsler 2017, 157, 208, 238-239.

Bertoldsheim *(fig. 9.10)*
Date: late 1st century - 1st half 3rd century AD.
Context: riparian zone of the Danube - stray find.
Description: coat of mail rolled up and now a solid block. Current weight 3.5 kg. 4-in-1. Alternating rows of riveted and solid rings. Most rings are iron, but the coat also has copper alloy rings. Iron riveted rings: vertical outer diameter c. 7.7 mm; vertical inner diameter c. 5.5 mm; overlap clockwise; shape overlap stumpy; round rivet head. Iron solid rings: outer diameter c. 7 mm; inner diameter c. 5.1 mm. Copper alloy rings are all riveted and placed in vertical lines throughout the garment. Copper alloy rings: vertical outer diameter c. 8 mm; horizontal outer diameter c. 8.1 mm; vertical inner diameter c. 6.2 mm; horizontal inner diameter c. 6.5 mm; overlap clockwise; shape overlap stumpy; round rivet head; length overlap c. 2 mm; width overlap 1.2 mm; cross-section wire round; cross-section wire 0.7-0.9 mm. Horizontal copper alloy lines are formed by unique links, made from loop-in-loop chain. Chain links: length 7.2 mm; maximum width c. 4.5 mm; made from square wire c. 0.8-1 mm in cross-section. Most vertical lines in the coat are two rings wide. The pattern appears more complex than a just a chequerboard pattern as has been suggested.
Fixture: a pair of decorated plates located on the upper chest are used to regulate the head opening. It has a large and a small plate that together form a symmetrical trapezoid shape. The large plate is embossed with the god Mars wearing a helmet and a mantle, and otherwise naked. He holds a spear in his right hand and rests his left hand on a shield. At the top there is an eagle. Each plate was connected to the mail coat with three omega-shaped loops soldered to the back of the plates.
Material: iron, copper alloy.
Remarks: examined by the author.
Location: Archäologie-Museum Schloss Neuburg an der Donau, inv. V 2267.
Literature: Bishop/Coulston 2006, 170, fig. 109.3; Boube-Piccot 1994, 55; Burandt 2017, 41, pl. 17.4; Coulston 1990, 147; D'Amato/Negin 2017, fig. 96; Fischer 2012, fig. 205; 2019, fig. 205; Garbsch 1984; 2000, 111, 116; Hansen 2003, 76, 168, (cat. no. C24); Junkelmann 1991, 172-173, fig. 112; Matešić 2015, 211; Stephenson 2001, 33-35, fig. 12; Stephenson/Dixon 2003, 44-45; Wijnhoven 2015c, 25, fig. 4; 2017, 186, 188, 193, fig. 8-9; 2019a, 8-9; Zanier 1992, 313.

Berlitt
Date: B2?
Context: funerary.
Description: mail wrapped into a ball. Alternating rows of riveted and solid rings. 4-in-1.
Material: iron.
Location: Berlin Charlottenburg, inv. II. 22706.
Literature: Hansen 2003, 181 (cat. no. C137); Künzl 2002, 137 (cat. no. 20); Raddatz 1959/1961b, 53; Rasmussen 1995, 75; Van der Sanden 1993, 4 (cat. no. 17); Waurick 1982, 115 (cat. no. 20).

Bretzenheim
Date: c. AD 500-550.
Context: funerary.
Description: mail fragment. Rings: outer diameter 10-12 mm. Textile adheres to the mail.
Material: iron.
Inventory: helmet, sword, spearhead, throwing axe, javelin, two arrowheads, horse bit, white metal buckle, double eyelet, two bronze vessels, bronze key, horse bones.
Location: formerly in the Altermuseum Mainz and now lost. Plaster copy in the Römisch-Germanisches Zentralmuseum, Mainz.
Literature: Böhner 1994, fig. 41.2; Fischer 2012, 159, fig. 194.3; 2019, 120, fig. 194.3; Vogt 2006, 38, 283.

Bockhorn
Date: C3.
Context: bog - isolated find.
Description: two large mail fragments in solid condition. Probably made from riveted and solid rings.
Material: iron.
Location: Kieler Museum (in 1906).
Literature: Articus 2004, 97; Hansen 2003, 180 (cat. no. C127); Künzl 2002, 137 (cat. no. 10); Raddatz 1959/1961b, 53; Rasmussen 1995, 75; Rose 1906, 50; Van der Sanden 1993, 4 (cat. no. 18); Waurick 1982, 115 (cat. no. 10).

Borstel
Date: C1b/C2.
Context: funerary - burial 13.
Description: two mail fragments.
Material: iron.
Inventory: knives, three bronze pendants, 26 glass and clay beads, bone needle, comb, various metal fragments, ceramic vessel.
Literature: Hansen 2003, 181 (cat. no. C142); Van der Sanden 1993, 4 (cat. no. 19).

Camin
Date: C/D.
Context: funerary - cemetery 2 - isolated find.
Description: small mail fragment. 4-in-1. Rings are reported to be partially riveted and partially with an overlap that has been left unriveted.
Rings: outer diameter 8 mm; inner diameter 5 mm.
Material: iron.
Location: Staatliches Museum Schwerin, inv. E 1690.
Literature: Adler 1993, 150; Articus 2004, 97; Hansen 2003, 180 (cat. no. C132); Künzl 2002, 137 (cat. no. 15); Raddatz 1959/1961b, 53; Rasmussen 1995, 75; Van der Sanden 1993, 4 (cat. no. 20); Voß 1998, 52; Waurick 1982, 115 (cat. no. 15).

Cheine
Date: Roman period?
Context: funerary?
Description: several mail rings, all are riveted: outer diameter 9 mm; inner diameter 5-6 mm.
Material: iron.
Literature: Hansen 2003, 181 (cat. no. C140); Künzl 2002, 137 (cat. no. 17); Van der Sanden 1993, 4 (cat. no. 22); Waurick 1982, 115 (cat. no. 17).

Cologne *(fig. 3.35)*
Date: c. AD 500-525.
Context: funerary.
Description: mail aventail of a *Spangenhelm*. Textile adheres to the mail remains.
Material: iron
Inventory: helmet, sword, throwing axe, spearhead, knife.
Remarks: grave of a young boy.
Location: Domschatzkammer Köln.
Literature: Mortimer 2011, 41-42; Vogt 2006, 38, 297.

Dahlhausen
Date: C2-C3.
Context: funerary - burial 14.
Description: two small mail fragments. 4-in-1. Riveted rings and solid rings. The latter has been described as welded.
Material: iron.
Inventory: bronze brooch, belt buckle, nail, pendant in shaped as a vessel, ceramic vessel.
Literature: Hansen 2003, 181 (cat. no. C138); Künzl 2002, 137 (cat. no. 19); Müller 2003, 438; Van der Sanden 1993, 4 (cat. no. 21); Waurick 1982, 115-116 (cat. no. 19).

Dangstetten 1
Date: 15/12-8 BC.
Context: Roman fort - findspot 2.
Description: mail fragments. 4-in-1. Rings: outer diameter 3.1 mm; cross-section wire 1 mm.
Material: iron.
Inventory: 36 hobnails, pottery sherds from at least seven vessels.
Literature: Fingerlin 1986, 18, 235 (cat. no. 2.1); Hansen 2003, 168 (cat. no. C19).

Dangstetten 2
Date: 15/12-8 BC.
Context: Roman fort - findspot 281.
Description: mail fragment. 4-in-1. Rings: outer diameter rings 4.5 mm; cross-section wire 1 mm.
Material: iron.
Inventory: chisel, metal fittings for a box, two iron bands, nail, ceramic lamp, sherds of at least five vessels.
Literature: Beck/Chew 1991, 163; Fingerlin 1986, 101, 316, pl. 2 (cat. no. 281.1); Hansen 2003, 168 (cat. no. C20).

Dangstetten 3
Date: 15/12-8 BC.
Context: Roman fort - findspot 863.
Description: mail fragment. 4-in-1. Rings: outer diameter rings 5 mm; cross-section wire 1 mm.
Material: iron.
Inventory: pickaxe, brooch, bronze eyelets, bronze sheet metal, iron rod, iron sheet, eleven iron nails, sherds of at least eight vessels.
Literature: Fingerlin 1998, 75, 264 (cat. no. 863.4); Hansen 2003, 168 (cat. no. C21).

Deersheim
Date: 5th - 7th century AD.
Context: funerary - burial 29.
Description: mail armour.
Literature: Kazanski 2007, 244.

Dessau-Grosskühnau 1
Date: C1/C2.
Context: funerary - burial 42.
Description: 14 rings: outer diameter 8 mm; cross-section round. Uncertain if this is mail.
Material: iron.
Inventory: knife, comb, three bone- and 38 glass beads, two disc brooches, two bronze jewellery discs, bronze belt parts, 16 pendants, parts of a closet, three spindle whorls, various metal objects, bone dies, ceramics.
Remarks: burial of a woman and child.
Location: Historisches Museum, Köthen, inv. EK: 35/300
Literature: Hansen 2003, 176 (cat. no. C94); Van der Sanden 1993, 4 (cat. no. 23).

Dessau-Grosskühnau 2
Date: C1/C2.
Context: funerary - burial 140.
Description: several mail rings corroded together.
Material: iron.
Inventory: comb, silver ring, three nails, ceramics.
Remarks: burial of an adult person.
Location: Historisches Museum, Köthen, inv. 35/398.
Literature: Hansen 2003, 176 (cat. no. C95).

Dessau-Grosskühnau 3
Date: C1.
Context: funerary - burial 194.
Description: three corroded mail fragments. Rings: outer diameter 7 mm; inner diameter 4-5 mm.
Material: iron.
Inventory: brooch, comb, three bone needles, bronze needle, two pendants, 38 glass beads, spindle whorl, various metal fragments, ceramics.
Remarks: burial of a woman.
Location: Museum für Naturkunde und Vorgeschichte, Dessau.
Literature: Articus 2004, 96; Hansen 2003, 176 (cat. no. C96).

Donzdorf
Date: 5th - 7th century AD.
Context: funerary - burial 79.
Description: mail armour.
Literature: Kazanski 2007, 244.

Dortmund-Oespel
Date: C1b-C3.
Context: settlement.
Description: mail fragment. Corroded, although the outlines of rings are still visible. The artefact was 3D-scanned revealing the mail weave. 4-in-1. Copper alloy and iron rings are present. Riveted rings are observed. Rings: diameter 6-7 mm.
Material: iron, copper alloy.
Inventory: discarded metal objects for recycling.
Literature: Brink-Kloke 1999, 47; Hansen 2003, 81, 123, 176 (cat. no. C 92); Künzl 2002, 138 (cat. no. 33); Matešić 2015, 211; Wijnhoven 2015c, 23, 25; 2017, 184, 186, 193.

Dünsberg
Date: 1st century BC?
Context: *oppidum*.
Description: c. twelve mail fragments exposed to fire. Alternating riveted and solid rings. Rings: diameter 5 mm.
Material: iron.
Inventory: 40 spearheads and spear butts, swords, and shield bosses, slingshot, horse tack.
Literature: Hansen 2003, 166; Sievers 2010, 38; Schultze-Forster 2002, 80, pl. 49.

Dürbheim
Date: c. AD 680-720.
Context: funerary - grave 2.
Description: coat of mail. 4-in-1.
Fixture: gold fixture.
Material: rings: iron.
Inventory: sword with silver mountings, shield, silver spurs, four silver belt fixtures, gold brocade clothing.
Remarks: grave of a man 30-50 years old.
Location: Archäologisches Museum Colombischlössle, Freiburg.
Literature: Fingerlin 1997, 53; Grunwald/Tröller-Reimer 1997, 173; Müller 2003, 440.

Echzell
Date: Roman period.
Context: Roman fort - section 10.
Description: coat of mail with current weight of 6.5 kg. Rings: outer diameter 7-8 mm. There are remnants of straw adhering, possibly pointing to it being stored or deposited adjacent to straw.
Material: iron.
Location: inv. 62/67.
Literature: Baatz 1963/1964, 51; Zanier 1992, 313.

Eining 1 - Abusina
Date: Roman Principate.
Context: Roman fort.
Description: corroded mail fragment. Length 12.1 cm; width 9.6 cm; height 5.5 cm. Rings: outer diameter 7.5-10 mm; thickness 1.6 mm.
Material: iron.
Location: Archäologisches Museum der Stadt Kelheim, inv. 2431.
Literature: Fabricius/Sarwey 1906, 39; Greiner 2006, 199; Gschwind 2004, 127, 316 (cat. no. C158); Matešić 2015, 218; Zanier 1992, 313.

Eining 2 - Abusina
Date: Roman Principate.
Context: Roman fort.
Description: mail fragment. Length 4.9 cm; width 4.8 cm; height 3.3 cm. Rings: outer diameter 9-11 mm; thickness 2 mm.
Material: iron.
Location: Archäologisches Museum der Stadt Kelheim, inv. A2678.
Literature: Fabricius/Sarwey 1906, 39; Greiner 2006, 199; Gschwind 2004, 127, 316 (cat. no. C159); Zanier 1992, 313.

Eining 3 - Abusina
Date: Roman Principate.
Context: Roman fort.
Description: mail fragment folded several times. Length 14.8 cm; width 11.9 cm; height 4.8 cm. 4-in-1.
Material: iron.
Location: Archäologisches Museum der Stadt Kelheim, inv. A2679.
Literature: Fabricius/Sarwey 1906, 39; Greiner 2006, 199; Gschwind 2004, 127, 316, pl. 139 (cat. no. C160); Zanier 1992, 313.

Eining 4 - Abusina
Date: Roman Principate.
Context: Roman fort.
Description: mail fragment. Length 19 cm; width 14 cm; height 8 cm. 4-in-1. Rings: outer diameter 9-11 mm; thickness 2 mm.
Material: iron.
Location: Archäologisches Museum der Stadt Kelheim, inv. A2680.
Literature: Fabricius/Sarwey 1906, 39; Greiner 2006, 199; Gschwind 2004, 127, 316, pl. 139 (cat. no. C161); Matešić 2015, 214; Zanier 1992, 313.

Eining 5 - Abusina
Date: Roman Principate.
Context: Roman fort.
Description: mail fragment. Length 6.8 cm; width 5.2 cm; height 3.8 cm. Rings: outer diameter 9-11 mm; thickness 1.6 mm.
Material: iron.
Location: Archäologisches Museum der Stadt Kelheim, inv. A2681.
Literature: Fabricius/Sarwey 1906, 39; Greiner 2006, 199; Gschwind 2004, 127, 316 (cat. no. C162); Matešić 2015, 214; Zanier 1992, 313.

Eining 6 - Abusina
Date: Roman Principate.
Context: Roman fort.
Description: mail fragment. Length 6.4 cm; width 6.1 cm; height 1.6 cm. 4-in-1. Rings: outer diameter 8-11 mm; thickness 2 mm.
Material: iron.
Location: Archäologisches Museum der Stadt Kelheim, inv. A2682.
Literature: Fabricius/Sarwey 1906, 39; Greiner 2006, 199; Gschwind 2004, 127, 316, pl. 139 (cat. no. C163); Zanier 1992, 313.
Eining 7 - Abusina
Date: Roman Principate.
Context: Roman fort.
Description: mail fragment. Length 7.7 cm; width 4.5 cm; height 3.1 cm. Rings: outer diameter 7.5-10 mm; thickness 1.6 mm.
Material: iron.
Location: Archäologisches Museum der Stadt Kelheim, inv. A2683.
Literature: Fabricius/Sarwey 1906, 39; Greiner 2006,

199; Gschwind 2004, 127, 316 (cat. no. C164); Zanier 1992, 313.

Eining 8 - Abusina
Date: Roman Principate.
Context: Roman fort.
Description: corroded mail fragment. Length 2.3 cm; width 1.2 cm; height 0.9 cm.
Material: iron.
Location: Stadt- und Kreismuseum Landshut.
Literature: Fabricius/Sarwey 1906, 39; Greiner 2006, 199; Gschwind 2004, 127, 316 (cat. no. C165); Zanier 1992, 313.

Eining 9 - Abusina
Date: Roman Principate.
Context: Roman fort.
Description: corroded mail fragment. Length 7.1 cm; width 5.7 cm; height 3.4 cm.
Material: iron.
Location: Stadt- und Kreismuseum Landshut.
Literature: Fabricius/Sarwey 1906, 39; Greiner 2006, 199; Gschwind 2004, 127, 316 (cat. no. C166); Zanier 1992, 313.

Eining 10 - Abusina
Date: Roman Principate.
Context: Roman fort.
Description: corroded mail. Length 8 cm; width 5.7 cm; height 3.4 cm.
Material: iron.
Location: Stadt- und Kreismuseum Landshut.
Literature: Fabricius/Sarwey 1906, 39; Greiner 2006, 199; Gschwind 2004, 127, 316 (cat. no. C167); Zanier 1992, 313.

Eining 11 - Abusina
Date: Roman Principate.
Context: Roman fort.
Description: corroded mail fragment. Length 7.3 cm; width 4.9 cm; height 3.4 cm.
Material: iron.
Location: Stadt- und Kreismuseum Landshut.
Literature: Fabricius/Sarwey 1906, 39; Greiner 2006, 199; Gschwind 2004, 127, 316 (cat. no. C168); Zanier 1992, 313.

Eining 12 - Abusina
Date: Roman Principate.
Description: corroded mail fragment. Length 7.3 cm; width 5.5 cm; height 3.4 cm.
Material: iron.
Location: Stadt- und Kreismuseum Landshut.
Literature: Fabricius/Sarwey 1906, 39; Greiner 2006, 199; Gschwind 2004, 127, 316 (cat. no. C169); Zanier 1992, 313.

Ellingen
Date: 2nd century - 1st half 3rd century AD.
Context: Roman fort.
Description: 16 mail fragments and loose rings weighing together 490 gr. Mostly rigid, but some rings are able to move. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: horizontal outer diameter 9.0 mm; vertical outer diameter 8.7 mm; horizontal inner diameter 5.7 mm; vertical inner diameter 5.1 mm; overlap clockwise; shape overlap stumpy; length overlap c. 3-4 mm; width overlap 2.4 mm; round rivet head on both sides; cross-section wire oval; width wire 1.7 mm; thickness wire 1.4 mm. Solid rings: outer diameter 8.7 mm; inner diameter 5.5 mm; thickness 1.0 mm; width 1.5 mm; cross-section rectangular; some rings have deformations and burrs.
Material: iron.
Inventory: human skull and animal bones.
Remarks: examined by the author.
Location: Archäologische Staatssammlung München, inv. 1983, 2769.
Literature: Hansen 2003, 167 (cat. no. C16); Matešić 2015, 218; Zanier 1992, 147-148, 164, 188, 313 (cat. no. C49).

Engers
Date: c. AD 520-720.
Context: funerary - isolated find.
Description: mail fragment broken in two. 4-in-1. Rings: diameter 18 mm.
Material: iron.
Literature: Grunwald 1998, 96-97, pl. 16.1.

Feldberg
Date: mid-2nd–mid-3rd century AD.
Context: Roman fort.
Description: various corroded mail fragments of which one weighs 5.1 and another 3.8 kg. 4-in-1. Alternating

rows of riveted and solid rings. Riveted rings: overlap clockwise; shape overlap stumpy; round rivet hole; round rivet head; cross-section wire oval. Solid rings: cross-section rectangular; presence of burrs and slight deformation from being punched out of sheet metal.
Material: iron.
Remarks: observed by the author through museum glass.
Location: Römerkastell Saalburg.
Literature: Alfs 1941, 77; Baatz 1963/1964, 51; Beck/Chew 1991, 163; Greiner 2006, 199; Haas/Firbas 1930, 87, fig. 37; Hansen 2003, 166 (cat. no. C5); Zanier 1992, 313.

Gammelin 1
Date: C.
Context: funerary - burial 80/189.
Description: mail armour. Rings: diameter 9.5 mm.
Material: iron.
Inventory: iron handle of a box, glass beads.
Location: Staatliches Museum Schwerin, inv. 1978/86.
Literature: Hansen 2003, 180 (cat. no. 129); Voß 1998.

Gammelin 2
Date: C1.
Context: funerary - burial 1977/2.
Description: mail armour. Rings: diameter 8-9 mm.
Material: iron.
Inventory: glass beads, brooch, bone comb, needle.
Location: Staatliches Museum Schwerin, inv. 1977/2.
Literature: Hansen 2003, 180 (cat. no. 130); Voß 1998, 53.

Gammertingen *(figs. 10.30, 11.1, 11.37)*
Date: c. AD 570.
Context: funerary.
Description: coat of mail deposited next to the deceased. The coat was spread out and measures nowadays 98 cm in length and 63 cm in width and has short sleeves of c. 7 cm. It has a hood-like collar that protected the neck and possibly (part of) the head. Current weight 7 kg and estimated c. 45.000 rings in original condition. The front of the mail coat has largely been preserved, while only 10-20% of the back survives. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter 9.2; inner diameter 6.2 mm; overlap anti-clockwise; paddle-shaped overlap; round rivet heads on both sides; cross-section wire lightly flattened oval; cross-section 1.5 mm. Solid rings: outer diameter 8.5 mm; inner diameter 4.5-5.1 mm; width 1.7-2 mm; thickness 1.3 mm; cross-section rectangular and washer-shaped; some corners have burrs.
Material: iron.
Inventory: gilded *Spangenhelm*, sword with scabbard, spear, javelin, axe, shield boss, bow, quiver with twelve arrows, belt buckle covered in gold sheet, silvered horse gear, two golden shoe buckles, various bronze vessels, wooden vessel, ceramic tableware, glassware, silver needle, silver sieve-spoon, scissors, bone comb, awl.
Location: Landesmuseum Württemberg, Stuttgart.
Literature: Adams 2010, 96; Arwidsson 1934, 255-257; Böhner 1994, fig. 14; Bruce-Mitford 1978, 237; Checksfield *et al.* 2012, 233; Fredman 1992, 5, 7, 16, fig. 11A-B; Gröbbels 1905, 34-35, pl. 7; Grunwald 1998, 97; Grunwald/Tröller-Reimer 1997, 173; Kelly 1931, 269, fig. 4; 1934, 206, fig. 2; Kokkotidis *et al.* 2019, 34-35; Müller 2003, 439-441; Novichenkova 2011, 278; Petér 2014, 25; Restauro 1997, 7; Riemer/Heinrich 1997, 54-55, 58-60; Rose 1906, 52; Stein 2003, 44-45, fig. 2; Steuer 1997, 276, 282; Van der Sanden 1993, 2, 4 (cat no. 24); Vogt 2003, 27; 2006, 215, fig. 79.

Gnotzheim *(fig. 3.16)*
Date: 2nd - 3rd century AD.
Context: Roman fort - detector find.
Description: small solid mail fragment and a loose ring with the remains of others adhering. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter c. 7 mm; inner diameter c. 4 mm; overlap clockwise; thickness c. 1.2 mm. Solid rings: outer diameter c. 7.5 mm; inner diameter c. 4.5 mm; cross-section square with rounded corners; thickness c. 1.5 mm; width c. 1.2-1.5 mm.
Material: iron.
Remarks: examined by the author.
Location: Archäologische Staatssammlung München, inv. 1983, 2564.
Literature: Herramhof *et al.* 1986-1987, 286-287; Zanier 1992, 313.

Groß Garz
Date: C/D.
Context: funerary?
Description: seven mail fragments, corroded and affected by fire. Rings: outer diameter c. 8 mm; inner diameter c. 5 mm.

Material: iron.
Remarks: burial of a woman.
Location: Stadtmuseum Berlin, inv. II 1539.
Literature: Articus 2004, 96; Hansen 2003, 181 (cat. no. C139); Van der Sanden 1993, 4 (cat. no. 25).

Großkrotzenburg
Date: 1st half 2nd century AD.
Context: Roman fort.
Description: two mail fragments in solid condition. A line of copper alloy rings can be observed in one of the fragments, which is a copper alloy trim. 4-in-1. Solid rings are observed among the copper alloy rings and these have a rectangular cross-section.
Material: iron, copper alloy.
Literature: Baatz 1963/1964, 51; Bishop/Coulston 2006, 170; Hansen 2003, 167 (cat. no. C11), Klee 1989, fig. 106; Matešić 2015, 211; Oldenstein 1976, 65; Stephenson 2001, 33; Stephenson/Dixon 2003, 44; Wijnhoven 2015c, 25; 2017, 186-187, 193; Zanier 1992, 313.

Großpaschleben
Date: C1/C2.
Context: funerary - disturbed burial.
Description: three corroded fragments. Rings: outer diameter 8-9 mm.
Material: iron.
Inventory: ceramics.
Location: Historisches Museum, Köthen, inv. EK: 21/84.
Literature: Hansen 2003, 182 (cat. no. C148).

Hagenow 1
Date: early 2nd century.
Context: funerary - burial 1899-2.
Description: corroded mail fragments. Alternating rows of riveted and solid rings. Rings: outer diameter 7-9 mm (7.5 mm at average).
Fixture: set of (now lost) bronze fasteners. Two of these sets together regulate the head opening of the coat. In addition, a small roundel, also lost, (covered in) silver with filigree decoration.
Material: rings: iron; fixtures: bronze, silver.
Inventory: helmet, sword, two spearheads, shield boss, buckle, sieve, two bronze containers, drinking horn fittings, various iron and copper alloy objects, molten glass, ceramic fragments, fire striker.
Location: Staatliches Museum Schwerin, inv. E 1121-1142.
Literature: Adler 1993, 150; Hansen 2003, 83-84, 180 (cat. no. C133); Miks 2007, 602; Müller 2003, 437-439; Pauli Jensen 2008, 218; Raddatz 1959/1961b, 53; Rasmussen 1995, 75; Voß 1994, 263-264; 1998, 59, pl.57.7-10; 2000, 197; 2007, 59-61; 2008, 254-256, fig. 4, 9; Waurick 1982, 115-116 (cat. no. 16); Wijnhoven 2015b, 97.

Hagenow 2
Date: AD 133-166.
Context: funerary - burial 1907-7.
Description: coat of mail of which 60 fragments have been preserved. Riveted and solid rings. Iron rings: outer diameter 7-9 mm (average 7.5 mm). Copper alloy rings: outer diameter 7-7.5 mm; inner diameter 4 mm.
Fixture: remnants of a copper alloy T-shaped fitting that belonged to the coat of mail.
Material: rings: iron, copper alloy; fixture: copper alloy.
Inventory: sword, two spearheads, shield boss, two spurs, buckle, hinged fitting, bronze container, bronze ladle, fittings, seven glass beads, textile remains.
Location: Staatliches Museum Schwerin, inv. E 2493.
Literature: Adler 1993, 150; Hansen 2003, 83-84, 180-181 (cat. no. C134); Künzl 2002, 137 (cat. no. 16); Matešić 2015, 211; Müller 2003, 437-439; Pauli Jensen 2008, 218; Przybyła 2016, 163; Raddatz 1959/1961b, 53; Rasmussen 1995, 75; Van der Sanden 1993, 4 (cat. no. 26); Voß 1994, 263-264; 1998, 59-60, pl. 61; 2000, 197; 2007, 59-61; 2008, 255-256; Waurick 1982, 115-116 (cat. no. 16); Wijnhoven 2015c, 23, 25; 2017, 184, 186, 193.

Hagenow 3 *(fig. 3.39)*
Date: AD 100-110.
Context: funerary - burial 9/1995.
Description: coat of mail with a current weight of 8 kg. Deposited with several other objects inside a cauldron that functioned as an urn. Textile adheres to the coat. Part of the rings is riveted. Rings: diameter 8-9 mm.
Fixture: two fixtures with a keyhole shaped eyelet. These must have had corresponding hooked counterparts that interact with the keyhole, and together regulate the head opening of the coat.
Material: rings: iron; fixtures: silver.
Inventory: sword, scabbard mouth, two spearheads, shield fragments, four pairs of spurs with silver inlay,

cauldron, two drinking horns, six brooches, hinged belt ornamented with silvered and gilded plates, two silver buckles, (sword) belt elements, gold bars, two fire strikers, finger ring, knife, ceramic vessel.
Location: Staatliches Museum Schwerin, inv. 1995/1463,1.
Literature: Hansen 2003, 83-84, 181 (cat. no. C134); Müller 2003, 437-439; Pauli Jensen 2008, 218; Przybyła 2016, 163, 165; Voß 1998, 61, pl. 61-62; 2000; 2007, 59-65; 2008, 255-259; Wijnhoven 2015b, 97.

Harzhorn
Date: c. AD 235.
Context: site of battlefield.
Description: several mail fragments, mostly heavily corroded. 4-in-1. Rings: outer diameter c. 6 mm. One fragment of ten rings is still flexible. Alternating rows of riveted and solid rings. Riveted rings: overlap clockwise; shape overlap stumpy; rivet head round; cross-section wire somewhat flattened. Solid rings: smaller than the riveted rings; cross-section square.
Material: iron.
Inventory: c. 1.500 battlefield related objects.
Literature: Fabian 2018, 40-41; Geschwinde 2013, 313, fig. 18; Geschwinde/Lönne 2013, 277, fig. 7.

Hemmoor-Warstade
Date: B2/C1a.
Context: funerary - burial 2.
Description: mail fragment measuring 2.8 x 1.7 cm. 4-in-1. Rings: outer diameter 8-10 mm; inner diameter 5-7 mm.
Material: iron.
Inventory: bronze container, comb, five bone objects, glass, bronze fragments, sherds.
Location: Landesmuseum Hannover, inv. 7423.
Literature: Articus 2004, 97; Hansen 2003, 82, 178 (cat. no. C118); Künzl 2002, 137 (cat. no. 12); Van der Sanden 1993, 4 (cat. no. 27); Waurick 1982, 115 (cat. no. 12).

Holdorf
Date: A-B1b.
Context: funerary - burial 1992/20.
Description: mail coat.
Material: iron.
Inventory: bronze cauldron used as an urn; belt hook? The cauldron with the mail coat has not been micro-excavated. It is likely that there are other objects inside the urn.
Location: Staatliches Museum Schwerin.
Literature: Voß 1994, 263; Hansen 2003, 180 (cat. No. C128); Pauli Jensen 2008, 218.

Issendorf
Date: 4th - early 5th century AD.
Context: funerary - burial 1003.
Description: mail fragment, corroded and caked together with bones and sand. Current weight 5 gr. Find is now lost.
Material: iron.
Inventory: iron ring, ceramic vessel.
Literature: Articus 2004, 97; Hansen 2003, 178-179 (cat. no. C119); Künzl 2002, 137 (cat. no. 13); Müller 2003, 438; Nicolay 2014, 152; Van der Sanden 1993, 4 (cat. no. 28); Waurick 1982, 115-116 (cat. no. 13).

Kalkar - Bornsche Veld *(fig. 1.2)*
Date: Roman period.
Description: mail coat deposited as a bundle (20 x 30.5 x 8.3 cm) and probably affected by fire. Now in solid condition with sand and pebble inclusions adhering. 4-in-1. Riveted rings are recognised by their domed rivet heads. Rings: outer diameter c. 9.5 mm; overlap probably clockwise; thickness c. 2-2.4 mm; cross-section wire oval.
Material: iron.
Remarks: examined by the author.
Location: Provinciaals Utrechts Genootschap van Kunsten en Wetenschappen, inv. 9394.
Literature: Janssen 1836, 126-127.

Kalkriese 1 *(fig. 3.3)*
Date: AD 9.
Context: battle site - section 9.
Description: eleven connecting mail rings: diameter 11-13 mm; thickness 2-4 mm.
Material: iron.
Inventory: many items belonging to the Roman army have been found at the site.
Location: Museum und Park Kalkriese, inv. 8353.
Literature: Harnecker 2008, 9, pl. 11 (cat. no. 113); 2011, 5; Rost/Wilbers-Rost 2010, fig. 11.113.

Kalkriese 2
Date: AD 9.
Context: battle site - section 37.

Description: mail fragment. Rings: diameter c. 3.8 mm.
Fixture: a silver button of concave shape that may have come from a shoulder guard.
Material: rings: iron; button: silver with iron washer.
Inventory: many items belonging to the Roman army have been found at the site.
Location: Museum und Park Kalkriese, inv. 35760.
Literature: Harnecker 2011, 26, pl. 2 (cat. no. 2136).

Kasseedorf 1
Date: C.
Context: funerary - burial 121.
Description: twelve connecting mail rings that have been affected by fire. Riveted and solid rings. Riveted rings: outer diameter 11 mm. Solid rings: outer diameter 8 mm. Several very small fragments of mail, containing together c. 20 rings.
Material: iron.
Inventory: ceramic vessel, two brooches, buckle, ring, perforated bird talon, at least 25 glass beads, knife, iron sheet probably belonging to a bone container for needles.
Remarks: burial of a woman.
Location: Museum für Archäologie Schloss Gottorf, Schleswig, inv. K.S. 23210.
Literature: Articus 2004, 96-98, 224, pl. 29; Hansen 2003, 180 (cat. no. C126); Künzl 2002, 137 (cat. no. 9); Van der Sanden 1993, 4 (cat. no. 29); Waurick 1982, 115 (cat. no. 9).

Kasseedorf 2
Date: B2.
Context: funerary - burial 16.
Description: at least seven connected mail rings. Riveted and solid rings. Rings: outer diameter 8 mm.
Material: iron.
Inventory: ceramic vessel, three brooches, three glass beads.
Remarks: burial of a woman.
Location: Museum für Archäologie Schloss Gottorf, Schleswig?
Literature: Articus 2004, 96-98, 218, pl. 4.

Kasseedorf 3
Date: B2-C3.
Context: funerary - burial 166.
Description: single ring, possibly mail, adhering to a molten glass bead. Ring: outer diameter 9 mm.
Material: iron.
Inventory: ceramic vessel, two glass beads.
Location: Museum für Archäologie Schloss Gottorf, Schleswig?
Literature: Articus 2004, 96-98, 227, pl. 40.

Kemnitz
Date: B2.
Context: funerary - burial 622.
Description: mail coat, burnt and folded. Current weight 15.5 kg, including several artefacts embedded into the mail coat. Rings: outer diameter 7-8 mm.
Material: iron.
Inventory: urn, iron ferrule, bronze fragments (lost), glass beads (lost). Next to the urn: gold finger ring, two bronze *situlae*, eight ceramic vessels, many glass beads, bronze belt with hinge, sheets of embossed bronze (probably part of the belt), buckles, bone comb, various bronze objects.
Location: Museum für Ur- und Frühgeschichte, Berlin, inv. 1962/40/538/12.
Literature: Budinský-Krička/Lamiová-Schmiedlová 1990, 284; Hansen 2003, 83, 182 (cat. no. C145); Fischer 2004, 131-135; Künzl 2002, 137 (cat. no. 21); Matešić 2015, 220-221; Müller 2003, 437; Pauli Jensen 2008, 218; Przybyła 2016, 163-164; Raddatz 1981, 56; Rasmussen 1995, 75; Van der Sanden 1993, 4-5 (cat. no. 30); Voß 1994, 264; Waurick 1982, 114-116 (cat. no. 21); Weski 1982, 40.

Krefeld-Gellep
Date: c. AD 515-525.
Context: funerary - grave 1782.
Description: mail aventail of a *Spangenhelm*. Broken into several pieces and heavily corroded. One fragment preserves two edges. It is 23 rows long and one edge is surrounded in leather. 4-in-1. Alternating rows of riveted and solid rings. Rings: thickness c. 3 mm.
Material: iron.
Inventory: *Spangenhelm*, ring-pommel sword, sword beads, sax, gold buckle, silver buckles, bronze buckles, spearhead, throwing axe, javelin, hunting spear, shield boss, fixtures covered in gold sheet, horse gear, gold fixture with inlays for a bag, fire stone, fire striker, silver needle, gold finger rings, two eating knives, two gold clamps, silver spoon, spit, two Late Roman glass, bronze vessels, bronze key, iron tripod with bronze tray, wooden bucket decorated with metal, bronze rim of a

wooden vessel, coin (*solidus* AD 491-518).
Location: Museum Burg Linn, Krefeld.
Literature: Vogt 2003, 11, 27; 2006, 37-38, 226.

Künzing 1
Date: mid-3rd century AD.
Context: Roman fort.
Description: corroded mail fragment. Only a faint outline of rings can be observed. 4-in-1. Rings: outer diameter c. 7.5 mm.
Material: iron.
Inventory: U-shaped piece of bronze, two spearheads, five nails, six glass sherds, ceramic sherds, slag; animal bones.
Remarks: examined by the author.
Location Prähistorischen Staatssammlung München, inv. 1967, 1066b.

Künzing 2
Date: mid-3rd century AD.
Context: Roman fort.
Description: two mail fragments in solid condition. 4-in-1. Alternating rows of riveted and solid rings. Only solid rings could be measured, since the riveted rings were embedded. Riveted rings: diameter appears similar to solid rings. Solid rings: outer diameter 7.7 mm; inner diameter 4.7 mm; thickness 1.7 mm; width 1.5 mm.
Material: iron.
Inventory: iron sword belt holder, spearhead, arrowhead, nails, L-shaped hook, punch, iron rod with hook, wedge, iron pen.
Remarks: examined by the author.
Location Prähistorischen Staatssammlung München, inv. 1966, 916b.

Künzing 3
Date: mid-3rd century AD.
Context: Roman fort.
Description: mail fragment in semi-rigid condition. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: horizontal outer diameter c. 7.6 mm; vertical outer diameter c. 7.4 mm; horizontal inner diameter c. 5.2 mm; vertical inner diameter c. 5 mm; overlap clockwise; round rivet on both sides; cross-section wire round; width 1-1.3 mm; thickness 1-1.3 mm. Solid rings: outer diameter 7.6 mm; inner diameter 4.55 mm; thickness 1.1-1.4 mm; width 1.7-1.9 mm; cross-section rectangular; some deformation on edge of rings.
Material: iron.
Inventory: two spearheads, five nails.
Remarks: examined by the author.
Location Prähistorischen Staatssammlung München, inv. 1966, 1273b.

Künzing 4 *(figs. 3.17, 5.3, 11.1, 11.18)*
Date: mid-3rd century AD.
Context: hoard at Roman fort.
Description: multiple fragments of mail, most of them (partly) in flexible condition, and numerous loose rings. Several fragments are rectangle-shaped and it is likely that the mail was cut into manageable pieces prior to deposition, possibly for recycling. 4-in-1. Alternating rows of riveted and solid rings. The riveting has been executed carelessly in various places. The fragments come from more than one garment. There are those with riveted rings much larger than the solid ones; and there are those with riveted rings slightly larger than the solid rings. Interestingly the solid rings in all fragments are the same and this could indicate that they were produced in the same workshop. Large riveted rings fragments: horizontal outer diameter 9.2 mm; vertical outer diameter 9.7 mm; horizontal inner diameter 6.4 mm; vertical inner diameter 6.0 mm; overlap clockwise; shape overlap stumpy; length overlap c. 2.9 mm; width overlap 2.3 mm; rivet head on both sides; cross-section wire oval; thickness 1.2 mm; width 1.5 mm. Smaller riveted rings fragments: horizontal outer diameter 8.1 mm; vertical outer diameter 8.2 mm; horizontal inner diameter 5.4 mm; vertical inner diameter 4.9 mm; overlap clockwise; shape overlap stumpy; length overlap c. 2.8 mm; width overlap 2.0 mm; rivet head on both sides; cross-section wire oval; wire thickness 1.2 mm; wire width 1.3 mm. Solid rings: outer diameter 7.4 mm; inner diameter 4.8 mm; width 1.4 mm; thickness 1.2 mm; cross-section square with slightly rounded edges; some burrs at the edges; upstanding circle at the edges.
Material: iron.
Inventory: 16 swords, six scabbard fragments, 51 daggers, 29 sheaths, *signum* head, 35 spearheads, two spear butts, ten arrowheads; various greaves, six axes, 32 cross hoes, seven *dolabrae*, twelve hoes, 34 hack knives, 27 beam nails, 65 pegs, 29 chains, 29 locks, 23 handcuffs, four keys, various iron objects.
Remarks: examined by the author.

Location Prähistorischen Staatssammlung München, inv. 1967, 2174.
Literature: Baatz 1963/1964, 51; Bishop/Coulston 2006, 170; Boube-Piccot 1994, 55; Hansen 2003, 53, 168 (cat. no. C25); Herrmann 1972, 9-10, 12; Horn/Rüger 1979, 637, pl. 139; Feugère 1993, 127; 2002, 100; Miks 2007, 645; Novichenkova 2011, 278-279; Robinson 1975, 173; Schönberger 1963/1964, 83); Southern/Dixon 1996, 97; Stephenson 2001, 33; Van der Sanden 1993, 4 (cat. no. 32); Wijnhoven 2019a, 7; Zanier 1992, 313.

Mainz 1 - Schillerstraße
Date: 2nd century AD.
Context: settlement - well.
Description: mail fragment, still flexible. 4-in-1. Alternating rows of riveted and solid rings. Rings: outside diameter 4 mm; inside diameter 3 mm.
Material: iron.
Inventory: sword, shoes, weapon parts, tools and equipment.
Location: Römisch-Germanisches Zentralmuseum Mainz.
Literature: Alfs 1941, 78; Baatz 1963/1964, 51; Blell-Tüngen 1877, 417; D'Amato/Sumner 2009, 210; Hansen 2003, 166 (cat. no. C7); Lindenschmit 1858, pl.4.4; Matešić 2015, 218; Miks 2007, 665; Robinson 1975, 173; Rose 1906, 6, fig. 12a-b; Rusu 1969, 289; Van der Sanden 1993, 4 (cat. no. 33); Zanier 1992, 313.

Mainz 2 - Kästrich
Date: Roman period.
Context: Roman fort.
Description: three mail fragments affected by fire. 4-in-1. Rings: outer diameter of the largest rings c. 10 mm.
Material: iron.
Location: Römisch-Germanisches Zentralmuseum Mainz.
Literature: Fischer 2012, 345, fig. 503; 2019, 322, fig. 503; Hansen 2003, 167 (cat. no. C8); Rose 1906, 6.
Mainz 3 - Phillipsschanze
Date: Roman period.
Context: depot of objects to be recycled.
Description: mail rolled up and corroded together. 4-in-1. Alternating rows of riveted rings and solid rings. Riveted rings: outer diameter c. 10 mm; inner diameter c. 7 mm. Solid rings: outer diameter c. 8 mm; inner diameter c. 5 mm.
Material: iron.
Inventory: swords, spearheads, daggers, helmet fragments, tools, fittings, nails and various metal fragments.
Location: Römisch-Germanisches Zentralmuseum Mainz.
Literature: Hansen 2003, 167 (cat. no. C9); Matešić 2015, 215; Oldenstein 1976, 71.

Rhine River near **Mainz** 4
Date: Roman period?
Context: river.
Material: iron.
Description: three mail coats and one large fragment, rolled up and corroded together. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter 8 mm; inner diameter 6 mm; cross-section 1 mm. Solid rings: outer diameter 7 mm; inner diameter 5 mm; cross-section 1 mm.
Location: Römisch-Germanisches Zentralmuseum Mainz.
Literature: Hansen 2003, 167 (cat. no. C10); Rose 1906, 6.

Rhine River near **Mainz** 5
Date: Roman period.
Context: river.
Description: mail fragment in flexible condition, measuring 26 cm x 12 cm. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter 8 mm; inner diameter 6 mm; cross-section 1 mm. Solid rings: outer diameter 7 mm; inner diameter 5 mm; cross-section 1 mm.
Location: in the collection of Walther Rose in 1906; formerly in the Gimbel Collection.
Literature: Rose 1906, 6-7, fig. 13.

Manching 1
Date: LT C1 - D1d.
Context: *oppidum*.
Description: five corroded mail fragments, found 30 metres apart. Uncertain if these come from one or several mail coats. Three fragments have been affected by fire. X-ray examination did not find the presence of rivets, which is not surprising given their condition. 4-in-1. Rings in three fragments: diameter 4-5 mm. Rings in two fragments: appear larger.
Material: iron.
Literature: Hansen 2003, 34, 41, 54, 161 (cat. no. 4), Sievers 2010, 38, pl. 59.

Manching 2
Date: AD 200-235.
Context: hoard?
Description: coat of mail. Nine fragments survive that partially fit together. 4-in-1. Rings: outer diameter rings c. 6 mm.
Material: iron.
Inventory: five armour fittings, greave, shield boss, bronze dish, saucepan, sieve, five iron keys, plough blades, two hooks, handle.
Location: Prähistorischen Staatssammlung München, inv. 1956, 171.
Literature: Hansen 2003, 168 (cat. no. C23); Zanier 1992, 313.

Mannheim - Seckenheim
Date: mid-6th century AD.
Context: funerary - burial 248.
Description: two mail fragments. 4-in-1. Rings: diameter c. 11-12 mm; cross-section flat.
Material: iron.
Inventory: gold pendant, two gilded silver disc brooches with garnets, bronze belt buckle, two gilded silver brooches, silver pendant, crystal sphere mounted in silver, glass and amber beads, knife, iron rings, flax tool, metal sheet that covered a box, scissors, keychain, comb, animal bones, egg shells, glass cup, bronze vessel, two ceramic vessels.
Remark: burial of a woman. Observed by the author through museum glass.
Location: Reiss-Engelhorn Museen, Mannheim.

Marnitz
Date: C.
Context: funerary.
Description: iron chain with three pendants (two bronze and one iron). Uncertain if this is mail.
Material: iron.
Remarks: no individual grave or inventory can be assigned to this find.
Literature: Hansen 2003, 181 (cat. no. C136).

Marxdorf
Date: transition B2 to C1.
Context: funerary.
Description: mail.
Remarks: burial of a woman.
Literature: Articus 2004, 97-98.

Mattstedt
Date: C/D.
Context: funerary - burial 8.
Description: four mail fragments. 4-in-1. Rings: outer diameter 7-8 mm; inner diameter 4-6 mm.
Material: iron.
Inventory: brooch, knife, comb, two bone needles, metal needle, several metal objects, ceramic vessel.
Remarks: possibly burial of a woman.
Literature: Articus 2004, 96-97; Czarnecka 1996, 246; Hansen 2003, 182 (cat. no. C149).

Mehring *(fig. 3.24)*
Date: 2nd half 4th century AD.
Context: Roman villa.
Description: mail fragments. 4-in-1. Alternating riveted and solid rings. Riveted rings: overlap clockwise.
Material: iron.
Inventory: many objects including weapons.
Remark: observed by the author through museum glass.
Location: Rheinisches Landesmuseum, Trier, inv. EV 1985,25.
Literature: Gilles 1985.

Morken
Date: AD 580-600.
Context: funerary.
Description: mail aventail of a *Spangenhelm*, now heavily corroded. 4-in-1.
Material: iron.
Inventory: *Spangenhelm*, sword, sword beads, throwing axe, two spearheads, javelin, shield boss, snaffle bit, belt fixtures, fire steel, fire stone, whetstone, comb, shears, miniature pot, glassware, key, iron fixtures of a wooden bucket, coin (*solidus* AD 578-582), textiles (silk, linen, wool), feathers, leather bag lined with linen, four iron fixtures of a wooden box, animal bones and egg shells.
Location: Rheinisches Landesmuseum, Bonn.
Literature: Adams 2010, 96; Böhner 1994, fig. 2; Vogt 2003, 11, 28; 2006, 37, 237, fig. 87, pl. 23.2.

Niederstotzingen
Date: start 7th century AD.
Context: funerary - burial 12.
Description: mail aventail of a lamellar helmet. Aventail is 18 rows deep and covered on both sides with a double layer of coarse diamond twill textile. 4-in-1. Only

riveted rings and no solid rings.
Material: iron.
Inventory: burial 12a: lamellar armour, sword, shield, belt buckle, horse bridle, key. burial 12b-c: two swords, various knives, gold and silver belt parts, saddle parts, horse bridle, lamellar helmet (which could have also belonged to burial 12a).
Remarks: burial contained three individuals: man 25-35 years old, person 30-40 years old, probable woman 20-30 years old.
Literature: Müller 2003, 440; Vogt 2006, 38, 298.

Nieholte
Date: C.
Context: funerary.
Description: fragment of fine chain, melted together. Uncertain if this is mail.
Material: iron.
Inventory: bronze vessel, two horn awls, ceramic sherds.
Location: Landesmuseum Natur und Mensch, Oldenburg.
Literature: Hansen 2003, 176 (cat. no. C91).

Neuwied
Date: 2nd - 3rd century AD.
Context: Roman fort - *praetorium*.
Description: mail fragment. 4-in-1. Alternating rows of riveted and solid rings. Rings: outer diameter 9 mm; inner 7 mm; cross-section flat.
Material: iron.
Inventory: helmet, 'body armour with holes'?.
Location: Bonner Museum (in 1906).
Literature: Dorow 1826, 82; Hansen 2003, 166 (cat. no. C3); Matešić 2015, 218; Rose 1906, 7-8; Zanier 1992, 312.

Norderdorf
Date: AD 450-750.
Context: funerary - burial 4.
Description: mail fragments.
Literature: Müller 2003, 62.

Obrigheim
Date: AD 450-750.
Context: probably funerary.
Description: mail fragment. Rings: outer diameter c. 10 mm.
Material: iron.
Location: Museum Speyer.
Literature: Grunwald 1998, 97; Polenz 1988, 349, pl. 139.3.

Oldenburg - Starigard
Date: 9th - 11th century AD.
Context: castle.
Description: five small mail fragments. 4-in-1. Some have alternating rows of riveted and solid rings; others are entirely made from riveted rings. Three fragments are made with copper alloy rings. Rings: outer diameters 6-11 mm; cross-section wire c. 1 mm; round rivets with a pronounced head.
Material: iron and copper alloy.
Literature: Müller 2003, 447.

Passau 1 - Rathausplatz
Date: AD 80-200.
Context: river (bank).
Description: mail fragment measuring 3 x 5 cm. 4-in-1. Rings: outer diameter c. 8 mm; cross-section c. 1 mm; described as having the ends of the rings flattened, probably indicating that some were riveted.
Material: iron.
Inventory: Roman coin (possibly Domitian AD 81-96), bronze object, knife, three locks, key, 25 iron fragments, two spindle whorls, *terra sigillata*.
Literature: Bender 2009, 47, pl. 13.373.

Passau 2 - Jesuitengasse
Date: early 4th century AD.
Description: various mail fragments. 4-in-1. Riveted rings are observed. Rings: outer diameter 5-7 mm; cross-section c. 0.5 mm.
Material: iron.
Inventory: Roman coin (AD 317-320), copper plate with a hole, bronze implement, bronze slag.
Literature: Bender 2009, 63, pl. 15.479.

Pfeffingen
Date: c. 6th century AD.
Context: funerary.
Description: corroded mail aventail now in four fragments. Rings: outer diameter 13 mm.
Material: iron.
Inventory: *Spangenhelm*. Grave has been robbed out before discovery and inventory is incomplete.

Literature: Stein 2003, 42-44; Vogt 2003, 11, 28; 2006, 37, 243.

Pfingstberg
Date: c. 6th century AD.
Context: funerary - burial 525.
Description: mail armour.
Remarks: burial of a woman.
Literature: Articus 2004, 96-98.

Planig *(fig. 11.36)*
Date: c. AD 510.
Context: funerary.
Description: complete mail coat of which now only fragments survive. The coat was placed, partly rolled up, on top of the body of the deceased. Also a mail aventail belonging to a *Spangenhelm*, now measuring 20 cm x 12 cm. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter 14 mm; overlap anti-clockwise; paddle-shaped overlap; rivet heads on both sides; entire ring is flattened; cross-section wire flat. Solid rings: outer diameter 10 mm; cross-section rectangular washer-like.
Material: iron.
Inventory: *Spangenhelm*, shield, sword, sword beads, sax and scabbard, spear, javelin, belt parts, two small knives, belt pouch (with a scale, tweezers, needle, firestone), throwing axe, three arrows, quiver, various (silver) buckles and strap ends, two belt distributors, gold wire, scissors, coin inside the mouth, bronze vessel, glassware, wooden vessel?, key, coin (*solidus* AD 457-474), textile remains.
Remarks: observed by the author through museum glass.
Location: Landesmuseum Mainz, inv. 0,335.
Literature: Adams 2010, 96; Böhner 1994, fig. 10; Grunwald 1998, 97; Hilgner 2010, 55, pl. 8.2; Kazanski 2007, 244; Müller 2003, 439; Vogt 2003, 11, 29; 2006, 37-38, 245-246.

Pleidelsheim
Date: 5th - 7th century AD.
Context: funerary - burial 115.
Description: mail armour.
Literature: Kazanski 2007, 244.

Pritzier
Date: C.
Context: funerary - burial 1481.
Description: 20 interconnected mail rings. Rings: outer diameter 12 mm; inner diameter 6 mm.
Material: iron.
Inventory: spindle whorl.
Literature: Hansen 2003, 180 (cat. no. C131).

Putensen
Date: A-B1.
Context: funerary? - find 395.
Description: ten mail fragments and various loose rings. 4-in-1. Riveted and solid rings. Rings: outer diameter 6.5 mm, inner diameter c. 4.5-5 mm.
Material: iron.
Inventory: scabbard brace, fibula with Late La Tène motive, two iron rivets, iron rod, sherds from c. 30 vessels. Uncertain if the inventory comes from a closed context.
Location: Archäologisches Museum Hamburg.
Literature: Adler 1993, 150; Erdrich 2002, 151; Hansen 2003, 62-64, 69, 120, 161 (cat. no. 3); Künzl 2002, 137 (cat. no. 14); Müller 2003, 437; Van der Sanden 1993, 4 (cat. no. 35); Waurick 1982, 114-115 (cat. no. 14); Weski 1982, 40.

Quelkhorn
Date: C/D.
Context: funerary.
Description: iron chain from flat rings. Uncertain if this is mail. Rings: outer diameter 12-15 mm; inner diameter 7-8 mm.
Material: iron.
Location: Niedersächsisches Landesmuseum, Hannover, inv. 7925.
Literature: Hansen 2003, 178 (cat. no. C117).

Rainau-Buch 1
Date: mid-2nd - mid-3rd century AD.
Context: Roman fort - *praetorium*.
Description: lump of corroded mail. Rings: outer diameter 7 mm; inner diameter 6 mm.
Material: iron.
Literature: Baatz 1963/1964, 51; Greiner 2008, 97; Hansen 2003, 167 (cat. no. C13).

Rainau-Buch 2
Date: AD 229–254.
Context: *vicus* - well 9.
Description: complete coat of mail, folded and cor-

roded solid, now weighing 5.7 kg. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter 10 mm. Solid rings: outer diameter 7.5 mm. The coat has been subjected to a CT-scan, which measured rings with an outer diameter of c. 15 mm at the core of the mail bundle. No fixtures or fasteners were discovered.
Material: iron.
Inventory: helmet (type Niederbieber), wooden sculpture.
Location: Limesmuseum Aalen.
Literature: Bishop 2015c, 99; Bishop/Coulston 2006, 170; Coulston 1990, 147; D'Amato/Sumner 2009, 129; Greiner 2006, 199, 201-202, fig. 1; 2008, 97-101; Hansen 2003, 167 (cat. no. C14); Kemkes/Scheuerbrandt 1997, 34, fig. 23; Kemkes/Scheuerbrandt/Willburger 2006, 86, fig. 77; Müller 2003, 435; Richter 2010, 193; Stephenson 2001, 33; Zanier 1992, 313.

Rainau-Buch 3
Date: Roman period.
Context: *vicus*.
Description: mail rings found in different buildings.
Material: iron.
Literature: Greiner 2008, 97.

Regensburg - Kumpfmühl
Date: AD 166 - 179.
Context: *vicus* - cellar.
Description: corroded mail fragment.
Material: iron.
Location: find no. vicus 10/58, no. 1.
Literature: Faber 1994, 147; Zanier 1992, 313.

Reinfeld - Schuhwiese
Date: Early Roman period.
Context: funerary.
Description: mail.
Remarks: burial of a woman.
Literature: Articus 2004, 97-98.

Rullstorf
Date: AD 700-750.
Context: funerary - cremation grave K8 - disturbed by ploughing.
Description: coat of mail that has been exposed to fire. 26 fragments were excavated. The largest fragments has four layers of mail measuring 10 x 5 cm. 4-in-1. Riveted rings are observed. Mail was mechanically cleaned, X-rayed and conserved.
Literature: Articus 2004, 97; Grunwald/Tröller-Reimer 1997; Müller 2003, 440.

Schlotheim
Date: Roman period.
Description: mail fragments.
Location: Museum Weimar.
Literature: Hansen 2003, 176 (cat. no. C93).

Sörup 1
Date: B2.
Context: funerary - burial K 10 – disturbed by ploughing.
Description: 22 mail fragments, many of which have been exposed to fire. Current weight c. 1.5 kg. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: vertical outer diameter 5.8 mm; thickness 1.1 mm; width overlap 1.9 mm; thickness overlap 1 mm; overlap clockwise; cross-section wire round. Solid rings: outer diameter 5.5 mm; thickness 1 mm; cross-section round. Metallographic analysis indicates that the solid rings are welded as indicated by slag inclusions and the presence of a weld seam.
Material: iron.
Inventory: glass and bronze fragments, ceramic sherds. Inventory is probably incomplete.
Location: Museum für Archäologie Schloss Gottorf, Schleswig, inv. KS C 448 (K 10).
Literature: Articus 2004, 96-97; Drescher 1981, 186-190; Greiner 2006, 200-201; Hansen 2003, 83, 179 (cat. no. C120); Jouttijärvi 1995, 103; Juncher 2016, 99; Künzl 2002, 136 (cat. no. 6); Matešić 2015, 213; Pauli Jensen 2008, 218; Raddatz 1981, 56-57, pl. 143, 168; Rasmussen 1995, 73, 75; Van der Sanden 1993, 4 (cat. no. 36); Waurick 1982, 115 (cat. no. 6).

Sörup 2
Date: C1.
Context: funerary - burial 427.
Description: mail fragment that probably belongs to Sörup 1 and entered by accident into grave 427. Rings: outer diameter 6 mm; round cross-section.
Material: iron.
Inventory: two bronze double buttons, ceramics.
Location: Museum für Archäologie Schloss Gottorf, Schleswig, inv. KS C 448 (427).

Literature: Articus 2004, 96-97; Hansen 2003, 179 (cat. no. C121); Juncher 2016, 99; Raddatz 1959/1961b, 53; 1981, 57.

Steckby
Date: C/D.
Context: funerary?
Material: iron.
Description: several interconnected rings. Uncertain if this is mail.
Literature: Hansen 2003, 181-182 (cat. no. C144).

Steinheim
Date: Roman period.
Context: settlement.
Description: mail fragments.
Inventory: 'scrap metal' from parade armour, helmet fragments, shield nails, iron tools.
Literature: Hansen 2003, 167 (cat. no. C12).

Straubing 1 - Bajuvarenstrasse
Date: 5th - 7th century AD.
Context: funerary - burial 470.
Description: mail armour.
Literature: Kazanski 2007, 244.

Straubing 2
Date: late 7th century AD.
Context: funerary - burial 3.
Description: small mail fragment that now adheres to a brooch. Rings: outer diameter 11.5 mm; inner diameter 7.5 mm; thickness 2.5 mm.
Material: iron.
Inventory: textile with gold threads (from a head band), two silver arm rings, glass, six rings, brooch, shell, fitting?, scissors?, knife.
Remarks: burial of a 17-20 year old woman.
Location: find no. 99/62-1.
Literature: Freeden, von 2009, 115, 142, fig. 16.A8, 19.5.

Stuttgart
Date: Roman period.
Description: mail rings. Riveted rings are observed. Metallographic analysis demonstrates that the wire has been worked at a low temperature (possibly c. 500 ^{0}C) with a small hammer. Another fragment from Stuttgart has wire of 0.95 mm and a structure that shows that it has also been worked at a low temperature with a hammer. Riveted ring: wire 1.2 mm.
Material: iron. Hardness is 180 VPN.
Literature: Sim/Kaminski 2012, 116-117, fig. 80.

Süderbrarup
Date: Roman period.
Context: funerary.
Description: three interconnecting mail rings. All rings are riveted: outer diameter rings 7.3-7.4 mm, inner diameter rings: 4.7-4.8 mm; cross-section wire oval.
Material: iron.
Location: Museum für Archäologie Schloss Gottorf, Schleswig, inv. K.S. 3226. Another mail fragment (inv. K.S. 3645) can no longer be located.
Literature: Articus 2004, 97; Hansen 2003, 179 (cat. no. C122); Künzl 2002, 137 (cat. no. 8); Van der Sanden 1993, 4 (cat. no. 37); Waurick 1982, 115 (cat. no. 8).

Theilenhofen
Date: end 1st - 3rd century AD.
Context: Roman fort.
Description: small mail fragment. 4-in-1. Rings: outer diameter 6-7.5 mm; inner diameter 4.5-5 mm.
Material: iron.
Literature: Beck/Chew 1991, 37, 163; Hansen 2003, 167 (cat. no. C15); Matešić 2015, 218.

Thorsberg 1
Date: C1b.
Context: bog.
Description: decorative trim of the hem of a mail shirt. The trim is four rows deep and demonstrates the presence of splits at the hem of the shirt. At the corner of the split there are some smaller rings, which could be a repair or done intentionally to soften the corner. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter 9.5-10.3 mm; inner diameter 7-8.4 mm; thickness 0.9-1.3 mm; overlap clockwise; shape overlap stumpy; round rivet heads; cross-section wire oval. Smaller riveted rings: outer diameter 7.3-8 mm; inner diameter 4.5-5 mm; thickness 1.1 mm. Solid rings: outer diameter 8.5-8.7 mm; inner diameter 6.3-6.9 mm; thickness 0.5-1.3 mm; cross-section rectangular. A separate small fragment probably also belongs to this trim. It has butted rings and one riveted ring. The butted rings differ in size and thickness, and are probably a repair. Riveted ring: outer diameter 8.4 mm; inner diameter 6.8 mm; thickness 0.5 mm. Butted

rings: outer diameter 7.4-10 mm; inner diameter 5.5-7.4 mm; thickness 0.4-1.6 mm.
Material: copper alloy.
Inventory: thousands of mainly military items.
Location: Nationalmuseet, Copenhagen, inv. S. 94 24854.
Literature: Alfs 1941, 78; Künzl 2002, 137 (cat. no. 7); Engelhardt 1863, 26-27; 1866, 46; Matešić 2015, 208-210, 215, 220-221, 512, pl. 104 (cat. no. M1142, M1143); Raddatz 1987, 62 (cat. no. 417); Rose 1906, 50; Wijnhoven 2015a, 6; 2015c, 23, 25; 2017, 186-187, 193.

Thorsberg 2
Date: C1b.
Context: bog.
Description: decorative trim of the hem of a mail coat. The decorative border is four rows deep with a corner, which is probably where the split would have been located. Iron rings still adhere in some places. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter 10.5-10.8 mm; inner diameter 7.5-8.2 mm; thickness 1.2-1.4 mm; overlap clockwise; cross-section wire oval. Solid rings: outer diameter 8.1-9 mm; inner diameter 6.6-6.8 mm; thickness 1-1.5 mm; cross-section rectangular.
Material: copper alloy, iron.
Inventory: thousands of mainly military items.
Location: Nationalmuseet, Copenhagen, inv. 24855.
Literature: Alfs 1941, 78; Engelhardt 1863, 26-27; 1866, 46; Matešić 2015, 209-210, 512, pl. 104 (cat. no. M1144); Raddatz 1987, 62 (cat. no. 417): Rose 1906, 50; Wijnhoven 2015a, 6; 2015c, 23, 25; 2017, 186-187, 193.

Thorsberg 3
Date: C1b.
Context: bog.
Description: decorative trim of a mail sleeve. The trim is complete and consist of 64 rows (32 riveted and 32 solid) two rings wide. Its circumference is c. 48 cm. Some solid iron rings still adhere to the copper alloy trim. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter 9.5-10.5 mm; inner diameter 6-8.5 mm; thickness 0.6-1.3 mm; overlap clockwise; shape overlap stumpy; round rivet with domed head on both sides; cross-section wire oval. Two riveted rings differ from the others: one has wire with a rectangular cross-section, the other is made from very thick wire. Both are likely repairs. Solid rings: outer diameter 8-9 mm; inner diameter 6.5-7.5 mm; cross-section rectangular.
Material: copper alloy, iron.
Inventory: thousands of mainly military items.
Location: Museum für Archäologie Schloss Gottorf, Schleswig.
Literature: Alfs 1941, 78; Engelhardt 1863, 26-27; 1866, 46; Matešić 2015, 210, 512, pl. 104 (cat. no. M1145); Rose 1906, 50; Wijnhoven 2015c, 23, 25; 2017, 185-187, 193.

Thorsberg 4
Date: C1b.
Context: bog.
Description: 19 interconnected copper alloy rings and a fragment of three rings. Riveted and solid rings. 4-in-1. Direction of the weave indicates that it was part of a trim for the sleeves. The small fragment has one copper alloy riveted ring, one iron solid ring, and one iron riveted ring with a copper alloy rivet. This is evidence that copper alloy trims were used together with iron rings with copper alloy rivets. Rings: outer diameter rings 8.2-11.4 mm; inner diameter 4.9-9.3 mm; thickness 0.5-1.1 mm. Riveted rings: overlap clockwise; shape overlap stumpy; rivet heads on both sides; cross-section wire round-oval. Solid rings: smaller than riveted ones; cross-section rectangular; rings look worn.
Material: copper alloy, iron.
Inventory: thousands of mainly military items.
Location: Museum für Archäologie Schloss Gottorf, Schleswig, inv. 1858 S. 322 F.S. 3676.
Literature: Matešić 2015, 209-210, 213, 215, 220-221, 512, pl. 104 (cat. no. M1146); Wijnhoven 2015c, 23, 25; 2017, 185-187, 192-193.

Thorsberg 5
Date: C1b.
Context: bog.
Description: eight interconnected rings: six butted copper alloy, one riveted copper alloy, one iron solid. The butted rings are likely a repair of the decorative trim. Copper alloy riveted ring: outer diameter 7.3 mm; inner diameter 6.1 mm; thickness 0.6 mm; overlap clockwise; cross-section wire oval. Iron solid ring: outer diameter 9.4 mm; inner diameter 7.1 mm; thickness 1.7 mm. Butted copper alloy rings: outer diameter

7.7-9.2; 5.4-6.6 mm; thickness 0.9-1.3 mm.
Material: copper alloy, iron.
Inventory: thousands of mainly military items.
Location: Museum für Archäologie Schloss Gottorf, Schleswig; inv. 1858 S. 322. F.S. 3677.
Literature: Matešić 2015, 210, 215, 513, pl. 104 (cat. no. M1147); Wijnhoven 2015c, 23, 25; 2017, 186, 193.

Thorsberg 6 *(fig. 8.17)*
Date: C1b.
Context: bog.
Description: 23 interconnected rings. Mostly copper alloy butted rings from a trim, but also several iron riveted and solid rings. Butted rings: outer diameter 8-10 mm; inner diameter 4-7 mm; thickness 0.9-1.6 mm. Riveted rings: larger than solid rings; overlap clockwise; shape overlap mid-size oval; round rivet head; oval cross-section. Solid rings: cross-section rectangular.
Material: copper alloy, iron.
Inventory: thousands of mainly military items.
Location: Museum für Archäologie Schloss Gottorf, Schleswig, inv. 1858 S. 322 F.S. 3677.
Literature: Matešić 2015, 210, 513, pl. 104 (cat. no. M1148); Wijnhoven 2015c, 23, 25; 2017, 186, 193.

Thorsberg 7
Date: C1b.
Context: bog.
Description: 19 butted rings of which 17 are connected. 4-in-1. Butted rings: outer diameter 3.7-9 mm; inner diameter 4.3-6.1 mm; thickness 1.2-1.4 mm; cross-section round.
Material: copper alloy.
Inventory: thousands of mainly military items.
Location: Museum für Archäologie Schloss Gottorf, Schleswig; inv. 1858 S. 322 F.S. 3677.
Literature: Matešić 2015, 513, pl. 104 (cat. no. M1149); Wijnhoven 2015c, 23, 25; 2017, 186, 193.

Thorsberg 8
Date: C1b.
Context: bog.
Description: two butted copper alloy rings: outer diameter 7.4-8 mm; inner diameter 5 mm; thickness 0.4-1.5 mm; cross-section round.
Material: copper alloy.
Location: Museum für Archäologie Schloss Gottorf, Schleswig.
Literature: Matešić 2015, 513, pl. 104 (cat. no. M1150); Wijnhoven 2015c, 23, 25; 2017, 186, 193.

Thorsberg 9
Date: C1b.
Context: bog.
Description: damaged riveted ring: outer diameter 9.7 mm; inner diameter 6.7 mm; thickness 1.1.-1.3 mm; cross-section oval.
Material: copper alloy.
Inventory: thousands of mainly military items.
Location: Museum für Vor- und Frühgeschichte Berlin, inv. II 9586a.
Literature: Hansen 2003, 179-180 (cat. no. C125); Matešić 2015, 513, pl. 104 (cat. no. M1151); Wijnhoven 2015c, 23, 25; 2017, 186, 193.

Thorsberg 10 *(fig. 11.32)*
Date: C1b.
Context: bog.
Description: mail remains in flexible condition, but affected by ring loss. Also 17 loose rings. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter 9.5-10 mm; inner diameter 6-8.5 mm; overlap clockwise; shape overlap mid-size oval; rivet head on both sides; cross-section wire oval. Solid rings: outer diameter 8-9 mm; inner diameter 6.5-7.5 mm; cross-section D-shaped and some rings have a multi-faceted outer surface.
Material: iron rings with copper alloy rivets.
Inventory: closed context: set of fasteners (Thorsberg 31), a copper alloy mounting covered with silver sheet, buckle.
Location: Museum für Archäologie Schloss Gottorf, Schleswig; inv. uncertain: F.S. 3676 or F.S. 6234.
Literature: Hansen 2003, 179 (cat. no. C124); Matešić 2015, 210, 212-213, 215, 219-212, 516, pl. 107 (cat. no. M1168); Raddatz 1987, 62 (cat. no. 413.1); Rose 1906, 50, fig. 16; Wijnhoven 2015c, 23, 25; 2017, 186, 192-193.

Thorsberg 11
Date: C1b.
Context: bog.
Description: several mail fragments and loose rings. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter 8.9-10.3 mm; inner diameter 7.2-8.2 mm; thickness 0.9-2.4 mm. Solid

rings: outer diameter 8.3 mm; inner diameter 5.7-6.8 mm; thickness 0.5-0.8 mm.
Material: iron rings, some with copper alloy rivets.
Inventory: thousands of mainly military items.
Location: Museum für Archäologie Schloss Gottorf, Schleswig, inv. F.S. 3673-3677?
Literature: Matešić 2015, 210, 212-213, 215, 221, 516, pl. 108 (cat. no. M1169); Rose 1906, 50, fig. 16; Wijnhoven 2015c, 23, 25, 27; 2017, 186, 192-193.

Thorsberg 12
Date: C1b.
Context: bog.
Description: one riveted and one solid ring. Riveted ring (has opened): outer diameter 10.6-13 mm; inner diameter 6.8-9.3 mm; wire thickness 1.3 mm; overlap clockwise; shape overlap mid-size oval; round rivet head; cross-section oval. Solid ring: outer diameter 8.5 mm; inner diameter 6.7 mm; thickness 0.9-1.2 mm; cross-section D-shaped.
Fixture: two sets of fasteners (one complete and one incomplete) that regulate the head opening. Each set is made of two parts: one with an eyelet and one with a hook.
Material: rings: iron with copper alloy rivet; fixtures: copper alloy.
Inventory: thousands of mainly military items.
Location: Nationalmuseet, Copenhagen, inv. S. 94 24857 (M1180); Museum für Archäologie Schloss Gottorf, Schleswig (M1181).
Literature: Hansen 2003, fig. 30.7; Matešić 2015, 219-221, 520-521, pl. 109 (cat. no. M1180-M1181); Przybyła 2010, 160-161, fig. 49.3-4; Raddatz 1987, 62, pl. 34.3-4 (cat. no. 418-419); Wijnhoven 2015b, 98, fig. 18.5-7; 2015c, 23, 25, 27; 2017, 186, 192-193.

Thorsberg 13
Date: C1b.
Context: bog.
Description: large mail fragment in flexible condition, measuring c. 60 by 40 cm. It may come from the same coat as Thorsberg 14 and 15. Despite many holes and tears, the weave is still intact in various places. Small part of the rings are corroded solid. During restoration two pieces became detached. These came from the left and right and may represent parts of the sleeves. 4-in-1. All rings are riveted: outer diameter: 8.1-11.4 mm; inner diameter 6-7 mm; thickness 1-2 mm; overlap anti-clockwise; shape overlap mid-size oval; large rivet heads; cross-section wire oval; evidence for strip drawing found on rings in a groove following its circumference.
Material: iron.
Inventory: found near the *Spangenkappe* (i.e. remnants of a helmet).
Location: Museum für Archäologie Schloss Gottorf, Schleswig, inv. 1858 S.321 F.S. 3674.
Literature: Matešić 2015, 212, 215, 223, 513-514, pl. 104-105 (cat. no. M1152, M1153, M1154); Raddatz 1987, 61 (cat. no. 408); Rose 1906, 50; Waurick 1982, 113.

Thorsberg 14 *(fig. 11.33)*
Date: C1b.
Context: bog.
Description: various small mail fragments in flexible, but damaged condition. These remains may have belonged to the same coat as Thorsberg 13 and 15. 4-in-1. Made of all riveted rings: outer diameter 8.7-10.3 mm; inner diameter 5.5-7 mm; overlap anti-clockwise; shape overlap mid-size oval; round rivet head on both sides; thickness 0.8-1.7 mm; cross-section wire oval.
Material: iron.
Inventory: thousands of mainly military items.
Location: Archäologisches Museum Hamburg, inv. H.H 564.65.
Literature: Engelhardt 1866, 46; Hansen 2003, 179-180 (cat. no. C125); Matešić 2015, 212, 215, 514 pl. 105 (cat. no. M1155).

Thorsberg 15
Date: C1b.
Context: bog.
Description: fragment of c. 20 rings in flexible condition. These remains may have belonged to the same coat as Thorsberg 13 and 14. 4-in-1. All riveted rings: outer diameter: 9.4-10.1 mm; inner diameter 6.2-6.7 mm; thickness 1.2-1.5 mm; overlap anti-clockwise; shape overlap mid-size oval; rivet heads are round and large.
Material: iron.
Inventory: thousands of mainly military items.
Location: Nationalmuseet, Copenhagen; probably inv. 19503.
Literature: Engelhardt 1866, 46; Matešić 2015, 212, 514, pl. 105 (cat. no. M1156).

Thorsberg 16
Date: AD 220-240.
Context: bog.
Description: large piece of mail measuring c. 60 x 41-59 cm, in fragmented, but flexible condition. These remains may have come from the same coat as Thorsberg 18 and 20. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter 10.5-12.5 mm; inner diameter 6.7-9 mm; overlap clockwise; shape overlap mid-size oval; rivet head on both sides; cross-section wire oval; thickness 1.4-1.7 mm; width 1.3-3.1 mm. Solid rings: outer diameter 12-12.5 mm; inner diameter 8.8-9.8 mm; thickness 1-1.4 mm; width 1.9-2.3 mm; cross-section D-shaped.
Fixture: two sets of hinged fasteners that were originally located at the shoulders to regulate the head opening. The fasteners are made from embossed sheet decorated with extensive filigree work.
Material: rings: iron; fixtures: gold, silver and copper alloy.
Inventory: half of the fastener sets were deposited in a ceramic vessel, while their corresponding parts were excavated in another place at the site. Closed context ceramic vessel: horse harness parts (Thorsberg 32), decorated disk.
Location: Museum für Archäologie Schloss Gottorf, Schleswig; inv. 1858 S. 318-320 F.S. 3673.
Literature: Engelhardt 1863, 27, 29-30, pl. 7.8; 1866, 46-47, pl. 7.8; Hansen 2003, 179, fig. 30.6-7 (cat. no. C123); Matešić 2015, 127-129, 212-213, 215, 219-224, 514, 517-518, pl. 105, 108 (cat. no. M1157, M1172, M1173); Raddatz 1987, 59-61, pl. 94-96 (cat. no. 407); Rose 1906, 49-50, fig. 15; Von Carnap-Bornheim 1997, 76-77, 80; 2004, pl. 34.5; Werner 1941, pl. 7.1; Wijnhoven 2015b, 96-97, fig. 17.

Thorsberg 17
Date: C1b.
Context: bog.
Description: large part of a mail coat measuring c. 58 x 41 cm, in fragmented, but flexible condition. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter 10-11 mm; inner diameter 5.7-8.4 mm; overlap clockwise; shape overlap mid-size oval; rivet head on both sides; cross-section wire oval; thickness 1.4-1.7 mm; width 1.4-2.5 mm. Solid rings: outer diameter 9.4-10 mm; inner diameter 6.9-7.2 mm; thickness 1-1.4 mm; width 1.5-2.3 mm; cross-section D-shaped.
Material: iron.
Inventory: thousands of mainly military items.
Location: Museum für Archäologie Schloss Gottorf, Schleswig; inv. is wrong.
Literature: Matešić 2015, 213, 215, 218, 514-515, pl. 106 (cat. no. M1158); Raddatz 1987, 59 (cat. no. 407.1).

Thorsberg 18
Date: C1b.
Context: bog.
Description: six or seven large mail fragments in flexible condition. These remains may have come from the same coat as Thorsberg 16 and 20. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter 10.2-12 mm; inner diameter 6-7.7 mm; cross-section wire oval; thickness 1.3-2mm. Solid rings: outer diameter 9.8-10 mm; inner diameter 6.7-9 mm; thickness 1-2 mm; cross-section D-shaped.
Material: iron.
Inventory: thousands of mainly military items.
Location: Nationalmuseet, Copenhagen; probably inv. S. 93-94 24853 or 24852.
Literature: Matešić 2015, 213, 215, 515, pl. 106-107 (cat. no. M1159, M1160); Raddatz 1987, 62 (cat. no. 416?).

Thorsberg 19
Date: C1b.
Context: bog.
Description: five large and eight small mail fragments. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter 9.6-13 mm; inner diameter 7.3-8 mm; cross-section wire oval; thickness 1-2mm. Solid rings: outer diameter 9.3-10 mm; inner diameter 7-7.3 mm; thickness 0.8-2.1 mm; cross-section D-shaped.
Material: iron.
Inventory: thousands of mainly military items.
Location: Nationalmuseet, Copenhagen; probably inv. S. 93-94 24853 or 24852.
Literature: Matešić 2015, 213, 215, 515, pl. 107 (cat. no. M1161); Raddatz 1987, 62 (cat. no. 416?).

Thorsberg 20
Date: C1b.
Context: bog.
Description: ten or eleven mail fragments in flexible condition. These remains may have come from the

same coat as Thorsberg 16 and 18. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter 10-12.5 mm; inner diameter 7.7-8.7 mm; overlap clockwise; shape overlap mid-size oval; round rivet heads on both sides; cross-section wire oval; thickness 1.2-2.5mm. Solid rings: outer diameter 9.8-10.2 mm; inner diameter 6.4-7.2 mm; thickness: 1.4-2.3 mm; cross-section D-shaped.
Material: iron.
Inventory: thousands of mainly military items.
Location: Nationalmuseet, Copenhagen; inv. 19503 (likely wrong number).
Literature: Matešić 2015, 213, 515, pl. 107 (cat. no. M1162); Raddatz 1987, 62 (cat. no. 416?).

Thorsberg 21
Date: C1b.
Context: bog.
Description: mail fragment in flexible condition. The fragment preserves a straight edge. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: overlap clockwise; shape overlap mid-size oval; round rivet head; cross-section oval; wire is much thicker than solid rings. Solid rings: cross-section D-shaped.
Material: iron.
Inventory: thousands of mainly military items.
Remarks: Thorsberg provenance is not entirely certain.
Location: Paris.
Literature: Matešić 2015, 213, 515, pl. 107 (cat. no. M1163).

Thorsberg 22
Date: C1b.
Context: bog.
Description: mail fragment consisting of c. 35 rings in flexible condition. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter 10.7-11.6 mm; inner diameter 6.4-8.7 mm; thickness 1.2-2.1 mm; cross-section oval. Solid rings: outer diameter 9.7-10.6 mm; inner diameter 7-7.4 mm; thickness 1-2.5 mm; cross-section D-shaped with multi-faceted appearance on the outside. The inventory number also contains two loose rings)that are thin and have an outer diameter of c. 7 mm; they must have come from another mail coat.
Material: iron.
Inventory: thousands of mainly military items.
Location: Nationalmuseet, Copenhagen; inv. C4209.
Literature: Matešić 2015, 213, 215, 516, pl. 107 (cat. no. M1164).

Thorsberg 23
Date: C1b.
Context: bog.
Description: seven fragmented loose rings (solid and riveted). Rings: outer diameter c. 10-12.6 mm; inner diameter c. 7.1 mm; thickness c. 1.3-2.4 mm.
Material: iron.
Inventory: thousands of mainly military items.
Location: Museum für Archäologie Schloss Gottorf, Schleswig; inv. F.S. 3673-3677?
Literature: Matešić 2015, 213, 516, pl. 107 (cat. no. M1165).

Thorsberg 24
Date: C1b.
Context: bog.
Description: solid mail ring: outer diameter 8.5 mm; inner diameter 6.9 mm; cross-section 0.6 x 1.2 mm.
Material: iron.
Inventory: thousands of mainly military items.
Location: Nationalmuseet, Copenhagen.
Literature: Matešić 2015, 215, 516, pl. 107 (cat. no. M1166).

Thorsberg 25
Date: C1b.
Context: bog.
Description: several loose riveted- and solid rings. Rings: outer diameter 10.3 and 8.4 mm; inner diameter 7.8 and 6.6 mm; thickness 1.1 and 0.7 mm. An interconnected riveted and solid ring: outer diameter 8.8 and 8.6 mm; inner diameter 8.1 and 6.9 mm; thickness 1.1. and 0.5 mm. Another interconnected riveted and solid ring: outer diameter 10.7 and 8.4-8.5; inner diameter 7.8 and 6.5-6.8 mm; thickness 1.5 and 0.7-1.2 mm.
Material: iron.
Inventory: thousands of mainly military items.
Location: Museum für Archäologie Schloss Gottorf, Schleswig; inv. F.S. 3673-3677?
Literature: Matešić 2015, 212-213, 516, pl. 107 (cat. no. M1167).

Thorsberg 26
Date: C1b.
Context: bog.

Description: mail fragment and several loose rings. Iron rings: diameter 10 mm. Copper alloy rings: diameter 8.5-11 mm.
Material: iron, copper alloy.
Inventory: thousands of mainly military items.
Location: Nationalmuseet, Copenhagen.
Literature: Matešić 2015, 213-214, 516 (cat. no. M1170); Raddatz 1987, 62 (cat. no. 416).

Thorsberg 27
Date: C1b.
Context: bog.
Description: two large mail fragments, nowadays supported by textile. One measures 58 x 40-60 cm and the other 58 x 42 cm. Riveted rings: diameter 12-12.8 mm. Solid rings: diameter 11.5-13 mm.
Material: iron.
Inventory: thousands of mainly military items.
Remarks: this fragment is described by Raddatz, but could not be found in 2015.
Location: Nationalmuseet, Copenhagen.
Literature: Matešić 2015, 213-214, 516 (cat. no. M1171); Raddatz 1987, 62 (cat. no. 415).

Thorsberg 28
Date: C1b.
Context: bog.
Description: three rings (riveted and solid) attached to a fixture. Rings: outer diameter 11-12 mm; inner diameter 9-9.5 mm; thickness 1.3-1.4 mm.
Fixture: round mail fixture of unknown function. The fixture is covered in embossed silver sheet that has been gilded.
Material: rings: iron; fixture: (gilded) silver, copper alloy.
Inventory: thousands of mainly military items.
Location: Nationalmuseet, Copenhagen, inv. 1860 S. 187 F.S. 6237.
Literature: Matešić 2015, 219, 519-520, pl. 108 (cat. no. M1177); Raddatz 1987, pl. 97.2 (cat. no. 412); Wijnhoven 2015b, 99, fig. 19.2.

Tötensen
Date: late 3rd - early 5th century AD.
Context: funerary.
Description: mail fragments.
Literature: Müller 2003, 438.

Trier - Augusta Trevorum
Date: 4th century AD.
Context: settlement - storage of metal for recycling.
Description: mail fragment c. 21 cm wide, perhaps an aventail for a helmet. 4-in-1.
Material: iron.
Inventory: remnants of iron, copper alloy box fittings, small metal implements, part of a helmet, copper alloy scales.
Location: Rheinisches Landesmuseum, Trier, inv. EV1975-11.
Literature: Bishop/Coulston 2006, 208; Fischer 2012, 159; MacDowall 1994, 57; 1996, 19; Miks 2008, 14, fig. 21; 2014, 218, pl. 51.

Wartberg
Date: LT?
Description: coat of mail.
Material: iron.
Remarks: the mail coat was found in 1818 during stone breaking operations on the top of this hill.
Literature: Schrickel 1969, 10, 91.

Weißenburg 1 *(fig. 9.5)*
Date: mid-3rd century AD.
Context: Roman fort - building P.
Description: large mail fragment corroded into a solid block measuring 41 x 15.7 cm. Eight mail fragments, partly flexible. Eleven mail fragments, heavily corroded. In addition 25 very small fragments. 4-in-1. Reported in literature to be made from riveted and solid rings, as well as butted ones. Examination of the large fragment by the author shows that it is very corroded, but at least has solid rings. There is no evidence for butted rings in this fragment.
Material: iron.
Remarks: large fragment examined by the author.
Location: Römermuseum Weißenburg, inv. WUG 22.
Literature: Alfs 1941, 77; Beck/Chew 1991, 163; Boube-Piccot 1994, 55; Fabricius/Sarwey 1906, 39, pl. 8.77-78; Hansen 2003, 167 (cat. no. C17); Junkelmann 1986, pl. 44; 1992, 188, fig. 168; MacDowall 1995, 13; Novichenkova 2011, 278; Rose 1906, 6; Van der Sanden 1993, 4 (cat. no. 39); Waurick 1982, 111; Zanier 1992, 313.

Weißenburg 2 *(fig. 6.12)*
Date: *terminus ante quem* AD 254.
Context: *vicus* - burnt cellar of a house.
Description: two large mail fragments in solid condition. The majority of the rings is iron, but copper alloy rings are also found throughout the fragments. These are placed within the matrix of iron rings forming a repetitive geometric design, measuring 3 to 5 or 6 ring rows high and at least several rings wide. 4-in-1. Rings: outer diameter c. 10 mm; inner diameter c. 6.2 mm; no size difference between iron and copper alloy rings.
Material: iron, copper alloy.
Remarks: examined by the author.
Location: Archäologische Staatssammlung München, find no. 459.
Literature: Wijnhoven 2015c, 25; 2017, 186-188, 193, fig. 10. Pers. comm. F.-S. Kirch 2015.

Westerwanna 1
Date: C3.
Context: funerary - burial 389.
Description: mail fragment. Rings: outer diameter c. 12 mm; inner diameter c. 10 mm.
Material: iron.
Inventory: three bronze finger rings, scissors, awl, various bronze objects, needles, beads, glass fragments, bone ring, spindle whorl, ceramics.
Location: Archäologisches Museum Hamburg, inv. 389.
Literature: Hansen 2003, 176 (cat. no. C97); Künzl 2002, 137 (cat. no. 11); Röhrer-Ertl 1971, 142; Waurick 1982, 115-116 (cat. no. 11).

Westerwanna 2
Date: C.
Context: funerary - burial 486.
Description: mail armour.
Material: iron.
Inventory: scissors, tweezers, iron and bronze objects, three beads, ceramics, bones.
Location: Archäologisches Museum Hamburg, inv. 486.
Literature: Hansen 2003, 176-177 (cat. no. C98); Künzl 2002, 137 (cat. no. 11); Röhrer-Ertl 1971, 142, 173; Waurick 1982, 115-116 (cat. no. 11).

Westerwanna 3
Date: C/D.
Context: funerary - burial 723.
Description: mail fragment measuring 4.2 x 3.2 cm. Rings: outer diameter 9-11 mm; inner diameter 6-8 mm.
Material: iron.
Inventory: knife, bronze buckle, hook key, needle, various bronze and iron objects, beads, bone needle box, bone needle, spindle whorl, ceramics, bones.
Location: Archäologisches Museum Hamburg, inv. 723.
Literature: Hansen 2003, 177 (cat. no. C99); Künzl 2002, 137 (cat. no. 11); Röhrer-Ertl 1971, 142; Waurick 1982, 115-116 (cat. no. 11).

Westerwanna 4
Date: C2/D.
Context: funerary - burial 818.
Description: mail fragment measuring 6.4 x 3 cm.
Material: iron.
Inventory: knife, bronze coin (AD 285-305), needle, bronze fragments, bone needle box, bead, molten glass, two ceramic vessels.
Location: Archäologisches Museum Hamburg, inv. 818.
Literature: Hansen 2003, 177 (cat. no. C100); Künzl 2002, 137 (cat. no. 11); Röhrer-Ertl 1971, 142; Waurick 1982, 115-116 (cat. no. 11).

Westerwanna 5
Date: C/D.
Context: funerary - burial 1002.
Description: mail.
Material: iron.
Inventory: sword fragments, knife, scissors, bronze fragments.
Location: Archäologisches Museum Hamburg, inv. 409.
Literature: Hansen 2003, 177 (cat. no. C101); Künzl 2002, 137 (cat. no. 11); Röhrer-Ertl 1971, 142; Waurick 1982, 115-116 (cat. no. 11).

Westerwanna 6
Date: C3/D.
Context: funerary - burial 1012.
Description: mail armour.
Material: iron.

Inventory: iron and bronze objects, ceramics.
Location: Archäologisches Museum Hamburg, inv. 419.
Literature: Hansen 2003, 177 (cat. no. C102); Künzl 2002, 137 (cat. no. 11); Röhrer-Ertl 1971, 142, 180; Waurick 1982, 115-116 (cat. no. 11).

Westerwanna 7
Date: C3/D.
Context: funerary - burial 1174.
Description: mail armour.
Material: iron.
Inventory: knife handle, brooch, various bronze and iron objects, bone needle box, spindle whorl.
Location: Archäologisches Museum Hamburg, inv. 863.
Literature: Hansen 2003, 177 (cat. no. C103); Künzl 2002, 137 (cat. no. 11); Röhrer-Ertl 1971, 143, 177; Waurick 1982, 115-116 (cat. no. 11).

Westerwanna 8
Date: C/D.
Context: funerary - burial 1563.
Description: mail armour.
Material: iron.
Inventory: brooch, belt buckle.
Literature: Hansen 2003, 177 (cat. no. C104); Künzl 2002, 137 (cat. no. 11); Röhrer-Ertl 1971, 143; Waurick 1982, 115-116 (cat. no. 11).

Westerwanna 9
Date: C/D.
Context: funerary - burial 1645.
Description: mail fragment measuring 2 x 1.6 cm. Rings: outer diameter 12 mm; inner diameter 8 mm.
Material: iron.
Inventory: iron object, ceramics.
Location: Archäologisches Museum Hamburg, inv. Mfv. 1901:76.
Literature: Hansen 2003, 177 (cat. no. C105); Künzl 2002, 137 (cat. no. 11); Röhrer-Ertl 1971, 143, 164; Waurick 1982, 115-116 (cat. no. 11).

Westerwanna 10
Date: C/D.
Context: funerary - burial 1654.
Description: various mail fragments.
Material: iron.
Inventory: knife, two brooch fragments, various bronze objects, glass remains.
Location: Archäologisches Museum Hamburg, inv. Mfv. 190: without number.
Literature: Hansen 2003, 177 (cat. no. C106); Künzl 2002, 137 (cat. no. 11); Röhrer-Ertl 1971, 143; Waurick 1982, 115-116 (cat. no. 11).

Westerwanna 11
Date: C3/D.
Context: funerary - burial 1707.
Description: mail fragment measuring 6.4 x 2.8 cm. Rings: outer diameter 8-10 mm; inner diameter 5-8 mm.
Material: iron.
Inventory: ceramic vessel.
Location: Archäologisches Museum Hamburg, inv. Mfv. 1903:29.
Literature: Hansen 2003, 177 (cat. no. C107); Künzl 2002, 137 (cat. no. 11); Röhrer-Ertl 1971, 143, 172; Waurick 1982, 115-116 (cat. no. 11).

Westerwanna 12
Date: C/D.
Context: funerary - burial 1761.
Description: six rings. Rings: outer diameter 14 mm; inner 8 mm. Uncertain if this is mail.
Material: iron.
Inventory: brooches, various iron objects, clay bead, ceramics.
Location: Archäologisches Museum Hamburg, inv. Mfv. 1903:87.
Literature: Hansen 2003, 177 (cat. no. C108); Künzl 2002, 137 (cat. no. 11); Röhrer-Ertl 1971, 143, pl. 19; Waurick 1982, 115-116 (cat. no. 11).

Westerwanna 13
Date: C2.
Context: funerary - burial 1894.
Description: mail fragment measuring 3.6 x 3.3 cm. Rings: outer diameter c. 11 mm; inner diameter 8 mm.
Material: iron.
Inventory: brooch, tweezers, molten glass, ceramics.
Remarks: burial of a man.
Location: Archäologisches Museum Hamburg, inv. Mfv. 1904:134.
Literature: Hansen 2003, 177-178 (cat. no. C109); Künzl 2002, 137 (cat. no. 11); Röhrer-Ertl 1971, 143, pl. 19; Waurick 1982, 115-116 (cat. no. 11).

Westerwanna 14
Date: C/D.
Context: funerary - burial 1936.
Description: mail fragment measuring 3.1 x 1.4 cm. 4-in-1. Rings: outer diameter 8-10 mm; inner diameter 5-7 mm
Material: iron.
Inventory: brooch, molten glass, ceramics.
Location: Archäologisches Museum Hamburg, inv. Mfv. 1904:176.
Literature: Hansen 2003, 178 (cat. no. C110); Künzl 2002, 137 (cat. no. 11); Röhrer-Ertl 1971, 143, pl. 19; Waurick 1982, 115-116 (cat. no. 11).

Westerwanna 15
Date: C3/D.
Context: funerary - burial 1959/1970.
Description: two mail fragments measuring 5.4 x 3 cm and 4.6 x 3 cm. 4-in-1. Rings: outer diameter 6-8 mm; inner diameter 4-6 mm.
Material: iron.
Inventory: bronze fittings, glass bead, ceramics.
Location: Archäologisches Museum Hamburg, inv. Mfv. 1905:24.
Literature: Hansen 2003, 178 (cat. no. C111); Künzl 2002, 137 (cat. no. 11); Röhrer-Ertl 1971, 143, 177, pl. 19; Waurick 1982, 115-116 (cat. no. 11).

Westerwanna 16
Date: C/D.
Context: funerary - burial 2013.
Description: mail fragment measuring 3.6 x 3 cm. Rings: outer diameter 14-16 mm; inner diameter 8-9 mm.
Material: iron.
Inventory: brooch, needle, molten glass, ceramics.
Location: Archäologisches Museum Hamburg, inv. Mfv. 1905:35.
Literature: Hansen 2003, 178 (cat. no. C112); Künzl 2002, 137 (cat. no. 11); Röhrer-Ertl 1971, 143, pl. 19; Waurick 1982, 115-116 (cat. no. 11).

Westerwanna 17
Date: C/D.
Context: funerary - burial 2067.
Description: mail fragment measuring 3.4 x 2 cm. Rings: outer diameter c. 8 mm; inner diameter 5-6 mm.
Material: iron.
Inventory: molten glass, ceramics, pieces of clay.
Location: Archäologisches Museum Hamburg, inv. Mfv. 1905:125.
Literature: Hansen 2003, 178 (cat. no. C113); Künzl 2002, 137 (cat. no. 11); Röhrer-Ertl 1971, 143, 180; Waurick 1982, 115-116 (cat. no. 11).

Westerwanna 18
Date: C/D.
Context: funerary - burial 2071.
Description: mail fragment measuring 2.4 x 1.7 cm. Rings: outer diameter 8-10 mm; inner diameter 6-8 mm.
Material: iron.
Inventory: brooch, molten bronze, molten glass, ceramics.
Location: Archäologisches Museum Hamburg, inv. Mfv. 11905:129.
Literature: Hansen 2003, 178 (cat. no. C114); Künzl 2002, 137 (cat. no. 11); Röhrer-Ertl 1971, 143; Waurick 1982, 115-116 (cat. no. 11).

Westerwanna 19
Date: C/D.
Context: funerary - burial 2081.
Description: mail fragment measuring 6.2 x 3 cm. Part of the rings is riveted. Rings: outer diameter 10 mm; inner diameter 7 mm.
Material: iron.
Inventory: brooch, molten glass, iron ring, ceramic sherds.
Location: Archäologisches Museum Hamburg, inv. Mfv. 1905:139.
Literature: Hansen 2003, 178 (cat. no. C115); Künzl 2002, 137 (cat. no. 11); Röhrer-Ertl 1971, 143, pl. 19; Waurick 1982, 115-116 (cat. no. 11).

Westerwanna 20
Date: C/D.
Context: funerary.
Description: mail fragment measuring 3 x 2 cm. Rings: outer diameter 14 mm; inner diameter 8 mm.
Material: iron.
Location: Archäologisches Museum Hamburg, inv. Mfv. 1901: -.
Literature: Hansen 2003, 178 (cat. no. C116); Künzl 2002, 137 (cat. no. 11); Röhrer-Ertl 1971, pl. 19; Waurick 1982, 115-116 (cat. no. 11).

Wilhelmsaue
Date: C/D.
Context: funerary - burial 73.
Description: chain made from rings. Rings: outer diameter 7-10 mm; inner diameter 4-5 mm. Uncertain if this is mail armour.
Material: iron.
Inventory: knife, bone comb, glass bead, molten glass, perforated vertebrae, molten silver spheres and fragments (brooch?), various bronze objects, stone plates, sherds of two vessels.
Literature: Hansen 2003, 82, 182 (cat. no. C146).

Wollenrade
Date: C/D.
Context: funerary.
Description: small mail fragment.
Material: iron.
Inventory: ceramics.
Location: formerly in Altmärkisches Museum der Hansestadt Stendal, inv. 2916.
Literature: Hansen 2003, 181 (cat. no. C141); Künzl 2002, 137 (cat. no. 18); Van der Sanden 1993, 4 (cat. no. 41); Waurick 1982, 115 (cat. no. 18).

Wonsheim
Date: AD 450-750.
Context: funerary.
Description: mail fragments.
Literature: Müller 2003, 62.

Wulferstedt
Date: C1/C2.
Context: funerary - burial 4.
Description: iron rings: diameter 5 mm.
Material: iron.
Inventory: comb, two bone needles, ceramics.
Literature: Hansen 2003, 181 (cat. no. C143).

Xanten 1 *(fig. 8.18)*
Date: 2nd half 1st - early 2nd century AD.
Context: settlement next to the Roman fort.
Description: 46 small fragments and 70 loose rings. Some fragments have iron rings, others have primarily copper alloy rings with some iron rings attached. There are two long copper alloy fragments that are three rows deep. Given their shape and the direction of the weave these are pieces of trim placed either at the head opening or at the hem of the mail coat. The considerable size of some copper alloy fragments makes it unlikely that all are trims. Some may concern patterns inserted into the iron matrix of the coat. One fragment has a triangular shape. 4-in-1. Alternating rows of riveted and solid rings. Copper alloy riveted rings: outer diameter 7-10 mm overlap clockwise; shape overlap stumpy; round rivet heads; cross-section wire oval. Copper alloy solid rings: outer diameter 5-9 mm; cross-section D-shaped; some have a multi-faceted outer surface. Some rings have an overlap, but have been left unriveted; there are likely repairs. Iron riveted rings: outer diameter rings 6-8mm (most c. 6 mm). Iron solid rings: outer diameter 4-7 mm.
Material: iron, copper alloy.
Inventory: unknown. The artefact was located in a box together with pottery remains.
Remarks: observed by the author through museum glass.
Location: LVR-Römermuseum Xanten.
Literature: Lenz 2006, 19-20, pl. 17-18 (cat. no. 132a-b); Wijnhoven 2015c, 25; 2017, 186-187, 193.

Xanten 2 *(figs. 11.1, 11.16)*
Date: 1st - early 2nd century AD.
Context: settlement next to the Roman fort.
Description: mail fragment 41 rows deep and c. 7-15 rings wide. 4-in-1. Alternating rows of riveted and solid rings. Rings: outer diameter c. 3 mm. Riveted rings: larger than solid rings; overlap clockwise; rivet head is round; cross-section wire round; flattening of the overlap also flattened the adjacent parts; shape overlap stumpy. Solid rings: cross-section rectangular; presence of conical deformation.
Material: copper alloy.
Remarks: observed by the author through museum glass.
Location: LVR-Römermuseum Xanten, inv. 36392.
Literature: Lenz 2006, 20, pl. 18 (cat. no. 133); Wijnhoven 2015c, 25; 2017, 186-187, 193.

Zauschwitz
Date: C1-C2.
Context: funerary - burial 9.
Description: three fragments of corroded rings and a loose ring. Rings: outer diameter 8-9 mm; inner diameter 5-6 mm. Uncertain if this is mail.
Material: iron.
Inventory: bone and bronze needles, bone comb, pen-

dants, glass slag, burned glass, various metal objects, ceramics.
Remarks: burial of a child.
Location: Landesmuseum für Vorgeschichte Dresden, inv. S.: 2547/63.
Literature: Hansen 2003, 182 (cat. no. C150).

Zugmantel
Date: AD 180-260.
Context: Roman fort.
Description: many corroded mail fragments, which together may represent a dozen mail coats. Total current weight almost 25 kg. Rings: outer diameter 8 and 10 mm. 4-in-1. Alternating rows of riveted and solid rings.
Material: iron.
Inventory: *lorica segmentata* fragments, *denarius* of the reign of Commodus, greave, numerous other items.
Location: Römerkastell Saalburg, inv. ZM1425, ZM4951.
Literature: Alfs 1941, 77, fig. 11; Baatz 1963/1964, 51; Beck/Chew 1991, 163; Bishop 2001, 42; 2015a, 23; Boube-Piccot 1994, 55; Greiner 2006, 199; Hansen 2003, 77, 166 (cat. no. C4); Novichenkova 2011, 278; Robinson 1969, 10; 1975, 171; Van der Sanden 1993, 4 (cat. no. 35, 42); Waurick 1982, 111; Zanier 1992, 312-313.

GREECE

Mount Athos
Date: AD 975-1025.
Description: mail coat in flexible condition. 4-in-1. Rings: outer diameter 10 mm. It is made entirely of riveted rings.
Material: the iron mail rings have been gilded.
Remarks: mail coat traditionally associated with the Byzantine general Leo Tornikios, c. AD 980.
Location: Iviron Monastery.
Literature: D'Amato 2012, 54, 56; Petrov *et al.* 2015, 575-576.

Samothrace
Date: 6th century BC – 5th century AD. Refined date: late 1st century BC - 2nd century AD.
Context: temple.
Description: six mail fragments. 4-in-1. Rings: outer diameter 3 mm.
Material: iron.
Inventory: statues, chest fixtures and key, bronze vessels, alabaster vase, bone *pyxis*, Hellenistic vase, gold finger ring, silver nail.
Location: Archaeological Museum of Samothrace, inv. 51.551, 51.656-660.
Literature: Hansen 2003, 67, 109, 162 (cat. no. B12); Lehmann 1953, 9-10, pl. 5a; Nicklasson 1989, 26; Novichenkova 2011, 278; Rustoiu 2006, 49-50; Van der Sanden 1993, 4 (cat. no. 43); Völling 1999, 95; Waurick 1979, 324, 327, 330, 332, fig. 196 (cat. no. 15).

HUNGARY

Alattyán-Tulat 1
Date: AD 600-650.
Context: funerary - cemetery I - burial 14.
Description: mail fragment.
Material: iron.
Inventory: beads (from a necklace), knives, iron bracelet, earrings, small and a large cross.
Remarks: burial of a woman.
Literature: Petér 2014, 89.

Alattyán-Tulat 2
Date: AD 600-650.
Context: funerary - cemetery I - burial 23.
Description: mail fragment.
Material: iron.
Inventory: beads (from a necklace), pair of earrings, spindle whorl, animal bones.
Remarks: burial of a woman.
Literature: Petér 2014, 90.

Alattyán-Tulat 3
Date: AD 600-650.
Context: funerary - cemetery I - burial 30.
Description: mail fragment.
Material: iron.
Inventory: beads (from a necklace), bone needles, copper alloy ring, spindle whorl, silver pair of earrings.
Remarks: burial of a woman.
Literature: Petér 2014, 90.

Alattyán-Tulat 4
Date: AD 600-650.
Context: funerary - cemetery I - burial 166.
Description: mail fragment.

Material: iron.
Inventory: beads (from a necklace), wooden container, bronze ring, spindle whorls, iron knives, silver earrings.
Remarks: burial of a woman.
Literature: Petér 2014, 90.

Alattyán-Tulat 5
Date: AD 650-700.
Context: funerary - cemetery II - burial 62.
Description: mail fragment.
Material: iron.
Inventory: iron buckle, iron knives, copper alloy wire, earrings.
Remarks: burial of a child.
Literature: Petér 2014, 90.

Alattyán-Tulat 6
Date: AD 650-700.
Context: funerary - cemetery II - burial 216.
Description: mail fragment.
Material: iron.
Inventory: copper alloy rings, iron knife, copper alloy rattle, iron buckle, button, gold earrings.
Remarks: burial of a woman.
Literature: Petér 2014, 90.

Andocs-Temető 1
Date: AD 650-900.
Context: funerary - burial 75.
Description: large number of mail fragments.
Material: iron.
Inventory: copper alloy earrings, bone needle, knife, cylindrical copper alloy object.
Remarks: burial of a woman.
Literature: Petér 2014, 90.

Andocs-Temető 2
Date: AD 650-900.
Context: funerary - burial 78.
Description: mail fragment.
Material: iron.
Inventory: bronze earrings.
Remarks: burial of a woman.
Literature: Petér 2014, 90.

Andocs-Temető 3
Date: AD 650-900.
Context: funerary - burial 99.
Description: large number of mail fragments.
Material: iron.
Inventory: beads, spindle whorl.
Remarks: burial of a woman.
Literature: Petér 2014, 90.

Andocs-Temető 4
Date: AD 650-900.
Context: funerary - burial 102.
Description: mail fragment.
Material: iron.
Literature: Petér 2014, 90.

Ásotthalom-Bilisics
Date: 9th century AD.
Context: funerary - burial 1.
Description: mail fragment.
Material: iron.
Inventory: bronze bracelet, negative mould?
Remarks: burial of a woman.
Literature: Petér 2014, 91.

Cikó
Date: 7th - 8th century AD.
Context: funerary - burial 513.
Description: mail fragments located around the neck.
Material: iron.
Inventory: beaded necklace, bronze earrings, bowls, shells, copper alloy ornaments, spindle whorl, other.
Remarks: burial of a woman.
Literature: Petér 2014, 91.

Csongrád-Öregszőlők
Date: 6th - 7th century AD.
Context: funerary.
Description: mail fragment.
Material: iron.
Inventory: beads, other objects.
Remarks: burial of a woman.
Literature: Petér 2014, 91.

Gátér 1
Date: Avar period.
Context: funerary - burial 45.
Description: mail fragments.
Inventory: 14 fragments of lamellar armour.
Literature: Csallány 1972, 30-31, fig. 11, 43.

Gátér 2
Date: Avar period.
Context: funerary - burial 46.
Description: two mail fragments.
Location: Kecskemét Museum.
Literature: Csallány 1972, 39, 44.

Gátér 3
Date: Avar period.
Context: funerary - burial 59.
Description: mail fragments of iron and one fragment that also has copper alloy rings.
Material: iron, copper alloy.
Inventory: bronze earring, various beads, other object(s).
Remarks: burial of a woman.
Location: Kecskemét Museum.
Literature: Csallány 1972, 39, 43-44; Petér 2014, 92.

Gátér 4
Date: Avar period.
Context: funerary - burial 63.
Description: mail remains.
Inventory: knife, beads, bronze earrings.
Location: Kecskemét Museum.
Literature: Csallány 1972, 38, 43; Petér 2014, 92.

Gátér 5
Date: Avar period.
Context: funerary - burial 83.
Description: mail fragment.
Inventory: spindle whorl, bronze earring, decorated bone sheath, various (glass, amber) beads.
Remarks: burial of woman.
Location: Kecskemét Museum.
Literature: Csallány 1972, 38, 43; Petér 2014, 92.

Gátér 6
Date: Avar period.
Context: funerary - burial 107.
Description: mail rings corroded together.
Material: iron.
Inventory: iron plate, other object (sword tip?).
Remarks: burial of a man.
Location: Kecskemét Museum.
Literature: Csallány 1972, 38, 43; Petér 2014, 92.

Gátér 7
Date: Avar period.
Context: funerary - burial 136.
Description: mail fragment.
Inventory: single lame of lamellar armour, two iron buckles, beads, silver earring, spindle whorls, some other objects.
Remarks: burial of a woman.
Location: Kecskemét Museum.
Literature: Csallány 1972, 31, 43.

Gátér 8
Date: Avar period.
Context: funerary - burial 151.
Description: three mail fragments and three large iron rings.
Inventory: beads, spindle whorls.
Remarks: burial of a woman.
Location: Kecskemét Museum.
Literature: Csallány 1972, 38, 43; Petér 2014, 92, pl. 13.3.

Gátér 9
Date: Avar period.
Context: funerary - burial 153.
Description: small mail rings and an iron buckle. Uncertain if the two were part of the same artefact.
Inventory: three lames from lamellar armour, buckles.
Location: Kecskemét Museum.
Literature: Csallány 1972, 31, 43.

Gátér 10
Date: Avar period.
Context: funerary - burial 167.
Description: mail armour.
Material: iron.
Inventory: silver belt elements, flint, ceramic vessels, other objects.
Remarks: burial of a man.
Location: Kecskemét Museum.
Literature: Csallány 1972, 38, 43; Petér 2014, 92.

Gátér 11
Date: Avar period.
Context: funerary - burial 170.
Description: four mail fragments.
Material: iron.
Inventory: iron buckle, bronze earring, glass beads, other objects.
Remarks: burial of a woman.

Location: Kecskemét Museum.
Literature: Csallány 1972, 39, 44; Petér 2014, 92.

Gátér 12
Date: Avar period.
Context: funerary - burial 174.
Description: mail fragment.
Inventory: parts of lamellar armour, earring, six glass beads, other objects.
Remarks: burial of a woman.
Location: Kecskemét Museum.
Literature: Csallány 1972, 31, 43.

Gátér 13
Date: Avar period.
Context: funerary - burial 221.
Description: mail fragment made from large rings. Also fragment with smaller rings. Buckle and mail are mentioned together, but it is uncertain if they belong together.
Material: iron.
Inventory: iron buckle, lame of lamellar armour.
Remarks: burial of a woman.
Location: Kecskemét Museum.
Literature: Csallány 1972, 32, 43.

Gátér 14
Date: Avar period.
Context: funerary - burial 238.
Description: mail armour.
Material: iron?
Inventory: knife, bronze brooch, fragments of lamellar armour, iron chains, bracelet.
Remarks: burial of a woman.
Location: Kecskemét Museum.
Literature: Csallány 1972, 39, 43; Petér 2014, 92.

Gátér 15
Date: Avar period.
Context: funerary - burial 251.
Description: fragment of mail.
Inventory: lame of lamellar armour.
Location: Kecskemét Museum.
Literature: Csallány 1972, 35, 43, fig. 10.

Gátér 16
Date: Avar period.
Context: funerary - burial 252.
Description: mail armour.
Inventory: lame of lamellar armour, buckle, other objects.
Remarks: burial of a woman.
Location: Kecskemét Museum.
Literature: Csallány 1972, 35, 43, fig. 10.

Gátér 17
Date: Avar period.
Context: funerary - burial 253.
Description: mail fragments.
Inventory: spindle whorls, bronze earrings, bronze rings, beads, iron objects.
Remarks: burial of a woman.
Location: Kecskemét Museum.
Literature: Csallány 1972, 39, 44; Petér 2014, 92.

Gátér 18
Date: 2nd half 6th century AD.
Context: funerary - burial 328.
Description: single mail ring.
Material: iron.
Literature: Glad 2009, 50, 116 (cat. no. 75).

Gátér 19
Date: Avar period.
Context: funerary - burial 334.
Description: four mail fragments.
Inventory: spindle whorl, iron buckle, curved iron rod, silver earring, glass beads.
Remarks: burial of a woman.
Location: Kecskemét Museum.
Literature: Csallány 1972, 39, 43; Petér 2014, 92.

Hódmezövásáhely 1
Date: 5th - 6th century AD.
Context: funerary - burial 29.
Description: mail fragment.
Literature: Glad 2009, 50, 116 (cat. no. 76); Rustoiu/Ciută 2015, 115.

Hódmezövásáhely 2
Date: 5th - 6th century AD.
Context: funerary - burial 19.
Description: mail fragment.
Literature: Glad 2009, 50, 116 (cat. no. 77).

Jutas 1
Date: Avar period.

Context: funerary - burial 79.
Description: mail fragments.
Inventory: other armour remains.
Location: Veszprém Museum.
Literature: Csallány 1972, 28, 43.

Jutas 2
Date: Avar period.
Context: funerary - burial 86.
Description: mail fragment.
Inventory: fragment of iron lamellar armour.
Location: Veszprém Museum.
Literature: Csallány 1972, 28, 43.

Kaposvár-Toponár
Date: 8th - 9th century AD.
Context: funerary - burial 4.
Description: mail fragment.
Material: iron.
Inventory: copper alloy jewellery, necklace of beads, bronze earrings, other.
Remarks: burial of a woman.
Literature: Petér 2014, 93.

Kereki-Homokbánya 1
Date: AD 750-835.
Context: funerary - burial 16.
Description: mail fragment.
Material: iron.
Inventory: two silver hair rings, bronze jewellery, bronze strap mounts, bronze buckle, animal bones, other objects.
Remarks: burial of a man 15-19 years old.
Literature: Petér 2014, 93.

Kereki-Homokbánya 2
Date: AD 750-835.
Context: funerary - burial 27.
Description: mail fragments placed at the neck region of the deceased.
Material: iron.
Inventory: bronze earrings, beads, bronze bracelet, spindle whorls, iron buckle, bronze Roman object, other objects.
Remarks: burial of a 20-39 year old woman.
Literature: Petér 2014, 93.

Kereki-Homokbánya 3
Date: AD 750-835.
Context: funerary - burial 29.
Description: mail fragment.
Material: iron.
Inventory: bronze earrings, bone needle, iron buckle, iron knives.
Remarks: burial of a 20-24 year old woman.
Literature: Petér 2014, 93.

Kereki-Homokbánya 4
Date: AD 750-835.
Context: funerary - burial 37.
Description: mail fragments.
Material: iron.
Inventory: iron knives, beads, bronze rings.
Remarks: burial of a 10-12 year old child.
Literature: Petér 2014, 94.

Kereki-Homokbánya 5
Date: AD 750-835.
Context: funerary - burial 40.
Description: mail fragments.
Material: iron.
Inventory: iron buckle, iron knives, glass beads, animal bones.
Remarks: burial of a 4-5 year old child.
Literature: Petér 2014, 94.

Kereki-Homokbánya 6
Date: AD 750-835.
Context: funerary - burial 53.
Description: mail fragment.
Material: iron.
Inventory: silver earrings, bronze jewellery, two pierced Roman coins, bronze clasps, bead necklace, spindle whorls, bronze bracelets, bronze ring?, iron knives, fragments of iron rings, bone needle.
Remarks: burial of a woman?
Literature: Petér 2014, 94.

Kereki-Homokbánya 7
Date: AD 750-835.
Context: funerary - burial 54.
Description: several small mail fragments.
Material: iron.
Inventory: copper alloy buckle, strap mount, pendant fittings, copper alloy beads, iron knife, other objects.

Remarks: burial of a 25-34 year old man?
Literature: Petér 2014, 94.

Kereki-Homokbánya 8
Date: AD 750-835.
Context: funerary - burial 57.
Description: mail fragment.
Material: iron.
Inventory: bronze earrings, iron knife, S-shaped links of a bronze chain.
Remarks: burial of a man?
Literature: Petér 2014, 94.

Kereki-Homokbánya 9
Date: AD 750-835.
Context: funerary - burial 63.
Description: mail fragments.
Material: iron.
Inventory: beaded necklace, bronze pendant, bronze earrings, iron rattle, knife, two large iron rings, other objects.
Remarks: burial of a 50-54 year old woman.
Literature: Petér 2014, 94.

Kereki- Homokbánya 10
Date: AD 750-835.
Context: funerary - burial 65.
Description: mail fragments located at the neck.
Material: iron.
Inventory: bronze earrings, spindle whorl, necklace of beads.
Remarks: burial of a 25-29 year old woman.
Literature: Petér 2014, 95.

Kereki-Homokbánya 11
Date: AD 750-835.
Context: funerary - burial 71.
Description: mail fragments located at the neck of the deceased.
Material: iron.
Inventory: bronze earrings, copper alloy ring, spindle whorls, animal bones.
Remarks: burial of a 20-24 year old man.
Literature: Petér 2014, 95.

Kereki-Homokbánya 12
Date: AD 750-835.
Context: funerary - burial 94.
Description: mail fragment.
Material: iron.
Inventory: iron earring, bronze buckle, knife, ceramic vessel.
Remarks: burial of a 18-22 year old man.
Literature: Petér 2014, 95.

Kereki-Homokbánya 13
Date: AD 750-835.
Context: funerary - burial 104.
Description: mail fragments located at the neck of the deceased together with beads.
Material: iron.
Inventory: silver earrings, bronze Roman coin, bronze brooch, bronze bracelets, bronze ring, iron bell, two iron spoons, bone needle, animal bones, knife.
Remarks: burial of a 22-24 years old woman.
Literature: Petér 2014, 95.

Kereki-Homokbánya 14
Date: AD 750-835.
Context: funerary - burial 109.
Description: mail armour located at head.
Material: iron.
Inventory: bronze strap end, bronze belt loop, iron rattle, knife, animal bones, other objects.
Remarks: burial of a 35-39 year old man.
Literature: Petér 2014, 95.

Kereki-Homokbánya 15
Date: AD 750-835.
Context: funerary - burial 111.
Description: mail fragments located at the neck. There are textile remains adhering to the fragments.
Material: iron.
Inventory: bronze earrings, copper alloy ring, bronze bracelets, pierced bronze Roman coins, beads, other objects.
Remarks: burial of a 55-59 year old woman.
Literature: Petér 2014, 95.

Kereki-Homokbánya 16
Date: AD 750-835.
Context: funerary - burial 63.
Description: mail fragments located at neck of the deceased together with beads.
Material: iron.
Inventory: iron bracelets, ceramic fragments.

Remarks: burial of a 25-29 year old woman.
Literature: Petér 2014, 95.

Keszthely-Fenékpuszta
Date: Avar period.
Context: funerary.
Description: mail fragment. Several rings in flexible condition. 4-in-1. Riveted and solid rings.
Material: copper alloy.
Inventory: spindle whorls, bead necklace, silver brooch, bronze belt buckle.
Literature: Petér 2014, 23, pl. 13.4.

Kiszombor
Date: Early Avar period.
Context: funerary - cemetery G - burial 2.
Description: mail fragments. Rings: outer diameter c. 10 mm.
Inventory: sword, fragments of lamellar armour, fire striker, five scales from scale armour, gold coin, gold earrings, glass beads, iron buckle, horse skeleton, cow's head, horse's head, two sheep's head, dog's head, silver trappings, two stirrups, ring-shaped bronze buckle, textile fragments, human body.
Remarks: burial of a man.
Location: Szeged Museum.
Literature: Csallány 1972, 23, 43.

Környe 1
Date: AD 550-620.
Context: funerary - burial 41.
Description: mail armour.
Material: iron.
Inventory: ceramic vessel, bronze chain, iron buckle, knife.
Remarks: burial of a woman.
Literature: Petér 2014, 96.

Környe 2
Date: AD 550-620.
Context: funerary - burial 75.
Description: mail armour.
Material: iron.
Inventory: sword, four gilded rosettes, silver and bronze objects, two knives, arrowheads, bone bow-plates. Burial was disturbed and inventory is probably incomplete.
Remarks: burial of a man.
Literature: Petér 2014, 96.

Környe 3
Date: AD 550-620.
Context: funerary - burial 83.
Description: mail fragment. 4-in-1.
Material: iron.
Inventory: bronze earrings, bronze disc, beads, knives, other object.
Remarks: burial of a woman.
Literature: Petér 2014, 96, pl. 13.2.

Környe 4
Date: AD 550-620.
Context: funerary - burial 86.
Description: mail fragment deposited near the skull together with beads.
Material: iron.
Inventory: bone comb, gilded silver mountings, four copper alloy buttons, iron buckle, carnelian necklace.
Remarks: burial of a 5-10 year old child.
Literature: Petér 2014, 96.

Környe 5
Date: AD 550-620.
Context: funerary - burial 91.
Description: mail fragment with textile adhering.
Material: iron.
Inventory: bone comb, beads, knife, iron buckle, bronze earrings.
Remarks: burial of a woman.
Literature: Petér 2014, 96.

Környe 6
Date: AD 550-620.
Context: funerary - burial 106.
Description: mail fragment.
Material: iron.
Inventory: lead cross, bronze buckle, copper alloy strap end, glass fragment, Roman coin, other object.
Remarks: burial of a 15-22 year old person.
Literature: Petér 2014, 96.

Orosháza-Községporta
Date: AD 660-670.
Context: funerary.
Description: mail fragment measuring c. 5 x 2-2.5 cm. 4-in-1. Rivets are observed in some rings. Rings: outer diameter c. 13 mm; cross-section 1.8 mm.
Material: iron.

Inventory: earring with pendant, beads, spindle whorl, bag suspended from a belt, iron buckle, sheep bones.
Remarks: burial of a young woman.
Literature: Lichtenstein 2006, 148, 150, 153.

Pécs
Date: AD 600-635.
Context: funerary - burial 55.
Description: mail fragment.
Material: iron.
Inventory: silver earrings, glass beads, four silver S-shaped hooks, bronze bracelet, arrowhead.
Remarks: burial of a child.
Literature: Petér 2014, 97.

Pécsvárad-Gőztéglagyár
Date: 8th - 9th century AD.
Context: funerary - burial 30.
Description: mail fragment.
Material: iron.
Inventory: silver earrings with glass beads, beads, bird-shaped brooch, spindle whorls, bronze buckle ring, iron cowbell (rattle).
Remarks: burial of a woman.
Literature: Petér 2014, 97.

Szatymaz 1
Date: 2nd half 7th century AD.
Context: funerary - cemetery A - burial 220.
Description: mail fragments.
Inventory: spindle whorls, three pieces of lamellar armour, glass beads, bone object.
Remarks: burial of a woman.
Location: Szeged Museum.
Literature: Csallány 1972, 19-21, 42.

Szatymaz 2
Date: Avar period.
Context: funerary – cemetery A - burials 25, 136, 148.
Description: various burials with mail (fragments).
Location: Szeged Museum.
Literature: Csallány 1972, 21, 42.

Szatymaz 3
Date: AD 600-720.
Context: funerary - burial 35.
Description: mail fragment.
Material: iron.
Inventory: beads, earrings, spindle whorls, iron buckle, knives, ceramics, fish bones.
Remarks: burial of a woman.
Literature: Petér 2014, 97.

Szatymaz 4
Date: AD 600-720.
Context: funerary - burial 50.
Description: mail fragment.
Material: iron.
Inventory: earrings bronze spoon, other object, bone plate for a purse, iron buckle.
Remarks: burial of a woman.
Literature: Petér 2014, 98.

Szatymaz 5
Date: AD 600-720.
Context: funerary - burial 60.
Description: mail fragment located at the hand of a deceased female.
Material: iron.
Inventory: glass beads, iron buckle, spindle whorls, knives, pig bones.
Remarks: burial of a woman and child.
Literature: Petér 2014, 98.

Szatymaz 6
Date: AD 600-720.
Context: funerary - burial 83.
Description: mail fragment.
Material: iron.
Inventory: bronze earrings, bronze rings, two iron buckles, spindle whorls, knives, pot fragment, other object.
Remarks: burial of an adult.
Literature: Petér 2014, 98.

Szatymaz 7
Date: AD 600-720.
Context: funerary - burial 240.
Description: mail fragment.
Material: iron.
Inventory: bronze earrings, decorated bone plates, steel bracelet, fabric remnants, iron buckle, knives, spindle whorls, animal bones, egg shells.
Remarks: burial of a woman and child.
Literature: Petér 2014, 98.

Szatymaz 8
Date: AD 600-720.
Context: funerary - burial 253.
Description: mail fragment.
Material: iron.
Inventory: bronze earrings, bronze rattle, spindle whorls, iron buckle, knives, animal bones.
Literature: Petér 2014, 98.

Szatymaz 9
Date: AD 600-720.
Context: funerary - burial 282.
Description: mail fragment.
Material: iron.
Inventory: bronze earrings, iron buckles, knives, bronze hair ornaments?
Remarks: burial of a woman and child.
Literature: Petér 2014, 98.

Szatymaz 10
Date: AD 600-720.
Context: funerary - burial 371.
Description: mail fragment.
Material: iron.
Inventory: silver earrings, glass beads, iron buckle, knives with decorated bone handle, animal bones.
Remarks: burial of a woman.
Literature: Petér 2014, 98.

Szeged
Date: Avar period.
Context: funerary - burial 116.
Description: mail fragments.
Remarks: burial of a woman.
Location: Szeged Museum.
Literature: Csallány 1972, 22, 43.

Szegvár-Oromdűlő
Date: Early Avar period.
Context: funerary - burial 33.
Description: mail fragment measuring 11 x 9.5 x 2.5 cm. 4-in-1. Rings: diameter 10 mm.
Material: iron.
Inventory: fragment of lamellar armour, sword and scabbard, quiver, arrowheads, bow, dagger, single edged knife, rosette-shaped plate, decorative belt strap-end, belt fittings, silver earring, snaffle bit, bridle ring, silver sheets that decorated the bridle, silver fittings, stirrups, buckles, wooden bowl, horse skeleton, parts of two other horses, two cows, sheep.
Remarks: burial of a 40-59 year old man. The mail was deposited next to the horse and has been speculated to concern horse armour.
Literature: Lőrinczy/Somogyi 2018, 234, 244, fig. 2.8.

Szentes Berekhát 1
Date: AD 480-610.
Context: funerary - burial 15.
Description: mail corroded into a solid mass, possibly from an aventail. Rings: outer diameter c. 14-15 mm.
Material: iron.
Inventory: *Spangenhelm* with bronze and gold. Grave inventory is incomplete.
Location: Koszta József Múzeum, Szentes.
Literature: Glad 2009, 43, 119, fig. 5.10 (cat. no. 91); Rustoiu/Ciută 2015, 115; Vogt 2003, 11, 28; 2006, 37, 263.

Szentes Berekhát 2
Date: 5th - 6th century AD.
Context: funerary - burial 89.
Description: mail fragment.
Material: iron.
Literature: Glad 2009, 50, 119 (cat. no. 92); Rustoiu/Ciută 2015, 115.

Szentes Berekhát 3
Date: 5th - 6th century AD.
Context: funerary - burial 139.
Description: mail fragment.
Material: iron.
Literature: Glad 2009, 50 119, fig. 5.11 (cat. no. 93); Rustoiu/Ciută 2015, 115.
Szentes - Lapistó
Date: 2nd half 6th century AD.
Context: funerary.
Description: mail fragment thought to be a neck guard of a helmet.
Material: iron.
Inventory: sword, horse skeleton, silver strap end, silver belt ornament, other (silver) objects.
Remarks: burial of a man.
Literature: Petér 2014, 99.

Szentes Nagyhegy
Date: 5th - 6th century AD.

Context: funerary - burial 81 or 83?
Description: three connected mail rings, two riveted and one solid.
Literature: Glad 2009, 119, fig. 5.15 (cat. no. 94).

Szekszárd 1
Date: 2nd half 6th century AD.
Context: funerary - burial 164.
Description: mail fragment.
Material: iron.
Inventory: ceramic vessel, bronze belt fixture.
Literature: Glad 2009, 50, 128, fig. 5.5 (cat. no. 87); Petér 2014, 99.

Szekszárd 2
Date: 2nd half 6th century AD.
Context: funerary - burial 228.
Description: mail fragment.
Material: iron.
Inventory: iron finger ring.
Remarks: burial of an adult.
Literature: Glad 2009, 50, 128, fig. 5.6 (cat. no. 88); Petér 2014, 99.

Szekszárd 3
Date: 2nd half 6th century AD.
Context: funerary - burial 282.
Description: mail fragment.
Inventory: knife, bronze chain.
Remarks: burial of an adult.
Literature: Glad 2009, 50, 128, fig. 5.7 (cat. no. 89); Petér 2014, 99.

Szekszárd 4
Date: 2nd half 6th century AD.
Context: funerary - burial 324.
Description: mail fragment.
Material: iron.
Inventory: blue glass bead, iron buckle, ceramic vessel.
Remarks: burial of a child.
Literature: Glad 2009, 128, fig. 5.8 (cat. no. 90); Petér 2014, 99.

Szekszárd 5
Date: 2nd half 6th century AD.
Context: funerary - burial 168.
Description: mail fragment.
Material: iron.
Inventory: silver earrings, copper alloy belt mountings.
Remarks: burial of a woman.
Literature: Petér 2014, 99.

Szekszárd 6
Date: 2nd half 6th century AD.
Context: funerary - burial 180.
Description: mail fragment.
Material: iron.
Inventory: iron buckle.
Remarks: burial of a man.
Literature: Petér 2014, 99.

Szőreg-Téglagyár 1
Date: cemetery: 5th - 6th century AD.
Context: funerary - burial 74.
Description: mail fragment. Rings: diameter c. 14 mm.
Material: iron.
Inventory: glass beads, bone comb.
Remarks: burial of a girl.
Literature: Bóna *et al.* 2005, 132, 164, pl. 25, 60; Glad 2009, 50, 119 (cat. no. 96); Migotti 2008, 208, fig. 3d; Rustoiu/Ciută 2015, 115.

Szőreg-Téglagyár 2
Date: cemetery: 5th - 6th century AD.
Context: funerary - burial 17.
Description: mail fragment. Rings: diameter c. 13 mm.
Material: iron.
Inventory: bone comb, iron brooch, knife, traces of textile.
Remarks: burial of a man.
Literature: Bóna *et al.* 2005, 125, 164, pl. 25, 49; Glad 2009, 50, 119 (cat. no. 95.); Migotti 2008, 208, fig. 3e; Rustoiu/Ciută 2015, 115.

Szőreg-Téglagyár 3
Date: cemetery: 5th - 6th century AD.
Context: funerary - burial 79.
Description: two connected rings and two loose rings. Rings: diameter 14-18 mm. Uncertain if this is mail.
Material: iron.
Inventory: spindle-whorl, iron belt buckle, iron ring with traces of textile.
Remarks: burial of a woman.
Literature: Bóna *et al.* 2005, 132, 164, pl. 25, 61; Glad 2009, 50, 119-120 (cat. no. 97); Migotti 2008, 208, fig. 3f; Rustoiu/Ciută 2015, 115.

Tiszadob-Sziget 1
Date: end 4th - start 5th century AD.
Context: funerary - burial 17.
Description: mail fragment. Rings: diameter c. 10 mm.
Material: iron.
Inventory: iron brooch, silver ring, bronze ring, cross-bow brooch, glass beads, wood fragments.
Literature: Migotti 2008, 207, fig. 3a.

Tiszadob-Sziget 2
Date: end 4th - start 5th century AD.
Context: funerary - burial 22.
Description: mail fragment. Rings: diameter c. 10 mm.
Material: iron.
Inventory: glass bead, traces of wood and textile.
Literature: Migotti 2008, 207, fig. 3b.

Tiszafüred-Majoroshalom 1
Date: 7th - start 9th century AD.
Context: funerary - burial 157.
Description: mail armour.
Material: iron.
Inventory: knife, glass paste, bronze pearl earrings.
Remarks: burial of a woman.
Literature: Petér 2014, 100.

Tiszafüred-Majoroshalom 2
Date: 7th - start 9th century AD.
Context: funerary - burial 394.
Description: mail armour.
Material: iron.
Inventory: bronze earrings.
Remarks: burial of a woman.
Literature: Petér 2014, 100.

Tiszafüred-Majoroshalom 3
Date: 7th - start 9th century AD.
Context: funerary - burial 495.
Description: corroded mail rings located near the jaw of the deceased.
Material: iron.
Inventory: bronze earrings, bronze chain.
Remarks: burial of a woman.
Literature: Petér 2014, 100.

Tiszafüred-Majoroshalom 4
Date: 7th - start 9th century AD.
Context: funerary - burial 1260.
Description: mail fragment.
Material: iron.
Inventory: bronze earrings with glass pendants, iron buckle, bronze mountings.
Remarks: burial of a child.
Literature: Petér 2014, 100.

Tiszafüred-Majoroshalom 5
Date: 7th - start 9th century AD.
Context: funerary.
Description: 37 burials contained mail.
Material: iron.
Remarks: seven male graves, 25 to 26 female grave, and four to five child graves.
Literature: Petér 2014, 100.

Tiszavasvari
Date: Early Middle Ages.
Context: funerary - burial 1.
Description: mail coat.
Literature: Glad 2009, 120 (cat. no.100).

Zamárdi-Réti földek
Date: Avar period.
Context: funerary - graves 65, 82, 125, 407, 441, 447, 467, 485, 506, 517, 1072, 1148, 1160, 1208, 1321, 1341, 1357, 1376, 1384/B, 1390, 1392,1494.
Description: small and larger mail fragments are recorded in 22 graves from this cemetery.
Material: iron.
Inventory: among the 22 graves: sword, horse bones, silver strap end, silver belt ornament, other (silver) objects. Inventory is incomplete.
Remarks: seven male graves, twelve female graves, three child graves.
Literature: Petér 2014, 100.

IRAQ

Nineveh
Date: 3rd - 6th century AD.
Description: fragments of a mail aventail adhering to a helmet. 4-in-1. Riveted rings are observed.
Material: iron.
Inventory: helmet.
Location: British Museum, London, inv. 22495.
Literature: Grancsay 1963, 260, fig. 6; James 1986, 119-120; Karamian *et al.* 2017, 132, fig. 28; Kubik 2016, 82,

91, fig. 5; Robinson 1969, 24, pl. 1a; Waller 1904, 58, 70, fig. 6

ISRAEL

Masada
Date: AD 73-74.
Context: citadel.
Description: small mail fragment.
Material: iron.
Literature: Stiebel 2007, 51.

ITALY

Aquileia
Date: 4th century AD.
Context: settlement - bridge over Natiso at Monastero.
Description: mail fragment measuring c. 10 cm^2. 4-in-1. Alternating rows of riveted and solid rings. Solid rings: outer diameter almost half the size of the riveted rings; thickness 0.5-1 mm.
Material: iron.
Inventory: six spearheads, two brooches, large number of coins (dating between AD 270 and 408), ten *stili*, tweezers, scalpel, several metal objects, five ceramic lamps. Items are not from a closed context.
Location: Museo Archeologico Nazionale, Naples, inv. 595032.
Literature: Buora 2001, 46; Hansen 2003, 172 (cat. no. C54); Tiussi *et al.* 2013, 214-215, fig. 19; Van der Sanden 1993, 4 (cat. no. 44); Waurick 1982, 111.

Castel Trosino 1
Date: AD 600-625.
Context: funerary - burial 90.
Description: mail fragment measuring 13 x 9.4 cm. Traces of leather adhere to one side. 4-in-1.
Material: iron.
Inventory: shield boss, sword, 14 arrowheads, four knives, saddle fragments, horse bit, bronze bucket, four gold plaques, four plaques with gold foil, three gilded plaques, four gold plaques with rounded corners, three goblets covered in gold foil, four bowls covered in gold foil, belt buckle in gold foil, rosette in gold foil, large plate of gold foil, several more objects finished in gold foil, silver foil case, silver cylindrical object, two silver buckles, two ornamented silver objects, plaques with silver foil, two silver plaques, fragmented silver plate, more objects with silver foil, three gilded bronze buttons, rectangular bronze hook, bronze plate, three flat bronze buttons, ceramic dish, glass vessel, brooch, bone comb, four iron fragments.
Remarks: burial of a young man.
Literature: Adams 2010, 96; Grunwald 1998, 97; Mengarelli 1902, 268, fig. 147.

Castel Trosino 2
Date: c. AD 625.
Context: funerary - burial 119.
Description: mail fragment measuring 13 cm in length, presumably from a neck guard for a helmet.
Material: iron.
Inventory: lamellar helmet, fragment of lamellar armour, shield boss, shield handle, sax, sword, dagger, two knives, eleven arrowheads, two bronze brackets (probably part of a quiver), spear, two silver bow ends, gold saddle parts, two spurs, two gold plaques, cross in gold foil, gold buckle, four gold rosettes, twelve studs covered in gold foil, several pieces of gold foil with decoration or objects covered in gold foil, circular edging (of a vessel) covered in silver sheet, silver stud, five silver (covered) plaques, three buckles with silver, buckle counter-plate with silver, iron buckle, plate missing its buckle, iron buckle decorated with silver and brass, fragments of buckles, cross-shaped application, diamond-shaped application, two iron applications, copper bowl, metal 'clamp' with suspension ring, four flat buttons, bone comb, scissors, iron bill hook, fire striker, oval ring and matching hook, glass vessel.
Remarks: burial of a man.
Literature: Christie 1991, 17, 23-24; Mengarelli 1902, 296.

Rome
Date: 2nd century BC - early 1st century AD.
Context: funerary - tomb of Scipios.
Description: small mail fragment.
Material: iron.
Location: Museo della Civilità Romana, Rome.
Literature: Bishop/Coulston 2006, 63; D'Amato/Negin 2017, 50; Liberati 1997, 29, fig. 17; Quesada Sanz/Rueda Galán 2017, 33; Quesada Sanz *et al.* 2019, 160; Wijnhoven 2019a, 5.

JORDAN

Hauarra
Date: Trajanic.
Context: Roman fort - barracks area H - near a forge.
Description: approximately 350 loose mail rings with a round cross-section. Rings have swollen due to corrosion. Rings: outer diameter c. 4-6 mm. In addition a smaller deposit of loose mail rings was found in the dump of the corridor leading into the southeast tower.
Material: iron.
Inventory: hobnails, bits, pieces of armour, scrap metal.
Remarks: the location and inventory point to a workshop area where mail was produced.
Literature: pers. comm. John P. Oleson, 2018.

KAZAKHSTAN

Sari-Tschon
Date: Turkic Khaganate.
Context: found next to an Old Turkish stone sculpture.
Description: mail fragment.
Literature: Borisenko *et al.* 2006, 120.

LIBYA

Leptis Magna
Date: 6th century AD.
Context: settlement.
Description: mail aventail of a helmet.
Material: iron.
Inventory: *Spangenhelm*.
Location: Archaeological Museum Sabratha.
Literature: Vogt 2003, 11, 28; 2006, 37, 232.

LUXEMBOURG

Titelberg 1
Date: LT D.
Context: *oppidum*.
Description: mail fragment. Rings are copper alloy and riveted, but the rivets are iron. The mail probably also included iron rings, now corroded away, since there is too much iron oxidation for just the rivets. Rings: outer diameter c. 8 mm; cross-section wire round.
Material: copper alloy rings with iron rivets.
Inventory: found at the Museum depot in a box with Late Iron Age ceramics and Republican *amphorae*.
Location: Musée National d'Histoire et d'Art Luxembourg.
Literature: Canestrelli 2018, 20; Hansen 2003, 34, 38-39, 43, 54-55, 123, 162 (cat. no. 13); Metzler 1995, 340, 344-347; Metzler *et al.* 2016, 260, fig. 261; Wijnhoven 2015c, 23, 25; 2017, 183, 186, 193.

Weiler-la-Tour
Date: 4th century AD.
Context: funerary.
Description: mail coat broken into eight fragments, now weighing just over 7 kg. The coat has been X-rayed and did not reveal any fixtures. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter 10-10.5 mm. cross-section wire round; cross-section 1.2-1.5 mm. Solid rings: outer diameter 8.5 mm; inner diameter 5 mm; cross-section square.
Material: iron.
Inventory: coins, pottery, bones.
Location: Staatsmuseum Luxemburg.
Literature: Bishop/Coulston 2006, 208; Boube-Piccot 1994, 55; Chew 1993, 314; Hansen 2003, 173 (cat. no. C59); Junkelmann 1992, 176; Müller 2003, 435; Van der Sanden 1993, 4 (cat. no. 46); Waurick 1982, 111, 121, fig. 1-2; 1983, 288.

MOROCCO

Banasa 1
Date: 2nd - 3rd century AD.
Context: settlement - northern baths.
Description: almost complete coat of mail in folded and corroded condition. 4-in-1. Rings: outer diameter c. 8 mm.
Material: iron.
Location: Museum of History and Civilizations, Rabat.
Literature: Boube-Piccot 1994, 11, 55, pl. 59-61 (cat. no. 26); Hansen 2003, 67, 172 (cat. no. C60); Waurick 1982, 111.

Banasa 2
Date: 2nd - 3rd century AD.
Context: settlement.
Description: small mail fragment. Rings: outer diameter c. 6-7 mm.
Material: iron.
Location: Museum of History and Civilizations, Rabat, inv. 73-50.

Literature: Boube-Piccot 1994, 11, 55 (cat. no. 26).

Sidi Ali Ben Ahmed 1 - Thamusida
Date: Roman period.
Context: Roman fort and settlement.
Description: corroded mail fragment measuring 5.2 x 3.1 x 1.3 cm. 4-in-1.
Material: iron.
Literature: Akerraz *et al.* 2013, 374, pl. 124 (cat. no. 1537).

Volubilis
Date: Roman period.
Description: three mail fragments. Rings: outer diameter c. 7-8 mm. 4-in-1.
Material: iron.
Location: Museum of History and Civilizations, Rabat.
Literature: Boube-Piccot 1994, 11, 56, pl. 62 (cat. no. 27).

NETHERLANDS

Aardenburg
Date: AD 175-275?
Context: Roman fort?
Description: two mail rings, probably riveted. Rings: outside diameter 9 mm; thickness 2 mm.
Material: copper alloy.
Location: Zeeuws Archeologisch Depot, Middelburg, inv. 006-179B.
Literature: Besuijen 2008, 72, 142; Wijnhoven 2015c, 25; 2017, 186, 193.

Alphen aan den Rijn 1 - Albaniana
Date: AD 41-275.
Context: Roman fort - detector find from spoil heap.
Description: small mail fragment c. 7 rows deep and several rings wide. 4-in-1. Alternating solid and riveted rings. Riveted rings: oval cross-section. Solid rings: rectangular cross-section; burrs and deformation at the edges of the rings.
Material: iron.
Location: privately owned.
Literature: Hagedoorn 2013, 52 (cat. no. 3.16).

Alphen aan den Rijn 2 - Albaniana
Date: AD 41-275.
Context: Roman fort - detector find from spoil heap.
Description: small mail fragment consisting of several rings, still flexible. 4-in-1. Alternating solid and riveted rings. Riveted rings: larger than solid rings; cross-section wire oval. Solid rings: rectangular cross-section; some deformation from punching out of plate metal.
Material: iron.
Location: privately owned.
Literature: Hagedoorn 2013, 52 (cat. no. 3.17).

Alphen aan den Rijn 3 - Albaniana
Date: AD 41-275.
Context: Roman fort - detector find from spoil heap.
Description: twelve interconnecting mail rings. 4-in-1. Alternating solid and riveted rings. Riveted rings: larger than solid rings; overlap clockwise; shape overlap stumpy; round rivet hole; cross-section wire round. Solid rings: cross-section rectangular with rounded corners.
Material: copper alloy.
Location: privately owned.
Literature: Hagedoorn 2013, 52 (cat. no. 3.18); Wijnhoven 2015c, 25; 2017, 186, 193.

Beumelerberg - Garderen
Date: Roman period - Early Middle Ages.
Context: funerary? Exact find context unknown.
Description: two corroded mail fragments. Rings: outer diameter 7.7 mm; inner diameter 6.3 mm; appear thicker in one fragment than in the other.
Material: iron.
Literature: Hansen 2003, 182 (cat. no. 152); Van der Sanden 1993, 4 (cat. no. 49).

The Hague 1 - Scheveningseweg *(fig. 6.3)*
Date: AD 190-240.
Context: Roman military post and *vicus* with possibly a temple nearby.
Description: two larger mail fragments and several smaller ones, all in solid condition. Some small fragments were found in other pits than the larger fragments. All fragments have the same ring size ring, except for one, which is likely from another garment. 4-in-1. Alternating rows of riveted and solid rings. The majority of rings is iron, but there are also copper alloy rings placed within the matrix of iron rings. The decoration repeats as small clusters of copper alloy rings (c. 7-12 rings) throughout the two large fragments. Its exact design could not be established. Not much detail

is preserved in the iron rings, but the presence of riveted rings is observed. Riveted copper alloy rings: outer diameter 7-8 mm; inner diameter 6-7 mm; clockwise overlap; shape overlap stumpy; rivet head on both sides; round rivet holes; cross-section wire round. Solid rings: cross-section square with rounded corners.
Material: iron, copper alloy.
Inventory: scabbard chapes, scabbard runner, hilt guards, belt plates, spearheads, brooches, eleven soles of hobnailed boots, c. 20 incomplete terracotta figurines, pottery sherds with graffito, nails.
Remarks: examined by the author.
Location: Museon, Den Haag, inv. sch84 787.1, 2408.1, 2522.1, 2523.2, 2530.1, 2531.1, 2536.3, 2619.1, 2620.1, 3206.1, 4020.6, 4500.3.
Literature: Beck/Chew 1991, 37; Hansen 2003, 53, 172 (cat. no. C61); Matešić 2015, 211; Novichenkova 2011, 278; Van der Sanden 1993, 4 (cat. no. 47); Van Ginkel/Vos 2018, 135; Van Ginkel/Waasdorp 1992, 44; Waasdorp 1989, 159, 161, fig. 2; 1999, 47-48, 55, fig. 2.7; Wijnhoven 2015c, 25, 27, fig. 1; 2017, 186, 188, 193, fig. 1.

The Hague 2 Ockenburg
Date: AD 150-250.
Context: Roman fort and *vicus* – stray find.
Description: small mail fragment in highly corroded condition. Rings: outer diameter c. 8 mm.
Material: iron.
Remarks: examined by the author.
Location: Archeologische Dienst Gemeente Den Haag.

Empel - De Werf
Date: 2nd century AD.
Context: sanctuary - well 303.
Description: flexible mail fragment that measures three rings wide and 66 rows long and must be a trim of a sleeve. 4-in-1. Alternating rows of riveted and solid rings. Rings: outer diameter c. 7 mm Riveted rings: larger than solid ones; overlap clockwise; shape overlap stumpy; rivet head round; cross-section wire round.
Material: copper alloy.
Inventory: 36 metal objects including helmet, shield boss, chain, heel, horse bit, 44 sherds, bucket, glass sherd.
Literature: Hiddink 2018, 99 (cat. no. 303-82); Nicolay 2007, 21-22, 121, pl. 7 (cat. no. 82.1); Wijnhoven 2015c, 25; 2017, 186-187, 193.

Fluitenberg *(figs. 2.18, 11.1, 11.8)*
Date: 300-115 BC.
Context: funerary.
Description: c. 25 small mail fragments that together measure about 70-75 cm^2. Although no longer flexible, most of the rings' characteristics can be observed. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: horizontal outer diameter 6.5 mm; vertical outer diameter 7.1 mm; horizontal inner diameter 3.6 mm; vertical inner diameter 3.7 m; overlap clockwise; shape overlap triangular; length overlap 3.6 mm; width overlap 2.4 mm; thickness overlap 0.9 mm; rivet is dome-headed on one side and protrudes on the other side for about 2.1 mm; cross-section wire oval; thickness 1 mm; width 1.3 mm. Solid rings: outer diameter 5.9 mm; inner diameter 3.2 mm; thickness 0.8 mm; width 1.32 mm; cross-section rectangular with rounded corners.
Fixture: iron buckle still attached to the mail fabric. In addition a small hook-shaped artefact that has been speculated to be a fastener.
Material: iron.
Inventory: hook-shaped object, c. 45 nails, unidentified bronze fragments, charcoal, animal bone.
Remarks: examined by the author.
Location: Drents Museum, Assen, inv. 1941/V-6.
Literature: Hansen 2003, 44, 82, 85, 182 (cat. no. C151) fig. 30.9; Jöns *et al.* 2013, 228-229, fig. 7; Lanting/Van der Plicht 2005/2006, 332; Van der Sanden 1992; 1993; 2003/2004; 2018, 177-178, 193; Wijnhoven 2010; 2014, 14, fig. 2; 2019b, fig. 20.

Leiden - Roomburg
Date: late 1st - 3rd century AD.
Context: *vicus*.
Description: flexible mail fragment. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: larger then solid rings; overlap clockwise; shape overlap stumpy; rivet hole round; cross-section wire oval. Solid rings: highly worn and thin; cross-section square with now rounded corners.
Material: copper alloy.
Location: Provinciaals Archeologisch Depot Zuid Holland, Alphen aan den Rijn, inv. 3376.
Literature: Brandenburgh/Hessing 2005, fig. 39; Hazenberg 2000, fig. 25e; Wijnhoven 2015c, 25; 2017, 186, 193.

Maastricht *(fig. 6.14)*
Date: AD 375-400.
Context: *castellum* - garden of the O.L.V. Baseliek.
Description: 16 lumps of mail. 4-in-1. Alternating rows of riveted and solid rings. Rings: outer diameter c. 11-13 mm. Riveted rings: overlap clockwise; paddle-shaped overlap; rivet head on both sides; cross-section wire flattened. Solid rings: cross-section rectangular; width is large compared to its thickness, making it washer-like.
Material: iron rings with copper alloy rivets.
Location: find no. 48, 6-BD-10.
Literature: Wijnhoven 2015c, 25, 27; 2017, 186, 191-193, fig. 12; 2019a, 8-9; pers. comm. Wim Dijkman 2013.

Nijmegen 1 - Canisiuscollege *(fig. 6.18)*
Date: AD 70-120.
Context: *canabae*?
Description: two small mail fragments in solid condition. Most rings are copper alloy, but some are iron. 4-in-1. Alternating rows of riveted and solid rings. Corrosion obscures most of the details. Rings: outer diameter c. 3.7 mm.
Material: iron, copper alloy.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 84-5-8769.
Literature: Wijnhoven 2015c, 25; 2017, 186, 193.

Nijmegen 2 - Canisiuscollege
Date: late Flavian.
Context: *canabae*.
Description: ten connected mail rings. 4-in-1. Riveted and solid rings. Riveted rings: outer diameter 7 mm; inner diameter 4.6 mm; overlap clockwise; shape overlap stumpy; rivet heads on both sides; cross-section wire round; width c. 1.3 mm. Solid rings: outer diameter c. 6.5 mm; width c. 1.3 mm; cross-section square.
Material: iron.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 22-2572.

Poeldijk - Westhof
Date: AD 70-200/250.
Context: settlement.
Description: mail fragment measuring 15 x 8 cm. 4-in-1. Rings: outer diameter 8 mm.
Material: iron.
Literature: Eimmerman 2009, 191; Feijst, van der 2007, 65, 68, fig. 6.4; Roemburg, van 2011, 82, fig. 4.24.

Rhenen 1 - Donderberg
Date: AD 575-600.
Context: funerary - burial 529.
Description: solid mail fragment measuring c. 7-8 x 5 cm. Located on a lightly curved metal plate with holes all along its edge. Dimensions plate: 8.5 x 7.3 x 0.1 cm. Uncertain if the mail and plate belong together. 4-in-1. Riveted rings are observed. Rings: outer diameter c. 15 mm; inner diameter c. 7 mm; direction overlap anti-clockwise?; large rivet heads; cross-section oval; width wire c. 3 mm; thickness wire c. 2 mm.
Material: iron.
Inventory: shield boss, horse bit, five fragments of copper alloy fixtures with leather remains, iron buckle.
Remarks: burial of a man. Observed by the author through museum glass.
Location: Rijksmuseum van Oudheden, Leiden, inv. Rh 529 C.
Literature: Wagner/Ypey 2011, 381-382, fig. 80.

Rhenen 2 - Donderberg
Date: AD 500-650?
Context: funerary - burial 433.
Description: three small mail fragments with textile remnants adhering. 4-in-1. Rings: outer diameter c. 15 mm; inner diameter c. 10 mm; thickness c. 2 mm; wire of round cross-section.
Material: iron.
Inventory: pair of brooches (white metal with garnets); pair of gilded silver garnet disk brooches, glass and amber beads, glass spindle whorl, copper alloy buckle, iron spoon, fragments of a gilded coin, wood remains, bell-shaped glass.
Remarks: burial of a woman.
Location: Rijksmuseum van Oudheden, Leiden, inv. Rh 433 E.
Literature: Wagner/Ypey 2011, 315-316.

Rhenen 3 - Donderberg
Date: AD 530-555.
Context: funerary - burial 530.
Description: mail fragment measuring c. 9.8 x 2.4 x 2.2 cm. Rings: outer diameter c. 14 mm; inner diame-

ter c. 10-11 mm; wire diameter c. 2 mm; cross-section wire round. Mail was partially wrapped in textile.
Material: iron.
Inventory: pair of gilded silver brooches, pair of silver disk-like brooches with garnets, 16 glass and amber beads, copper alloy buckle, knife, small iron plate.
Remarks: burial of a woman. Observed by the author through museum glass.
Location: Rijksmuseum van Oudheden, Leiden, inv. Rh 530 E.
Literature: Wagner/Ypey 2011, 383.

Rhenen 4 - Donderberg *(fig. 3.33)*
Date: AD 530-565.
Context: funerary - burial 696.
Description: two mail fragments measuring 4.7 x 3.5 x 2.2 cm and 7.1 x 3.9 x 2 cm. Rings: outer diameter 13 mm; some rings inner diameter c. 8 mm; other rings inner diameter 6-7 mm (solid and riveted rings?); thickness wire c. 2 mm; cross-section wire round. Textile adheres to the mail fragments.
Material: iron.
Inventory: pair of gilded silver rosette brooches with garnets, silver hair needle with bird, 48 beads of amber, glass and bronze, iron buckle, knife, scissors, hinge.
Remarks: burial of a woman. Observed by the author through museum glass.
Location: Rijksmuseum van Oudheden, Leiden, inv. Rh 696 E.
Literature: Wagner/Ypey 2011, 489.

Unprovenanced, probably Netherlands *(fig. 6.4)*
Date: Roman period.
Description: six connected mail rings. Riveted and solid rings. Riveted rings: outer diameter horizontal 10.1 mm; outer diameter vertical 9.9 mm; inner diameter horizontal 7.9 mm; inner diameter vertical 6.3 mm; overlap clockwise; shape overlap mid-size oval; length overlap c. 3.9 mm; width overlap 1.8 mm; height overlap 1.3 mm; rivet heads on both sides, but not very pronounced; cross-section wire oval; thickness wire 0.95 mm; width wire 1.1 mm. Solid rings: outer diameter 9.3 mm; inner diameter 7.7 mm; thickness 0.87 mm; width 0.97 mm; cross-section square with rounded edges.
Material: copper alloy.
Remarks: examined by the author. This object may come from Vechten, given the attached label.
Location: Provinciaals Utrechts Genootschap van Kunsten en Wetenschappen, inv. 5138.
Literature: Hulsebos 1890, 31; Wijnhoven 2017, 185, 193, fig. 2.

Utrecht 1 – De Meern
Date: AD 200-250.
Context: *vicus*.
Description: two lumps of mail consisting of mainly iron and some copper alloy rings. Riveted and solid rings. Rings: outer diameter 7 mm. Solid rings: cross-section square.
Material: iron, copper alloy.
Location: find no. 467.
Literature: Kerkhoven 2012, 146, fig. 6.16; Wijnhoven 2015c, 25; 2017, 186, 193.

Vechten 1
Date: AD 5-270.
Context: near the Roman fort.
Description: small mail fragment and several loose rings. Possibly these come from the same garment as Vechten 3. 4-in-1. Alternating rows of riveted and solid rings. Rings: outer diameter 7 to 7.4 mm. Riveted rings: larger than solid rings; cross-section wire oval. Solid rings: cross-section rectangular; presence of burrs; conical deformation.
Material: iron.
Inventory: various items.
Location: privately owned.
Literature: Hansen 2003, 173 (cat. no. C64); Kalee 1989, 193, 216, fig. 20; Matešić 2015, 218; Novichenkova 2011, 278; Van der Sanden 1993, 4 (cat. no. 51).

Vechten 2 *(fig. 6.7)*
Date: AD 5-270. Refined date: AD 100-270.
Description: mail fragment, 42 rows in length and 2-3 rings in width, still in flexible condition. All rings are copper alloy and given the direction of the weave this must be a trim of a sleeve. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter horizontal 7.2 mm; outer diameter vertical 7.4 mm; inside diameter horizontal 5.3 mm; inside diameter vertical 5.0 mm; overlap clockwise; shape overlap stumpy; length overlap 2.2 mm; width overlap 1.6 mm; height overlap 1.4 mm; rivet heads on both sides; cross-section wire oval; thickness 0.8 mm; width 0.9 mm. Solid rings: outside diameter 6.7 mm; inside

diameter 5.2 mm; thickness 0.8 mm; width 0.7 mm; cross-section square.
Material: copper alloy.
Remarks: examined by the author.
Location: Provinciaals Utrechts Genootschap van Kunsten en Wetenschappen, inv. 3824.
Literature: Muller 1995, 151; Wijnhoven 2015c, 25, fig. 2; 2017, 185-186, 187, 193, fig. 5.

Vechten 3
Date: AD 5-270.
Context: loose finds from soil removed from the location of the Roman fort of Fectio.
Description: various mail fragments in flexible condition. Possibly from the same mail coat as Vechten 1. Post-excavation these have been made into one large fragment by connecting them with butted rings. Current measurement c. 40 x 50 cm. Part of the bottom hem of the mail coat has been preserved. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: overlap clockwise; shape overlap stumpy; round rivet heads; cross-section wire oval. Solid rings: cross-section square with rounded corners, probably through wear; presence of burrs.
Material: iron.
Inventory: horse skull, iron spike.
Location: Archeologiezolder IJsselstein.
Literature: Hessing *et al.* 1997, fig. 50.

Woerden - Hoochwoert
Date: AD 150-250.
Context: *vicus*.
Description: 42 loose copper alloy rings, probably from mail armour.
Material: copper alloy.
Location: Provinciaal Archeologisch Depot, Utrecht.
Literature: Hoss 2008, 244, fig. 10.10; Wijnhoven 2015c, 25; 2017, 186, 193.

Zwammerdam
Date: Roman period.
Context: river - waste disposal of Roman fort.
Description: complete coat of mail in solid condition. Its shape suggest that was rolled up in a textile bag when deposited.
Material: iron.
Inventory: shield parts, spearheads, swords.
Literature: Guillaud 2019, 214; Hansen 2003, 172-173 (cat. no. C63); Nicolay 2007, 183; Novichenkova 2011, 278-279; Van der Sanden 1993, 4-5 (cat. no. 52).

NORWAY

Englaug
Date: Vendel period.
Context: funerary.
Description: small mail fragment.
Inventory: helmet. Inventory is incomplete.
Literature: Arwidsson 1942, 32.

Gjermundbu *(figs. 11.1, 11.39)*
Date: c. 10th century AD.
Context: funerary - burial 1.
Description: coat of mail. 85 fragments survive and have been reconstructed as the front of a short sleeved mail coat. Some rings adhere to a helmet. It is uncertain whether these are from the coat or if the helmet had a mail aventail. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter horizontal 7.8 mm; outer diameter vertical 8.0 mm; overlap anti-clockwise; shape overlap reshaped oval; length overlap c. 4 mm; oval rivet hole; conical shaped rivet head on one side and flush on the other side; length rivet 1.8 mm; rivet shank is round on the side with the rivet head and becomes oval towards the flush side; cross-section ring wire oval; width 1.9 mm; thickness 1.3 mm. Solid rings: outer diameter 8.1 mm; inner diameter 4.9 mm; thickness c. 1.5 mm; width c. 1.5 mm; cross-section square with rounded corners; rings have been reworked with a swage. All rings have suffered from wear, deforming their shape towards a square outline.
Material: iron. Metallography shows very little slag inclusions and demonstrates that the riveted rings are made from drawn wire, while the solid rings are punched from sheet metal.
Inventory: helmet, sword, scabbard chape.
Location: Universitets Oldsaksamling, Oslo, inv. C 27317.
Literature: Ehlton 2002/2003, 8, 12; Grunwald 1998, 97; Müller 2003, 444-446; O'Connor 1992, 1185; Short 2009, 56-57, 59-61; Vike 2000, 8-18; Wijnhoven 2015a, 1; Wyley 1995a, 31; 1995b, 27.

Smedenga i Ullensaker
Date: c. AD 600.
Context: funerary.

Description: 40-50 rings in poor to good condition, some still articulating. Alternating rows of riveted rings and undetermined rings. Riveted rings: outer diameter 10.4-11.9 mm; overlap anti-clockwise; rivet heads are prominent and round; cross-section wire oval; cross-section wire 1.3 x 1.3 to 1.8 x 1.6 mm. Undetermined rings: outer diameter 10-10.8 mm; cross-section almost round; cross-section 1 x 1.2 to 1.8 x 1.6 mm.
Material: iron.
Remarks: burial of a woman.
Location: Universitets Oldsaksamling, Oslo, inv. 15968.
Literature: O'Connor 1992, 1184.

POLAND

Biejków
Date: Roman period.
Description: fragment of mail.
Literature: Hansen 2003, 184 (cat. no. 166).

Ciebłowice
Date: B2/C1a.
Context: funerary - burial 1.
Description: mail fragment measuring 9 x 2 cm. 4-in-1. Rings: outer diameter 7 mm; inner diameter 5 mm.
Inventory: spindle whorl, molten glass, ceramic sherds from and urn. Disturbed grave and inventory probably incomplete.
Location: Muzeum w Tomaszów Mazowiecki, inv. MT/A 90.1104.
Literature: Czarnecka 1996, 246, 251; Hansen 2003, 185 (cat. no. C175).

Chorula
Date: B2/C1a.
Context: funerary - burial 14.
Description: six rings: outer diameter 7.5 mm; inner diameter 4.5 mm. Uncertain if this is mail.
Material: iron.
Inventory: two iron brooches, knife, needle, comb rivets.
Literature: Czarnecka 1996, 246; Hansen 2003, 184 (cat. no. C163).

Ciosny
Date: C1b/C2.
Context: funerary - burial 1.
Description: one ring: outer diameter 7.5 mm; inner diameter 4 mm. Uncertain if this is mail.
Material: iron.
Inventory: three ceramic vessels.
Literature: Hansen 2003, 183 (cat. no. C155).

Czaszkowa
Date: AD 250-320.
Context: lake.
Description: various small mail fragments. 4-in-1. Riveted and solid rings. Rings: outer diameter c. 4-5 mm, thickness wire c. 1 mm. Riveted rings: overlap clockwise; shape overlap stumpy; square rivet hole; round rivet heads; cross-section wire oval. Solid rings: cross-section square.
Material: iron and one fragment with copper alloy rings.
Inventory: more than 400 iron artefacts, among which spearheads, battle daggers and swords, silver belt fittings and buckles with zoomorphic representations, gold mounts for sword and scabbard, figurine of a vulture, brooches, pendant fragments.
Literature: Bitner-Wróblewska/Rzeszotarska-Nowakiewicz 2016, 291, fig. 48; Nowakiewicz/Rzeszotarska-Nowakiewicz 2012, 62-63, 128-129; 2013, 22; Wijnhoven; 2017, 184, 186, 193.

Drochlin 1
Date: C2/D.
Context: funerary - burial 3.
Description: three rings: outer diameter 7 mm; inner diameter 6 mm; cross-section round. Uncertain if this is mail
Material: iron.
Inventory: iron buckle, iron brooch, tweezers, two pendants, various metal objects, glass beads, ceramics including *terra sigillata*.
Literature: Czarnecka 1996, 245; Hansen 2003, 185 (cat. no. C180).

Drochlin 2
Date: B2/C1.
Context: funerary - burial 100.
Description: Three rings: outer diameter 7 mm; inner diameter 6 mm. Uncertain if this is mail.
Material: iron.
Inventory: awl, glass- amber- and clay beads, molten bronze fragments, two ceramic vessels, iron object.
Literature: Hansen 2003, 185 (cat. no. C181).

Drochlin 3
Date: C2/D.
Context: funerary - burial 207.
Description: mail fragment and two loose rings. Rings: outer diameter 9-10 mm; inner diameter 7-8 mm.
Material: iron.
Inventory: iron buckle, iron needle, three iron fixtures, iron handle, various metal objects, comb, glass fragments, sherds from several ceramic vessels.
Literature: Hansen 2003, 185 (cat. no. C182); Migotti 2008, 207, fig. 3c.

Drochlin 4
Date: B2/D.
Context: funerary - isolated find.
Description: five mail fragments and a loose ring. 4-in-1. Part of the rings is riveted. Rings: outer diameter 6-10 mm; inner diameter 4-6 mm.
Material: iron.
Literature: Czarnecka 1996, 246; Hansen 2003, 185-186 (cat. no. C183).

Grzybów
Date: B2-C1.
Context: funerary?
Description: ten mail fragments, some loose rings and various interconnecting rings. 4-in-1. Rings: outer diameter 8 mm; inner diameter 5 mm; cross-section oval.
Material: iron.
Inventory: iron spur, bone dies, iron nail, iron ring, iron chain, ceramic sherds including *terra sigillata*, bones. Inventory probably incomplete.
Literature: Czarnecka 1996, 246; Hansen 2003, 184 (cat. no. C170); Pauli Jensen 2008, 218.

Jakuszowice
Date: Roman period.
Context: settlement.
Description: mail fragment measuring 3.1 x 1.6 cm. Rings: outer diameter 8 mm; inner diameter 5 mm.
Material: iron.
Location: Instytut Archeologii Uniwersytetu Jagiellońskiego, inv. 36/82; 887/85; 1249/87.
Literature: Czarnecka 1996, 246; Hansen 2003, 184 (cat. no. C173).

Kawczyce
Date: B1/C1.
Context: funerary?
Description: mail fragment measuring 1.4 x 1.2 cm. Rings: outer diameter 5-6.5 mm; inner diameter 2-3 mm.
Material: iron.
Literature: Hansen 2003, 184 (cat. no. C167).

Kietrz
Date: B2/C1a.
Context: funerary - burial 1563.
Description: three ringed fragments. Rings: outer diameter 6-7 mm; inner diameter 4-5 mm. Uncertain if this is mail.
Inventory: bronze sieve, ladle, bronze vessel, key, silver bracelet, gold fixtures, bone needle, three pendants, bronze brooch fragment, various metal objects, ceramic sherds including *terra sigillata*.
Literature: Czarnecka 1996, 246; Hansen 2003, 82, 184 (cat. no. C165).

Komorów
Date: C/D.
Context: funerary? - object was bought as a loose item.
Description: four interconnecting rings. One ring is bigger than the other three (difference between riveted and solid rings?). Large ring: outer diameter 11 mm; inner diameter 8.5 mm. Smaller rings: outer diameter 8 mm; inner diameter 4.5-5.6 mm. Uncertain if this is mail.
Material: iron.
Literature: Hansen 2003, 183 (cat. no. C157); Künzl 2002, 138 (cat. no. 26); Raddatz 1959/1961b, 53; Rasmussen 1995, 75; Van der Sanden 1993, 4 (cat. no. 53); Waurick 1982, 116 (cat. no. 26).

Krajanka
Date: B2/C1b.
Context: funerary? - without find context.
Description: mail fragment measuring 3.2 x 2 cm. Rings: outer diameter: 6-8 mm; inner diameter 4-5 mm.
Material: iron.
Literature: Hansen 2003, 183-184 (cat. no. C162).

Kryspinów
Date: B2/C1b.
Context: funerary - burial 61.
Description: mail armour.

Inventory: double burial. Older individual: two pendants, several bronze objects, 22 glass- and amber beads, amber pendants. Younger individual: iron buckle, bone comb, ceramics including *terra sigillata*.
Location: Instytut Archeologii Uniwersytetu Jagiellońskiego, inv. 965/73.
Literature: Hansen 2003, 186 (cat. no. C184).

Łajski 1
Date: Roman period.
Context: funerary - burial 3.
Description: mail fragment.
Location: Państwowe Muzeum Archeologiczne w Warszawie.
Literature: Hansen 2003, 183 (cat. no. C158).

Łajski 2
Date: Roman period.
Context: funerary - burial 81.
Description: mail fragment.
Location: Państwowe Muzeum Archeologiczne w Warszawie.
Literature: Hansen 2003, 183 (cat. no. C159).

Młodzikowo
Date: C1.
Context: funerary - burial 57.
Description: mail fragment measuring 1.5 x 1.8 cm. 4-in-1. Riveted rings: outer diameter 4.5-6 mm; inner diameter 3-4 mm.
Material: iron.
Inventory: bronze and iron brooches, belt buckle, three keys, needle, pendant, bronze and iron objects, glass beads, molten glass, five ceramic vessels.
Remarks: burial of a woman. This cemetery also has rendered isolated finds of mail.
Location: Muzeum Archeologczne w Poznaniu, inv. 1950/1598.
Literature: Czarnecka 1996, 245-246; Hansen 2003, 183 (cat. no. C154); Künzl 2002, 138 (cat. no. 24); Müller 2003, 437; Pauli Jensen 2008, 218; Van der Sanden 1993, 4 (cat. no. 54); Waurick 1982, 116 (cat. no. 24); Weski 1982, 40.

Nowa Huta Pleszów
Date: B2/C1?
Context: loose find.
Description: mail armour.
Location: Muzeum Archeologczne w Krakowiem.
Literature: Czarnecka 1996, 246; Hansen 2003, 186 (cat. no. C185); Künzl 2002, 138 (cat. no. 31).

Nowa Huta Mogiła
Date: Roman period?
Context: settlement.
Description: mail armour.
Location: Muzeum Archeologczne w Krakowie.
Literature: Czarnecka 1996, 246; Hansen 2003, 186 (cat. no. C186).

Piaski
Date: B2/C1a.
Context: funerary - burial 95.
Description: three mail fragments. 4-in-1. A miniature shield, lunula pendant, miniature scissors, and miniature knife were probably attached to the mail. 4-in-1. Rings: outer diameter: 7-8 mm; inner diameter 4.5-5 mm.
Material: iron.
Inventory: brooch, various metal objects, ceramics. Disturbed burial and inventory probably incomplete.
Remarks: burial of a juvenal-adult woman
Literature: Beilke-Voigt 1997, 606, fig. 1; Czarnecka 1996, 246, 251, fig 3; Hansen 2003, 79-80, 185 (cat. no. C174).

Puławy-Włostowice
Date: Roman period.
Context: funerary - burial 8.
Description: fragmented mail armour.
Literature: Hansen 2003, 184 (cat. no. C172).

Opalenie
Date: LT D.
Context: funerary.
Description: mail armour, heavily corroded and rolled up. 4-in-1. Rings: diameter c. 7 mm. The mail remains are now lost, but a sketch survives. The sketch (of unknown accuracy) shows unriveted rings.
Material: iron.
Inventory: sword and scabbard, spearhead, shield boss, fibula with Middle La Tène motive, bronze bucket.
Remarks:
Location: formerly in the Museum für Völkerkunde Berlin, inv. II 3426-3433.
Literature: Hansen 2003, 63, 69, 120, 162-163 (cat.

no. 14); Bochnak 2009, 13, fig. 8.5; Bochnak/Harasim 2012, 69, 75, 78, 80, fig. 6.4; Künzl 2002, 137 (cat. no. 22); Malfilâtre 1993, 2;Van der Sanden 1993, 4 (cat. no. 55); Waurick 1982, 114-115 (cat. no. 22).

Opatów 1 *(fig. 3.34)*
Date: B2-C1b.
Context: funerary - burial 49.
Description: strip of mail, now measuring c. 9 cm x 2.3 cm, with seven pendants attached: i.e. miniature shield, two knives, hammer, scissors, two keys and a lunula. 4-in-1. Rings: outer diameter 7 mm; inner diameter 5 mm; cross-section round. According to the excavator the shield functioned as a clasp for the ends of the mail strip, with the other miniature elements hanging from it as in a 'bracelet'. The large size of the pendants (c. 7 cm in length) would have made it uncomfortable to wear and casts doubt upon this interpretation.
Material: iron.
Inventory: bronze brooch, ceramics.
Location: Muzeum Archeologczne w Krakowie.
Literature: Czarnecka 1996, 246, 250-251, fig. 1; Hansen 2003, 79-80, 185, fig. 28.1 (cat. no. C176); Künzl 2002, 138 (cat. no. 27); Pauli Jensen 2008, 218; Van der Sanden 1993, 4 (cat. no. 56); Waurick 1982, 116 (cat. no. 27).

Opatów 2
Date: B2-C1b.
Context: funerary - burial 147.
Description: four mail fragments with pendants in the shape of miniature objects: i.e. knife, fork, key, fragment of a tool. 4-in-1. Rings are reported to be riveted and butted. 4-in-1. Rings: outer diameter 6-7 mm; inner diameter 4-5 mm.
Material: iron.
Inventory: three brooches, molten bronze, small antler comb, ceramics.
Location: Muzeum Archeologczne w Krakowie.
Literature: Czarnecka 1996, 246, 251, fig. 2; Hansen 2003, 185 (cat. no. C177); Pauli Jensen 2008, 218; Van der Sanden 1993, 4 (cat. no. 56); Waurick 1982, 116 (cat. no. 27).

Opatów 3
Date: B2-C1.
Context: funerary - burial 826.
Description: two mail fragments. Rings: outer diameter 6-7 mm; inner diameter 3-4 mm.
Material: iron.
Inventory: four brooches, four pendants, miniature knife, iron needle, molten gold remnants, various metal objects, molten glass, bone needle, two ceramic vessels.
Remarks: burial of a woman and infant.
Literature: Hansen 2003, 82, 185 (cat. no. C178); Opreanu 2011, 221-222, fig. 5.1; Pauli Jensen 2008, 218.

Opatów 4
Date: C1a.
Context: funerary - burial 890.
Description: three rings: outer diameter 5-7.5 mm; inner diameter 3-4.5 mm. Uncertain if this is mail.
Material: iron.
Inventory: brooch, iron lunula pendant, fragment of a miniature object, iron fragments, ceramic sherds.
Literature: Czarnecka 1996, 246; Hansen 2003, 185 (cat. no. C179); Pauli Jensen 2008, 218.

Starachowice 1
Date: B2/C1a.
Context: funerary - burial IV.
Description: two mail fragments.
Material: iron.
Inventory: key, various metal objects, wooden box, antler comb, bone needle, necklace with stone beads and an animal claw pendant, glass beads, two clay beads, four ceramic objects, three spindle whorls, needle, awl, knife fragment, two corroded tools, miniature clay vessel.
Location: Państwowe Muzeum Archeologiczne w Warszawie, inv. IV-248.
Literature: Czarnecka 1996, 245-246; Hansen 2003, 184 (cat. no. C168).

Starachowice 2
Date: B2/C1a.
Context: funerary - burial V.
Description: various mail fragments. Rings: outer diameter 7 mm; inner diameter 5 mm.
Material: iron.
Inventory: knives, brooch, buckle, two needles, key, five ceramic vessels.
Literature: Hansen 2003, 184 (cat. no. C169).

Święcica
Date: Roman period.

Context: funerary.
Description: fragmented mail remains.
Literature: Hansen 2003, 184 (cat. no. C171).

Tarnów
Date: B2-C2.
Context: funerary - burial 29/1936.
Description: two rings: outer diameter 6 mm; inner diameter c. 4 mm. Uncertain if this is mail.
Material: iron.
Inventory: needle, bronze remains, ceramics.
Literature: Hansen 2003, 184 (cat. no. C164).

Witaszewice
Date: B2/C1a.
Context: funerary - burial 22.
Description: eleven mail fragments now weighing c. 2 kg. Rings: outer diameter: 6-7 mm; inner diameter 3-4 mm.
Material: iron.
Inventory: spurs, silver vessel fragments, bronze vessels fragments, various copper alloy and iron objects, ceramic vessels.
Location: Muzeum Archeologiczne i Etnograficzne w Łodzi, inv. III-1935/155.
Literature: Budinský-Krička/Lamiová-Schmiedlová 1990, 284; Czarnecka 2013, 172; Hansen 2003, 81, 83, 183 (cat. no. C153); Kaczanowski 1994, 220; Künzl 2002, 137 (cat. no. 23); Müller 2003, 437; Pauli Jensen 2008, 218; Raddatz 1981, 56; Rasmussen 1995, 75; Van der Sanden 1993, 4 (cat. no. 57); Waurick 1982, 116 (cat. no. 23).

Zadowice
Date: 4th century AD.
Context: funerary - burial 67.
Description: mail fragment measuring 8.25 x 3 cm. All rings are riveted: outer diameter 6.5 mm; inner diameter 4.5 mm; cross-section round. Speculated to concern a mail bracelet.
Material: iron.
Inventory: knife, two brooches, iron buckle, molten glass and bronze, ceramics.
Location: Muzeum Archeologiczne i Etnograficzne w Łodz, inv. 1953/179.
Literature: Budinský-Krička/Lamiová-Schmiedlová 1990, 284; Czarnecka 1996, 245; Hansen 2003, 183 (cat. no. C156); Künzl 2002, 138 (cat. no. 25); Van der Sanden 1993, 4 (cat. no. 58); Waurick 1982, 116 (cat. no. 25); Weski 1982, 40.

Zakrzów 1
Date: B2/C1b.
Context: funerary - burial 17.
Description: two mail fragments. Rings: outer diameter 8 mm.
Material: iron.
Inventory: multiple ceramic vessels. Disturbed grave with incomplete inventory.
Location: Muzeum Górnośląskie w Bytomiu.
Literature: Czarnecka 1996, 246; Hansen 2003, 183 (cat. no. C160).

Zakrzów 2
Date: B2/C1b.
Context: funerary - burial 28.
Description: mail fragment measuring 1 x 1 cm. Rings: outer diameter 7 mm; inner diameter 5 mm.
Material: iron.
Inventory: ceramic sherds. Inventory is incomplete.
Location: Muzeum Górnośląskie w Bytomiu.
Literature: Czarnecka 1996, 246; Hansen 2003, 183 (cat. no. C161).

ROMANIA

Bârlad-Valea Seacă
Date: C2.
Context: funerary - grave M426.
Description: several mail rings.
Material: iron.
Inventory: globular bronze pendant.
Literature: Opreanu 2011, 221-223, fig. 2.

Berzovia
Date: start 1st century AD.
Context: Roman fort.
Description: mail fragment, now solid and folded. 4-in-1.
Material: iron.
Literature: Petculescu 2006, 450-451.

Cetăţeni 1
Date: 1st century BC.
Context: funerary.
Description: various mail fragments. 4-in-1. Riveted

and solid rings. Rings: diameter 7 mm, cross-section wire 1 mm. A separate fragment is at the Muzeul Județean Argeş, Piteşti, which is speculated to come from the same grave. 4-in-1. Rings: outer diameter 5-6 mm; thickness 1 mm.

Fixture: moon-shaped gold fixture attached to the mail coat by a stud.

Material: iron.

Inventory: silver and gold fragments, glass beads, pottery sherds, remnants of weapons, shield boss?, cremation remains, urn.

Location: Muzeul Militar Național, Bucharest, inv. 45267; Muzeul Județean Argeş, Piteşti.

Literature: Borangic 2011a, 174, 182, 191, 203-206 (cat. no. 1); Hansen 2003, 61-62, 69, 163 (cat. no. B20); Măndescu 2013; Roux/Coffyn, 1987, 39; Rustoiu 1996, 33, 36; 2006, 49; Rusu 1969, 289; Sîrbu *et al.* 2007a, 160; 2007b, 82; Van der Sanden 1993, 4 (cat. no. 59); 2003/2004, 371; Vulpe 1976, 208, 212; Vulpe/Căpitanu 1971, 162-3; Waurick 1979, 324 (cat. no. 12).

Cetățeni 2

Date: 1st century BC.

Context: funerary.

Description: four mail fragments, affected by fire. Rings: outer diameter 9 mm; cross-section wire 1 mm.

Material: iron.

Inventory: glass beads, ceramic vessel, shield boss?

Location: Muzeul Municipal Câmpulung Muscel, inv. 276/2722; 277/2619; 278/2723; 279/2721.

Literature: Borangic 2011a, 175, 182, 191, 205 (cat. no. 3); Hansen 2003, 61, 69, 163 (cat. no. B21); Rusu 1969, 289; Sîrbu *et al.* 2007a, 160; 2007b, 82; Van der Sanden 2003/2004, 371; Vulpe 1976, 208, 212; Vulpe/Căpitanu 1971, 162-3; Waurick 1979, 324 (cat. no. 12).

Cetățeni 3

Date: 1st century AD.

Context: funerary.

Description: 17 mail rings. One ring is riveted, the others are too corroded to determine the ring type. Rings: diameter 11 mm; cross-section wire 1-2 mm.

Material: iron.

Location: Muzeul Județean Argeş, Piteşti, inv. 2643.

Literature: Borangic 2011a, 176, 182, 191, 203-206 (cat. no. 4); Rusu 1969, 289; Vulpe/Căpitanu 1971, 162-3.

Cetățeni? 4

Date: 1st century BC.

Context: funerary?

Description: several mail fragments affected by fire. 4-in-1. Rings: outer diameter 6 mm, cross-section wire 1.5 mm.

Material: iron (Fe 98.2-99.1%).

Location: Muzeul Național de Istorie a României, Bucharest, inv. 67764, 96495.

Literature: Borangic 2011a, 175-176, 182, 191, 203-206 (cat. no. 2); Borangic/Bădescu 2014, 65-67; Rusu 1969, 289; Van der Sanden 2003/2004, 371; Vulpe/Căpitanu 1971, 162-3.

Ciumeşti *(figs. 2.11, 3.9, 4.6a, 8.19)*

Date: likely 250-200 BC, possibly 300-200 BC.

Context: funerary.

Description: coat of mail, rolled up and corroded together, and made flexible by mechanical cleaning. This treatment caused fragmentation of the coat. One fragment preserves a straight edge, possibly from a bottom hem. Another fragment preserves a L-shaped edge that probably corresponds to the upper chest. There are four fragments that were found during later excavation and are still solid. 4-in-1. The rings have been described in the literature as: all butted, all riveted, partly all riveted and partly alternating solid and butted, or alternating riveted and welded rings. Examination by the author demonstrates that all rings are butted. Two gauges of butted rings are observed: main stock, and in two places slightly lighter rings. Main stock: outer diameter 8.9 mm; inner diameter 5.5 mm; width 1.6 mm; thickness 1.6 mm; cross-section wire round; butted ends are straight. The lighter rings are probably placed to what corresponds to the hem of the neck and the hem at the arm. Lighter rings: inner diameter 8 mm; inner diameter 5,5 mm; width 1,3 mm; thickness 1,3 mm; cross-section wire round; butted ends are straight.

Fixture: plate-like fastener made of a base-plate with two bronze rosette-like disks attached, decorated with a triskele. The fastener pivots on one end, while the other extremity has a key-shaped opening to receive a button. In addition, there is a single bronze rosette-like disk, similar in appearance to those on the fastener. Lastly there is a small iron button.

Material: rings: iron; fastener and rosette: copper alloy; button: iron.

Inventory: helmet with bird, greaves, spearhead, part of a brooch, belt parts, scissors, various iron objects, pottery.
Remarks: examined by the author.
Location: Muzeul Județean de Istorie şi Arheologie Maramureş, inv. 3326-3329; Muzeul Județean Satu Mare, inv. 31306.
Literature: Bader 2012, 283-284, pl. 3; Barril Vicente *et al.* 1998, 74-75, fig. 9; Borangic/Palinga 2013, 18; Canestrelli 2018, 20-21; Connolly 1990, 19; 1998, 123-125; Dedyulkin/Shevchenko 2017, 51; Demarsin/Derwael 2019, 90-91; Demierre 2012, 166; 2015, 157; Dimitrov 2009-2010, 101, 104, fig. 7; Edge 2001, 227; Ehlton 2002/2003, 8; Fabian 2018, 39; Feugère 1993, 89; Foster 1986, 85; Fredman 1992, fig. 8; Gilmour 1997 33-34; 1999, 166; Hansen 2003, 26, 34-35, 43-45, 47-49, 51, 56, 65, 68-69, 74, 121-122, 163 (cat. no. B15); Kaul 2003, 154; Maier 1973, 467-469; Malfilâtre 1993, 2, 4, 11-12; Mordvintseva *et al.* 2012, 323; Müller 1986, 121, fig. 8; 2011, 525, fig. 6; Müller 2003, 434; Nemeti 1975, 243, fig. 2.4; Nicklasson 1989, 25; Novichenkova 2011, 277, 279; Quesada Sanz *et al.* 2019, 158-159; Galán 2017, 32-34; Randsborg 1995, 27; Ritchie/Ritchie 1997, 48, 51, fig. 30; Roux/Coffyn, 1987, 38-39; Rustoiu 2006, 49-52, fig. 1.4; 2012 164, 171; Rusu 1969, 276-278, 289-290, fig. 5, pl. 143-146; Stead 1991, 56; Szabó 1988, 25, fig. 30; Van der Sanden 1993, 4 (cat. no. 60); 2003/2004, 371-372; Waurick 1979, 324, 326-327, 330 (cat. no. 9); Wijnhoven 2014, 13; Zeller 1980, 129, fig. 22; Williams 2003, 29; Zirra 1991, 382-383.

Cugir
Date: LT D1.
Context: funerary - *tumulus* 2.
Description: 58 mail fragments that in original condition would have weighed c. 12-14 kg. 4-in-1. Alternating rows of riveted and solid rings. Rings: diameter 6-8 mm; wire diameter 1-1.1 mm. Two museums have fragments and the rings are reported to be of a slightly different size.
Fixture: damaged set of S-shaped fasteners attached by a central button. Four more buttons that were presumably located at the shoulder guards.
Material: rings: iron; fastener and buttons: iron.
Inventory: chariot with two horses and one riding horse, helmet, sword with scabbard, spearhead, shield boss, *sica* knife, bow, spurs, three horse bits, bronze *situla*, silver brooches, gold jewellery, pottery, burnt bones (horse).
Location: Muzeul Național al Unirii Alba Iulia, inv. D 4647(MNUAI); Clubul Elevilor Cugir.
Literature: Borangic 2011a, 177-179, 183, 191, 202, 207-213 (cat. no. 5); D'Amato/Sumner 2009, 159-158, fig. 12, 218, 219; Hansen 2003, 61, 69, 163 (cat. no. B18); Quesada Sanz/Rueda Galán 2017, 32; Rustoiu 1996, 36; 2006, 49, 51; 2009, 33, fig. 2; Sîrbu *et al.* 2007a, 160; 2007b, 81.

Galații Bistriței
Date: 6th - 1st half 7th century AD.
Context: funerary - burial 39.
Description corroded mail fragments.
Material: iron.
Inventory: belt button, silver belt plate, bronze nails, iron rings, iron plate, fragments of human bones. Burial was disturbed.
Literature: Harhoiu 2008, 190-191, fig. 20.13.

Hunedoara
Date: 1st century BC.
Context: funerary - complex 70, deposit 7.
Description: mail armour cut into fragments and exposed to fire. 4-in-1. Alternating rows of riveted and solid rings. Rings: outer diameter 5.5-6 mm; cross-section wire 1.5 mm. Riveted rings: overlap anti-clockwise; shape overlap triangular; rivet head on one side and protruding on the other side; cross-section: round. Solid rings: cross-section D-shaped.
Fixture: '... plus a number of other types of connection items'.
Material: iron.
Inventory: helmet?, sword and scabbard, shield bosses, bridle bit, bones of a horse and pig.
Remark: burial of an adult man.
Location: Muzeul Castelul Corvinilor, Hunedoara, inv. A 5561.
Literature: Sîrbu *et al.* 2007a, 158-160, fig. 5-6, 12; Sîrbu *et al.* 2007b, 48-49, 72, 75, 81-82, 196, fig. 42-44; Borangic 2011a, 179-180, 191, 214-215 (cat. no. 6).

Independența - Halmyris
Date: late 4th - early 5th century AD.
Description: large mail fragment.
Location:: Bishop/Coulston 2006, 208; Charles 2007,10; Glad 2009, 43, 117 (cat. no. 79); Vujović 2017, 246.

Măgura Moigradului
Date: 50 BC-AD 50.
Context: settlement - hillfort.
Description: mail fragments. 4-in-1. Rings: diameter 5-6 mm; cross-section wire 1 mm.
Material: iron.
Inventory: iron buckle, pottery, ceramic vessel.
Location: Muzeul Județean de Istorie şi Artă, Zalău, inv. C.C. 324/1992.
Literature: Borangic 2011a, 188-189, 225 (cat. no. 16); Borangic 2011b, 128, 136, 138, 146; Borangic/Palinga 2013, 18.

Poiana
Date: 1st century BC.
Context: funerary.
Description: mail fragments. 4-in-1. No visible rivets. Rings: diameter 8-9 mm; cross-section wire 1 mm.
Material: iron.
Inventory: bronze helmet.
Location: Muzeul Județean Gorj Alexandru Ştefulescu, Târgu Jiu, inv. 347.
Literature: Borangic 2011a, 180, 191, 216-217 (cat. no. 7); Hansen 2003, 61, 69, 163 (cat. no. B19); Rustoiu 1996, 36; 2006, 49; Sîrbu *et al.* 2007a, 160; 2007b, 82; Van der Sanden 1993, 4 (cat. no. 61); 2003/2004, 371; Vulpe 1976, 208, 212; Vulpe/Căpitanu 1971, 162; Waurick 1979, 324 (cat. no. 11).

Popeşti 1
Date: 2nd half 1st century BC.
Context: funerary - *tumulus* 2.
Description: twelve mail fragments. 4-in-1. Rings are reported to be butted.
Fixture: partial set of S-shaped fastener with central button.
Material: iron.
Inventory: sword and scabbard, spearhead, knives, gold belt fragments, bronze mirror, iron brooch, bronze bracelet, finger rings, pendant, various bronze and iron objects, seven glass beads, pottery sherds, cremation remains.
Location: Muzeul Național de Istorie a României, Bucharest?
Literature: Borangic 2011a, 173, 180-181, 191 (cat. no. 8); Hansen 2003, 61-62, 69, 74, 163-164 (cat. no. B22); Rustoiu 1996, 34, 36; 2006, 49, 51; Rusu 1969, 289; Sîrbu *et al.* 2007a, 160; 2007b, 82; Van der Sanden 1993, 4 (cat. no. 62); 2003/2004, 371; Vulpe 1976, 198, 212, fig. 5.17, 5.20, 15.13-25; Vulpe/Căpitanu 1971, 162; Waurick 1979, 324 (cat. no. 13).

Popeşti 2
Date: 2nd half 1st century BC.
Context: funerary - *tumulus* 3.
Description: various mail fragments. Rings are reported to be butted.
Material: iron.
Inventory: shield edge, bronze brooch, various iron objects, pottery sherds, cremation remains.
Location: Muzeul Național de Istorie a României, Bucharest.
Literature: Borangic 2011a, 173, 182, 191 (cat. no. 9); Hansen 2003, 61, 69, 74, 164 (cat. no. B23); Rustoiu 1996, 36; 2006, 49; Rusu 1969, 289; Sîrbu *et al.* 2007a, 160; 2007b, 82; Van der Sanden 1993, 4 (cat. no. 62); 2003/2004, 371; Vulpe 1976, 201, 212; Vulpe/Căpitanu 1971, 162; Waurick 1979, 324 (cat. no. 13).

Popeşti 3
Date: 1st half 1st century BC.
Context: funerary - *tumulus* 4.
Description: complete mail coat, now folded and affected by fire. 4-in-1. Part of the rings is riveted. Rings: diameter 8 mm; cross-section wire 2 mm.
Fixture: two associated, damaged fixtures of undetermined function.
Material: iron.
Inventory: bronze helmet, sword with scabbard, short sica sword, spearhead, shield boss, knives, arrowhead, sickle, fragments of a horse bit, silver coin, iron brooch, bronze brooch, bronze bracelet, glass beads, various iron objects, pottery sherds.
Location: Muzeul Național de Istorie a României, Bucharest, inv. 73471a-b.
Literature: Borangic 2011a, 173, 183, 190-191, 218, 220 (cat. no. 11); Borangic/Bădescu 2014, 64; Hansen 2003, 61-62, 69, 74, 164 (cat. no. B24); Roux/Coffyn, 1987, 39; Rustoiu 1996, 36; 2006, 49, 51; Rusu 1969, 289; Sîrbu *et al.* 2007a, 160; 2007b, 82; Van der Sanden 1993, 4 (cat. no. 62); 2003/2004, 371; Vulpe 1976, 201, 212, fig. 11.1, 15.1; Vulpe/Căpitanu 1971, 162; Waurick 1979, 324 (cat. no. 13).

possibly **Popeşti** 4
Date: Iron Age?
Description: corroded mail fragments affected by fire.

Rings: diameter 6 mm; wire diameter 1.5 mm.
Material: iron.
Remarks: no information on its provenance, possibly from Popeşti**.**
Location: Muzeul Naţional de Istorie a României, Bucharest, inv. 96495.
Literature: Borangic 2011a, 182-183, 219 (cat. no. 10).

Răcătău de Jos
Date: 200/175-150 BC.
Context: funerary.
Description: large mail fragment, still partly flexible, but much damaged. 4-in-1. Reported to consist of alternating rows of riveted and butted rings. Rings: cross-section round. Riveted rings: outer diameter 8-9 mm; inner diameter 5-6 mm. Reported butted rings: outer diameter 6 mm; inner diameter 5 mm.
Fixture: conical shaped button. Also, a broken leaf-shaped fixture. Lastly, a base plate of a buckle with its loop now missing.
Material: iron.
Inventory: scale armour fragments, sword, scabbard, shield boss, cauldron, wine bowl, various bronze and iron objects, pottery sherds.
Location: Muzeul Judeţean de Istorie Iulian Antonescu, Bacău.
Literature: Borangic 2011a, 184-186, 191 (cat. no. 12); Hansen 2003, 61-62, 69, 163 (cat. no. B16); Rustoiu 1996, 34, 36-37, 43-44; 2006, 49; Van der Sanden 1993, 4 (cat. no. 63); Vulpe 1976, 213; Vulpe/Căpitanu 1971, 158, 162-163, fig. 3.1-2, 4.2-3; Waurick 1979, 324 (cat. no. 10).

Radovanu *(fig. 3.6)*
Date: 1st century BC.
Context: funerary.
Description: mail coat in flexible condition. It has many tears and holes, making it difficult to understand its original shape. 4-in-1. Alternating riveted and solid rings. Rings: diameter 7 mm; cross-section wire 1-1.5 mm. Riveted rings: same size as solid rings; overlap anti-clockwise; shape overlap large oval; rivet heads on both sides; cross-section wire round. Solid rings: cross-section D-shaped and some have a multi-faceted outer appearance.
Fixture: button attached to the mail fabric by two washers. Also, two fixtures with a curved bar ending on both sides in an oval shape.
Material: rings: iron; fixtures: iron.
Inventory: iron fragment of a probable helmet, two spearheads, *sica* knives, horse harness, animal bones.
Location: Muzeul Militar Naţional, Bucharest, inv. 43491.
Literature: Borangic 2011a, 185-186, 190-191, 223 (cat. no. 13); Hansen 2003, 61-62, 69, 164 (cat. no. B25); Măndescu 2013, 13; Rustoiu 1996, 36; 2006, 49; Van der Sanden 1993, 4 (cat. no. 64); 2003/2004, 371; Vulpe 1976, 208, 212, fig. 18.6-8; Vulpe/Căpitanu 1971, 162; Waurick 1979, 324 (cat. no. 14); Wijnhoven 2015a, 1.

Şimleu Silvaniei
Date: 1st century BC - start 1st century AD. Refined date: late 1st century BC – start 1st century AD.
Context: settlement - isolated find.
Description: three mail fragments. Originally there were more fragments, but the discoverer did not hand these over by to the museum. 4-in-1. Rings: diameter 4 mm; cross-section wire 1 mm. Rings have been described as not-riveted.
Material: iron.
Inventory: metal objects, stones and pottery, coins, silver ornaments.
Location: Muzeul Judeţean de Istorie şi Artă, Zalău, inv. C.C. 13/1975.
Literature: Borangic 2011a, 189-190, 225 (cat. no. 17); Borangic 2011b, 128, 136-138, 146.

Unirea - Vereşmort
Date: AD 580-625.
Context: funerary - grave 1.
Description four mail fragments, measuring each several cm^2. Possibly a mail aventail belonging to a helmet. 4-in-1.
Material: iron.
Inventory: horse skeleton, bit, stirrups, horse harness with mounts, single edged sword, scabbard with bronze fittings, bow, arrows, silver elements of a pressed belt set, gold earring, bronze and iron buckles, silver rods, many elements of iron, fire steel.
Remarks: burial of a 25-28 year old man.
Literature: Cosma 2008, 26, 74, pl. 15.1-4; Dobos 2015, 76; Rustoiu/Ciută 2015, 108.

Zimnicea
Date: Iron Age.
Description: mail armour.
Literature: Alexandrescu 1980.

RUSSIA

Balyk-Sook

Date: 8th - 1st half 9th century AD.
Context: grave - kurgan 11.
Description: aventail belonging to a lamellar helmet. 4-in-1. Alternating rows of riveted and solid rings. Mail has large iron- and small copper alloy rings. Although the exact pattern can no longer be established, it seems that the two materials were used in an alternating fashion. Copper alloy rings: diameter 7-8 mm; thickness 0.7 mm; width 1 mm. Iron rings: diameter 16-17 mm; thickness 2 mm; width 3-4 mm. The presence of organic remains and silk, indicates that the aventail was lined with these materials.
Material: iron, copper alloy.
Inventory: iron lamellar armour, lamellar helmet, silver hasp and strap tips, bone implement for loosing knots, iron fire striker, flint, two horn plaques, silver vessel, iron knife, decorated belt, horn hasps of horse-locks, gold earring, iron spearhead, horn terminal and haft of riding crop, silver buckles, horn arrow whistle, arrowhead, iron belt tip, buckle and iron points, iron stirrups, horn parts of a bow, adze-axe, horse harness set (silver plates, buckles, and a triplet-allocator), iron girth buckles, iron curb bits and horn check pieces, three horse skeletons.
Literature: Kubarev 1997; Kubarev/Kubarev 2003; Péter 2014, pl. 18.2; Wijnhoven 2017, 184.

Dájovskaya

Date: 2nd century BC - 2nd century AD.
Context: funerary armour.
Description: mail.
Literature: Dedyulkin/Shevchenko 2017, 53 (cat. no. 9).

Diurso

Date: 9th century AD.
Context: funerary.
Description: mail aventail attached to an iron helmet.
Inventory: helmet. Inventory incomplete.
Literature: Gorelik 2002, fig. 11-5.3.

Federovka

Date: 5th century AD.
Context: funerary.
Description: mail fragment, still flexible, measuring c. 10 x 7 cm. 4-in-1.
Material: iron.
Inventory: sword with scabbard (decorated with garnets and gold), four arrowheads, various belt components, silver buckle, metal plates with polychrome decoration, bridle.
Literature: Adams 2010, 97; Glad 2009, 43, 50,116, fig. 5.2 (cat. no. 74); Kazanski 2012, fig. 2.12.

Gorgippia

Date: first centuries AD.
Context: funerary.
Description: two mail fragments, one measuring 15 x 9.5 x 6 cm and the other somewhat smaller. 4-in-1. Combination of copper alloy and iron rings. Iron rings: diameter 10 mm. Copper alloy rings: diameter 8 mm.
Material: iron, copper alloy.
Literature: Dedyulkin/Shevchenko 2017, 53 (cat. no. 6); Goroncharovski 2006, 446; Wijnhoven 2017, 184, 186, 193.

Gorodskoy farmstead

Date: end 1st - 2nd century AD.
Context: funerary.
Description: 13 burials containing mail armour. Each armour was rolled up and in that condition measures 110 cm or more. It is thought that the mail coats reached approximately to the knees. Approximate weight per coat 12-15 kg. On the inside of the armour were traces of leather or linen that was worn underneath the mail coat. It is uncertain if this is from a separate garment left inside, or from an integrated lining or padding.
Fixture: a drawing of the armour shows one or possibly more buckles located next to the head opening, possibly to open and close it.
Material: iron.
Inventory: found in the 13 burials: helmets, swords, spears, torcs, golden rings, silver vessels, many imported Roman objects, some graves with horse skeletons.
Remarks: cemetery of which c. 25% of the graves contained mail armour and a helmet. The contents of the graves have been associated with the equipment of Cataphracts.
Literature: Goroncharovski 2006, 446, fig. 3.2; Kazanski 2013, 510; Kazanski/Mastykova 2003, 28-29, 202; Negin/D'Amato 2018, 12-13, 44.

Iur' evskaya Gorka

Date: c. AD 500-550.

Context: settlement.
Description: several mail rings.
Inventory: arrowhead, two riding bits, two axe fragments.
Literature: Kazanski 2007, 244, 249, fig. 6.7.

Jaroslavskaja Staniča
Date: 1st - start 3rd century AD.
Context: funerary.
Description: three mail garments. One is especially large, but has not been preserved, and has been speculated to be the protection of a horse. The other two are probably mail coats belonging to the two deceased in the burial.
Material: iron.
Inventory: knives, stone axe with iron handle, iron wine bowl, ladle, bronze bells, glassware, ceramics, bone needle, horse tooth, boar teeth, two human skeletons.
Literature: Hansen 2003, 118, 188 (cat. no. C208); Negin 1998, 74; Simonenko 2001, 298.

Jatukái
Date: 1st century AD.
Context: funerary - burial 9.
Description: mail armour.
Literature: Dedyulkin/Shevchenko 2017, 53 (cat. no. 17).

Kalininskaya
Date: 2nd century AD.
Context: funerary - burial mound 3.
Description: mail armour.
Literature: Dedyulkin/Shevchenko 2017, 53 (cat. no. 15).

Kazanskaja Staniča 1
Date: 1st - start 3rd century AD.
Context: funerary - kurgan 2.
Description: armour described as a combination of mail and scale, but concerns probably two separate garments: one scale- and one mail armour.
Material: iron.
Inventory: gold fittings, gold remains, piece of lead.
Literature: Hansen 2003, 187 (cat. no. C197); Simonenko 2001, 272-276.

Kazanskaja Staniča 2
Date: 1st - start 3rd century AD.
Context: funerary - kurgan 8.
Description: armour described as a combination of mail and scale, but concerns probably two separate garments: one scale- and one mail armour.
Material: iron.
Literature: Bârcă 2006, 214, fig. 206.4-6; Hansen 2003, 187 (cat. no. C198); Negin 1998, 69; Simonenko 2001, 272.

Kazanskaja Staniča 3
Date: 1st - start 3rd century AD.
Context: funerary - kurgan 17.
Description: armour described as a combination of mail and scale, but concerns probably two separate garments: one scale- and one mail armour.
Material: iron.
Literature: Hansen 2003, 187 (cat. no. C199); Simonenko 2001, 272.

Kazanskaja Staniča 4
Date: 1st - start 3rd century AD.
Context: funerary - kurgan 19.
Description: armour described as a combination of mail and scale, but concerns probably two separate garments: one scale- and one mail armour.
Material: iron.
Literature: Hansen 2003, 187 (cat. no. C200); Simonenko 2001, 272.

Kazanskaja Staniča 5
Date: 1st - start 3rd century AD.
Context: funerary - kurgan 20.
Description: armour described as a combination of mail and scale, but concerns probably two separate garments: one scale- and one mail armour.
Material: iron.
Literature: Hansen 2003, 187 (cat. no. C201); Simonenko 2001, 272.

Kazanskaja Staniča 6
Date: 1st - start 3rd century AD.
Context: funerary - kurgan 40.
Description: armour described as a combination of mail and scale, but concerns probably two separate garments: one scale- and one mail armour.
Material: iron.
Literature: Hansen 2003, 187 (cat. no. C202); Simonenko 2001, 272.

Kazanskaja Staniča 7
Date: 1st - start 3rd century AD.
Context: funerary - kurgan 44.
Description: large mail fragment.
Material: iron.
Literature: Hansen 2003, 188 (cat. no. C203); Simonenko 2001, 278.

Kazanskaja Staniča 8
Date: 1st - start 3rd century AD.
Context: funerary - kurgan 51.
Description: large mail fragment.
Material: iron.
Literature: Hansen 2003, 188 (cat. no. C204); Simonenko 2001, 278.

Kazanskaja Staniča 9
Date: 1st - start 3rd century AD.
Context: funerary - kurgan 1.
Description: large mail fragment, reported to have a textile lining on the inside. It is probable that the lining actually concerns the scale armour also found in this burial. The scale- and mail armour are unlikely from the same garment.
Material: iron.
Literature: Bârcă/Symonenko 2009, 304; Dedyulkin/Shevchenko 2017, 53 (cat. no. 23); Hansen 2003, 188 (cat. no. C205); Simonenko 2001, 278.

Kazazovo
Date: Early Khazar period.
Context: funerary - *tumulus* 106.
Description: well-preserved mail shirt. Drawing shows a semi-long mail coat with deep splits at the front and back to facilitate movement. The sleeves cover most of the upper arms. The coat has an integrated collar with an offset split, which when closed covers the neck.
Inventory: helmet with mail aventail. Inventory incomplete.
Literature: Adams 2010, 97; Dedyulkin/Shevchenko 2017, 53 (cat. no. 13); Gorelik 2002, 133, 135, fig. 11-5.4, 11-5.13; Kubic 2016, 92, 98, fig 12; Petér 2014, 21, 25, pl. 12.4.

Kišpek
Date: 4th century AD.
Context: funerary - *tumulus* 13.
Description: mail fragment. 4-in-1.
Material: iron.
Inventory: lamellar helmet decorated with gold and coral, sword, spear, knife, bronze cauldron, metal containers, ceramic and wooden vessels, horse harness, horse bits, saddle, brooch, bronze and silver buckles, mirror, two tripods, various metal fixtures.
Literature: Adams 2010, 97, 109; Glad 2009, 15, 42-43, 117, fig. 5.3 (cat. no. 80); Kazanski 1995, 189, fig. 4.6; 2013, fig. 10.4; Péter 2014, pl. 19.1.

Koerganinsk
Date: 1st century BC.
Context: funerary - burial mound 1.
Description: mail armour.
Literature: Dedyulkin/Shevchenko 2017, 53 (cat. no. 11).

Kudirge
Date: Turkic Khaganate.
Context: funerary.
Description: small mail fragment.
Literature: Borisenko *et al.* 2006, 119.

Ladožskaja Staniča 1
Date: 1st - start 3rd century AD.
Context: funerary - kurgan 26/1.
Description: armour described as a combination of mail and scale, but concerns probably two separate garments: one scale- and one mail armour.
Material: iron.
Literature: Bârcă 2006, 214; Hansen 2003, 188 (cat. no. C209); Simonenko 2001, 272.

Ladožskaja Staniča 2
Date: 1st - start 3rd century AD.
Context: funerary - kurgan 28.
Description: armour described as a combination of mail and scale, but concerns probably two separate garments: one scale- and one mail armour.
Material: iron.
Literature: Bârcă 2006, 214; Dedyulkin/Shevchenko 2017, 53 (cat. no. 21); Hansen 2003, 188 (cat. no. C210); Simonenko 2001, 272.

Lagerevo
Date: 7th - 8th century AD.
Context: funerary burial 53.
Description: mail fragment.

Material: iron.
Inventory: fragments of lamellar armour. Inventory is probably incomplete.
Literature: Glad 2009, 50, 117 (cat. no. 82); Gorelik 2002, fig. 11-12.9.

Lebyajee 1
Date: 5th - 7th century AD.
Context: funerary - burial 32.
Description: three mail rings.
Literature: Glad 2009, 117 (cat. no. 83); Kazanski 1999, 204, 216; 2007, 244.

Lebyajee 2
Date: 5th - 7th century AD.
Context: funerary - burial 63.
Description: one mail ring.
Literature: Glad 2009,117 (cat. no. 84); Kazanski 1999, 204, 216; 2007, 244.

Leninokhablskaya
Date: 2nd - 1st half 3rd century AD.
Context: funerary - burials 31, 135, 142.
Description: mail armour found in three burials.
Literature: Dedyulkin/Shevchenko 2017, 53 (cat. no. 18).

Lysaja Gora
Date: 1st - 2nd century AD.
Context: funerary - kurgan 2.
Description: mail armour. Rings: outer diameter 6-7 mm; inner diameter 4 mm. Also the presence of scales which comes probably from a separate scale armour.
Material: iron.
Literature: Bârcă, 2006, 214, fig. 206.9; Dedyulkin/Shevchenko 2017, 53 (cat. no. 12); Hansen 2003, 188 (cat. no. C207); Simonenko 2001, 272.

Majkop
Date: 1st century AD.
Context: funerary.
Description: mail armour.
Literature: Dedyulkin/Shevchenko 2017, 53 (cat. no. 28).

Mezmay 1
Date: 225-175 BC.
Context: funerary - burial 3.
Description: complete mail coat, now a solid bundle. Current weight 9.6 kg and estimated original weight 8 kg. 4-in-1. Rings: outer diameter 6 mm.
Material: iron.
Inventory: two bronze helmets, four swords, battle axe, six spearheads, six javelins, arrowhead, bone knife, gold brooch, silver brooch, gold ring, gold bracelet, three gold clothing adornments, three gold plates, gold plaque with polychrome inlay, gold bead, long bead with gold, gold *umbo* shaped plate, four gold buttons, pendant made from gold coin, bronze mirror, bronze bracelet, iron tripod, iron tong, censer, bronze basin, bronze jug, two glass vessels, six pottery vessels, horn object.
Literature: Dedyulkin/Shevchenko 2017, 48, 51, fig. 2.2; Mordvintseva *et al.* 2012, 286, 289, 311, fig. 16.1, 3.

Mezmay 2
Date: 20 BC-AD 20.
Context: funerary - burial 11.
Description: large lump of mail, rolled up next to the deceased. Current weight 16 kg. It has been speculated in the past to be horse armour, because of its weight, but could also concern a mail coat. Rings: diameter c. 4 mm.
Material: iron.
Inventory: numerous gold ornaments, beads, bronze needle, mirror, two glass bowls, ceramic vessels, two horses (one with bridle and one with gold and glass ornaments).
Remarks: burial of a woman.
Literature: Dedyulkin/Shevchenko 2017.

Mezmay 3
Date: c. 200-30 BC.
Context: funerary - disturbed burial.
Description: corroded mail coat that has been smashed to pieces by modern grave robbers. Rings: diameter c. 5 mm.
Fixture: plate-like fastener.
Material: rings: iron; fastener: bronze.
Literature: Dedyulkin/Shevchenko 2017, 51-52, fig. 2.3.

Mezmay 4
Date: c. 200-30 BC.
Context: funerary - disturbed burial.
Description: corroded mail fragment. 4-in-1. Alternat-

ing rows of solid and riveted rings. Rings: diameter c. 5 mm; thickness wire 1.1 mm. Fabric remains adhere and it has been suggested that the coat may have been lined.
Fixture: bronze openwork roundel has corroded together with the mail fragment. Uncertain if the two belong together or are simply deposited on top of each other.
Material: rings: iron; roundel: bronze.
Remarks: Unidentified
Literature: Dedyulkin/Shevchenko 2017, 51-52, fig. 2.4-5, 3.1-2.

Michajlovskaja Staniča
Date: 1st century AD.
Context: funerary - kurgan 2.
Description: mail fragment measuring c. 50 x 30 cm. Iron rings and two rows of copper alloy rings. It is described that each copper alloy ring connects to five others. This is very unusual and a drawing of the fragment looks like regular 4-in-1 pattern. The remark is probably erroneous. Rings: outer diameter 7-8 mm; inner diameter 3-4 mm; cross-section wire round.
Material: iron, copper alloy.
Inventory: sword, gold brooch, silver buckle, silver monogram, alabaster vessel, patera, bronze cauldron, iron ladle, two beads, iron hooks, lights, three ceramic vessels, whetstone.
Literature: Bârcă/Symonenko 2009, 304; Dedyulkin/Shevchenko 2017, 53 (cat. no. 26); Hansen 2003, 57, 186 (cat. no. C187); Kaminskaja 1985, 229, fig. 2.4; Matešić 2015, 211; Novichenkova 2009, 285; 2011, 280; Simonenko 2001, 278; Wijnhoven 2015c, 23, 25; 2017, 184, 186, 193.

Moschenka
Date: 6th - 7th century AD.
Context: fortified settlement.
Description: mail fragment
Inventory: armour scale, brooch. Inventory probably incomplete
Literature: Glad 2009,118 (cat. no. 85); Kazanski 1999, 204, 217.

Novolabinski
Date: 244-100 BC.
Context: funerary - burial mound 1.
Description: mail armour.
Literature: Dedyulkin/Shevchenko 2017, 51, 53 (cat. no. 14).

Nekrasovskja Staniča
Date: 1st - start 3th century AD.
Context: funerary - kurgan 4.
Description: armour described as a combination of mail and scale, but concerns probably two separate garments: one scale- and one mail armour.
Material: iron.
Literature: Bârcă 2006, 214; Hansen 2003, 188 (cat. no. C206); Simonenko 2001, 272.

Nikol'skij Mogil'nik
Date: 1st - 2nd century AD?
Context: funerary?
Description: armour described as a combination of mail and scale, but concerns probably two separate garments: one scale- and one mail armour.
Material: iron.
Literature: Hansen 2003, 188 (cat. no. C211); Simonenko 2001, 272.

Perm
Date: c. AD 500-700.
Description: fragments of a mail aventail still in flexible condition. The aventail is attached by rivets to the rim of the helmet.
Material: iron.
Location: State Hermitage Museum, St. Petersburg.
Literature: Nicolle 2017, 225, fig. 17.

near **Phanagoria**
Date: 2nd century AD.
Context: funerary.
Description: mail armour.
Material: iron.
Literature: Goroncharovski 2006, 446.

Pokrovsk-Voskhod
Date: probably 4th or 5th century AD.
Context: funerary.
Description: mail fragment.
Inventory: sword hilt, spearhead, gold chain necklace, earring, belt plate, two small buckles with gold sheet, pottery fragments.
Remarks: deceased had a deformed cranium.
Literature: Glad 2009, 50, 118 (cat. no. 86).

Psenafa
Date: 2nd - 1st century BC.
Context: funerary - burial mound 1.
Description: small mail fragment, measuring 6.1 x 4.5 cm. Rings: diameter 5 mm.
Literature: Dedyulkin/Shevchenko 2017, 53 (cat. no. 10).

Tarasovo
Date: 4th - 5th century AD.
Context: funerary - burial 1784.
Description: mail aventail belonging to a helmet.
Material: iron.
Inventory: *Spangenhelm* with silver and gold. Inventory probably incomplete.
Literature: Miks 2009, fig. 76.6.

Tarasovskij
Date: 4th century AD.
Context: funerary - burial 116.
Description: two mail fragments. 4-in-1.
Material: iron.
Inventory: knife, belt fittings, pearl necklace, two brooches, two fragments of bridles.
Literature: Glad 2009, 43, 120, fig. 5.1 (cat. no. 98).

Tbilisskaya Staniča 1
Date: 1st - start 3rd century AD.
Context: funerary.
Description: two large and several smaller mail fragments. Alternating rows of riveted and solid rings. 4-in-1. Rings: outer diameter 4-6 mm; inner diameter 2.5-5 mm. The armour has been described as a combination of mail and scale, but concerns probably two separate garments: one scale- and one mail armour.
Material: iron.
Inventory: helmet, sword, dagger, horse gear.
Literature: Bârcă 2006, 214; Glad 2009, 60; Hansen 2003, 57-58, 186 (cat. no. C188); Lenz 1902, 123-124; Simonenko 2001, 277-278.

Tbilisskaya Staniča 2
Date: 1st - start 3rd century AD.
Context: funerary - kurgan 1.
Description: mail fragments made from iron and copper alloy rings. The burial also contained scales from a separate item of scale armour.
Material: iron, copper alloy.
Literature: Bârcă 2006, 214; Bârcă/Symonenko 2009, 304; Hansen 2003, 186 (cat. no. C189); Matešić 2015, 211-212; Simonenko 2001, 278; Wijnhoven 2015c, 23, 25; 2017, 184, 186, 193.

Tbilisskaya Staniča 3
Date: 1st - start 3rd century AD.
Context: funerary - kurgan 3.
Description: armour described as a combination of mail and scale, but concerns probably two separate garments: one scale- and one mail armour.
Material: iron.
Literature: Bârcă 2006, 214; Hansen 2003, 186 (cat. no. C190); Simonenko 2001, 272.

Tbilisskaya Staniča 4
Date: 1st - start 3rd century AD.
Context: funerary - kurgan 10.
Description: armour described as a combination of mail and scale, but concerns probably two separate garments: one scale- and one mail armour.
Material: iron.
Literature: Bârcă 2006, 214; Hansen 2003, 186 (cat. no. C191); Novichenkova 2011, 279; Simonenko 2001, 272.

Tbilisskaya Staniča 5
Date: 1st - start 3rd century AD.
Context: funerary.
Description: armour described as a combination of mail and scale, but concerns probably two separate garments: one scale- and one mail armour.
Material: iron.
Inventory: lancehead, brooch, buckles, golden beads, silver tube, iron plates, two iron rings, ceramic sherds, human bones, horse bones. Burial has been robbed out, inventory incomplete.
Literature: Bârcă 2006, 214; Hansen 2003, 186 (cat. no. C192); Simonenko 2001, 272.

Tbilisskaya Staniča 6
Date: AD 50-150.
Context: funerary – kurgan 15 - later interment.
Description: armour described as a combination of mail and scale, but concerns probably two separate garments: one scale- and one mail armour.
Material: iron.

Inventory: lancehead, dagger, arrowheads, horse harness, torc, gold beads with stone inlays, gold fittings, gold ankle chain, silver vessel, two silver handles, iron basin, two bronze vessels, two bronze buckles, iron boar's head, various metal objects, beads in a decayed bag, whetstone, leather remains, wood remains.
Remarks: burial of a man.
Literature: Bârcă 2006, 214; Dedyulkin/Shevchenko 2017, 53 (cat. no. 22); Hansen 2003, 187 (cat. no. C193); Novichenkova 2009, 285; 2011, 279-280; Simonenko 2001, 274, 276.

Tbilisskaya Staniča 7
Date: 1st - start 3rd century AD.
Context: funerary - kurgan 16.
Description: armour described as a combination of mail and scale, but concerns probably two separate garments: one scale- and one mail armour.
Material: iron.
Literature: Bârcă 2006, 214; Hansen 2003, 187 (cat. no. C194); Simonenko 2001, 276.

Tbilisskaya Staniča 8
Date: 1st - start 3rd century AD.
Context: funerary - kurgan 51.
Description: armour described as a combination of mail and scale, but concerns probably two separate garments: one scale- and one mail armour.
Material: iron.
Inventory: gold belt buckle with stone inlays, gold sheet, iron objects with gold sheet overlay, copper fittings, copper buttons, flint. Disturbed grave and inventory probably incomplete.
Literature: Bârcă 2006, 214; Hansen 2003, 187 (cat. no. C195); Negin 1998, 69; Simonenko 2001, 272.

Tbilisskaya Staniča 9
Date: 1st - start 3rd century AD.
Context: funerary - kurgan 52.
Description: mail armour.
Material: iron.
Inventory: sword, spearhead, dagger, silver belt buckle, copper bowl with iron handle, cupper fitting, mirror fragments. Burial was partially robbed out.
Literature: Bârcă 2006, 214; Hansen 2003, 187 (cat. no. C196).

Tsemdolina
Date: 2nd century AD.
Context: funerary - burials 10, 50, 68.
Description: mail armour found in three burials.
Literature: Dedyulkin/Shevchenko 2017, 53 (cat. no. 7).

Turaevo 1
Date: late 4th - early 5th century AD.
Context: funerary - kurgan 6.
Description: mail coat.
Inventory: sword, dagger, horse harness elements, copper buckles, belt fittings, iron buckles.
Literature: Glad 2009, 120 (cat. no. 102).

Turaevo 2
Date: late 4th - early 5th century AD.
Context: funerary - kurgan 7.
Description: fragments of a mail coat.
Material: iron.
Inventory: knife, two iron buckles, copper belt fittings, wooden vessel.
Literature: Glad 2009, 43, 120 (cat. no. 103).

Turaevo 3
Date: 4th - 5th century AD.
Context: funerary - kurgan 7/1a.
Description: mail aventail lined with leather.
Material: iron.
Inventory: iron helmet with silver and copper decoration, scale armour, sword, iron snaffle bit, knife, axe, spearheads, gold belt tongue, belt buckles.
Literature: Miks 2009, 500, fig. 76.1; Yiu-Kang 2010, 62-63.

Učkeken–Tereze
Date: 4th century AD.
Context: funerary.
Description: coat of mail.
Inventory: buckle. Inventory probably incomplete.
Literature: Kazanski/Mastykova 2003, 42; Shchukin *et al.* 2006, 69.

Ust-Labinskaya stanitsa
Date: 1st-3rd century AD?
Context: funerary - burial mound 41.
Description: mail armour.
Inventory: iron plates, scale armour. Inventory probably incomplete.

Literature: Bârcă 2006, 214; Dedyulkin/Shevchenko 2017, 53 (cat. no. 19); Negin 1998, 69; Novichenkova 2011, 280.

Vasjurina Gora
Date: 180-150 BC.
Context: funerary - burial mound 2.
Description: eight mail fragments in solid condition. 4-in-1. Rings: diameter 8-9 mm.
Material: iron.
Inventory: scale armour, gold plates, decorated bone sarcophagus, two *amphora* handles. Uncertain if the inventory is complete. The burial mound contains various burials, so uncertain if the inventory belongs to the same context.
Location: State Hermitage Museum, St. Petersburg, inv. VAS 90.
Literature: Bârcă/Symonenko 2009, 305; Beck/Chew 1991, 34; Černenko 2006, 28, 56 (cat. no. 56); Dedyulkin/Shevchenko 2017, 51, 53 (cat. no. 5); Hansen 2003, 59, 68-69, 119, 121, 164 (cat. no. C26); Quesada Sanz *et al*. 2019, 159; Simonenko 2001, 278; 2010, 129, fig. 101; Vlasova 2004, 171; Waurick 1979, 324, 326 (cat. no. 16).

Vladimirskaya
Date: 1st - 2nd century AD.
Context: funerary.
Description: mail armour.
Literature: Dedyulkin/Shevchenko 2017, 53 (cat. no. 27).

Voskhod
Date: 5th - 7th century AD.
Context: funerary.
Description: mail armour.
Literature: Kazanski 2007, 244.

Vozdviženskaja Staniča *(fig. 3.22)*
Date: 1st century BC.
Context: funerary.
Description: mail fragments. Rings: outer diameter 6.7-8.3 mm; inner diameter 5-5.8 mm; cross-section wire 3 x 1 mm. The armour that has been described as a combination of mail and scale, but concerns probably two separate garments: one scale- and one mail armour.
Material: iron.
Inventory: two swords, dagger, spear, arrowheads, two gold fixtures, axe, chisel, pin, wooden box with decorated gold fixtures, gold brooch, two plaques with decoration, whetstone, mirror, alabastron, tinsel threads, two silver vessels, ceramic vessel, glass vessel, iron brooch with gold plate, three copper vessels, cauldron, copper basin, ceramic pot, human bones of various individuals.
Location: State Historical Museum, Moscow, inv. 42418.
Literature: Bârcă, 2006, 214, fig. 206.7; Bârcă/Symonenko 2009, 299-300; Dedyulkin/Shevchenko 2017, 53 (cat. no. 25); Hansen 2003, 54, 58-59, 69, 164 (cat. no. 28); Minns 1913, 228-230; Müller 1986, 121; Negin 1998, 69, fig. 3.7; Simonenko 2001, 278-279; 2010, 111-112, 119; Waurick 1979, 325-326 (cat. no. 17-18); Wijnhoven 2016a, 84.

Zubov
Date: 1st century BC.
Context: funerary - *tumulus* 1.
Description: mail fragments. Rings: outer diameter 5-8.3 mm, inner diameter 2.5-5 mm. 4-in-1. The armour has been described as a combination of mail and scale, but concerns probably two separate garments: one scale- and one mail armour.
Material: iron.
Inventory: sword with golden hilt, iron arrowheads, iron bits with gold appliques, various gold roundels that served as belt ornaments, gold belt parts, two gold bracelets, silver bowl, glass cup, cauldron, copper jug, silver plaques, whetstone, earthen jug.
Location: State Hermitage Museum, St. Petersburg, inv. 2234/27.
Literature: Bârcă, 2006, 214, fig. 206.8; Bârcă/Symonenko 2009, 299-300; Dedyulkin/Shevchenko 2017, 53 (cat. no. 24); Gushchina,/Zasetskaia 1989, 114-118; Hansen 2003, 57, 58, 59, 69, 164 (cat. no. 24); Minns 1913, 230-233; Negin 1998, 69, fig. 3.8; Simonenko 2001, 278-279; 2010, 111-112, 119; Waurick 1979, 325-326 (cat. no. 17-18); Wijnhoven 2016a, 84.

SERBIA

Bácsújfalu-Selenča
Date: end 6th - end 7th century AD.
Context: funerary.
Description: mail fragments. 4-in-1.

Inventory: many weapons, horse harness elements, other objects such as a bronze cauldron and a silver lid.
Literature: Glad 2009, 50, 116 (cat. no. 73); Petér 2014, 97, pl. 13.1.

Batajnica
Date: c. 6th century AD.
Context: funerary.
Description: five mail fragments, corroded solid, probably from an aventail. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter c. 15 mm; direction overlap probably anti-clockwise; some rivets are copper alloy; cross-section wire flattened. Solid rings: outer diameter c. 15 mm; cross-section rectangular.
Material: iron rings with some copper alloy rivets.
Inventory: *Spangenhelm*, sword, spearhead, shield boss, bridle rings, ceramics. Uncertain if all come from this grave.
Remarks: one fragment examined by the author.
Location: Arheološki Muzej u Zagrebu, inv. 5440.
Literature: Vogt 2006, 37, 195.

Bijele Crkve near Sremska Rača *(fig. 6.20)*
Date: Roman period. Refined date: AD 300-500.
Context: river.
Description: very large lump of mail in solid condition, measuring c. 43 x 43 x 21 cm. In addition five smaller flexible fragments that came from this lump. Its size and weight (c. 20 kg) indicate that this is likely more than one mail garment. Moreover, the lump has parts with two different ring sizes, reaffirming that it are probably two mail garments wrapped together. 4-in-1. Alternating rows of riveted and solid rings. The majority of the mail remnants is made from large rings, mainly iron and some decorative copper alloy rings. The five loose fragments concern mostly copper alloy rings, which were separated by its discoverers, thinking that it was gold. Riveted rings: outer diameter horizontal 15.1 mm; outer diameter vertical 14 mm; inner diameter horizontal 9 mm; inner diameter vertical 9.3 mm; overlap clockwise; paddle-shaped overlap; overlap length c. 7.3 mm; overlap with 4.5 mm; large rivet heads on both sides; thickness ring wire 1.2 mm; width wire 3.1 mm; cross-section wire highly flattened. Solid rings: outer diameter 14.6 mm; inner diameter 8.8 mm; width 2.9 mm; thickness 1.1 mm; cross-section rectangular as a washer. Some of the copper alloy rings are probably trim. There is also a triangle-shaped fragment of copper alloy rings. Lastly, there are also copper alloy rings that likely represent an inserted pattern into the coat. One of these parts measures c. 12 rings wide and at least 12 rows deep. The other mail garment has smaller rings. These have not preserved well enough to provide much detail. Rings: outer diameter c. 11 mm; rings less flat than the large rings.
Material: iron, copper alloy. The copper alloy rings are probably brass and their rivets probably bronze.
Inventory: said to be found together with a sword.
Remarks: examined by the author.
Location: Arheološki Muzej u Zagrebu, inv. A-18004, A-9959.
Literature: Alfs 1941, 78; Dautova-Ruševljan/Vujović 2006, 42; Hansen 2003, 166 (cat. no. C1); Hoffiller 1912, 43-45, fig.19-20; Jeremić 2009, 257; Matešić 2015, 211, 214-215, 218; Vujović 2017, 244; Wijnhoven 2015c, 25; 2017, 186, 193.

Gamzigrad - Romuliana
Date: c. AD 311.
Context: funerary - possibly the mausoleum of emperor Galerius.
Description: several mail fragments, affected by fire and corrosion. 4-in-1. Alternating rows of riveted and solid rings. Rings: outer diameter 13 mm; inner diameter 6 mm; width 3 mm. Riveted rings: overlap clockwise; paddle-shaped overlap?; rivet hole c. 1.5 mm; rivet head on both sides; diameter rivet head c. 3 mm; cross-section wire flat. Solid rings: thickness 2-3 mm; cross-section flat rectangular.
Material: iron.
Inventory: two spears, armour fragments, part of a helmet, two iron buckles, silver vessel, several bronze and iron hoops, knife. Looted in antiquity, inventory incomplete.
Location: National Museum Zaječar.
Literature: Savić 2017, 42-43, 116, pl.33.2; Vujović 2017.

Guberevac - Gomilica
Date: 1st half 2nd century AD.
Context: funerary.
Description: mail fragment in flexible condition, measuring 13 rows deep and two to three rings wide. 4-in-1.
Material: iron.
Inventory: glazed pitcher, glass container, cup, nails, coin with emperor Hadrian, bracelets.

Literature: Savić 2017, 22, 107, pl. 6.

Justiniana Prima
Date: AD 535-615.
Description: several loose mail rings. Most are solid, and one or two are partial riveted rings. Rings are heavily corroded, but some characteristics can be observed. All rings are large, although one solid ring is substantially larger than the others. Riveted rings: overlap probably anti-clockwise; iron ring with copper alloy rivet head; very flat cross-section. Solid rings: cross-section is very flat, giving them a washer-like appearance.
Material: iron rings with copper alloy rivets.
Remarks: observed by the author through museum glass.
Location: National Museum Lescovac.

Saldum
Date: 6th century AD.
Context: roman castle – tower C.
Description: mail fragment. 4-in-1.
Material: iron.
Remarks: observed by the author through museum glass.
Location: Archaeological Museum of Đerdap, inv. 298/70.
Literature: Jeremić 2009, 156-157, fig. 78 (cat. no. 464); Vujović 2017, 244.

Sremska Rača 1 - Sirmium
Date: Roman period.
Context: settlement - locality 4 - chance find.
Description: coat of mail broken into five fragments measuring 12 x 15 cm, 12 x 8 cm, 9 x 6.5 cm, 7 x 5 cm, and 19 x 23 cm. 4-in-1. Rings: outer ring diameter c. 10 mm.
Material: iron.
Remarks: observed by the author through museum glass.
Location: Museum of Srem, Sremska Mitrovica/Museum of Vojvodina, Novi Sad, inv. A 762.
Literature: Dautova-Ruševljan/Vujović 2006, 42; Jeremić 2009, 257; Vujovic 2017, 244.

SLOVAKIA

Abrahám
Date: D1.
Context: funerary - burial 156.
Description: three mail fragments. 4-in-1. Rings are reported to be partly butted. Rings: outer diameter 8-9 mm; 6-7 mm. One large ring: outer diameter 24 mm; inner diameter 18 mm. The mail remains are considered to possibly represent a bracelet.
Material: iron.
Inventory: iron fixtures, needle fragments, glass fragment, resin lump.
Location: Ponitrianske múzeum v Nitre, inv. 813/67.
Literature: Budinský-Krička/Lamiová-Schmiedlová 1990, 284; Czarnecka 1996, 246; Hansen 2003, 189 (cat. no. C215); Krekovič 1996, 220, fig. 8.2; Künzl 2002, 138 (cat. no. 32).

Biely Kostol
Date: 2nd half 2nd century AD.
Context: settlement?
Description: small pieces of mail.
Inventory: the site also rendered scale armour.
Literature: Krekovič 1996, 220.

Gerulata
Date: 2nd - 3th century AD.
Context: settlement in the hinterland of a Roman fort - pit house 96.
Description: mail fragment. Rings: outer diameter 8 mm.
Material: iron.
Inventory: Flavian coin, bronze brooch, bonze bead, lead fragment, two hobnails, iron ring, nails, angled iron fragment, two whetstones, bone needle, glass bowl, fragments of glassware, *terra sigillata*.
Literature: Hansen 2003, 173-174 (cat. no. C73); Krekovič 1996, 212; Varsik 1999, 228, fig. 10.12.

Horný Jatov *(fig. 2.12)*
Date: 300-250 BC.
Context: funerary - burial 460.
Description: two small corroded mail fragments.
Material: iron.
Inventory: sword and scabbard, shield rim, shield boss, fragmented belt parts, two iron brooches, spearhead fragment, three nails, four ceramic vessels, animal bones. Burial is disturbed and partially robbed out.
Location: Ponitrianske múzeum v Nitre.
Literature: Benadík *et al.* 1957, 31-32, fig. 4.15, pl. 10.4-5; Borangic/Palinga 2013, 18; Budinský-Krič-

ka/Lamiová-Schmiedlová 1990, 283-284; Canestrelli 2018, 20; Dedyulkin/Shevchenko 2017, 51; Hansen 2003, 34, 38-39, 47, 49, 51, 165 (cat. no. 30); Quesada Sanz/Rueda Galán 2017, 33-34; Quesada Sanz *et al.* 2019, 160; Roux/Coffyn, 1987, 39; Rustoiu 2006, 49-50; Rusu 1969, 289; Stead 1991, 56;Van der Sanden 1993, 4 (cat. no. 4); 2003/2004, 371; Waurick 1979, 324, 326 (cat. no. 7); Wijnhoven 2014, 13.

Iža 1
Date: c. AD 166-180.
Context: Roman fort.
Description: large rectangular mail fragment. 4-in-1. Rings: outer diameter 6-7mm; cross-section round.
Material: iron.
Literature: Bishop/Coulston 2006, fig. 84.4; Burandt 2017, 41, pl. 18.3; Hansen 2003, 174 (cat. no. C74); Matešić 2015, 218; Rajtár 1994, 93, fig. 7.13; Tejral 1994, 39, fig. 5.1.

Iža 2
Date: c. AD 166-180.
Context: Roman fort.
Description: small mail fragment. 4-in-1. X-ray examination showed that part of the rings is riveted. Rings: outer diameter 6 mm; cross-section described as flat.
Material: iron.
Literature: Burandt 2017, 41, pl. 18.2; Hansen 2003, 174 (cat. no. C74); Rajtár 1994, 93, fig. 7.14.

Iža 3
Date: c. AD 166-180.
Context: Roman fort.
Description: small mail fragment adhering to a sword.
Material: iron.
Inventory: sword.
Literature: Rajtár 1994, 83, fig. 3.1.

Lesné
Date: B2/C1a.
Context: funerary - *tumulus* 3, burial 1.
Description: various mail fragments. Rings: outer diameter 10-11 mm; cross-section round.
Material: iron.
Inventory: shield boss, shield grip, spearhead, various metal objects, ceramic sherds.
Remarks: burial of an adult.
Literature: Budinský-Krička 1967, 309-310, Budinský-Krička/Lamiová-Schmiedlová 1990, 283; Hansen 2003, 189 (cat. no. C216); Krekovič 1996, 220. 283.

Nad mlynom
Date: AD 225-300.
Context: settlement.
Description: mail fragment.
Inventory: the site rendered Roman artefacts, such as a *denarius*, a silver buckle, and a gold ring.
Literature: Svihalek 2018, 77.

Očkov
Date: C2/C3.
Context: funerary - burial 47.
Description: mail fragment measuring 4.1 x 4.4 cm. Rings are reported to be butted and welded or riveted. 4-in-1. Rings: outer diameter 8-10 mm; inner diameter 6-7 mm.
Material: iron.
Inventory: bronze bangle, bone comb, sherds from various ceramic vessels.
Remarks: burial of an infant.
Literature: Budinský-Krička/Lamiová-Schmiedlová 1990, 284; Czarnecka 1996, 246, 251; Hansen 2003, 189 (cat. no. C214); Krekovič 1996, 220, fig. 8.1.

Stupava
Date: 2nd half 2nd century AD.
Context: Roman fort.
Description: mail fragments. 4-in-1.
Material: low-carbon steel (0.2% C). Reported hardness 178 VPH; tensile strength MPa.
Literature: Krekovič 1996, 217; Turčan 2012, 420, fig. 3; Williams 2010, 27, 29.

Závod
Date: 1st – 1st half 4th century AD.
Context: funerary.
Description: mail fragment.
Fixture: mail fixture without further information.
Inventory: disturbed cemetery that rendered Germanic and (provincial) Roman objects, such as spurs, brooches, urns, local ceramic, *terra sigillata*, bronze vessels, glassware.
Literature: Bazovský *et al.* 2019, 267.

Zemplín
Date: B1.

Context: funerary - *tumulus* 3, cremation burial 78.
Description: fragmented mail coat exposed to fire. Current weight 9.5 kg. 4-in-1. Reported to be made from alternating welded (round in cross-section) and butted rings. The literature states different sizes for the rings: either 9-11 mm or 8-9 mm outer diameter; inner diameter 6.2-7 mm; cross-section wire 1.4 mm. Recent metallographic examination shows that the wire was made by roll-drawing.
Material: steel (Fe 97, 86%, 1.09% C, 1.05% Si).
Inventory: sword, bronze scabbard, three bronze vessels, two decorated bronze handles, whetstone, various iron and bronze objects. Inventory incomplete, since the mail coat envelops several artefacts.
Remarks: burial of an adult male.
Location: Zemplínske Múzeum, Michalovce.
Literature: Borangic 2011a, 186-187, 191 (cat. no. 14); Budinský-Krička/Lamiová-Schmiedlová 1990, 283-286; Hansen 2003, 82-83, 189 (cat. no. C217); Kaczanowski 1994, 208; Krekovič 1996, 220; Künzl 2002, 138 (cat. no. 28); Longaurová/Longaur 1990; Miks 2007, 767; Müller 2003, 437; Özşen/Willer 2016; Rasmussen 1995, 73; Rustoiu 1996, 36; 2006, 49; Sîrbu *et al.* 2007a, 160; 2007b, 82; Van der Sanden 2003/2004, 371; Waurick 1979, 324, 326 (cat. no. 8); 1982, 114, 116 (cat. no. 28).

SLOVENIA

Kovačevše
Date: LT B2 - Augustan.
Context: uncertain - found in a test pit.
Description: mail fragment. Rings: diameter rings 9 mm; cross-section round.
Material: iron.
Inventory: two helmets, spearheads, finger ring, seven brooches, fragments of 15 more brooches, two collars, ceramic sherds.
Location: Goriški muzej Kromberk, Nova Gorica, inv. 44.
Literature: Hansen 2003, 34, 42-43, 55, 165 (cat. no. 31).

Ptuj
Date: 1st century AD.
Context: amphitheatre near a Roman fort.
Description: mail fragment. 4-in-1.
Material: iron.
Inventory: crest holder of a helmet.
Literature: Kavur 2014, 51-52.

SPAIN

León 1
Date: AD 100-150.
Context: Roman fort - Botines building.
Description: fragmented copper alloy ring covered in iron.
Material: copper alloy, iron?
Location: Museo de León?
Literature: Aurrecoechea 2010, 87; Wijnhoven 2017, 186, 193.

León 2
Date: Roman period.
Context: Roman fort - workshop for armour repair.
Description: mail fragment in solid condition. 4-in-1.
Material: iron.
Inventory: more than 20 armour fragments, including *lorica segmentata*, scale-, and mail armour.
Location: Museo de León.
Literature: ILRUV 2012, 39, 91.

Piquía *(figs. 11.1, 11.10)*
Date: 1st half 1st century BC.
Context: funerary.
Description: several small mail fragments, affected by the cremation fire, but in relatively good condition after treatment. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outside diameter 9.8 mm; inside diameter 5.1 mm; overlap anti-clockwise; shape overlap large oval; large round rivet head; cross-section flat. Metallographic analysis demonstrates that the riveted rings are made from drawn wire. Solid rings: outer diameter 8.1 mm; inner diameter 4.7 mm; 1.7 mm width; 0.8-0.9 mm thickness; cross-section rectangular.
Fixture: bronze rectangular metal plate with a key-shaped hole and a slit. Also a round bronze stud. It is uncertain if they formed part of the mail coat's fastening system.
Material: iron (94%) and other elements, but very little carbon. Hardness between 118 and 156 HV.
Inventory: chariot, sword, spurs, spear, shield, various Iberic vessels, Roman vessel, arms, two gold pendants, glass vessels, attic vases, more than 200 (divination?) bones.

Remarks: the tomb is thought to be of an Iberian 'prince'.
Literature: Quesada Sanz *et al.* 2019; Rueda Galán/ Grau Mira 2017, 319.

SWEDEN

Birka 1
Date: 10th century AD.
Context: barracks and workshops, next to a fort - possibly an armour (repair) workshop.
Description: c. 100 finds of mail. Mostly single rings, and 38 fragments of two or more linked rings. 4-in-1. Alternating rows of riveted and solid rings. The outer diameter of the rings varies considerably per find (between 7.8 and 19.2 mm) with the majority around 9-11.5 mm. Thickness of wire is between 1.2 and 2.3 mm. The larger rings are usually made from thicker wire. Riveted rings: overlap anti-clockwise; shape overlap mid-size oval; cross-section wire round; rivet heads are large and prominent. Solid rings: cross-section round in most, oval in three and flat in another three rings. Metallographic analysis of one solid ring indicates that it was punched from sheet metal.
Material: iron, copper alloy.
Inventory: many items of military equipment.
Location: Statens Historiska Museum, Stockholm, inv. SHM 21064.
Literature: Bruce-Mitford 1978, 237; Ehlton 2002/2003; Fredman 1992, 23, 34, 43-44; Müller 2003, 446; Short 2009, 60.

Birka 2
Date: Viking period.
Context: settlement.
Description: small mail fragments, many well-preserved. Among them is a fragment of 15 connected copper alloy rings placed in three ring rows. It is made from alternating rows of riveted and solid rings and is likely a trim for a sleeve. Rings: outer diameter c. 7.5 mm; overlap anti-clockwise; round rivet head. Besides this fragment there is also an iron riveted ring, and a fragment of seven copper alloy rings.
Material: copper alloy, iron.
Location: Statens Historiska Museum, Stockholm, inv. SHM 5208, SHM 14563, SHM 26264.
Literature: Arwidsson 1934, 356.

Fingarne
Date: Viking period or earlier?
Context: stray find.
Description: two corroded lumps of mail. One must be a coat of mail, based upon its size (26 x 25 x 13 cm) and weight (5.1 kg). The other is smaller at 10 x 6 x 5 cm and weighing 235 gr. Rings: outer diameter 10 mm; cross-section wire 1.7 mm; cross-section wire round.
Location: Statens Historiska Museum, Stockholm, inv. SHM 23188.
Literature: Fredman 1992, 24, 44.

Fullerö
Date: C3.
Context: funerary (chamber burial).
Description: mail fragments. Riveted rings are observed. Rings: outer diameter 17-20 mm; round and large rivet heads; thickness ring wire 1.5 mm; width wire 3-5 mm wide; cross-section wire flat.
Inventory: weapon panoply, comb, spurs, three gold finger rings, gold pendant, pendant made from Roman gold coin, silver fittings, silver objects, belt buckle, game pieces. Inventory is incomplete.
Location: Statens Historiska Museum, Stockholm, inv. SHM 20724.
Literature: Bruce-Mitford 1978, 237; Ehlton 2002/2003, 8; Fredman 1992, 6, 24, 28, 31, 45, fig. 11e; Grunwald 1998, 97; Ilkjaer 1990, 353 (cat. no. 181) Juncher 2016, 95, 100; Müller 2003, 438.

Gamla Uppsala 1
Date: Vendel or 3rd century AD?
Context: funerary.
Description: mail fragments consisting of c. 500-1,000 rings. All rings are riveted. Rings: outer diameter 8.5 mm; cross-section wire 1.25 mm; cross-section wire round.
Location: Uppsala Universitet Museum för Nordiska Fornsaker, inv. UMF 1267
Literature: Fredman 1992, 24, 45, fig. 11c.

Gamla Uppsala 2
Date: AD 710-750.
Context: funerary – grave 6016.
Description: mail fragment of c. 60 connected and well-preserved rings. 4-in-1. All rings are riveted. Rings: outer diameter 9.5 mm; overlap anti-clockwise;

shape overlap mid-sized oval; round pronounced rivet head; cross-section wire rings round.
Inventory: copper alloy strap fitting, belt fitting, copper alloy bracelet, 55 glass beads, possible bronze bead, damaged belt fitting. Inventory possibly incomplete.
Literature: Beronius Jörpeland 2017, 176, 179.

Gamla Uppsala 3
Date: AD 600-700.
Context: funerary – grave 6114.
Description: single mail ring.
Inventory: c. 80 red beads, bone bead, copper alloy ring, organic material. Inventory possibly incomplete.
Literature: Beronius Jörpeland 2017, 176.

Gränby
Date: B2/C1b.
Context: funerary.
Description: complete coat of mail in fragmented condition. Two fragments are still flexible. 4-in-1. All rings are riveted. Rings: outer diameter 8-9 mm; inner diameter 5-6 mm; overlap appears anti-clockwise.
Material: iron.
Inventory: shield boss, two swords.
Location: Uppsala Universitet Museum för Nordiska Fornsaker, inv. UMF 1256.
Literature: Arwidsson 1934, 256, fig. 12; Bruce-Mitford 1978, 237; Fredman 1992, 24, 48; Grunwald 1998, 97; Hansen 2003, 188 (cat. no. C212); Müller 2003, 446; Nicklasson 1989, 31, 34; Pauli Jensen 2008, 218; Van der Sanden 1993, 4 (cat. no. 65).

Gunnerstad
Date: Vendel period.
Context: funerary.
Description: mail ring.
Material: iron.
Location: Statens Historiska Museum, Stockholm, inv. SHM 27141.
Literature: Fredman 1992, 42.

Helgö
Date: Vendel period.
Context: funerary.
Description: small mail fragment of c. 8 rings, possibly from a mail aventail. Riveted rings can be observed. Riveted rings: outer diameter 12 mm; wire thickness 1.8 mm; heavily flattened overlap; overlap anti-clockwise; paddle-shaped overlap (in drawing); rivet heads on both sides.
Inventory: helmet? Inventory incomplete.
Location: Statens Historiska Museum, Stockholm, inv. SHM 26491.
Literature: Fredman 1992, 23, 28, 44.

Lund
Date: 10th century AD.
Context: settlement.
Description: mail fragments. Riveted rings are observed. Rings: outer diameter c. 9.5-10 mm?; cross-section wire c. 1.7?
Location: inv. KM 66166:2917.
Literature: Fredman 1992, 23, 41-42.

Måsta
Date: Viking period?
Context: funerary.
Description: 14 interconnected rings and some loose rings. Riveted and solid rings. Rings: outer diameter 10 mm; round rivet; cross-section wire 1.5 mm; cross-section wire round.
Location: Statens Historiska Museum, Stockholm, inv. SHM 31112.
Literature: Fredman 1992, 23, 42.

Nalaviberg
Context: funerary.
Date: Viking period.
Description: 16 mail rings and some fragments. All rings are riveted. Rings: outer diameter 11 mm; round rivet; cross-section wire 1.6 mm; cross-section wire round.
Remarks: burial of a woman.
Location: Statens Historiska Museum, Stockholm, inv. SHM 13308:I:4.
Literature: Arwidsson 1934, 356; Fredman 1992, 23, 41.

Öremölla
Date: B2.
Context: funerary.
Description: various corroded mail fragments affected by fire. Current weight 8 kg. 4-in-1. Alternating rows of riveted and solid rings. X-rays have been done on the better preserved fragments. Riveted rings: outer diameter 7.5 mm; overlap clockwise; prominent rivet

heads; cross-section ring wire 1.3 mm; cross-section wire oval. Solid rings: outer diameter 7.5 mm; cross-section D-shaped.
Material: iron.
Inventory: sword, shield, spurs, bronze cauldron, bronze ladle and sieve, two glass beakers, pottery sherds, cremated human remains wrapped in textile.
Remarks: observed by the author through museum glass.
Location: Statens Historiska Museum, Stockholm, inv. SHM 4792.
Literature: Arwidsson 1934, 256-257; Ehlton 2002/2003, 8; Fredman 1992, 6, 23, 28, 42, fig. 11a-b; Hansen 2003, 83, 188 (cat. no. C213); Ilkjaer 1990, 393-394 (cat. no. 833); Juncher 2016, 95, 100; Kelly 1931, 269; 1934, 206; Künzl 2002, 136 (cat. no. 5); Montelius 1888, 101-102, 106, fig. 110; Morris 1934, 194; Nicklasson 1989, 31, 34; O'Connor 1992, 1183, fig. 589g-h; Pauli Jensen 2008, 218; Rasmussen 1995, 75; Rose 1906, 50-51, fig. 18; Van der Sanden 1993, 4 (cat. no. 66); Waurick 1982, 115-116 (cat. no. 5).

Rickeby
Date: Vendel period.
Context: funerary.
Description: 29 complete and partial rings, probably from an aventail that belonged to a helmet. All the rings are riveted. Rings: diameter 9.5 mm; round rivet; cross-section wire 1.5 mm; cross-section wire oval.
Inventory: helmet.
Literature: Fredman 1992, 10, 24, 28, 46, fig. 11d.

Slite
Date: Viking period or later.
Context: funerary - burials 14.7 and 8.
Description: several mail fragments, treated with wax. 4-in-1. Two fragments that fit together were conserved and radiographed, revealing a strip of 20 rows deep and 5 rings wide. This fragment has iron and copper alloy rings. The direction of the latter indicates that it concerns the trim of a mail sleeve. Riveted copper alloy rings: outer diameter: c. 8.8 mm; overlap anti-clockwise; circular-oval rivet hole of c. 1 mm; round iron rivets with slightly domed heads; cross-section ring wire 1.1 mm; wire has a groove running along the ring circumference, pointing to them being made by strip drawing. Solid copper alloy rings: outer diameter 8.15 mm; cross-section 1.7 x 1.2 mm; cross-section oval. Corroded iron rings: outer diameter 8.5-8.9 mm; probably part of them is riveted.
Material: iron, copper alloy.
Location: Statens Historiska Museum, Stockholm, inv. SHM 23248
Literature: Fredman 1992, 11, 23, 40; O'Connor 1992, 1185, fig. 589l-m.

Spelvik
Date: AD 600-650.
Context: funerary - cremation burial A/1944.
Description: 56 mail fragments that come from two garments, possibly a coat and an aventail. The rings have been exposed to fire. Within each fragment the rings have similar characteristics. 4-in-1. Fragments with smaller rings consist of riveted and undetermined (solid?) rings. Riveted rings: outer diameter 6.5-6.8 mm; cross-section 1.2 mm; cross-section round; rivet heads on both sides of the overlap. Undetermined rings: outer diameter c. 8 mm; cross-section 1.1 mm. There are also fragments with larger rings, that have riveted rings every other row. Larger rings: outer diameter 10-12 mm; cross-section 1.5-1.8 mm.
Material: iron.
Inventory: helmet, sword?, shield?, whetstone, horse, hounds, mountings and buckles for straps, six to seven combs, gaming pieces, glassware, flint, food (meat, wheat, bread and fish).
Location: Statens Historiska Museum, Stockholm, inv. SHM 23243
Literature: Fredman 1992, 23, 28, 42-43; Lamm 1962, 288, 294, fig. 6.16; O'Connor 1992, 1184, fig. 589i.

Stora Ire
Date: Vendel period.
Context: funerary.
Description: mail armour. Rings: outer diameter 10 mm.
Location: Statens Historiska Museum, Stockholm, inv. SHM 20550:134.
Literature: Fredman 1992, 40.

Tuna 1
Date: Viking period?
Context: stray find.
Description: 15 rings arranged in eight rows forming a conjunction with rows running at an angle, possibly for tailoring. All rings are riveted: outer diameter 8.5

mm; round rivet head; cross-section 1.3 mm; cross-section wire round.
Material: iron.
Location: Statens Historiska Museum, Stockholm, inv. SHM 14159.
Literature: Arwidsson 1934, 256; Fredman 1992, 23, 41; O'Connor 1992, 1185.

Tuna 2
Date: Viking period?
Context: stray find.
Description: three mail rings. All three are riveted rings: outer diameter 11.9-12.3 x 10.3-11.8 mm; cross-section 1-1.1 x 1.7-1.9 mm; overlap anti-clockwise; rivet highly domed on one side and flat on other; cross-section flat.
Material: iron.
Location: Statens Historiska Museum, Stockholm, inv. SHM 14482.
Literature: Arwidsson 1934, 256; Fredman 1992, 23, 41; O'Connor 1992, 1185.

Valsgärde 1
Date: AD 600-680.
Context: funerary - burial 6.
Description: mail aventail, corroded and folded. 4-in-1. It was attached to the lower edge of the helmet and behind the face guard and nasal. The aventail goes around the entire helmet, but is not of the same length: on one end it is c. 34 rows deep; the other 17 or 18 rows. In the reconstruction the short side is placed at the back. The aventail attaches to the helmet by a metal wire that runs through the top row and is fixed to the helmet with small bronze plates. Rings: outer diameter 9.2-10.2 mm; cross-section 1.6-2.1 mm; cross-section wire round.
Material: iron.
Inventory: boat, helmet, three shields, two swords, scabbards and baldric, two saxes, spear, arrows, two belts, three bridles, horse neck ring, three holsters, saddle?, three decorative hooks, nails, two or three dogs, two glass cups, glass bowl, cauldron, cauldron chain, cauldron fork, spit, fire dogs, tongs, axe, tool chest containing different tools, another chest, uncertain wooden object with iron fittings, gaming pieces, dice and gaming board, pig-iron, textile remains, fragments of feathers from upholstering or a cushion, various other items, various wooden items, birch bark mats, two horses, ox, many other animal remains.
Location: Gustavianum, Uppsala, inv. Uppsala 6.
Literature: Arwidsson 1934, 244-245, pl. 12; 1942, 28-29, 31-35, fig. 22-23, 27, pl. 3-5; Böhner 1994, 533, fig. 38.2; Bruce-Mitford 1978, 237, fig. 182b; Ehlton 2002/2003, 7; Fredman 1992, 5, 24, 28, 45, fig. 3, 11a-b; Müller 2003, 445; Mortimer 2011, 30-31; O'Connor 1992, 1184.

Valsgärde 2
Date: AD 600-680.
Context: funerary - burial 7.
Description: mail aventail, broken into three large fragments and some smaller pieces. Poorly to reasonably well preserved. Remnants of textile adhere to the mail. 4-in-1. The aventail goes around the entire helmet. A continuous metal strip is used to attach it to the helmet. The strip is folded over and has slots. The rings are inserted into the slots and locked into place with a metal wire. X-rays indicate the presence of rivets, although not in all rings, which may be an indication for solid rings also being present. Different sizes are reported in the literature for the rings: outer diameter all rings 9.2-11 mm, or two different outer diameters, one 8.5 mm and one 10 mm (difference riveted and solid rings?); cross-section 1.6-2 mm; cross-section round.
Material: iron.
Inventory: boat, helmet, three shields, two swords with scabbards and baldrics, two saxes, spear, arrows, four bridles, saddle, other horse gear, two dogs with collars, three drinking horns, eight wooden plates, wooden casket, water bucket?, two wooden buckets, cauldron, cauldron chain, cauldron fork, spit, frying pan, tongs, axe, small appliances, gaming pieces, dice, textile remains, padding and pillows, leather remains, wooden and plant remains, four horses, ox, boar, snow owl.
Location: Gustavianum, Uppsala, inv. Uppsala 7.
Literature: Adams 2010, 96; Arwidsson 1942, 33; 1977, 23, fig. 22; Böhner 1994, 533; Ehlton 2002/2003, 7; Fredman 1992, 5, 24, 28, 46, fig. 11a-b; Mortimer 2011, 35-36, 75-77; Müller 2003, 445-446; O'Connor 1992, 1184-1185.

Valsgärde 3
Date: AD 560-600.
Context: funerary - burial 8.
Description: set of splinted greaves and a splinted vam-

brace with mail on one extremity, probably covering the feet and the sword hand. The greaves have small holes through which the mail rings were connected. Conversely, the vambrace splints fold over and have slots. The rings are inserted into the slots and locked into place by a wire. Rings: outer diameter 10 mm; cross-section wire 1.75 mm; cross-section wire round. In addition also a mail aventail that connects to the helmet in the same manner as the vambrace. The aventail goes around the entire helmet. 4-in-1. Aventail rings: outer diameter 12.5 mm; cross-section 1.8-2.4 mm.

Material: iron.

Inventory: boat, helmet, two shields, sword, sax, spears, arrows, two bridles, holster, saddle, other horse equipment, two dogs with collars, glass vessel, drinking horn, wooden cup, wooden plates, box, spoon, ornamented wooden object, several wood fragments, iron kettle, kettle chain, kettle fork, axe, knife, tool box with tools and objects, game board and gaming pieces, several small objects, textiles, wool felt?, animal hides, wood and plant remains, birch bark mats.

Location: Gustavianum, Uppsala, inv. Uppsala 8.

Literature: Adams 2010, 96; Arwidsson 1942, 33; 1954, 19, 26-27, 29, 31, 34-40, fig. 10, 12, 15-19, 23, pl. 1-2, 6-9; 1977, 23; Böhner 1994, 533; Ehlton 2002/2003, 7, 10, fig. 4, 6; Fredman 1992, 5, 24, 28, 46, fig. 11a-b; Grunwald 1998, 97; Mortimer 2011, 35-36, 78-80, 163-164; Müller 2003, 445-446; Negin/Kamisheva 2018, 59-63; Robinson 1969, fig. 6; O'Connor 1992, 1184; Post 1944; Stephenson 2006, 68, 71, 74-76, fig. 62, 65; Tweddle 1992, fig. 503, 553.

Vendel 1

Date: AD 600-640.

Context: funerary - burial 1.

Description: 30 mail fragments, much corroded, with a current weight of c. 1.5 kg. On both sides of the armour there are remnants of textile and leather adhering. Rings: outer diameter 13.5-14.4 mm; cross-section 2.5-2.9 mm; cross-section wire round.

Material: iron.

Inventory: boat, helmet, shield boss, two swords with scabbard mounts, remains of another scabbard for a sword or long dagger, many decorative metal fixtures of uncertain use, two spearheads, arrowhead, belt buckle, glass vessels, horse bit and horse gear, chain, tools.

Location: Statens Historiska Museum, Stockholm, inv. SHM 7250:I.

Literature: Arwidsson 1934, 353-354; 1954, 40; 1942, 33; Fredman 1992, 24, 28, 46-47, fig. 11a-b; Mortimer 2011, 30, 68-69; Müller 2003, 446; O'Connor 1992, 1184; Stolpe/Arne 1927, 18.

Vendel 2

Date: AD 720-750.

Context: funerary - burial 3.

Description: 14 mail fragments, poorly preserved. All fragments have large rings (c. 15 mm in diameter) except for one fragment that has a layer of smaller rings on one side. This fragment was conserved and radiographed. The large rings result riveted, while the ring type of the smaller rings remains undetermined. Large rings: different outer diameter reported in the literature, either 13.9 mm or 15-16 mm; round rivet; cross-section 2.2 mm; cross-section round. Smaller rings: outer diameter c. 9.5-10 mm; cross-section c. 1.7-2.2 mm; cross-section round. The two ring sizes probably represent two mail garments.

Material: iron.

Inventory: boat, horse gear, glass beads, knives, two arrowheads, chain, tools, many other objects, bones of three horses, two dogs, and of other animals.

Location: Statens Historiska Museum, Stockholm, inv. SHM 7250:III.

Literature: Arwidsson 1934, 353; 1942, 33; Fredman 1992, 24, 28, 47, fig. 11a-b; O'Connor 1992, 1185, fig. 589f.

Vendel 3

Date: c. AD 850.

Context: funerary - burial 8.

Description: mail fragments of two different ring sizes. Fragments with smaller rings may come from an aventail, while the larger rings may come from a mail coat. No helmet has been found in the grave. Smaller size rings: outer diameter 10 mm; cross-section wire 1.5 mm; cross-section wire round. Larger size rings: riveted rings are observed; outer diameter 13-14 mm; round rivet; cross-section wire 2.5 mm; cross-section round.

Inventory: thin gold wire, ornamented belt part, spearhead, knife, bit, fragments of chain, rivet, several metal objects, bone awl, two horse skeletons, one dog, sheep remains.

Location: Statens Historiska Museum, Stockholm, inv. SHM 7250:VIII.
Literature: Arwidsson 1942, 33; Fredman 1992, 24, 28, 47, fig. 11a-b; Stolpe/Arne 1927, 33.

Vendel 4
Date: AD 520-600.
Context: funerary - burial 10.
Description: approximately 90 heavily corroded mail fragments treated with wax. 4-in-1. One fragment of c. 50 rings was conserved and radiographed. 4-in-1. Rings: outer diameter 10.3 mm; cross-section 1.8 mm; cross-section round. Also fragments with larger rings: riveted rings are observed; outer diameter 16 mm; round rivet; cross-section 2.5-3 mm; cross-section wire round.
Material: iron.
Inventory: part of a helmet, metal bands from a shield, three arrowheads, iron cauldron, several decorated pieces of metal, hook, utensil with three hooks, belt fittings, iron buckle, horse gear, knife, rivets, several metal items, human tooth, horse skeleton, bones of several animals.
Location: Statens Historiska Museum, Stockholm, inv. SHM 7250:X.
Literature: Arwidsson 1934, 353-354; 1942, 33; 1954, 40; Fredman 1992, 24, 28, 47-48, fig. 11a-b; Grunwald 1998, 97; Mortimer 2011, 35; Müller 2003, 445-446; O'Connor 1992, 1183, fig. 589k; Stolpe/Arne 1927, 38-39, pl. 27.16.

Vendel 5
Date: AD 520-600.
Context: funerary - burial 11.
Description: c. 250 mail fragments with a current weight of c. 9 kg. Textile adheres to (both sides of) some of the remains. 4-in-1. Five fragments have been conserved and radiographed. Riveted rings were found and another ring type that could not be determined. The fragments do not all have the same rings. Fragment with large size rings: riveted rings are observed; outer diameter 14.4-15 mm; round rivet; cross-section 2.7-2.8 mm; cross-section wire round. Fragment with mid-size rings: outer diameter 10.4 mm; round rivet; cross-section 1.9 mm. Another fragment with mid-size riveted rings: outer diameter 9.5 mm; overlap anti-clockwise?, cross-section 1.5-2.1 mm; cross-section wire round. Fragment with small rings: riveted rings are observed; outer diameter 6.8-7.2; cross-section: 1-1.3 mm. Another fragment with small rings: outer diameter 6.4-7.6 mm; cross-section 1-1.5 mm. Given the total weight of the fragments and the different ring sizes, probably more than one mail garment is represented.
Material: iron.
Inventory: boat, helmet, shield boss, shield applications, spearheads, chains, horse bit, knife, sculpted animal head, tools, cauldron, many more metal items, textile remains, three horse skeletons.
Location: Statens Historiska Museum, Stockholm, inv. SHM 7250:XI.
Literature: Adams 2010, 97; Arwidsson 1934, 353; 1942, 33; 1954, 40-41; Fredman 1992, 7, 24, 28, 48, fig. 11a-b; Grunwald 1998, 97; Mortimer 2011, 35; Müller 2003, 445-446; O'Connor 1992, 1183-1184, fig. 589a-e; Stolpe/Arne 1927, 40, 42-44, pl. 32.2.

Vendel 6
Date: AD 520-600.
Context: funerary - burial 12.
Description: four larger fragments and c. 25 small fragments from an aventail in highly corroded condition. Total weight c. 500 gr. 4-in-1. The helmet, to which it belonged, has a strip along its edge with serrations where the rings were inserted and locked into place with a metal wire. Rings: outer diameter 9.2-10.1 mm; cross-section 2-2.8 mm; cross-section wire round. Textile remains adhere in some places.
Material: iron.
Inventory: helmet, two shield bosses, shield grip, shield applications, sword, three spearheads, arrowheads, horse bit, two knives, glass vessel, tools, various other metal objects, two horse skeletons, bones of several other animals.
Remarks: observed by the author through museum glass.
Location: Statens Historiska Museum, Stockholm, inv. SHM 7250:XII.
Literature: Arwidsson 1934, 353-354; 1942, 33; Böhner 1994, 533, fig. 38.2; Bruce-Mitford 1978, 237-238, fig. 182a; Fredman 1992, 24, 28, 48, fig. 11a-b; Grunwald 1998, 97; Mortimer 2011, 30, 70-71; Müller 2003, 445; O'Connor 1992, 1184, fig. 589j; Post 1944, 113, fig. 19; Robinson 1969, fig. 11b; Stolpe/Arne 1927, 49, pl. 40.10.

SWITZERLAND

Avenches - Aventicum
Date: Roman period.
Context: settlement.
Description: mail fragment folded onto itself and in corroded condition. Rings: diameter c. 7-9 mm.
Material: iron.
Location: inv. X/1870.
Literature: Kelly 1931, 269; 1934, 206;Voirol 2000, 17, 68 (cat. no. 49); 2001, 33.

Boscéaz
Date: 270-200 BC.
Context: funerary - burial 733.
Description: mail fragment located at the abdomen of the deceased. Fragment is folded and corroded.
Material: iron.
Remarks: burial of a man.
Location: inv. OB96/14658-03.
Literature: Kaenel/Lanthemann 2016, 78, 83, 88, 372, fig. 68.

Conthey
Date: 15 BC-AD 50.
Context: funerary?
Description: mail fragment. 4-in-1. Rings: outer diameter 3.5-4 mm, inner diameter 1.5-2 mm.
Material: iron, copper alloy.
Inventory: eight bronze and one silver bracelet, brooch.
Remarks: find circumstances uncertain. Bought in 1894 by the Historischen Museum Basel from an antiquarian.
Location: Bernisches Historisches Museum.
Literature: Hansen 2003, 173 (cat. no. C72); Müller 1986, 123; Wijnhoven 2015c, 23, 25; 2017, 183, 186, 193.

Tiefenau *(figs. 9.6-7)*
Date: early 2nd - 1st century BC.
Context: lake.
Description: only one (certain) mail fragment has been preserved from this complete mail coat. The fragment has been mechanically cleaned and made flexible. 6-in-1. Consisting of butted rings: outer diameter nearly 13 mm; inner diameter 10 mm; thickness wire c. 1 mm. Possibly another fragment from the same coat in the collection of the Musée Cantonal d'Archéologie et d'Histoire in Lausanne. The British Museum also possesses a fragment, measuring 6 x 5 x 4 cm, which had a now lost label with the word 'Tiefenau' and may have come from the same coat. This fragment is heavily corroded offering not much detail other than the outlines of rings.
Material: iron.
Inventory: weapons, chariot parts, horse harness, clothing, iron bars, metal vessels, tools and equipment, coins.
Remarks: when found in the mid-19th century the complete coat of mail was hacked to pieces to see if there was something inside. Through the years the fragments have been given away to collectors and museums.
Location: Bernisches Historisches Museum, inv. 12857; Musée d'Archéologie et d'Histoire, Lausanne, inv. CT 2442. 165; British Museum, London, inv. 1860,0919.1.
Literature: Alfs 1941, 80; Barril Vicente *et al.* 1998, 75-76; Beck/Chew 1991, 35; De Bonstetten 1860, 15, pl. 8,2-6; Brunaux/Lambot 1987, 107; Canestrelli 2018, 20; Fabian 2018, 40; Fitzpatrick 1989, 336; Gilmour 1997, 32-34; 1999, 166; Gut 2009, 67, fig. 2; Hansen 2003, 34, 37-38, 43, 52-53, 86, 122, 164-165 (cat. no. B29); Kaenel/Lanthemann 2016, 83; Malfilâtre 1993, 2, 12; Moralejo Ordax 2011, 290; Müller 1986; 1991, 527; Müller 2003, 436; Nicklasson 1989, 26; Novichenkova 2011, 278-279; Quesada Sanz/Rueda Galán 2017, 33; Quesada Sanz *et al.* 2019, 158, 160; Roux/Coffyn, 1987, 39; Rusu 1969, 289; Rustoiu 2006, 49-50; Stead 1991, 56; Van der Sanden 1993, 4 (cat. no. 67); 2003/2004, 370; Viand 2008, 41; Waurick 1979, 323, 326, 330 (cat. no. 5).

Vindonissa 1 - Windisch
Date: 1st century AD.
Context: Roman fort - rubble mound 12.
Description: rectangular mail fragment of copper alloy rings, still in flexible condition. 4-in-1. Alternating rows of riveted and solid rings. It is five to six rings wide and has a length of c. 35 rows. It is probably a piece of trim. Riveted rings: outer diameter c. 6 mm, inner diameter c. 4 mm; overlap clockwise; shape overlap stumpy; round rivet head; cross-section flat. Solid rings: outer diameter c. 4.5 mm, inner diameter c. 3 mm; cross-section rectangular; conical deformation in rings.
Material: copper alloy.
Location: Vindonissa-Museum, Brugg, inv. 12:852.

Literature: Baatz 1963/1964, 51; D'Amato/Sumner 2009, fig. 162; Hansen 2003, 173 (cat. no. C71); Unz/Deschler-Erb 1997, 63, pl. 83 (cat. no. 2428); Wijnhoven 2015c, 25; 2017, 185-187, 193; Zanier 1992, 313.

SYRIA

Dura-Europos 1 *(fig. 6.6, 10.19)*
Date: mid-3rd century AD.
Context: settlement - tower 19 countermine.
Description: skeleton of a man wearing a mail coat in solid condition. Currently the back is 52 cm long in creased condition and would have measured about 60-70 cm. The sleeves reach at least below the elbow, possibly to the wrist. It has splits at the sides that measure 10.5 cm. The bottom hem has three rows of copper alloy rings as a decorative trim. The head opening is a simple slit in the mail fabric, that was also trimmed with three rows of copper alloy rings. On the chest, just below the neck, is the shape of a trident made with contrasting copper alloy rings. The base of the trident is 8 or 9 cm long and each fork is three rings wide and c. 5 cm in height. The shaft is probably 5 cm long, but the end is covered by a fold in the mail. Inside the coat is an unidentified light brown fibrous material, which is not a woven fabric. This may be some type of padding. 4-in-1. Rings: outer diameter c. 8 mm; thickness wire c. 1 mm.
Material: iron, copper alloy.
Inventory: sword, helmet with mail aventail (Dura-Europos 2).
Location: Yale University Art Gallery, New Haven, inv. 1934.463.
Literature: Bishop 2015c, 99; James 2004, 110-111, 116-117 (cat. no. 379); Hansen 2003, 174 (cat. no. C75); Matešić 2015, 210; Robinson 1969, 10, 18; Southern/Dixon 1996, 96; Travis/Travis 2011, 74; Wijnhoven 2015b, 93-94, 99; 2015c, 23-25; 2017, 184-186, 188, 193, fig. 4; 2018, 562.

Dura-Europos 2
Date: mid-3rd century AD.
Context: settlement - tower 19 countermine.
Description: skeleton of a man wearing a helmet with a mail aventail. The rings in the upper row of the aventail passed probably through the holes of the helmet. The aventail goes around the entire helmet, covering the entire neck and throat. The mail is too folded and oxidized to reveal much about its shape and length. Rings: diameter c. 9 mm.
Material: iron.
Inventory: sword, mail coat (Dura-Europos 2).
Location: Yale University Art Gallery, New Haven, inv. 1981.62.28.
Literature: Bishop/Coulston 2006, 214; James 1986, 120-128; 2004, 101-105 (cat. no. 371); Karamian *et al.* 2017, 125, fig. 11; Mielczarek 1993, 66; Miks 2008, 5, fig. 4; 2009, 428, fig. 8; 2014, 226-227, pl. 90-91; Robinson 1969, 10, 21; Southern/Dixon 1996, 94.

Dura-Europos 3
Date: mid-3rd century AD.
Context: settlement - exact find location unknown.
Description: complete mail coat, partly folded and creased, in corroded solid condition. 4-in-1. Rings: outer diameter rings c. 8-9 mm; thickness wire c. 1 mm.
Material: iron.
Location: Yale University Art Gallery, New Haven, inv. 1930.595.
Literature: Bishop/Coulston 2006, 170; James 2004, 116, fig. 56 (cat. no. 380).

Dura-Europos 4
Date: mid-3rd century AD.
Context: settlement - exact find location unknown.
Description: intact mail sleeve without the rest of the coat, heavily corroded. One end of the sleeve has a copper alloy trim three rings wide. The circumference of the opening for the arm is c. 40 cm. The sleeves extends approximately to the mid-upper arm. 4-in-1.
Material: iron, copper alloy.
Location: Yale University Art Gallery, New Haven, inv. 1934.463.
Literature: James 2004, 116-117, fig. 57 (cat. no. 381); Wijnhoven 2015c, 25.

Dura-Europos 5
Date: mid-3rd century AD.
Context: settlement - tower 19 countermine?
Description: fragment of a mail coat, preserving part of the lower hem. 4-in-1. One ring has an anomalous orientation from the weave and is probably a repair. Rings: outer diameter c. 7-10 mm.
Material: iron.

Remarks: rivet (from a shield?), iron finger rings and human finger bones adhere to mail.
Location: Yale University Art Gallery, New Haven.
Literature: James 2004, 117-118, fig. 58 (cat. no. 382).

Dura-Europos 6
Date: mid-3rd century AD.
Context: settlement - tower 19 countermine?
Description: mail sleeve no longer attached to a mail coat. The sleeve still has the arm bones of its owner inside and must have reached to the mid-forearm. Its current length is 32 cm, but has not been preserved in its entirety. The end of the sleeve has an approximate circumference of 28-32 cm. 4-in-1. Rings: outer diameter c. 8-9 mm.
Material: iron.
Remarks: shield boss fragment, sword fragment.
Location: Yale University Art Gallery, New Haven.
Literature: James 2004, 117-118, fig. 59 (cat. no. 383).

Dura-Europos 7
Date: mid-3rd century AD.
Context: settlement - exact find location unknown.
Description: four mail fragments with traces of copper corrosion, probably from copper alloy rivets used in iron rings. 4-in-1. Alternating rows of solid and riveted rings. Rings: outer diameter 8 mm. The use of copper alloy rivets in iron rings is particularly clear in one fragment of c. 6 rings, with an outer diameter of 10 mm and a thickness of c. 1-1.25 mm.
Material: iron rings with copper alloy rivets.
Location: Yale University Art Gallery, New Haven, inv. 1938.5999.1138.
Literature: James 2004, 118, fig. 60 (cat. no. 384); Wijnhoven 2015c, 25.

Dura-Europos 8
Date: mid-3rd century AD.
Context: settlement - E8-80.
Description: heavily corroded mail fragments. One fragment comes from a hem and has copper alloy rings. The copper alloy rings are butted. Copper alloy rings: outside diameter 7-8 mm; thickness just over 1 mm.
Material: iron, copper alloy.
Remarks: site card at Yales states: 'Mail corselet found w[ith] skeleton. Found in folded + crumpled mass of frag[ment]s. Partly iron, partly bronze mail…'
Location: Yale University Art Gallery, New Haven, inv. 1938.5956 (Dura no. H403)
Literature: James 2004, 118, fig. 61 (cat. no. 385); Wijnhoven 2015c, 25.

Dura-Europos 9
Date: mid-3rd century AD.
Context: settlement - G3-H5.
Description: four mail fragments with traces of copper alloy trimming. 4-in-1. Rings: outer diameter c. 9 mm.
Material: iron, copper alloy.
Location: Yale University Art Gallery, New Haven, inv. 1930.595c? (Dura no. J171?).
Literature: James 2004, 119 (cat. no. 386); Wijnhoven 2015c, 25.

Dura-Europos 10
Date: mid-3rd century AD.
Context: settlement - exact find location unknown.
Description: four mail fragments. 4-in-1.
Material: iron.
Location: Yale University Art Gallery, New Haven, inv. 1982.62.81.
Literature: James 1990, 140, pl. 2.2h.

Dura-Europos 11
Date: mid-3rd century AD.
Context: settlement - exact find location unknown.
Description: mail fragments. 4-in-1.
Material: iron.
Location: Yale University Art Gallery, New Haven, inv. 1982.62.83.
Literature: James 1990, 140, pl. 2.2i.

Dura-Europos 12
Date: mid-3rd century AD.
Context: settlement - exact find location unknown.
Description: three mail fragments. 4-in-1.
Material: iron.
Location: Yale University Art Gallery, New Haven.
Literature: James 1990, 140, pl. 2.2i.

Dura-Europos 13
Date: mid-3rd century AD.
Context: settlement - G5.7 D31.
Description: folded fragment of iron mail with rows of copper alloy rings. Iron rings: outer diameter 8-9 mm.
Material: iron, copper alloy.
Location: Yale University Art Gallery, New Haven, inv. 1935.557.

Literature: James 2004, 119 (cat. no. 390); Wijnhoven 2015c, 25.

Dura-Europos 14
Date: mid-3rd century AD.
Context: settlement - tower 19 countermine?
Description: mail fragment. Rings: outer diameter c. 9 mm.
Material: iron.
Location: Yale University Art Gallery, New Haven, inv. 1933.714 (Dura no. F1329).
Literature: James 2004, 119 (cat. no. 391).

Dura-Europos 15
Date: mid-3rd century AD.
Context: settlement - tower 19.
Description: iron ring adhering to several copper alloy rings. This must be the copper alloy trim of a mail coat. 4-in-1. Copper alloy rings are butted: outer diameter rings 7.5 mm.
Material: iron, copper alloy.
Location: Yale University Art Gallery, New Haven, inv. 1938.3727.
Literature: James 2004, 119 (cat. no. 398); Wijnhoven 2015c, 25.

Dura-Europos 16
Date: mid-3rd century AD.
Context: settlement - exact find location unknown.
Description: copper alloy trim of an iron mail shirt. The trim is four rows deep. 4-in-1. Rings: outer diameter 7.25 mm; thickness 1.25 mm. Traces of iron rings still adhering.
Material: iron, copper alloy.
Location: Yale University Art Gallery, New Haven, inv. 1938.3728.
Literature: James 2004, 119 (cat. no. 399); Wijnhoven 2015c, 25.

Dura-Europos 17
Date: mid-3rd century AD.
Context: settlement - exact find location unknown.
Description: copper alloy trim of an iron mail coat. The trim is four rows wide. Rings: outer diameter 6 mm; thickness wire 0.6 mm. Traces of iron rings still adhering.
Material: iron, copper alloy.
Location: Yale University Art Gallery, New Haven, inv. 1938.3729.
Literature: James 2004, 119 (cat. no. 400); Wijnhoven 2015c, 25.

Dura-Europos 18
Date: mid-3rd century AD.
Context: settlement - exact find location unknown.
Description: copper alloy trim, three rows wide, with traces of iron rings adhering.
Material: iron, copper alloy.
Location: Yale University Art Gallery, New Haven, inv. 1938.3730.
Literature: James 2004, 119 (cat. no. 401); Wijnhoven 2015c, 25.

Dura-Europos 19
Date: mid-3rd century AD.
Context: settlement - exact find location unknown.
Description: copper alloy trim, three rows wide, with traces of iron rings adhering.
Material: iron, copper alloy.
Location: Yale University Art Gallery, New Haven, inv. 1938.3731.
Literature: James 2004, 119 (cat. no. 402); Wijnhoven 2015c, 25.

Dura-Europos 20
Date: mid-3rd century AD.
Context: settlement - exact find location unknown.
Description: copper alloy trim of a sleeve, measuring now five ring rows long by one to two rings wide. Rings: outer diameter 8 mm; thickness 1.2 mm.
Material: copper alloy.
Location: Yale University Art Gallery, New Haven, inv. 1938.3732.
Literature: James 2004, 119 (cat. no. 403); Wijnhoven 2015c, 25.

Dura-Europos 21
Date: mid-3rd century AD.
Context: settlement - L7-W.
Description: five butted interconnected rings: outer diameter 8 mm; thickness 1.5 mm. One ring is slightly smaller: outer diameter 7 mm; thickness 1 mm.
Material: copper alloy.
Location: Yale University Art Gallery, New Haven, inv. 1938.3658, Dura no. F1155.

Literature: James 2004, 119 (cat. no. 404); Wijnhoven 2015c, 25.

Dura-Europos 22
Date: mid-3rd century AD.
Context: settlement - M8-W2.
Description: mail fragment. 4-in-1.
Material: copper alloy.
Location: Yale University Art Gallery, New Haven, inv. 1938.3653, Dura no. F777.
Literature: James 2004, 119 (cat. no. 405); Wijnhoven 2015c, 25.

Dura-Europos 23
Date: mid-3rd century AD.
Context: settlement - L7-W23.
Description: copper alloy mail fragment made from solid and butted rings, with some partial iron rings attached. Butted rings: outer diameter 8.5 mm; thickness 1.5 mm. Solid rings: outer diameter 7.5 mm.
Material: copper alloy, iron.
Location: Yale University Art Gallery, New Haven, inv. 1938.3654, Dura no. F1541.
Literature: James 2004, 119 (cat. no. 406); Wijnhoven 2015c, 25.

Dura-Europos 24
Date: mid-3rd century AD.
Context: settlement.
Description: copper alloy mail fragment made from solid and butted rings. 4-in-1. Five ring rows survive. Butted rings: outer diameter 8 mm; thickness 1.3 mm. Solid rings: outer diameter 6-7 mm; thickness 0.5-1 mm.
Material: copper alloy.
Location: Yale University Art Gallery, New Haven, inv. 1938.3656, Dura no. I406.
Literature: James 2004, 119 (cat. no. 407); Wijnhoven 2015c, 25.

Dura-Europos 25
Date: mid-3rd century AD.
Context: settlement - J3/5, Temple of Bel.
Description: mail fragment.
Material: iron.
Location: recorded at the Dura archive, but not located at Yale University, inv. Dura no. K424.
Literature: James 2004, 120 (cat. no. 412).

Dura-Europos 26
Date: mid-3rd century AD.
Context: settlement - G5-D1.
Description: 16 mail fragments, including a large folded fragment.
Material: iron.
Remarks recorded at the Dura archive, but not located at Yale University.
Literature: James 2004, 120 (cat. no. 413).

Dura-Europos 27
Date: mid-3rd century AD.
Context: settlement - M8.
Description: mail fragments of copper alloy rings with some iron rings adhering.
Material: copper alloy, iron.
Location: recorded at the Dura archive, but not located at Yale University, inv. 1932.1516a, Dura no. E1043.
Literature: James 2004, 119 (cat. no. 408); Wijnhoven 2015c, 25.

Dura-Europos 28
Date: mid-3rd century AD.
Context: settlement - B3-30.
Description: mail fragment. 4-in-1.
Material: copper alloy.
Location: recorded at the Dura archive, but not located at Yale University, inv. 1938.3655, Dura no. G1664?
Literature: James 2004, 119 (cat. no. 409); Wijnhoven 2015c, 25.

Dura-Europos 29
Date: mid-3rd century AD.
Context: settlement - L7-W.
Description: five mail rings.
Material: copper alloy.
Location: recorded at the Dura archive, but not located at Yale University, inv. 1938.3660, Dura no. F1155.
Literature: James 2004, 119 (cat. no. 410); Wijnhoven 2015c, 25.

Dura-Europos 30
Date: mid-3rd century AD.
Context: settlement - J7-W1.
Description: mail fragment.
Material: copper alloy.
Location: recorded at the Dura archive, but not located

at Yale University, inv. Dura no. G1786.
Literature: James 2004, 119 (cat. no. 411); Wijnhoven 2015c, 25.

Dura-Europos 31
Date: mid-3rd century AD.
Context: settlement - J7-W2.
Description: mail fragment.
Material: copper alloy.
Location: recorded at the Dura archive, but not located at Yale University, inv. Dura no. G1977.
Literature: James 1990, 144; Wijnhoven 2015c, 25.

Dura-Europos 32
Date: mid-3rd century AD.
Context: settlement.
Description: mail fragment. Rings: outer diameter 8 mm.
Material: iron.
Location: Royal Ontario Museum, inv. 933.25.22.
Literature: James 1990, 144.

Dura-Europos 33
Date: mid-3rd century AD.
Context: settlement.
Description: mail fragment. Probably the same as Dura-Europos 29.
Material: iron.
Location: Royal Ontario Museum, inv. 933.25.23.
Literature: James 1990, 144.

Dura-Europos 34
Date: mid-3rd century AD.
Context: settlement.
Description: mail fragment. Probably the same as Dura-Europos 29.
Material: iron.
Location: Royal Ontario Museum, inv. 933.25.24.
Literature: James 1990, 144-145.

Dura-Europos 35
Date: mid-3rd century AD.
Context: settlement.
Description: mail fragment. Rings: outer diameter rings c. 8 mm.
Material: iron.
Location: Royal Ontario Museum, inv. 933.25.25.
Literature: James 1990, 145.

Dura-Europos 36
Date: mid-3rd century AD.
Context: settlement.
Description: folded mail fragment. Rings: outer diameter c. 9 mm.
Material: iron.
Location: Royal Ontario Museum, inv. 933.25.26.
Literature: James 1990, 145.

Dura-Europos 37
Date: mid-3rd century AD.
Context: settlement - exact find location unknown.
Description: six interconnected rings.
Material: copper alloy.
Location: Yale University Art Gallery, New Haven, inv. 1938.3657.
Literature: Wijnhoven 2015c, 25; online database Yale University Art Gallery.

Dura-Europos 38
Date: mid-3rd century AD.
Context: settlement - exact find location unknown.
Description: eleven connected rings. Identification as mail not entirely certain.
Material: copper alloy.
Location: Yale University Art Gallery, New Haven, inv. 1938.3712.
Literature: Wijnhoven 2015c, 25; online database Yale University Art Gallery.

Dura-Europos 39
Date: mid-3rd century AD.
Context: settlement - exact find location unknown.
Description: ten connected rings.
Material: copper alloy.
Location: Yale University Art Gallery, New Haven, inv. 1938.3713.
Literature: Wijnhoven 2015c, 25; online database Yale University Art Gallery.

Dura-Europos 40
Date: mid-3rd century AD.
Context: settlement - exact find location unknown.
Description: twelve connected rings. Identification as mail not entirely certain.
Material: copper alloy.
Location: Yale University Art Gallery, New Haven, inv. 1938.3714.

Literature: Wijnhoven 2015c, 25; online database Yale University Art Gallery.

Dura-Europos 41
Date: mid-3rd century AD.
Context: settlement - exact find location unknown.
Description: five connected rings. Identification as mail not entirely certain.
Material: copper alloy.
Location: Yale University Art Gallery, New Haven, inv. 1938.3721.
Literature: Wijnhoven 2015c, 25; online database Yale University Art Gallery.

Dura-Europos 42
Date: mid-3rd century AD.
Context: settlement - exact find location unknown.
Description: seven connected rings. Identification as mail not entirely certain.
Material: copper alloy.
Location: Yale University Art Gallery, New Haven, inv. 1938.3723.
Literature: Wijnhoven 2015c, 25; online database Yale University Art Gallery.

Dura-Europos 43
Date: mid-3rd century AD.
Context: settlement - exact find location unknown.
Description: seven connected rings. Identification as mail not entirely certain.
Material: copper alloy.
Location: Yale University Art Gallery, New Haven, inv. 1938.3724.
Literature: Wijnhoven 2015c, 25; online database Yale University Art Gallery.

Dura-Europos 44
Date: mid-3rd century AD.
Context: settlement - exact find location unknown.
Description: twelve connected rings.
Material: copper alloy.
Location: Yale University Art Gallery, New Haven, inv. 1938.3738.
Literature: Wijnhoven 2015c, 25; online database Yale University Art Gallery.

Dura-Europos 45
Date: mid-3rd century AD.
Context: settlement - exact find location unknown.
Description: eight connected rings.
Material: copper alloy.
Location: Yale University Art Gallery, New Haven, inv. 1938.3739.
Literature: Wijnhoven 2015c, 25; online database Yale University Art Gallery.

Dura-Europos 46
Date: mid-3rd century AD.
Context: settlement - exact find location unknown.
Description: corroded mail fragment.
Material: iron.
Location: Yale University Art Gallery, New Haven, inv. 1938.5154.1
Literature: online database Yale University Art Gallery.

Dura-Europos 47
Date: mid-3rd century AD.
Context: settlement - exact find location unknown.
Description: corroded mail fragment.
Material: iron.
Location: Yale University Art Gallery, New Haven, inv. 1938.5999.1300.
Literature: online database Yale University Art Gallery.

Dura-Europos 48
Date: mid-3rd century AD.
Context: settlement - exact find location unknown.
Description: corroded mail fragment.
Material: iron.
Location: Yale University Art Gallery, New Haven, inv. 1938.5999.1301.
Literature: online database Yale University Art Gallery.

Dura-Europos 49
Date: mid-3rd century AD.
Context: settlement - exact find location unknown.
Description: corroded mail fragment.
Material: iron.
Location: Yale University Art Gallery, New Haven, inv. 1938.5999.5227.
Literature: online database Yale University Art Gallery.

Dura-Europos 50
Date: mid-3rd century AD.
Context: settlement - exact find location unknown.
Description: corroded mail fragment.

Material: iron.
Location: Yale University Art Gallery, New Haven, inv. 1981.62.25.
Literature: online database Yale University Art Gallery.

Dura-Europos 51
Date: mid-3rd century AD.
Context: settlement - exact find location unknown.
Description: corroded mail fragment.
Material: iron.
Location: Yale University Art Gallery, New Haven, inv. 1985.1.3.
Literature: online database Yale University Art Gallery.

TURKEY

Gordion - Yassihüyük
Date: late 1st - early 2nd century AD.
Context: settlement - possible Roman army barrack block.
Description: several loose rings and some linked rings of mail armour.
Material: iron.
Inventory: several loose scales (iron and copper) from an armour, copper alloy bow brooch, iron bow brooch, pottery fragments, glassware.
Literature: Bennett/Goldman 2009, 1610.

Karalar
Date: 160-30 BC.
Context: funerary - *tumulus* C.
Description: coat of mail.
Inventory: bones, part of a shoe, gold torcs with gems. Robbed out *tumulus*, inventory incomplete.
Literature: Arik/Coupri 1935, 140; Picard 1935, 44; Rustoiu 2006, 49-50.

Zeugma 1
Date: mid-3rd century AD.
Context: settlement - site 12, house 4, room P45.
Description: mail fragment measuring c. 15 x 12 cm. Current weight 760 gr. Iron and copper alloy rings. Iron rings: diameter 8 mm. Copper alloy rings: diameter 6.5 mm.
Material: iron, copper alloy.
Inventory: iron lock, iron rod.
Location: inv. 12535-1.
Literature: Dieudonné *et al.* 2013, 255, pl. 78 (cat. no. 1430); Feugère 2006, 93; Wijnhoven 2015c, 25; 2017, 186, 193.

Zeugma 2
Date: *terminus post quem* 4th century AD.
Context: settlement - site 5, Z.96.
Description: folded mail fragment measuring c. 20 x 13 x 5 cm. 4-in-1.
Material: iron.
Inventory: fragments of scale armour, copper alloy chain?
Literature: Dieudonné *et al.* 2013, 255, pl. 78 (cat. no. 1431); Feugère 2006, 93; Wijnhoven 2016a, 84; 2017, 186, 193.

Zeugma 3
Date: mid-3rd century AD.
Context: settlement - site 12, house 3, room P35.
Description: block of mail measuring 20.4 x 13 cm, broken in two. The objects next to the mail coat may have stained the mail with copper alloy corrosion. Without scientific examination it cannot be determined if there are copper alloy rings among the iron ones. 4-in-1.
Material: iron, copper alloy?
Inventory: the mail coat was stored in a bag with other objects: spearhead, other iron and copper alloy objects.
Location: inv. BZMB-00-304.
Literature: Dieudonné *et al.* 2013, 255, pl. 78 (cat. no. 1432); Feugère 2006, 93; Wijnhoven 2017, 186, 193.

Zeugma 4
Date: mid-3rd century AD.
Context: settlement - site 12, house of the Euphrates, peristyle P22.
Description: coat of mail, now a solid block measuring 57 x 32 cm. Current weight 14 kg. 4-in-1. Rings: outer diameter c. 9.5 mm. The coat fell onto the floor when the house burned down and now preserves the imprint of the mosaic floor.
Material: iron.
Inventory: small terracotta vase, copper alloy tap, iron lock, iron ring, remains of a lyre.
Location: inv. BZMD-00-28.
Literature: Dieudonné *et al.* 2013, 255-256, pl. 79 (cat. no. 1433); Feugère 2006, 93.

Zeugma 5
Date: mid-3rd century AD.

Context: settlement - site 12, house 3, room P35.
Description: two mail fragments measuring 33 x 28 and 24 x 14.5 cm. Current weight 4.65 and 1.52 kg. 4-in-1. Rings: outer diameter c. 10 mm. When the house burned down, the coat of mail fell onto the floor.
Material: iron.
Inventory: two copper alloy lamps, spearhead, two copper alloy rings, iron stud, iron reinforcement fixture, copper alloy ring of a casket.
Location: inv. BZMD-00-302.
Literature: Dieudonné *et al.* 2013, 256, pl. 79 (cat. no. 1434); Feugère 2006, 93.

Zeugma 6
Date: mid-3rd century AD?
Context: settlement - site 12.
Description: three mail fragments with a weight of 2.22 kg. Rings: outer diameter c. 9 mm.
Material: iron.
Location: inv. BZMD-B.01.
Literature: Dieudonné *et al.* 2013, 256 (cat. no. 1435); Feugère 2006, 93.

Zeugma 7
Date: mid-3rd century AD.
Context: settlement - site 12, house of the Euphrates, room P19.
Description: three mail fragments with a weight of 470 gr. 4-in-1.
Material: iron, copper alloy.
Inventory: gutter fragment, four copper alloy pedestals, remains of several jugs, *patera* handle, fragments of copper alloy vessels and other metal objects.
Location: inv. BZMD-99-3.01.
Literature: Dieudonné *et al.* 2013, 256, pl. 80 (cat. no. 1436); Feugère 2006, 93; Wijnhoven 2017, 186, 193.

Zeugma 8
Date: mid-3rd century AD.
Context: settlement - site 12, house of the Euphrates, room P17.
Description: mail fragments with a weight of 100 gr. 4-in-1.
Material: iron.
Inventory: knife, iron ring, copper alloy vessel handle, hinges, swivel hooks, several metal objects.
Location: inv. BZMD-2-11.01.
Literature: Dieudonné *et al.* 2013, 256, pl. 80 (cat. no. 1437) Feugère 2006, 93.

Zeugma 9
Date: *terminus post quem* 3rd century AD.
Context: settlement - site 9.
Description: copper alloy trim about 19 cm in length. Rings: diameter 8 mm. Uncertain if this is mail.
Material: copper alloy.
Inventory: iron ring, lock, furniture fixture, incense burner, bronze lion, axe, adze, anvil?, cart reinforcement?
Location: inv. Me 9870.
Literature: Dieudonné *et al.* 2013, 256 (cat. no. 1438); Feugère 2006, 93.

UKRAINE

Černeliv-Rus'kyj 1
Date: 2nd - 3rd century AD.
Context: funerary - burial 73.
Description: mail fragment measuring 3.5 x 3.5 cm that has been affected by fire. 4-in-1. Rings: outer diameter 8-9 mm; c. 1.3-2.5 mm thick.
Material: iron.
Literature: Gobkalo/Tyliščak 2010, 86, 94, fig. 4.3-4.

Černeliv-Rus'kyj 2
Date: 2nd - 3rd century AD.
Context: funerary - burial 243.
Description: folded mail fragment measuring c. 4.3 x 2.5 cm that has been exposed to fire. 4-in-1. Rings: outer diameter 8-9 mm; c. 2 mm thick.
Material: iron.
Literature: Gobkalo/Tyliščak 2010, 86, 94, fig. 4.3-4.

Igren-Podkova
Date: 5th - 7th century AD.
Context: settlement.
Description: mail fragment.
Literature: Glad 2009, 116-117 (cat. no. 78); Kazanski 1999, 204, 220; 2007, 244.

Mala Kopanya
Date: 1st century BC - 1st century AD.
Context: funerary - grave M1/1936.
Description: three mail fragments, affected by fire, and weighing together several kg. One fragment is now

lost. 4-in-1. Alternating rows of riveted and solid rings. Rings: outer diameter 8-9 mm; inner diameter 7 mm; wire diameter 1.3-1.4 mm. Riveted rings (observations from a drawing): overlap clockwise; round rivet head; shape overlap stumpy.
Material: iron.
Inventory: helmet fragments?, shield boss, three spearheads, two spurs, two needles, U-shaped metal sheet with four bronze rings, pottery.
Location: Museum Mukačeve, inv. B3-573.
Literature: Borangic 2011a, 187-188, 191, 202 (cat. no. 15); Budinský-Krička/Lamiová-Schmiedlová 1990, 284; Hansen 2003, 189 (cat. no. C219); Kaczanowski 1994, 208; Künzl 2002, 138 (cat. no. 30); Kotyhoroshko 2015, 211, fig. 41.19-20.

Manvelovka
Date: 9th century AD.
Context: funerary.
Description: mail fragment. 4-in-1.
Inventory: fragment of lamellar armour. Inventory probably incomplete.
Literature: Gorelik 2002, fig. 11-12.10.

Mutyn
Date: late 1st century BC.
Context: funerary.
Description: fragmented mail armour.
Inventory: the burials from this site contained: 13 swords, scabbards, spearheads, shield bosses, helmets.
Literature: Kazakevich 2012, 189.

Ogultsy
Date: AD 380-420.
Context: hoard - detector find.
Description: mail fragment in flexible condition. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter c. 16 mm; overlap clockwise; paddle-shaped overlap; round rivet head on both sides; cross-section flattened. Solid rings: outer diameter c. 16 mm; cross-section rectangular with a washer-like appearance.
Material: iron.
Inventory: 35 Roman *denarii*, two gilded brooches with inlaid stones, three pendants.
Location: privately owned.
Literature: Shaposhnik 2010.

UNITED KINGDOM

Abergavenny - Gobannium
Date: AD 60-250.
Context: Roman fort.
Description: mail fragments.
Literature: Burnham/Davies 2010, 198.

Baldock 1
Date: AD 20-35.
Context: funerary.
Description: 20 small mail fragments, probably intentionally cut into pieces and subsequently burned on the funeral pyre. 4-in-1. Alternating rows of riveted and solid rings. Rings: outer diameter c. 4.8-5 mm; inner diameter c. 3.5-3.8 mm; cross-section 1.2-1.3 mm. Riveted rings: overlap clockwise; shape overlap stumpy; round rivet head; cross-section wire round. Solid rings: cross-section D-shaped?
Material: iron.
Inventory: (partly gilded) bronze remains, rim of a bronze vessel, wooden bucket with bronze and iron fittings, ceramics, cremation remains, animal (pig) bones.
Location: Letchworth Museum.
Literature: Foster 1986, 83; Gilmour 1997, 26, 28, 30-31; 1999, 165; Hansen 2003, 34, 38-39, 43, 47, 49-50, 161 (cat. no. B6); Novichenkova 2011, 279; Stead 1991, 56; Van der Sanden 1993, 4-5 (cat. no. 69); 2003/2004, 371-372.

near **Baldock** 2
Date: AD 43-100.
Context: settlement - nearby a sanctuary.
Description: at least 75 mail fragments, probably intentionally cut to pieces.
Material: iron.
Inventory: one silver- and six bronze Iron Age coins, three Roman coins, Romano-British pottery, animal bones, two iron implements, Late Bronze Age spearhead, brooch, Roman comedy figure head, stand.
Literature: Burnham *et al.* 2006, 412.

Birdoswald 1
Date: 2nd century AD.
Context: funerary.
Description: mail fragment used to wrap other objects inside a funerary urn.

Material: iron.
Inventory: c. nine objects placed in an urn, some are copper alloy.
Remarks: the urn contains the remains of a woman and child.
Location: find SF3501.
Literature: pers. comm. Rob Collins, 2017.

Caerleon 1
Date: 2nd century AD.
Context: Roman fort - *via principales* 207.
Description: several mail rings, some riveted and some solid. Riveted rings: width 1 mm; thickness 1.1 mm. Solid rings: outside diameter c. 7 mm; inside diameter c. 5 mm; thickness c. 1-1.4 mm.
Material: iron.
Literature: Sim 1997, 360-362; Sim/Kaminski 2012, 114, 127, 130, 134.

Caerleon 2 - Prysg Field
Date: 3rd century AD.
Context: Roman fort - room 40-41.
Description: eight mail fragments, affected by fire. All are of substantial size and come probably from a single mail coat. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter c. 7.5-9 mm; overlap clockwise; shape overlap stumpy; wire thickness c. 1.2 mm. Solid rings: outer diameter c. 7.5 mm and smaller than riveted rings.
Material: iron.
Remarks: examined by the author.
Location: National Museum of Wales, inv. 32.60.
Literature: Bishop/Coulston 2006, 266; Chapman 2005, 87 (cat. no. Ma01); Coulston 1990, 147; Hansen 2003, 170-171 (cat. no. C46); Matešić 2015, 212; Nash-Williams 1932, 68, fig. 16.

Caerleon 3 - Vicarage Garden
Date: AD 75-AD 300?
Context: Roman fort.
Description: several loose rings and some rings clustered together. The rings appear butted and it is uncertain if this is mail armour.
Material: iron, copper alloy.
Remarks: examined by the author.
Location: National Museum of Wales, inv. 69.326.
Literature: Chapman 2004, 88 (cat. no. Mb03); Wijnhoven 2015c, 25; 2017, 186, 193.

Caerleon 4
Date: AD 100-230.
Context: Roman fort - baths.
Description: one damaged riveted ring: outer diameter c. 7 mm; round rivet hole.
Material: copper alloy.
Remarks: examined by the author.
Location: National Museum of Wales, inv. 81.79H.
Literature: Chapman 2004, 88 (cat. no. Mb04); Matešić 2015, 211; Wijnhoven 2015c, 25; 2017, 186, 193.

Caerleon 5
Date: Roman period.
Context: amphitheatre.
Description: two mail rings, one riveted and one solid. Riveted ring: has split open; estimated outside diameter 8 mm; overlap clockwise; shape overlap stumpy; round rivet hole. Solid ring: outer diameter 8.3 mm; inside diameter 6.6 mm; thickness 0.7 mm; width 1.3 mm; burr marks.
Material: copper alloy.
Remarks: examined by the author.
Location: National Museum of Wales, inv. 35.119.
Literature: Matešić 2015, 211; Wijnhoven 2015c, 25; 2017, 186, 193.

Caerleon 6 - British Telecom Site *(fig. 8.20)*
Date: early 3rd century AD.
Context: west end sidewalk - area of workshop activity.
Description: many loose rings consisting of solid and riveted iron rings and of butted copper alloy rings. Iron riveted rings: all are damaged; outer diameter c. 8 mm; inner diameter c. 6 mm; overlap clockwise; shape overlap stumpy; round rivet hole; width wire c. 1.5 mm; thickness wire c. 0.9 mm; cross-section wire oval. Solid iron rings: outer diameter 7.5 mm; inner diameter 5.4 mm; width 1.2-1.5 mm; thickness c. 0.9-1.3 mm. Butted copper alloy rings: round cross-section, wire thickness 0.9-1.7 mm.
Material: iron, copper alloy.
Remarks: examined by the author.
Location: National Museum of Wales, inv. 138/207: 736-737.
Literature: Wijnhoven 2015c, 25; 2017, 186, 193.

Caerleon 7
Date: AD 160-230.
Context: Roman fort - baths - drain group 4.

Description: various connected rings: diameter 6-8 mm. This could also be a piece of chain. X-ray examination could not observe rivets.
Material: iron.
Inventory: several iron objects, possibly bath house fittings, three nails, tack, chisel fragment, hobnails, *strigil*.
Location: National Museum of Wales, inv. 81.79H.
Literature: Chapman 2005, 87 (cat. no. Ma02); Zienkiewicz 1986, 195, fig. 66.14.

Caerleon 8 - Legionary Museum Site
Date: c. AD 200-346+ .
Context: Roman fort.
Description: folded and corroded mail fragment, that still shows the outlines of the rings.
Material: iron.
Location: National Museum of Wales, inv. 84.43H.
Literature: Chapman 2005, 87 (cat. no. Ma09).

Caerleon 9 - British Telecom Site
Date: early 3rd century AD.
Description: small mail fragment. 4-in-1. Alternating rows of riveted and solid rings. Rings: outer diameter rings c. 7.5 mm.
Material: iron.
Remarks: examined by the author.
Location: National Museum of Wales, inv. 88.3H.
Literature: Chapman 2005, 87-88 (Ma10).

Caersws
Date: AD 100-130.
Context: settlement - house 3, room 8.
Description: mail fragment measuring 2.5 x 2.5 cm. Rings: outer diameter 7 mm; inner diameter c. 5 mm.
Material: iron.
Literature: Hansen 2003, 170 (cat. no. C45); Matešić 2015, 218.

Carlingwark Loch *(figs. 8.15, 10.20-21, 11.1, 11.17)*
Date: AD 80-200.
Context: hoard.
Description: many mail fragments in flexible and good condition. 4-in-1. No evidence for tailoring. Alternating rows of riveted and solid links. Some fragments preserve the lower straight hem of the coat. One fragment has a vertical line where the rings clash in ring slope. This is an indication that the mail coat was made in the flat and subsequently folded and closed at the sides. Riveted rings: outer diameter vertical: 7.3 mm; outer diameter horizontal: 7.3 mm; inner diameter vertical: 4.5 mm; inner diameter horizontal: 5 mm; overlap clockwise; shape overlap stumpy; overlap length: c. 2 mm; overlap height: c. 0.9 mm; rivet heads on both sides; thickness wire rings 0.7 mm; width wire: 1.1 mm; cross-section wire oval. Solid rings: outer diameter: 7 mm; inner diameter 5 mm; thickness 1 mm; width 1 mm; square cross-section with slightly rounded corners; presence of some burrs and deformations.
Material: iron.
Inventory: bronze cauldron containing tips of eight swords, bridle parts, bronze bowl, gridiron, tools, c. 100 scrap metal fragments.
Remarks: examined by the author.
Location: National Museum of Scotland, Edinburgh, inv. X.DW 2 (1866); Dumfries Museum.
Literature: Bishop/Coulston 2006, 242; Boube-Piccot 1994, 55; Burgess 1955, 50, pl. 2; Capwell 2003, 23; Cessford 1994, 75; Curle 1931-1932, 321; Dixon/Southern 1992, 36; Foster 1986, 85; Hansen 2003, 53, fig. 22.3 (cat. no. C33); MacGregor 1962, 28; Matešić 2015, 218; Novichenkova 2009, 285; 2011, 279; Piggott 1955, 8, 11, 38-40, pl. 2; Richter 2010, 193, fig. 202; Robinson 1975, 171-173, pl. 483; Simkins 1984, 21; Van der Sanden 1993, 4 (cat. no. 71).

Castlehaven
Date: Late Roman period – Early Middle Ages.
Context: settlement.
Description: several interconnected rings: diameter c. 6 mm.
Material: iron.
Inventory: millstone, cylindrical stone, whetstones, stone disk, polished stone with hole, polished disk, burnisher, glass bead, incomplete amber bead, two finger rings, brooch.
Literature: Barbour 1906-1907, 79; Cessford 1994, 74; Hansen 2003, 169 (cat. no. C34); Van der Sanden 1993, 4 (cat. no. 72).

Chelmsford – Caesaromagus - Moulsham Street
Date: AD 150-210.
Context: settlement - building C.
Description: six rings: outer diameter 10-14 mm; inner diameter 8-10 mm; cross-section oval. Uncertain if this is mail.

Material: iron.
Inventory: various objects, including *terra sigillata*.
Literature: Hansen 2003, 171 (cat. no. C53).

Chester 1
Date: late 1st century AD.
Description: three mail fragments. 4-in-1. Alternating rows of riveted and punched rings. Rings: outer diameter 7 mm.
Material: iron.
Location: Grosvenor Museum, Chester, inv. 245, 252, 257.
Literature: Beck/Chew 1991, 163; Croom/Griffiths 1996, 3; Hansen 2003, 170 (cat. no. C43); Kelly 1931, 269; 1934, 206; Sim 1997, 360.

Chester 2 – Old Market
Date: AD 74-200.
Context: Roman fort.
Description: mail fragment c. 3.5 cm wide and corroded solid. 4-in-1. Alternating riveted and solid rings. Rings: estimated outer diameter c. 3-4 mm.
Material: brass (established through metal analysis).
Location: Grosvenor Museum, Chester.
Literature: Fernández Reyes 2014, 135, 405, 455 (CHE614); Lloyd-Morgan 1987, 93; Wijnhoven 2017, 183, 186, 193.

Chester 3 - Dearny Field
Date: 1st century AD.
Context: Roman fort.
Description: mail fragment c. 6 cm long and corroded solid. 4-in-1. Alternating riveted and solid rings. Rings: estimated outer diameter c. 7 mm.
Material: iron.
Location: British Museum, London, inv. 1928. 7-9. 8.
Literature: Lloyd-Morgan 1987, 93.

Chester 4 - Bridge
Date: Roman period.
Context: bridge adjacent to Roman fort - top soil.
Description: mail fragment c. 4 cm in length. 4-in-1. Rings: outer diameter 7 mm; diameter wire 1 mm; round cross-section.
Location: SF no. CH1.56; 5.
Literature: Croom 2000, fig. 1.4; Croom/Griffiths 1996, 3-4.

Colchester 1 - Camulodunum
Date: AD 49-61.
Context: Roman fort - pit L12.
Description: fragmented piece of mail made from very small riveted and solid rings.
Material: copper alloy.
Literature: Beck/Chew 1991, 163; Hansen 2003, 171 (cat. no. C52); Hawkes/Hull 1947, 338; Matešić 2015, 211; Van der Sanden 1993, 4 (cat. no. 74); Wijnhoven 2015c, 25; 2017, 186, 193.

Colchester 2 - Camulodunum
Date: AD 49-61.
Context: Roman fort.
Description: mail fragment corroded into a solid block, measuring 13 x 7 cm.
Material: iron.
Literature: Hansen 2003, 171 (cat. no. C52); Hawkes/Hull 1947, 338, fig. 63.7.

Colchester 3 - Camulodunum
Date: AD 54-61.
Context: industrial site next to Roman fort – rubbish pit.
Description: corroded mail fragment.
Material: iron.
Inventory: coarse pottery, Gallo-Belgic wares, *amphorae*, *terra sigillata*, glass fragments, coin, fragments of domestic and military equipment: iron fitting, chisel, ferrule, *lorica segmentata* fragment, mail fastener (Colchester 5), more than 80 fragments of iron and copper alloy, casting sprue, slag, fragment of crucibles, fragment of pellet of Egyptian blue, small pieces of sandstone, lamp fragment, fragments of burnt daub (kiln or furnace?).
Literature: Niblett 1985, 36, 113, pl. 19.

Corbridge
Date: late 1st - 2nd half 2nd century AD.
Context: unprovenanced - Roman fort?
Description: folded lump of mail, making up about 25 cm^2. 4-in-1. All rings are iron, except for two rows of copper alloy rings. Rings: diameter 6 mm.
Material: iron, copper alloy.
Location: Great North Museum: Hancock, Newcastle upon Tyne, inv. 75.3410.
Literature: Bishop/Dore 1988, 196, fig. 91.20; Croom 2000, fig. 1.2; Croom/Griffiths 1996, 3-4; Hansen

2003, 170 (cat. no. C38); Matešić 2015, 211; Wijnhoven 2015c, 25; 2017, 186, 193.

Doune
Date: c. AD 79-87.
Context: Roman fort - rubbish deposit.
Description: 16 (partial) mail rings, among which solid and riveted ones. Rings: outer diameter varies between 4.5-7 mm; thickness c. 1.5 mm.
Material: iron.
Inventory: coin, blacksmith's punch, file(s), knife, nails, T-clamp, washer, 51 hobnails, bar fragment, decorative mount.
Literature: pers. com. Frasier Hunter.

Halton Chesters 1
Date: late 1st - early 3rd century AD.
Context: Roman fort - find context unknown.
Description: two mail fragments.
Location: Great North Museum: Hancock, Newcastle upon Tyne, inv. 1956.202.
Literature: Croom/Griffiths 1996, 3-4; Hansen 2003, 170 (cat. no. C37).

Halton Chesters 2
Date: late 1st - early 3rd century AD.
Context: Roman fort - find context unknown.
Description: heavily corroded mail fragment.
Material: iron. Microscopy on one ring revealed that the iron consisted of slightly elongated grains of ferrite with very few slag inclusions. The iron is very clean and was probably warm worked. Mean hardness 211 Hv.
Location: Great North Museum: Hancock, Newcastle upon Tyne, inv. 1956.359.
Literature: Croom/Griffiths 1996, 3-4; Fulford *et al.* 2005, 242-244.

Hayling Island
Date: mid-1st century BC - early 1st century AD.
Context: sanctuary.
Description: large mail fragment.
Material: iron.
Inventory: sword scabbard elements, spearheads, shield parts, wagon elements, horse harness, metal vessels, belt fittings, brooches, finger rings, necklaces, c. 170 Celtic coins, bars of iron, glass and amber beads, ceramic vessels, animal bones.
Literature: Croom 2000, 133; Fitzpatrick 1989, 335; Gilmour 1997, 31; 1999, 163; Hansen 2003, 52, 171 (cat. no. C50).

Housesteads 1 - Vercovicium
Date: Roman period.
Context: Roman fort.
Description: complete coat of mail, rolled up. Now lost.
Literature: Croom 2001, 59; Hansen 2003, 170 (cat. no. C40); Novichenkova 2011, 278; Robinson 1975, 171; Van der Sanden 1993, 4 (cat. no. 75).

Housesteads 2 - Vercovicium
Date: late 2nd - 3rd century AD.
Context: Roman fort - H20:7:40.
Description: lump of corroded mail. The rings have been described as possibly butted, but not much can be concluded given their condition. Rings: inner diameter 4 mm; thickness 1 mm.
Material: iron.
Literature: Allason-Jones 2009, 457 (cat. no. 313).

Inveresk 1
Date: Antonine.
Context: Roman fort.
Description: mail fragment measuring 44 x 29 x 13 mm and 18 rows deep. Partly in flexible condition. Riveted and solid rings. Rings: outer diameter 8 mm. Also 26 loose- and some fragmented riveted and solid rings recovered during sieving. Majority Rings: outer diameter 6.5-8 mm; thickness 0.5-1.5 mm.
Material: iron.
Location: inv. IK00 C.2006; IK99 C.328; IK99 C.209; IK99 C.264; IK99 C.271; IK99 C.380; IK00 C.2449; IK00 C.2577.
Literature: pers. com. Frasier Hunter.

Inveresk 2
Date: Antonine.
Context: midden at the North of the Roman fort.
Description: small fractured lumps of articulated and fragmentary rings. 4-in-1. Alternating rows of riveted and solid rings. Rings: outer diameter 7 mm; thickness 0.7 mm.
Material: iron.
Location: inv. SF178.
Literature: Kirby 2020, 97, 99.

Inveresk 3
Date: Antonine.
Context: ditch - North of the Roman fort.
Description: 21 corroded fragments of articulated mail. The fragments form rectangular strips or squared patches, perhaps for recycling. Together the fragments form an area of c. 10 x10 cm. 4-in-1. Alternating rows of solid and riveted rings. Rings: outer diameter 6.5-7 mm; thickness 0.7 mm.
Material: iron.
Location: inv. SF290.
Literature: Kirby 2020, 96-97, 99, fig. 7.12.

Inveresk 4
Date: Antonine.
Context: funerary - burial 539, North of the Roman fort.
Description: single damaged mail ring: thickness 1.5 mm.
Material: iron.
Location: inv. SF132.
Literature: Kirby 2020, 14, 97.

Kirkburn *(fig. 2.15, 10.26)*
Date: LT B2.
Context: funerary - burial K5.
Description: complete coat of mail laid out on top of the deceased. Size coat when excavated 92 x 48 cm. Badly corroded and fragmented, some ringed structures can still be observed by eye. Between the two layers of mail there was no leather or textile, except for the shoulder guards which were probably lined with textile. 4-in-1. Rings originally reported butted, but X-rays demonstrated the presence of riveted rings. Rings: outer diameter c. 8.2-9.2 mm; thickness c. 1.4-1.7 mm.
Fixture: set of S-shaped fasteners with the central pivoting button and washer present. Three further buttons located at the shoulder guards.
Material: rings: iron; fasteners: iron; buttons: iron.
Inventory: chariot, two bridles, copper alloy toggle, unidentified organic object (lid of a box?), pig bones.
Remarks: examined by the author.
Location: British Museum, London, inv. 1987,0404.25.
Literature: Canestrelli 2018, 20-21; Demierre 2012, 166; 2015, 157; Dove/Goldstraw 1992; Gilmour 1997, 31-34; 1999, 162, 164-166; Hansen 2003, 34, 36-37, 43-49, 51, 56, 68, 74, 121-122, 161 (cat. no. B5); Malfilâtre 1993, 6, 11; Novichenkova 2011, 277; Quesada Sanz/Rueda Galán 2017, 33; Rustoiu 2006, 49, 51; Stead 1988; 1991: 30-33, 54-56, 122-124, 226-227; Van der Sanden 1993, 2, 4 (cat. no. 76); 2003/2004, 371-372; Viand 2008, 41; Wijnhoven 2014, 14, fig. 1; 2018, 562.

Lexden
Date: c. 17-10 BC.
Context: funerary.
Description: 16 mail fragments and loose rings. The armour appears to have been cut to pieces and scattered around the *tumulus*. 4-in-1. Alternating rows of riveted rings and solid rings. Rings: outer diameter 5.5-5.8 mm; cross-section wire 1.4-1.6 mm; cross-section wire riveted rings round.
Fixture: two copper alloy buckles. In addition two hinges, one complete and one incomplete, that were fixed to the mail. Lastly, five round silver fixtures of which one has a gilded surface.
Material: rings: iron; fixtures: copper alloy, (gilded) silver.
Inventory: bronze table, bronze pedestal, three bronze figurines, bronze studs, palstave, iron strips from wheels?, nails, various bronze and iron objects, gold thread, trefoil-shaped silver ornaments, two silver buckles, silver medallion with Augustus, melon bead, two stone mullers, oval pebbles (sling shot?), large number of *amphorae*, urn, beaker, wood remains, leather remains, horn remains. The burial was disturbed and has traces of ancient robbery. Inventory is probably incomplete.
Location: Colchester Castle Museum.
Literature: Beck/Chew 1991, 163; Demierre 2015, 157; Foster 1986, 82-88, pl. 16; Fitzpatrick 1989, 333-334; Gilmour 1997, 26, 31-32; 1999, 162, 165; Hansen 2003, 34, 39-41, 43-45, 47, 49-51, 161-162 (cat. no. B7); Laver 1927, 246-248, pl. 53-55; MacGregor 1962, 28; Piggott 1955, 11, 38; Stead 1991, 56; Van der Sanden 1993, 4-5 (cat. no. 77); 2003/2004, 371-372; Viand 2008, 4.

Loughor 1
Date: c. AD 115-260.
Context: West rampart of reduced Roman fort.
Description: five small mail fragments. 4-in-1. Riveted and solid rings. Rings: outer diameter c. 4.2-4.5 mm.
Material: iron.

Remarks: examined by the author.
Location: National Museum of Wales, inv. 98.6H/4.
Literature: Chapman 2005, 88 (cat. no. Ma11).

Loughor 2 *(fig. 3.16)*
Date: c. AD 260-310+ .
Context: Roman fort - surface of *via sagularis*.
Description: two mail fragments. 4-in-1. Riveted and solid rings. Riveted rings: outer diameter c. 5.5 mm. Solid rings slightly smaller. One fragment includes three larger riveted rings of approximately 7 mm, which are probably repairs.
Material: iron.
Remarks: examined by the author.
Location: National Museum of Wales, inv. 98.6H/4.
Literature: Chapman 2005, 88 (cat. no. Ma12).

The Lunt, Baginton 1
Date: AD 60-79.
Context: Roman fort - T 11.
Description: mail fragment. 4-in-1. Alternating rows of riveted and solid rings. Rings: outer diameter rings c. 3 mm; inner diameter c. 1.7-2 mm. Riveted rings: overlap clockwise; shape overlap stumpy (due to the small ring size also the adjacent area was flattened); cross-section wire round. Solid rings: cross-section rectangular.
Material: copper alloy.
Location: Herbert Art Gallery and Museum, Coventry, inv. 67/245.
Literature: Beck/Chew 1991, 37; Boube-Piccot 1994, 55; Dixon/Southern 1992, 36-37; Hansen 2003, 170 (cat. no. C44); Hobley 1969, 116, 118, fig. 21.13; Matešić 2015, 211, 218; Moralejo Ordax 2011, 290; Novichenkova 2009, 285; 2011, 278-279; Quesada Sanz *et al.* 2019, 159; Robinson 1975, 173, pl. 482; Stephenson 2006, fig. 47; Stephenson/Dixon 2003, fig. 24; Van der Sanden 1993, 4 (cat. no. 69); Wijnhoven 2015c, 25; 2016a, 84; 2017, 186, 193.

Maiden Castle
Date: 1st century BC - 1st century AD.
Context: hillfort.
Description: triangular mail fragment. 4-in-1. Riveted and solid rings. Rings: outer diameter 7.0 mm; inner diameter 5.7-6 mm; cross section 1.0-1.3 mm.
Material: iron.
Literature: Foster 1986, 85; Gilmour 1997, 31; 1999, 162; Hansen 2003, 171 (cat. no. C49); MacGregor 1962, 28; Stead 1991, 56; Van der Sanden 1993, 4 (cat. no. 78).

Manchester
Date: Roman period?
Context: Roman fort - isolated find.
Description: mail fragment consisting of 16 rings. 4-in-1. Alternating rows of riveted and solid rings. Rings: outer diameter 12.7 mm; inner diameter 10-11 mm; oval cross-section.
Material: iron.
Literature: Hansen 2003, 170 (cat. no. C42); Matešić 2015, 212, 214, 218; Phelps 1909, 173, pl. 97, 102; Van der Sanden 1993, 4 (cat. no. 79).

Newstead 1 *(fig. 3.16)*
Date: AD 140-180.
Context: Roman fort - *principia* - pit 1.
Description: solid mail fragment made flexible through treatment, now three fragments and several loose rings. Rings are iron, but also one solid (broken) copper alloy ring among the loose rings. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: horizontal outer diameter 7.8 mm; vertical outer diameter 8 mm; horizontal inner diameter 5.4 mm; vertical inner diameter 4.6 mm; overlap clockwise; shape overlap stumpy; length overlap c. 2.5 mm; height overlap c. 1.2 mm; rivet heads on both sides; thickness ring wire 0.9 mm; width wire 1.25 mm; cross-section wire oval. Solid rings: outer diameter 7 mm; inner diameter: 4.9 mm; thickness: 1.1 mm; width 1 mm; cross-section square with slightly rounded corners; deformations present from punching out of sheet.
Material: iron, copper alloy.
Inventory: quern stone, knives, lynch pin, iron bar, sickle, *lorica segmentata*, wooden bucket, two sculpted stone blocks, five arrowheads, iron shield boss, brass fragments, brass coin (Flavian), iron holdfast, wall plaster, and *amphora* sherds.
Remarks: examined by the author.
Location: National Museum of Scotland, Edinburgh, inv. X.FRA 119.
Literature: Beck/Chew 1991, 163; Bishop 2001, 27; Boube-Piccot 1994, 55; Burgess 1955, 50; Capwell 2003, 23; Curle 1911, 161, pl. 38.10; D'Amato/Sumner 2009, 129; Dixon/Southern 1992, 36; Hansen 2003, 169 (cat. no. C35); Kelly 1931, 269; 1934, 206; Mac-

Dowall 1995, 12; Matešić 2015, 218; Novichenkova 2009, 285; 2011, 279; Piggott 1955, 11, 40; Richter 2010, 193; Robinson 1975, 171, pl. 481; Rusu 1969, 289; Van der Sanden 1993, 4 (cat. no. 80); Waurick 1982, 111; Wijnhoven 2015c, 25; 2017, 186, 193.

Newstead 2
Date: probably AD 80-180.
Context: Roman fort - exact location unknown.
Description: single ring, probably mail. Heavily corroded ring: outer diameter 7.9 mm; inner 3.5 mm; thickness 1.95 mm; width c. 2.4 mm.
Material: iron.
Remarks: examined by the author.
Location: National Museum of Scotland, Edinburgh, inv. X.FRA 4778 (1999/27)
Newstead 3
Date: probably AD 80-180.
Context: Roman fort - exact location unknown.
Description: single solid ring, broken in two, probably mail. Outer diameter 8.2 mm; inner diameter 4.2 mm; thickness 1.25 mm; width 2 mm.
Material: iron.
Remarks: examined by the author.
Location: National Museum of Scotland, Edinburgh, inv. X.FRA 4883 (1999/27).

Richborough Castle
Date: c. AD 260-295.
Context: Roman fort.
Description: mail fragment, three ring rows deep, that served as a decorative trim. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: overlap clockwise; shape overlap stumpy. Solid rings are smaller than riveted rings. Microscopy demonstrates that the solid rings were punched from sheet.
Material: brass (no tin, 21% zinc).
Literature: Biek 1963, 162-163, pl. 21; Wijnhoven 2015c, 25; 2017, 183, 186, 193; pers. comm. Philip Smither 2018.

St Albans - Folly Lane
Date: c. AD 55.
Context: funerary.
Description: complete mail coat, folded together. Its current shape indicates that was probably stored in a bag when deposited. Size 33 x 25 x 14.5 cm; current weight 10.2 kg. X-ray examination does not reveal associated fixtures, although these may have melted in the funerary pyre. 4-in-1. Alternating rows of riveted and solid rings. Rings: outside diameter 6.8-7.1 mm; cross-section wire 1.5-1.6 mm. Riveted rings: overlap clockwise; rivet head domed on one side and less pronounced on the other side; cross-section round. Solid rings: cross-section now oval through bloating by corrosion, possibly originally square.
Material: iron.
Inventory: furniture fittings, firedog, silver lump, chariot parts, horse harness, hobnails, molten metal remains (bronze and silver), sherds of at least 40 vessels, wood fragments, ivory fragments, animal remains.
Location: Saint Albans Museum.
Literature: Gilmour 1997, 26-30; 1999; Hansen 2003, 72, 171, fig. 22.1-2 (cat. no. C51); Matešić 2015, 209; Niblett 1992, 923, fig. 9; Selkirk 1992, 486, 488; Van der Sanden 1993, 4 (cat. no. 81); 2003/2004, 372.

near **Stanhope** - Heathery Burn Cave
Date: Roman period?
Context: said to have been found at a cave.
Description: described as a 'Roman sleeve of mail armour'. Uncertain if it was indeed mail, a sleeve or Roman.
Remarks: a letter to the Society of Antiquaries of Newcastle-upon-Tyne in 1816 narrates how it was found c. 60 years earlier in a cave.
Location: now lost.
Literature: Britton 1971, 21.

South Shields 1 - Arbeia *(fig. 3.25)*
Date: late 3rd - early 4th century AD.
Context: Roman fort - rubble of burnt down barrack 2.
Description: complete mail coat broken into four parts upon recovery. X-rays show that no fixtures were present. Current weight 5.4 kg (none of the original iron survives). 4-in-1. Alternating rows of riveted and solid rings. The rings have inflated due to corrosion. Riveted rings: outer diameter 8 mm; overlap clockwise; shape overlap stumpy; length overlap c. 1.75 mm; rivets with domed heads c. 1mm. Solid rings: outer diameter 7 mm
Material: iron, now completely mineralised and X-rays of rings show light lines within the riveted rings, which are probably slag inclusions that run along the length of the rings and could point to drawn wire.

Inventory: fragments of a copper alloy greave.
Remarks: observed by the author through museum glass.
Location: Arbeia Roman Fort and Museum, inv. 2002.1311 (small finds no. I740).
Literature: Bishop 2015c, 99; Bishop/Coulston 2006, 170; Croom 1998; 2001; Matešić 2015, 209, 218; Quesada Sanz *et al.* 2019, 163; Sim/Kaminski 2012, pl. 4a-b; Stephenson 2001, 33; Stephenson/Dixon 2003, 44; Travis/Travis 2011, 74, 86.

South Shields 2 - Arbeia
Date: AD 100-199.
Context: Roman fort - hoard underneath a rampart?
Description: two corroded mail fragments. Rings: outer diameter 7 mm, inner diameter 5 mm; cross-section round.
Material: iron.
Inventory: various objects of military equipment.
Remarks: mail was found in the same year, 1900, as the hoard and was X-rayed together in 1953. However, it is uncertain if it formed part of the hoard.
Location: Arbeia Roman Fort and Museum, South Shields, inv. 1900.74; Great North Museum: Hancock, Newcastle upon Tyne, inv. 1956.128.40.
Literature: Croom 2000, 129, 133 fig. 1.1; Croom/Griffiths 1996, 3-4; Hansen 2003, 170 (cat. no. C39).

Stanwick 1
Date: mid-1st century AD.
Context: hoard near an *oppidum*.
Description: discovered in the mid-19th century, but probably from the same hoard as Stanwick 2 discovered in 2011. Eleven mail fragments, heavily corroded. 4-in-1. Alternating rows of riveted and solid rings. Rings: c. 6 mm in outer diameter.
Fixture: two rosette-like buttons attached to mail fabric. They are copper alloy and partly gilded. In addition a set of S-shaped fasteners with their central button. Also two buttons to which these fasteners connected.
Remarks: examined by the author.
Material: rings: iron; fasteners: copper alloy; buttons: gilded copper alloy.
Inventory: helmet, sword with scabbard, shield, spearhead, chariot fittings, horse harness, bronze bowl fragments, various iron and bronze objects.
Location: British Museum, London, inv. 1847,0208.96a-h,t, 1847,0208.145, 1847,0208.63, 1847,0208.81, 1847,0208.138.
Literature: Beck/Chew 1991, 163-4, fig. 14.17; Canestrelli 2018, 20; Deschler-Erb 1996, 83; Foster 1986, 85; Gilmour 1997, 31; 1999, 162, 166; Hansen 2003, 53, 74, 170, 211, fig. 23.6 (cat. no. C41, 9.38); Laver 1927, 248; MacGregor 1962, 21, 28, 33-34, 49, 52-53, fig. 14 (cat. no. 117-120); Piggott 1955, 11, 38; Spratling 1981, 14-15; Stead 1991, 54, 56; Van der Sanden 1993, 4 (cat. no. 82).

Probably **Stanwick** 2
Date: mid-1st century AD.
Context: hoard near an *oppidum*.
Description: probably the same hoard as Stanwick 1 that was discovered in the mid-19th century. Two mail fragments in much corroded condition. 4-in-1. Probably riveted and solid rings. Rings: outer diameter c. 7.4 mm.
Fixtures: the number of fixtures, together with Stanwick 1, indicates the presence of more than one coat of mail. Left gilded S-shaped fastener, broken in two. Three copper alloy rosette-shaped buttons with mail still adhering to them. In addition one rosette-shaped partially gilded copper alloy button, almost identical to Stanwick 1.
Material: rings: iron; fasteners: copper alloy; buttons: (gilded) copper alloy.
Inventory: strap fittings and harness, turrets and chariot gear, copper alloy sheet and binding fragments, metal working waste, coin, boar figurine fragment, ring, ferrule, two copper alloy fittings.
Remarks: examined by the author.
Location: British Museum, London, find no. DUR344A72; DURD07127; DURD07B37; DURD08561; DURD09DB5; DURD0A7D8; DUR340D74.

Sutton Hoo
Date: AD 610-635.
Context: funerary.
Description: corroded coat of mail that has been folded a number of times. Nowadays its maximum length measures c. 60-62 cm, suggesting an armour of at least tunic length or longer. Radiography could not observe fixtures. Alternating rows of riveted and solid rings. Scientific examination demonstrated that areas of the mail coat have iron rings with copper alloy rivets. Solid rings have been described as forged or welded, with-

out evidence how this conclusion was reached. Rings: outer diameter c. 8 mm; no variation in ring size. Textile and leather are associated with the mail coat and are perhaps the remains of a bag.
Material: iron rings with in some parts copper alloy rivets.
Inventory: boat, helmet, shield, spears, sword and scabbard, sword harness and belt, gold buckle, two shoulder clasps, purse with money, ten silver bowls, two silver spoons, drinking vessels (including two drinking horns), bronze bowl, two hanging bowls, textile remains, shoes, feather cushion, iron hammer-axe, silver dish, wooden cups, antler combs, metal knives, silver bowl, toilet equipment?, gaming pieces, gaming board, silver platter.
Remarks: observed by the author through museum glass.
Location: British Museum, London.
Literature: Adams 2010, 96-98; Bruce-Mitford 1978, 232-237, 240; Cessford 1994, 74; Grunwald 1998, 97; Mortimer 2011, 161; Müller 2003, 444; Nicklasson 1989, 34; 1991, 22; Nicolay 2014, 174; Novichenkova 2011, 279; Oddy/Werner 1978, 240; Underwood 1999, 91; Van der Sanden 1993, 4-5 (cat. no. 83); Wijnhoven 2015c, 24, 27; 2017, 184, 192; Williams 2003, 30-31.

Usk 1 - Cattle Market Site
Date: AD 60-66.
Context: Roman fort - pit.
Description: eight much corroded mail fragments. 4-in-1. Rings: estimated outer diameter just over 3 mm.
Material: iron.
Remarks: examined by the author.
Location: National Museum of Wales, inv. 82.11H.
Literature: Chapman 2005, 87 (cat. no. Ma05); Manning *et al.* 1995, 13-14 (cat. no. 23a-h), pl. 1-2; Price 1983, 13; Wijnhoven 2016a, 84.

Usk 2 - Cattle Market Site
Date: AD 60-66.
Context: Roman fort - pit.
Description: heavily corroded mail fragment about eight rows high. Rings: outer diameter c. 8 mm; corroded wire thickness 1.6 mm.
Material: iron.
Remarks: examined by the author.
Location: National Museum of Wales, inv. 82.11H.
Literature: Chapman 2005, 87 (cat. no. Ma06); Manning *et al.* 1995, 14 (cat. no. 24); Price 1983, 13.

Usk 3 - Cattle Market Site
Date: AD 60-66.
Context: Roman fort - pit.
Description: small mail fragment, much corroded. 4-in-1. Rings: outer diameter rings c. 4.5-5.5 mm.
Material: iron.
Remarks: examined by the author.
Location: National Museum of Wales, inv. 82.11H.
Literature: Chapman 2005, 87, (Ma04); Manning *et al.* 1995, 13 (cat. no. 22); Price 1983, 13.

Usk 4 - Cattle Market Site
Date: AD 60-66.
Context: Roman fort - pit.
Description: 13 corroded mail fragments. 4-in-1. The fragments are of three different ring sizes. Some have rings with an outer diameter of c. 3.5 mm, others of 4.5-6 mm, and one fragment has rings of c. 10 mm. These differences indicate that probably three or more garments are represented.
Material: iron.
Remarks: examined by the author.
Location: National Museum of Wales, inv. 82.11H.
Literature: Chapman 2005, 87, (Ma07); Manning *et al.* 1995, 14 (cat. no. 25), pl. 2; Price 1983, 13.

Usk 5 - Cattle Market Site
Date: AD 60-66.
Context: Roman fort - pit.
Description: small mail fragment, heavily corroded. 4-in-1. Rings: outer diameter c. 5 mm.
Material: iron.
Remarks: examined by the author.
Location: National Museum of Wales, inv. 82.11H.
Literature: Chapman 2005, 87, (Ma03); Manning *et al.* 1995, 13 (cat. no. 21); Price 1983, 13.

Usk 6 - Cattle Market Site
Date: probably AD 60-66.
Context: Roman fort - gully.
Description: two mail fragments. 4-in-1. Too corroded to observe much detail. Rings: outer diameter c. 3 mm.
Remarks: examined by the author.
Material: iron.
Location: National Museum of Wales, inv. 82.11H.

Literature: Chapman 2005, 87, (Ma08); Manning *et al.* 1995, 14 (cat. no. 26); Price 1983, 13; Wijnhoven 2016a, 84.

Vindolanda 1 - Chesterholm
Date: AD 196-225.
Context: Roman fort - *principia*.
Description: large corroded mail fragment in solid condition. Modern fractures indicate that it was larger when excavated, possibly a complete mail coat. 4-in-1. Rings: many characteristics are obscured by corrosion; outer diameter c. 7.3 mm; inner diameter c. 4.3 mm; thickness c. 1.2-1.4 mm.
Material: iron.
Remarks: examined by the author.
Location: National Museum of Scotland, Edinburgh, inv. X.FS 224 (1933.268).
Literature: Capwell 2003, 23; Yule 1933-1934, 15.

Vindolanda 2 - Chesterholm
Date: Roman period.
Context: Roman fort
Description: corroded mail fragment about 9 cm long.
Material: iron.
Location: Tyne and Wear Archives and Museums, inv. 1956.254A

Wallsend 1 - Segedunum
Date: AD 160-235.
Context: Roman fort - barrack XII, room 5.
Description: coat of mail, now fragmented. Current weight 5.6 kg. X-rays reveal no associated fixtures. 4-in-1. Alternating rows of riveted and solid rings. Rings: diameter 7 mm; thickness c. 1 mm.
Material: iron.
Remarks: found buried under the barrack floor and speculated to be a votive offering. Observed by the author through museum glass.
Location: Segedunum Roman Fort, Wallsend, inv. 2003.1065 (small finds no. WSFE710, 9123).
Literature: Bishop 2015c, 99; Croom 2000, fig. 1.3; 2001, 59; Hodgson 2003, 217-218.

Wallsend 2 - Segedunum
Date: Roman period.
Context: Roman fort.
Description: large mail fragment measuring 10 x 3 x 10.5 cm.
Material: iron.
Location: Tyne and Wear Archives and Museums, inv. 2001.2211 (small finds no. WS.FE.333).

Woodeaton
Date: 1st century AD.
Context: sanctuary.
Description: mail armour. Alternating rows of riveted and solid rings. Riveted rings: diameter 7-7.5 mm; cross-section 0.8 mm; cross-section wire round. Solid links: diameter 7 mm; cross-section square and likely to have been made from sheet metal. Inserted into the iron mail mesh are two groups of copper alloy links, which are butted. These could be decoration or repairs. Copper alloy links: diameter 7.2-7.5 mm; cross-section 1-1.1 mm.
Material: iron, copper alloy.
Inventory: bronze sculptures, eight amulets, miniature weapons, miniature anchor, 65 bangles, 23 finger rings, 177 brooches, needles, bronze sheet, various metal objects.
Location: Ashmolean Museum, Oxford, inv. 1936.183.
Literature: Croom 2000, 133; Foster 1986, 83, 85; Gilmour 1997, 31, 34; 1999, 163, 165; Hansen 2003, 52, 171 (cat. no. C48); Jope 1957; Matešić 2015, 211; Novichenkova 2011, 278; Stead 1991, 56; Wijnhoven 2015c, 25; Van der Sanden 1993, 4 (cat. no. 84).

York - Coppergate *(fig. 11.38)*
Date: AD 750-775.
Context: wood-lined pit
Description: mail aventail belonging to a helmet. Deposited inside the helmet and originally in solid condition and made flexible by mechanical cleaning. Surviving mail is 28 rows deep and maximum 81 rings wide. 4-in-1. Alternating rows of riveted and solid rings. No evidence for tailoring. Mostly iron rings and one row of solid copper alloy rings used for the suspension of the aventail (8-8.5 mm diameter; 1.2-1.4 mm cross-section). These rings hang from a copper alloy suspension strip. There are four more copper alloy rings in the surviving mail: one hangs free and is speculated to be a talisman; the other three come from the bottom row of which only these survive. The aventail probably had originally two rows of copper alloy rings trim at the bottom. The copper alloy rings are riveted and solid and have the same size as the iron rings. Riveted iron rings: outer diam-

eter c. 7.8-8.2 mm; inner diameter 5.53 mm; overlap anti-clockwise; shape overlap oval: other - narrow; length overlap c. 4 mm; rivet hole 0.8-0.9 mm; rivet heads are almost flush with the rings; cross-section wire round; thickness rings c. 0.9-1.2 mm. Solid rings: outer diameter c. 7.8-8.2 mm; inner diameter 5.54 mm; cross-section oval; thickness c. 0.9-1.2 mm; metallographic examination demonstrated that these were welded. A few rings differ from the main stock: the first row has just behind the check pieces three or four larger rings, 10-12 mm diameter, presumably to gather part of the aventail behind the cheek pieces to allow easy removal of the helmet. Also some odd rings that are likely repairs.
Material: iron, copper alloy.
Inventory: helmet, sword-beater, churn dasher, crucible fragment, antler beam, rubbing stone, fragments of ash and glass.
Location: Yorkshire Museum, York.
Literature: Böhner 1994, 545, fig. 43.1; Bottomley/Stallybrass 2000, 134-135; Cessford 1994, 74; Checksfield *et al*. 2012, 235; Edge 2001, 228; Ehlton 2002/2003, 12; Fredman 1992, 10; Gilmour 1997, 28-29, 33; 1999, 163, 165; Miks 2009, 427, fig. 18; Mortimer 2011, 39, 161; Müller 2003, 444-445; O'Connor 1983; Tweddle 1992, 929-935, 999-1009, 1057-1081; Underwood 1999, 92-93, 102-103; Wijnhoven 2015c, 24; 2017, 184; Williams 2003, 30-32.

UNPROVENANCED

Unprovenanced 1 *(fig. 11.9)*
Date: uncertain. Refined age: Iron Age
Description: mail fragment in solid condition. It still preserves ring characteristics and has been exposed to fire. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: horizontal outer diameter 8.6 mm; vertical outer diameter 7.6 mm; overlap clockwise; shape overlap large oval; overlap length c. 3.7 mm; overlap width 2.5 mm; rivet holes round; rivet made from 1.3 mm square wire; round rivet head on one side and protruding from the other; protrusion c. 2.7-2.8 mm; thickness wire 1.1 mm; width wire 1.6 mm; cross-section wire flat. Solid rings: outer diameter 6.7 mm; thickness 0.8 mm; width 1.4 mm; cross-section rectangular; burrs present; some deformation of the rings.
Material: iron.
Remarks: examined by the author.
Location: privately owned.

Unprovenanced 2
Date: uncertain. Refined age: Iron Age.
Description: 21 interconnected mail rings, still flexible. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: horizontal outer diameter 7.9 mm; vertical outer diameter 8.5 mm; horizontal inner diameter 5.1 mm; vertical inner diameter 4.5 mm; overlap clockwise; shape overlap large oval; overlap length c. 4 mm; overlap width 2.4 mm; rivet holes round; rivet head on one side and protruding on the other side; length protrusion c. 2.8 mm; rivet made from square wire c. 1.1 mm thick; wire rings is flattened; ring thickness 1 mm; ring width 1.4 mm. Solid rings: outer diameter 7 mm; inner diameter 3.6 mm; thickness 0.9 mm; width 1.6 mm; cross-section rectangular to flat; burrs and deformations are present.
Material: iron.
Remarks: examined by the author.
Location: privately owned.

Unprovenanced 3
Date: Roman period, possibly Late Republican or Early Empire.
Description: composite armour made from two sets of hinged metal plates that cover the shoulders. It contains a graffito reading: OP . MAMILIO . Q . L . The armour may have been used in gladiatorial context. There are holes at the bottom of the plates from where mail was attached.. The rings connect to the plates by placing one half of the overlap on the inside and the other half at the outside of the plate. A single rivet closes each ring and attaches it at the same time to the plate. Only the first ring row survives partially, which are all riveted rings: sturdy appearance; overlap clockwise; shape overlap large oval; rivet head on both sides?; cross-section wire flat.
Material: iron.
Location: Privately owned.

UZBEKISTRAN

Mount Mugh
Date: 8th century AD.
Description: mail fragments.
Literature: Ahmad 2017, 24.

WEST BANK

Hebron

Date: 1st half 2nd century AD.
Context: possibly a hoard from a cave.
Description: coat of mail bought on the art market. 4-in-1. Several scales adhere to the mail coat. It has been speculated that these could have formed part of the same armour. However, the two were not connected to each other and it appears that they are simply two separate items of armour deposited together.
Material: iron.
Inventory: two helmets, scale armour fragment, greaves.
Location: The Israel Museum, Jerusalem, inv. 71.91.341-347.
Literature: Fischer 2012, 92, 152; 2019, 55, 113; Hansen 2003, 174 (cat. no. C80); Künzl 2002, 140 (cat. no. 5); Stiebel 2007, 51-53, 316; Waurick 1982, 111; Weinberg 1979, 82, 85, fig. 25.7; Wijnhoven 2016a, 84.

BULGARIA

Unprovenanced from Bulgaria 3
Date: Roman period. Refined date: end 1st century BC – 2nd century AD.
Description: small fragment of hybrid armour measuring c. 6.5 x 4.5 cm. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter c. 4 mm; inner diameter c. 2.7 mm; overlap clockwise; shape overlap stumpy; small rivet head on one side, the rivets facing the scales are left protruding; cross-section wire round; thickness c. 0.7 mm; width c. 0.7 mm. Solid rings: outer diameter 3.3 mm; inner diameter 2.1 mm; thickness 0.3 mm; width 0.6 mm; conical deformation, burrs. Scales: length 10.8 mm; width top 7 mm; width bottom 5.7 mm; thickness 0.5 mm; 90 degree ledge with holes; mid-rib on outside of scale; tapering towards bottom; straight bottom with rounded corners.
Material: copper alloy.
Remarks: said to have come from Ratiaria. Examined by the author.
Location: privately owned.
Literature: Wijnhoven 2016a, 78-79, fig. 6.

FRANCE

Mandeure
Date: Roman period. Refined date: end 1st century BC - 2nd century AD.
Description: fragment of hybrid armour. 4-in-1. Alternating rows of riveted and solid rings. Rings: diameter c. 3 mm; riveted rings are larger than solid rings. Scales: length 11 mm; width top 8 mm; width bottom 5 mm; 90 degree ledge with holes; mid-rib on outside of scale; tapering towards bottom; straight bottom with rounded corners.
Material: rings: copper alloy; scales: copper alloy covered in white metal.
Location: Musée des Beaux Art et d'Archéologie de Besançon, inv. 855.1.231.
Literature: Bishop 2017, 151; Feugère 1996, 119; Hansen 2003, 59, 169 (C31); Künzl 2002, 140 (cat. no. 6); Matešić 2015, 211; Wijnhoven 2009a, 24-25, 55; 2016a, 79.

GERMANY

Augsburg – Kornhausgasse *(fig. 10.23)*
Date: Claudian - Neronian.
Context: *vicus* - timber chest in a layer of burnt soil.
Description: hybrid armour that was rolled up and has corroded together. Current length 26 cm, thickness 11 cm. The majority of the upper part of the armour has been preserved. The garment has been reconstructed through the aid of X-rays at various depths. The coat has two shoulder guards that come from the back to the front. At the front is a small flap that protects the upper chest. This flap contains a double set of fasteners. 4-in-1. Mail consists of alternating rows of riveted and solid rings. The iron rings are so heavily corroded that they preserve almost no details. X-rays show for the riveted rings: outer diameter 3.8-4.2 mm; thickness 0.5-0.7 mm; oval cross-section; no evidence observed of riveting. Solid rings: outer diameter of 3.8-4.2 mm; thickness 0.4 mm; made by punching from sheet metal. Scales: 90 degree ledge at top with four holes; mid-rib on outside; taper towards the bottom; bottom straight with rounded corners; length 9.4-10.8 mm (most 9.8-10.6 mm); width top 6.2-8.6 mm (most 6.7-8.2 mm); width bottom 5.6-8 mm (most 6.2-6.8 mm); thickness 0.2 mm; some scales have only three holes; these scales are slimmer. All scales point downwards in the armour; therefore at the apex of the shoulders the scales change direction. The contrast of iron and copper alloy scales is put into a decorative pattern of diamond shapes and lines.
Fixture: double set of S-shaped fasteners with key-hole-shaped opening. The bottom set is connected with one button, while each fastener in the top set has its own button and are mounted separated from each other by several cm. Four additional buttons are located at the shoulder guards, to which the fasteners connect.
Material: rings: iron; scales: brass, iron; fasteners and buttons: brass covered in white metal.
Location: Römisches Museum Augsburg.
Literature: Bakker 1985, 90, fig. 60; Bishop 2017, 151; Boube-Piccot 1994, 55; Dixon/Southern 1992, 37; Driehaus 1968, 14-15; Driehaus *et al.* 2012; Fischer 2012, 171, 215, fig. 219; 2019, 113, 186, fig. 219;

Hansen 2003, 59, 168 (cat. no. C22, 9.42); Kemkes/Scheuerbrandt 1997, 34, fig. 24; Künzl 2002, 138-140, fig. 13 (cat. no. 4); Matešić 2015, 211; Novichenkova 2009, 285; 2011, 279; Onurkan 1978, 50-51; Price 1983, 12; Richter 2010, 189, 193; Robinson 1975, 173, pl. 484; Weber 1973, 68-69; Wijnhoven 2009a, 9-12, 26-27, 52; 2016a, 79-80, 82-83, fig. 8; 2016b, 64.

Xanten 3
Date: 1st - early 2nd century AD?
Context: settlement next to Roman fort.
Description: small fragment of hybrid armour about 12 rows in length and 8-12 rings wide. Only two partial scales are still attached to the mail. 4-in-1. Alternating rows of riveted and solid rings. Rings: outer diameter 3 mm. Riveted rings: larger than solid rings; overlap clockwise; shape overlap stumpy, and because of small ring size the adjacent area to the overlap is also flattened; cross-section wire round; round rivet head on one side and unknown for the other side. Solid rings: deformed into a conical shape by being punched from sheet. Scales: front have a medial rib.
Material: copper alloy.
Location: LVR-Römermuseum Xanten, find 8657.
Literature: Bishop 2017, 151; Lenz 2006, 20, pl. 18 (cat. no. 134); Wijnhoven 2009a, 24, 55; 2016a, 79.

ISRAEL

Jerusalem
Date: AD 70.
Context: upper city.
Description: two small fragments of hybrid armour. Scales: length c. 10 mm; medial rib on the outside.
Material: rings: iron; scales: copper alloy.
Literature: Stiebel 2007, 51, 53-54, 113-114.

ITALY

near **Rome**
Date: Roman period. Refined date: end 1st century BC – 2nd century AD.
Description: fragment of hybrid armour in solid condition. 4-in-1. Described as all-riveted, which is unlikely given the other examples of hybrid armour. Rings: outer diameter 3-4 mm. Scales: length c. 8 mm; width c. 5 mm; 90 degree ledge at the top; medial rib; shape tapers towards the bottom.
Material: iron.
Remarks: bought in 1842 as a Grand Tour souvenir. Formerly in the Altes Museum, Berlin, inv. Bronzen 1025. Now lost.
Literature: Alfs 1941, 79; Bishop 2017, 151; Friederichs 1871, 230; Hansen 2003, 172 (cat. no. C55); Jähns 1880, 194; Künzl 2002, 138 (cat. no. 1); Rose 1906, 8, fig. 14a-b; Toelken 1850, 31; Wijnhoven 2009a, 5-8, 52; 2016a, 79.

NETHERLANDS

Nijmegen 3 - Rooie Dorp
Date: AD 70-104.
Context: *vicus*.
Description: fragment of hybrid armour measuring 3 x 29 cm. Besides two partial scales embedded among the rings, no scales have been preserved. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outside diameter horizontal c. 3.5 mm; outside diameter vertical c. 3.5 mm; inside diameter horizontal 2.8 mm; inside diameter vertical 2.6 mm; overlap length c. 1.6 mm; overlap width 0.9 mm; overlap clockwise; shape overlap stumpy; rivet heads are rounded on both sides of the ring; round rivet holes measuring 1 mm; wire round cross-section; thickness 0.7 mm; width c. 0.7 mm. Solid rings: outside diameter 3.1 mm; thickness c. 0.4 mm; width c. 0.7 mm; conical in shape due to being punched from sheet; some rings preserve burrs at the edges. Scales: shape and size is unknown.
Material: copper alloy.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, inv. Ub5.30.070.
Literature: Thomas 2010, 75; Van Enckevoort/Thijssen 2004, 4; Wijnhoven 2016a, 77, 79, fig. 4.

Nijmegen 4 - *castra* - Ubbergseveldweg
Date: late 1st century BC - 1st century AD.
Context: Roman fort.
Description: small fragment of hybrid armour measuring c. 10 x 1.5 x 1.5 cm. The fragment is in solid condition and most of the scales have been lost. Alternating rows of solid and riveted rings. 4-in-1. Riveted rings: outer diameter 4 mm; overlap clockwise; protruding rivets; cross-section wire round. Solid rings: outer diameter 3.6 mm; inner diameter 2.3 mm; conical deformation; burrs present at their edges. Scales:

length 10.1 mm; with top 5.9 mm; width bottom 5.2 mm; 90 degree ledge with four holes; medial rib at the front; soft taper towards the bottom, which is straight with rounded corners.
Material: copper alloy.
Inventory: coin, sherds.
Remarks: found in the upper layers of the excavations at the *castra* of the 10th legion where the soldier barracks were located. Examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, inv. I-137.
Literature: Van der Veen 2020, fig. 23.8.

Nijmegen 5 - *castra* - Kloostertuin *(fig. 3.20)*
Date: late 1st century BC - 1st century AD.
Context: Roman fort.
Description: small fragment of hybrid armour measuring 4.5 x 4 cm. The fragment still has some scales, but most of them are lost or damaged. Although the fragment is corroded, several parts are still able to move. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter horizontal 4 mm; outer diameter vertical 4.4 mm; inner diameter horizontal 2.7 mm; inner diameter vertical 2.8 mm; overlap clockwise; shape overlap stumpy; overlap length c. 1.6 mm; overlap width 1 mm; protruding rivet facing inside of scales; round rivet head facing the wearer; rivets protrude c. 1.2 mm; cross-section wire round; thickness wire 0.5-0.6 mm. Solid rings: outer diameter 3.6 mm; inner diameter 2.3 mm; thickness 0.5 mm; width 0.9 mm; conical deformation from being punched out of sheet. Scales: 90 degree ledge with four holes; medial rib at the front; tapering shape towards the bottom and ending in a triangular shape; length 10 mm; width at top 8.3 mm; width where triangular shape starts 7.6 mm; depth ledge 2.1 mm; diameter holes ledge 1.3 mm.
Material: copper alloy.
Inventory: S-shaped fastener (Nijmegen 11).
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 1962-I-C.1962.834.
Literature: Van der Veen 2020, fig. 23.9.

Ouddorp *(figs. 3.19, 9.13, 11.20)*
Date: *terminus post quem* AD 75. Refined date: AD 70-200.
Description: various fragments of hybrid armour measuring together c. 32 x 20 cm. The remains are still flexible. Many of the scales have been lost or broken. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter horizontal 4.3 mm; outer diameter vertical 4.0 mm; inside diameter horizontal 2.9 mm; inside diameter vertical 2.5 mm; overlap length c. 1.8 mm; overlap width 1.2 mm; overlap clockwise; shape overlap stumpy; height overlap 0.7 mm; rivet hole is round; cross-section rivets square (c. 0.5 x 0.5 mm); rivet head round on one side and protrudes for c. 2 mm on the side facing the scales; wire thickness rings 0.6 mm; wire width 0.6 mm; cross-section wire round. Solid rings: outer diameter 3.2 mm; inner diameter 2.2 mm; thickness 0.2 mm; width 0.5 mm; conical deformation by being punching from sheet; some edges have burrs. Scales: 90 degree ledge with four holes; mid-rib only on the front; taper to the bottom ending straight with rounded corners. Three different types of scales have been observed: regular scales; small scales; and 3-holed scales. Regular scales: length 11.1 mm; width top 6.5 mm; width bottom 5.8 mm; thickness 0.2 mm; depth ledge 2.1 mm; width mid-rib 0.7 mm; diameter holes 1.3 mm. Small scales: length 8.3 mm; width top 5.8 mm; width bottom 5.0 mm; thickness 0.2 mm; depth of ledge 1.7 mm; width mid-rib 0.6 mm; diameter holes c. 1 mm. The placement of the small scales is restricted to one area. There are two scales with three holes. These were similar in size to the regular ones, except for a reduced width. The function of the smaller and three-hole scales is unknown.
Material: copper alloy.
Inventory: sold together with pottery sherds to the museum.
Remarks: examined by the author. Formerly mounted together as one large fragment. After a recent treatment, they are now displayed separately.
Location: Rijksmuseum van Oudheden, Leiden, inv. h1902/3.1a-b.
Literature: Boube-Piccot 1994, 55; Bishop 2017, 151; De Bruin 2020, 36; De Bruin *et al.* 2012, 144-145; Dixon/Southern 1992, 37; Hansen 2003, 59, 172, fig. 26 (cat. no. C62); Künzl 2002, 140 (cat. no. 10); Matešić 2015, 211; Novichenkova 2009, 285; 2011, 279; Olivier 2004, 6; Onurkan 1978, 51; Price 1983, 12; Quesada Sanz *et al.* 2019, 159; Richter 2010, 193; Robinson 1975, 173; Sim 1997, 360-361; Sim/Kaminski 2012, 130-132, 134, fig. 86, 100-101, pl. 4c; Sim/Ridge 2002,

pl. 23; Stuart 1986, 111; Van der Sanden 1993, 4 (cat. no. 50); Van Ginkel/Vos 2018, 199; Wijnhoven 2009a, 16-17, 53; 2009b; 2010, 150, fig. 12; 2016a, 79, fig. 7.

TURKEY

Dülük Baba Tepesi

Date: *terminus ante quem* AD 256. Refined date: late 1st century BC - 2nd century AD

Context: sanctuary.

Description: two fragments of hybrid armour. One unpublished measuring c. 45 cm x 15 cm and still flexible. The other published in Fischer (2011). 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: larger diameter than the solid rings; overlap clockwise. Scales: 90 degree ledge with four holes; medial rib on outside; slight taper with a straight bottom with rounded corners.

Material: copper alloy.

Inventory: (incomplete) items of Roman military equipment, e.g. scale armour, sword and scabbard, *pilum*, arrowheads, brooches, parts of horse harness, bronze applique in the shape of Iupiter Dolichenus.

Remarks: it probably concerns votive gifts at the temple of Iupiter Dolichenus that were cleared out.

Location: find 05 206-517.

Literature: Fischer 2011, 107-108, 116, pl. 27.2; 2012, 71; Matešić 2015, 211; Wijnhoven 2016a, 78-79, 85.

Vize *(fig. 10.24)*

Date: AD 35-50.

Context: funerary - *tumulus* A.

Description: complete hybrid armour in good condition, although most parts are no longer flexible. It is thought that the armour would have weighted c. 18 kg in finished condition. The armour consist of a front and a back with shoulder guards. At the front there is a flap that protects the upper chest. Here are two sets of fasteners that connect with the buttons on the guards. Two small areas underneath the armpits do not have scales, but only mail. There is a split at one side; the other side forms a natural split when the armour is closed at the side. The armour was deposited unfinished (i.e. parts are missing; no wear on fasteners; one fastener has always been broken; only one fastener has been covered in white metal; the front and back of the armour are not aligned; there is no closure system for the side; some of the rings are butted; lining is not attached properly in many places). The majority of the scales are copper alloy, but decoration has been created by inserting iron scales. These are placed in lines and diamond shapes. A coarse linen lining with a purple fringe is still preserved within the armour. 4-in-1. Alternating rows of riveted and solid rings. Rings: outer diameter c. 3-4 mm. Riveted rings: round cross-section. Solid rings: conical deformation; burrs present at the edges. Scales: 90 degree ledge with four holes; medial rib at the front, taper towards the bottom; straight bottom with rounded corners; length 12 mm; width 6 mm.

Fixture: two sets of S-shaped fasteners with a keyhole opening. The bottom set is attached with one button; the top set with two buttons. Four more buttons are located at the shoulder guards.

Material: rings: copper alloy; scales: copper alloy, iron; fasteners: copper alloy covered in white metal.

Inventory: stone sarcophagus, silvered copper alloy helmet, sword, two spearheads, diadem made of 60 gold laurel leaves, two gold rings, five silver cups, silver spoon, glasswork, ceramic vessels.

Remarks: thought to be the burial of Thracian king Rhoimetalkes III that died in AD 45/46.

Location: İstanbul Arkeoloji Müzeleri, inv. 5731.

Literature: Amborn 1976, 91; Bechert 1974, 92; Bishop 2017, 151; D'Amato/Negin 2017, 187, XVI, pl.9; Dawson 2013, 32-33; Driehaus 1968, 15-16; Driehaus *et al.* 2012; Fischer 2012, 171, 215, fig. 219; 2019, 133, 186, fig. 219; Hansen 2003, 58, 69, 74, 77, 174, 211, fig. 27.7-8 (cat. no. C79, 9.39); Ignatov/Gospodinov 2013, 31; Künzl 2002, 133, 135-136, 138, fig. 10 (cat. no. 3); Mansel 1939, 165; 1940, 129; 1941, 175; Matešić 2015, 211; Miks 2015, fig. 10.5; Müller 2003, 432, 436; Onurkan 1978; Schmid 2009, fig. 23; Waurick 1983, 277-278; Wijnhoven 2009a, 12-15, 26-27, 52; 2016a, 77-85, fig. 9-11; 2016b, 64; 2018, 560-562.

UNITED KINGDOM

Healam Bridge

Date: 2nd century AD.

Context: *vicus* next to military fort.

Description: fragment of hybrid armour measuring 5.6 x 3.9 x 0.2 cm. 4-in-1. Rings: outer diameter c. 3.3 mm; thickness 0.7 mm; presence of riveted rings. Copper alloy scales: c. 7 x 6 mm. Iron scales: c. 8 x 7 mm.

Material: rings: copper alloy; scales: copper alloy, iron.

Location: inv. A1DB09, RF 675.
Literature: Bishop 2017, 151, 153, fig. 223; Wijnhoven 2016a, 79.

Usk 7 - Cattle Market Site
Date: AD 60-66.
Context: Roman fort - latrine pit.
Description: fragment of hybrid armour about 6.9 cm in length and in solid condition. The scales now face the inside of the fragment and the mail backing the outside. Rings: outer diameter c. 3 mm, thickness of wire c. 1 mm. Scales: length 9 mm; width 5 mm; medial rib; taper toward the bottom; bottom is straight with rounded corners.
Material: iron.
Remarks: examined by the author.
Location: National Museum of Wales, inv. 82.11H.
Literature: Bishop 2017, 151; Chapman 2005, 90 (cat. no. Oa01); Künzl 2002, 127, 140 (cat. no. 7); Manning *et al.* 1995, 16 (cat. no. 31); Matešić 2015, 211; Price 1983, 12; Wijnhoven 2009a, 19-22, 27, 54; 2016a, 77, 79.

Usk 8 - Cattle Market Site
Date: AD 60-66.
Context: fortress pit.
Description: fragment of hybrid armour measuring 9.5 cm in length and in solid and twisted condition. Rings: outer diameter c. 3 mm, thickness wire c. 1 mm. Scales: medial rib; taper towards the bottom, which is straight with rounded corners; length c. 11 mm; width 5-6 mm.
Material: iron.
Remarks: examined by the author.
Location: National Museum of Wales, inv. 82.11H.
Literature: Bishop 2017, 151; Chapman 2005, 90 (cat. no. Oa02); Künzl 2002, 127, 140 (cat. no. 8); Manning *et al.* 1995, 16 (cat. no. 32), pl. 3; Matešić 2015, 211; Price 1983, 12; Wijnhoven 2009a, 19-22, 27, 54; 2016a, 77, 79.

Usk 9 - Cattle Market Site
Date: AD 60-66.
Context: Roman fort - pit.
Description: fragment of hybrid armour about 6 cm in length and in solid condition. Rings: outer diameter c. 3.5 mm, thickness wire c. 1 mm. Scales: medial rib; taper towards the bottom, which is straight with rounded corners; length 10 mm; width 5 mm.
Material: iron.
Remarks: examined by the author.
Location: National Museum of Wales, inv. 82.11H.
Literature: Bishop 2017, 151; Chapman 2005, 90 (cat. no. Oa03); Künzl 2002, 127, 140 (cat. no. 9); Manning *et al.* 1995, 16 (cat. no. 33), pl. 3; Matešić 2015, 211; Wijnhoven 2009a, 19-22, 27, 54; 2016a, 77, 79.

Usk 10 - Cattle Market Site
Date: AD 60-66.
Context: Roman fort - pit.
Description: small fragment of hybrid armour rolled into a ball. Two types of rings present. Solid rings: outer diameter of c. 3 mm. Other rings: outer diameter of c. 6 mm. Largest scale measures 6 x 5 mm, but is incomplete.
Material: copper alloy.
Location: National Museum of Wales, inv. 82.11H.
Literature: Bishop 2017, 151; Manning *et al.* 1995, 15-16 (cat. no. 30), pl. 3; Matešić 2015, 211; Price 1983, 12; Wijnhoven 2009a, 19-22, 27, 54; 2016a, 77, 79.

Newstead 4 *(figs. 8.14, 11.21)*
Date: Antonine.
Context: Roman fort - storehouse, block 16.
Description: several small fragments of hybrid armour. Only some scales have survived and none is complete. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: vertical outside diameter: 4.2 mm; horizontal outside diameter: 4.1 mm; vertical inside diameter 2.4 mm; horizontal inside diameter 2.8 mm; overlap clockwise; shape overlap stumpy; length overlap c. 1.4 mm; rivet made from square wire; domed head on one side and protruding on the other side; total length rivet c. 2.2 mm; length rivet protrusion c. 1.4 mm; cross-section wire round; thickness 0.4 mm; width 0.5 mm. Solid rings: outer diameter 3.5 mm; inner diameter 2.3 mm; thickness 0.3 mm; width 0.7 mm; conical deformation; presence of burrs. Scales: 90 degree ledge with four holes; medial rib on the outside; light tapering and ending in a triangular shape; length damaged scale 9.9 mm; width top 7.55 mm; width at start triangle 6.7 mm.
Material: copper alloy.
Remarks: examined by the author.
Location: National Museum of Scotland, Edinburgh, inv. X.FRA 120.

Literature: Alfs 1941, 79; Bishop 2017, 151; Boube-Piccot 1994, 55; Capwell 2003, 23; Curle 1911, 161, pl. 38.8; Dawson 2013, 33; Dixon/Southern 1992, 37; Hansen 2003, 59, 169-170 (cat. no. C36); Künzl 2002, 138 (cat. no. 2); Matešić 2015, 211; Novichenkova 2011, 279; Onurkan 1978, 51; Price 1983, 12; Richter 2010, 193; Robinson 1975, 171-173, pl. 481; Schmid 2009, fig. 3, 20; Wijnhoven 2009a, 17-19, 27, 53; 2009b, 36-37; 2016a, 78-79, fig. 2-3.

UNPROVENANCED

Unprovenanced 4, possibly Balkans
Date: Roman period. Refined date: late 1st century BC - 2nd century AD.
Description: small fragment of hybrid armour. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter c. 4 mm. Solid rings: outer diameter 3-3.5 mm; thickness c. 1 mm. Scales: 90 degree ledge with four holes; mid-rib on outside; tapering towards the bottom; straight bottom with rounded corners; length 10 mm; width top 6.5 mm; width bottom 4.5-5.5 mm.
Material: copper alloy.
Location: privately owned.
Literature: Bishop 2017, 151; Wijnhoven 2009a, 22-24, 55; 2016a, 78-79.

Unprovenanced 5, possibly Balkans
Date: Roman period. Refined date: late 1st century BC - 2nd century AD
Description: small fragment of hybrid armour measuring 16.5 x 13 cm. 4-in-1. Alternating rows of riveted and solid rings. Riveted rings: outer diameter 4.5 mm; overlap length 1.6-1.9 mm; overlap width 1.1-1.4 mm; overlap clockwise; shape overlap stumpy; cross-section wire round; wire thickness 0.6-0.8 mm; rivet hole round; rivet made from square wire; round head on one side and protruding on the other side, where they are lightly bent over. Solid rings: outer diameter 3.5 mm; inside diameter 2.1 mm; thickness 0.24-0.36 mm; conical deformation; burrs present. Some repair rings, which are butted and larger and thicker than the other rings. Scales: 90 degree ledge with four holes; medial rib on the front of the scales; tapering towards the bottom, which ends straight with rounded corners; length 11 mm; width top 5.9 mm; width bottom 5.4 mm; thickness 0.22-0.32 mm.
Material: copper alloy.
Remarks: said to have come from the Balkans.
Location: privately owned.
Literature: www.roman-artifacts.com.

APPENDIX 3. CATALOGUE OF ISOLATED FINDS OF FASTENERS AND FIXTURES

AUSTRIA

Bregenz 1 - Brigantium
Date: late Augustan - early Tiberian.
Context: Roman fort.
Description: damaged left S-shaped fastener.
Literature: Kopf 2015, 116-117, fig. 5.5; 2016, 245-246, fig. 3.15.

Bregenz 2 - Brigantium
Date: Early Principate.
Context: Roman fort.
Description: left S-shaped fastener.
Location: Vorarlberg Museum, Bregenz, inv. 12.98.
Literature: Deschler-Erb 1996, 83; Hansen 2003, 211 (cat. no. 9.32); Schimmer 2005, 612, pl. 10.3.

Bregenz 3 - Brigantium
Date: 15 BC-AD 15.
Context: Roman fort.
Description: damaged right S-shaped fastener.
Literature: Kopf 2018, 935, fig. 4.

Carnuntum 4 - Bad Deutsch-Altenburg
Date: 1st century AD.
Context: Roman fort.
Description: right S-shaped fastener.
Location: Museum Carnuntium, Bad Deutsch-Altenburg, inv. 21901.
Literature: Beutler *et al.* 2017, 265-266 (cat. no. 346).

Carnuntum 5 - Bad Deutsch-Altenburg
Date: 1st century AD.
Context: Roman fort.
Description: right S-shaped fastener with central button.
Location: Museum Carnuntium, Bad Deutsch-Altenburg.
Literature: Beutler *et al.* 2017, 265-266 (cat. no. 347).

Carnuntum 6 - Bad Deutsch-Altenburg
Date: 1st century AD.
Context: Roman fort.
Description: right S-shaped fastener.
Location: Museum Carnuntium, Bad Deutsch-Altenburg, inv. 21326.
Literature: Beutler *et al.* 2017, 265-266 (cat. no. 348).

Magdalensberg 2
Date: end 1st century BC - 1st century AD.
Context: *oppidum* and Roman settlement.
Description: S-shaped fastener.
Location: inv. TB 1987/II/74.
Literature: Deschler-Erb 1999, 38; Dolenz 1998, 83.

BELGIUM

Unprovenanced from Belgium
Date: start 1st century AD.
Description: right S-shaped fastener.
Location: Grand Curtius, Liege.

CROATIA

Ivoševci - Burnum
Date: 1st half 1st century AD.
Context: Roman fort.
Description: right S-shaped fastener ending in a horned animal head. Almost no decoration, except for two horizontal lines at its base. Size c. 6x5 cm.
Material: copper alloy.
Location: Archaeological Museum, Burnum.
Literature: Miletić 2010, 147 (cat. no. 11).

Salona 2 - Tilurium
Date: 1st century AD.
Context: Roman fort?
Description: right S-shaped fastener.
Location: Arheoloski Muzej Split, inv. AMS H-658.
Literature: Ivčević 2013a, 305, 310, pl. 2.21 (cat. no. 21).

Salona 3 - Tilurium
Date: 1st century AD.
Context: Roman fort.
Description: damaged left S-shaped fastener.
Location: Arheoloski Muzej Split, inv. AMS H-219.
Literature: Ivčević 2013a, 305, 310, pl. 2.22 (cat. no. 22).

Salona 4 - Tilurium
Date: 1st century AD.
Context: Roman fort.
Description: left S-shaped fastener.
Location: Arheoloski Muzej Split, inv. AMS H-4053.
Literature: Ivčević 2013b, 436, 439, 445, fig. 4.3 (cat. no. 17); Sanader/Tonočinić 2010, 68 (cat. no. 26).

Sisak 5 *(fig. 3.14)*
Date: 1st century AD.
Description: left S-shaped fastener.
Remarks: examined by the author.
Location: Arheološki Muzej u Zagrebu, inv. 7445.
Literature: Radman-Livaja 2004, 77-79, 130, pl. 27 (cat. no. 130).

Sisak 6
Date: 1st century AD.
Description: left S-shaped.
Remarks: examined by the author.
Location: Arheološki Muzej u Zagrebu, inv. 7445.
Literature: Radman-Livaja 2004, 77-79, 130, pl. 27 (cat. no. 131).

Sisak 7
Date: 1st century AD.
Description: left S-shaped fastener.
Remarks: examined by the author.
Location: Arheološki Muzej u Zagrebu, inv. 7445.
Literature: Radman-Livaja 2004, 77-79, 130, pl. 27 (cat. no. 132).

DENMARK

Vimose 9 *(fig. 3.29)*
Date: C1b.
Context: bog.
Description: a pair of roundel-shaped fixtures that were inside a solid bundle of mail when excavated. The base is copper alloy and covered with gilded embossed silver sheet.
Inventory: circa 5.600 objects retrieved of which the majority concerned weapons.
Remarks: examined by the author.
Location: Nationalmuseet, Copenhagen, inv. 24224, 24225
Literature: Engelhardt 1869, 12, pl. 4.3; Ilkjær 2003, fig. 10; Pauli Jensen 2008, 217; Przybyła 2010, 158, fig. 47.4; Von Carnap-Bornheim/Ilkjær 1996, vol. 6, 302; Wijnhoven 2015b, 99, fig. 19.3-4.

FRANCE

Alésia 1 *(fig. 3.11c)*
Date: mid-1st century BC.
Context: *oppidum*.
Description: three buttons that may have come from mail coats. Also a possible damaged fastener.
Literature: Poux 2008, 350, fig. 34, Feugère/Poux 2001, 86; Hansen 2003, 43, 209, fig. 23.3.

Alésia 2
Date: mid-1st century BC.
Context: *oppidum* - trench of Caesar's siege.
Description: central button with the base of the fasteners still attached. Under the same inv. no. are two pieces of metal. Uncertain if the latter were part of a fastener.
Location: Musée des Antiquités Nationales, Saint-Germain-en-Laye, inv. 24374.
Literature: Duval/Lyon-Caen 1994, 273-274, 288, fig. 222-223.

Essey-lès-Nancy *(fig. 3.11a)*
Date: 1st century BC.
Context: *oppidum*.
Description: button possibly for a mail coat.
Location: Musée Lorrain, Nancy.
Literature: Dechezleprêtre 2008, 100-101, fig. 5.6; Poux 2008, fig. 34.

Paris - Rue P.-M. Curie
Date: Claudian.
Context: settlement (Lutetia).
Description: button of a mail coat.
Inventory: most objects found at this excavation are military.
Literature: Poux/Robin 2000, 204, fig. 15.1; Feugère/Poux 2001, 86.

GERMANY

Asberg 1 - Asciburgium
Date: Augustan - Vespasian.
Description: left S-shaped fastener with central button and washer still present.
Location: Kultur- und Stadthistorisches Museum

Duisberg.
Literature: Deschler-Erb 2012, 49, 110, pl. 6 (cat. no. B38).

Asberg 2 - Asciburgium
Date: Augustan - Vespasian.
Context: Roman fort.
Description: S-shaped fastener.
Location: Stadtarchäologie Duisburg, inv. A 79/174.
Literature: Deschler-Erb 2012, 49, 110 (cat. no. B39).

Asberg 3 - Asciburgium
Date: Augustan - Vespasian.
Context: *vicus*.
Description: right S-shaped fastener.
Location: Kultur- und Stadthistorisches Museum Duisberg, inv. 5155.
Literature: Bechert 1974, 92, fig. 68.1; Deschler-Erb *et al.* 1992, 140 (cat. no. 3.1); 2012, 49, 110-111, pl. 6 (cat. no. B40); Hansen 2003, 210 (cat. no. 9.15).

Burghöfe - Submuntorium
Date: 1st century AD.
Context: Roman fort.
Description: right S-shaped fastener.
Location: Archäologische Staatssammlung München, inv. 1983,1093.
Literature: Deschler-Erb 1996, 83; Franke 2009, 15, pl. 3.50 (cat. no. 50).

Dangstetten 4
Date: 15/12-8 BC.
Context: Roman fort.
Description: damaged left S-shaped fastener.
Inventory: bronze rod, iron band, iron clamp, iron hinge, wooden wedge, iron nails, hobnails, sherds of at least four vessels.
Literature: Beck/Chew 1991, 163, fig. 13.1; Descher-Erb *et al.* 140 (cat. no. 2.1); Fingerlin 1986, 56, 272, pl. 6 (cat. no. 149.1); Hansen 2003, 211 (cat. no. 9.41).

Dangstetten 5
Date: 15/12-8 BC.
Context: Roman fort.
Description: left S-shaped fastener.
Inventory: bronze strips, hobnails, two unidentified pieces of iron, sherds of at least six vessels.
Literature: Aurrecoechea 2010, 87; Deschler-Erb 1991, 140 (cat. no. 3.2); Fingerlin 1986, 70, 286 pl. 6 (cat. no. 180.1); Hansen 2003, 210 (cat. no. 9.20).

Dangstetten 6
Date: 15/12-8 BC.
Context: Roman fort.
Description: right S-shaped fastener.
Inventory: slither of bronze, bronze clump, iron nail, sherds from at least 12 vessels.
Literature: Beck/Chew 1991, 163, fig. 13.3; Descher-Erb *et al.* 140 (cat. no. 2.1); Fingerlin 1986, 77, 292, pl. 6 (cat. no. 203.1); Hansen 2003, 210 (cat. no. 9.20).

Dangstetten 7
Date: 15/12-8 BC.
Context: Roman fort.
Description: right S-shaped fastener with central concave-shaped button still present.
Inventory: iron (clothing) hook, decorative nail, fragment of scabbard fixture, sherds of at least two vessels.
Literature: Beck/Chew 1991, 163, fig. 13.5; Deschler-Erb 1991, 140 (cat. no. 3.2); Fingerlin 1986, 196, 428, pl. 6 (cat. no. 541.1); Hansen 2003, 210 (cat. no. 9.20).

Dangstetten 8
Date: 15/12-8 BC.
Context: Roman fort.
Description: left S-shaped fastener with central concave-shaped button and washer still present.
Inventory: bronze brooch, iron band, sherds of at least 13 vessels.
Literature: Bishop/Coulston 2006, fig. 51.4; Fingerlin 1998, 35, 221, pl. 1 (cat. no. 698.2); Hansen 2003, 210 (cat. no. 9.20).

Dangstetten 9
Date: 15/12-8 BC.
Context: Roman fort.
Description: left S-shaped fastener.
Inventory: part of a buckle, iron arrowhead, iron nails, sherds of at least eight vessels.
Literature: Fingerlin 1998, 60, 248, pl. 1 (cat. no. 802.1); Hansen 2003, 210 (cat. no. 9.20).

Dangstetten 10
Date: 15/12-8 BC.
Context: Roman fort - isolated find.
Description: left S-shaped fastener.

Literature: Fingerlin 1998, 101, 297 (cat. no. 945.1).

Dangstetten 11
Date: 15/12-8 BC.
Context: Roman fort.
Description: damaged left S-shaped fastener.
Inventory: bronze sheet, iron brooch, *pilum* ferrule, sheet of iron, sherds of at least six vessels.
Literature: Fingerlin 1998, 139, 342 (cat. no. 1095.1); Hansen 2003, 211 (cat. no. 9.41).

Dangstetten 12
Date: 15/12-8 BC.
Context: Roman fort.
Description: damaged right S-shaped fastener.
Inventory: two half bronze coins, two buckles, bronze disk, bronze sheet in shape of animal head, bronze rivet, bronze button, bronze toggle, bronze rod, bronze sheet, two finger rings, two plumb lines, iron handle, three decorative iron rivets, iron rivets, pilum ferrule, five bone writing implements, five small bone disks, iron spatula, band-like remains of lead sheet, ceramic lamp, sherds of at least 28 vessels.
Literature: Beck/Chew 1991, 163, fig. 13.2; Fingerlin 1998, 186, 395 (cat. no. 1337.6); Hansen 2003, 210 (cat. no. 9.20).

Haltern
Date: mid-Augustan.
Context: Roman fort.
Description: damaged right S-shaped fastener with central concave-shaped button still present.
Literature: Deschler-Erb 1991, 140 (cat. no. 3.3); Hansen 2003, 210 (cat. no. 9.13); Müller 2002, 37, 182, pl. 41 (cat. no. 452).

Hofheim
Date: late Tiberian - early Vespasian.
Description: damaged left S-shaped fastener.
Literature: Beck/Chew 1991, 164, fig. 13.6; Deschler-Erb 1991, 140 (cat. no. 3.4); Hansen 2003, 210 (cat. no. 9.17).

Kalkriese 3 *(fig. 3.3)*
Date: AD 9.
Context: battle site - section 12 west profile.
Description: set of S-shaped fasteners. One fastener has a graffito on its back: M. AII [cohort] I > [centuria] FAB[ricii]. The other fastener contains a graffito made by small punches: M. AIVS [cohort] I [centuria] FABRICI[i].
Location: Museum und Park Kalkriese, inv. 3147A-B.
Literature: Beck/Chew 1991, 42, 164, fig. 13.7a; Berger 1995, 152-154, fig. 3; Burandt 2019, fig. 6; Deschler-Erb 1996, 83; Haalebos 1994, 704; Hansen 2003, 210 (cat. no. 9.12); Harnecker 2008, 9-10, pl. 11 (cat. no. 114); 2011, 6; Müller 2003, 438; Rost/Wilbers-Rost 2010, 123, fig. 11.114; Travis/Travis 2011, fig. 35.

Kalkriese 4
Date: AD 9.
Context: battle site - section 23.
Description: fragment of a left S-shaped fastener.
Location: Museum und Park Kalkriese, inv. 17144.
Literature: Deschler-Erb 1991, 140; Franzius 1995, 76, fig. 7.2; Hansen 2003, 211 (cat. no. 9.40); Harnecker 2011, 26, pl. 8 (cat. no. 2138).

Kalkriese 5
Date: AD 9.
Context: battle site - section 19.
Description: right S-shaped fastener.
Location: Museum und Park Kalkriese, inv. 15096.
Literature: Berger 1995, 153; Deschler-Erb 1996, 83; Harnecker 2008, 10, pl. 11 (cat. no. 115); 2011, 6; Rost/Wilbers-Rost 2010, 123, fig. 11.115.

Kalkriese 6
Date: AD 9.
Context: battle site - section 7.
Description: central button with two partial fasteners still attached.
Location: Museum und Park Kalkriese, inv. 781.
Literature: Beck/Chew 1991, 164, fig. 13.7b; Harnecker 2008, 10, pl. 11 (cat. no. 116); 2011, 6; Rost/Wilbers-Rost 2010, 123, fig. 11.116; Travis/Travis 2011, fig. 35.

Kalkriese 7
Date: AD 9.
Context: battle site - section 20.
Description: possible button from a mail coat.
Location: Museum und Park Kalkriese, inv. 10602.
Literature: Harnecker 2008, 10, pl. 11 (cat. no. 117); Rost/Wilbers-Rost 2010, 123, fig. 11.117.

Kalkriese 8
Date: AD 9.
Context: battle site - section 36.
Description: damaged left S-shaped fastener.
Location: Museum und Park Kalkriese, inv. 29480.
Literature: Harnecker 2011, 6, pl. 8 (cat. no. 2137).

Neuss 1
Date: Augustan - Claudian.
Context: Roman fort - *principia*.
Description: left S-shaped fastener. The front has a graffito: >TERENTI ROMANI. The back another, possibly: >TERENTI. Over the latter are scratched letters, possibly reading: ATTIANI.
Location: Rheinisches Landesmuseum Bonn.
Literature: Beck/Chew 1991, 42, 164, fig. 13.8; Bishop/Coulston 2006, fig. 18.3; Descher-Erb 1991, 140, fig. 7.2 (cat. no. 2.2); 1999, 38; Dixon/Southern 1992, 38; Hansen 2003, 210 (cat. no. 9.16); Klein 1891, 37; Lehner 1904, 380, fig. 12-13; Stephenson/Dixon 2003, 44; Waurick 1982, 112, fig. 3; Zandstra 2019, 116-117.

Neuss 2
Date: Augustan - Claudian.
Context: Roman fort.
Description: left S-shaped fastener.
Location: find 5234.
Literature: Descher-Erb *et al*. 1991, 140 (cat. no. 3.5); Simpson 2000, 69, pl. 22 (cat. no. 22).

Neuss 3
Date: late 1st century BC - 1st century AD.
Context: Roman fort.
Description: damaged right S-shaped fastener.
Location: find 15517.
Literature: Simpson 2000, 69, pl. 22 (cat. no. 23).

Neuss 4
Date: late 1st century BC - 1st century AD.
Context: Roman fort.
Description: central button and washer with the base of a left S-shaped fastener present.
Location: find no. 2902c
Literature: Simpson 2000, 69, pl. 22 (cat. no. 24).

Oberaden
Date: late 1st century BC - 1st century AD.
Description: S-shaped fastener.
Literature: Fischer 2012, 326; 2019, 305; Muller 2002, 37.

Oberstimm
Date: *terminus post quem* Claudian
Context: Roman fort.
Description: damaged right S-shaped fastener.
Location: Stadtmuseum Ingolstadt.

Porta Westfalica-Barkhausen
Date: 12 BC-AD 16.
Context: Roman marching camp.
Description: damaged left S-shaped fastener.
Inventory: the camp rendered over 60 (Roman and Celtic) coins, field ovens, fragments of grain mills, three drinking cups, ceramic vessel for storing grain, three tent pegs, spear butt, numerous hobnails, at least ten brooches, pilum head, two spearheads.
Literature: Kröger/Best 2014, 8; Tremmel 2009, 46.

Rheinzabern
Date: Claudian - Flavian.
Context: *vicus* - area A.
Description: right S-shaped fastener.
Literature: Bernhard 1981, 135-136, fig. 9.3; Deschler-Erb 1991, 140 (cat. no. 3.6); Hansen 2003, 210 (cat. no. 9.18).

Schwarzenbach
Date: 1st century AD.
Description: right S-shaped fastener. On the front is a graffito: P LICINI RVTICI and P XIII.
Location: Rheinisches Landesmuseum Bonn.
Literature: Beck/Chew 1991, 42, 164, fig. 13.9; Deschler-Erb 1996, 83; Hansen 2003, 210 (cat. no. 9.19); Klein 1891, 36.

Thorsberg 29
Date: C1b.
Context: Bog.
Description: two ornate hinged fixtures used to regulate the opening for the head. Made from a copper alloy base-plate and covered in embossed silver sheet.
Material: copper alloy, silver.
Inventory: thousands of mainly military items.
Location: Staatliches Museum Schwerin, inv. F.S. 3674b (probably erroneous); Nationalmuseet, Copenhagen, inv. 1858 S. 321 F.S. 3675.

Literature: Engelhardt 1863, 29, pl. 6.4; 1866, 47, pl. 6.4; Matešić 2015, 140-142, 219, 518-519, pl. 108 (cat. no. M1174, M1175); Raddatz 1987, 61, pl. 97.1, 97.4 (cat. no. 409, 410); Voß 2008, fig. 4, 9; Wijnhoven 2015b, 96-97, fig. 17.

Thorsberg 30
Date: C1b.
Context: bog.
Description: roundel shaped fixture of unknown function. Made from a copper alloy base-plate and covered in embossed silver sheet.
Location: Nationalmuseet, Copenhagen, inv. 1858 S. 322 F.S. 3676.
Literature: Matešić 2015, 219, 519, pl. 108 (cat. no. M1176); Przybyła 2010, 152, fig. 46.8; Raddatz 1987, 61, pl. 97.3 (cat. no. 411); Wijnhoven 2015b, 99, fig. 19.1.

Thorsberg 31
Date: C1b.
Context: bog - find concentration 1860/III, dig N.
Description: two sets of fixtures, each consisting of two iron plates, used to regulate the opening for the head.
Inventory: one of the sets came from a closed context: mail armour (Thorsberg 10), copper base-plate with silver sheet, buckle.
Location: Nationalmuseet, Copenhagen, inv. 1860 S. 186; Staatliches Museum Schwerin, inv. F.S. 6234.
Literature: Engelhardt 1863, 29, pl. 6.5; 1866, 47, pl. 6.5; Matešić 2015, 219, 520, pl. 109 (cat. no. M1178, M1179); Przybyła 2010, 160-161, fig. 49.1-2; Raddatz 1987, 62, pl. 34.1-2 (cat. no. 413.2, 414); Von Carnap-Bornheim 2004, pl. 34.3-4; Wijnhoven 2015b, 98, fig. 18.1-4.

Xanten 4
Date: mid-Augustan - Claudian.
Context: settlement next to Roman fort.
Description: damaged left S-shaped fastener.
Location: LVR-Römermuseum Xanten, find 31196.
Literature: Hansen 2003, 210 (cat. no. 9.14); Lenz 2006, 20, pl. 18 (cat. no. 135).

Xanten 5
Date: Tiberian - Flavian.
Context: settlement next to Roman fort.
Description: damaged S-shaped fastener.
Location: LVR-Römermuseum Xanten, find 9907.
Literature: Deschler-Erb 1996, 83; Lenz 2006, 20, pl. 18 (cat. no. 136).

HUNGARY

Budapest - Aquincum-Víziváros
Date: AD 30-100.
Context: *vicus* - destroyed house.
Description: left S-shaped fastener.
Inventory: the site has rendered various items of militaria
Location: inv. 2001.5.5.
Literature: Kérdő *et al.* 2007, 2-3, fig. 13; Mráv 2012, 539, fig. 6.

LUXEMBOURG

Dalheim
Date: late 1st century BC - 1st century AD.
Description: S-shaped fastener.
Literature: Deschler-Erb 1996, 83; Hansen 2003, 210-211 (cat. no. 9.26).

Titelberg 2
Date: late 1st century BC - 1st century AD.
Context: *oppidum* - pit UF 49.
Description: concave shaped button that may come from a mail coat.
Location: Musée National d'Histoire et d'Art Luxembourg?, inv. 2002-78/730.
Literature: Metzler *et al.* 2016, 260, 635, fig. 470.3.

Titelberg 3
Date: 1st century BC - 1st century AD?
Context: *oppidum* - pit UF 250.
Description: flat button that may have come from a mail coat.
Location: Musée National d'Histoire et d'Art Luxembourg?, inv. 1997-70/1451.
Literature: Metzler *et al.* 2016, 260, 635, fig. 470.4.

MACEDONIA

Lake Ochrid
Date: 1st century AD.
Description: right S-shaped fastener. The reverse has a graffito: XII IV.

***Location**:* privately owned.
***Literature**:* www.roman-artifacts.com.

MOROCCO

Sidi Ali Ben Ahmed 2 - Thamusida
Date: 1st century AD?
Context: uncertain, possibly Roman fort or settlement.
Description: damaged right S-shaped fastener.
Location: Musée de Rabat, inv. Th. 1252.
Literature: Boube-Piccot 1994, 11, 56, pl. 62 (cat. no. 27); Deschler-Erb 1996, 83; Hansen 2003, 67, 211 (cat. no. 9.27); Rebuffat 1977, 232, pl. 93.

NETHERLANDS

Alphen aan den Rijn 4 - Albaniana
Date: AD 40-100.
Context: Roman fort.
Description: mail fastener.
Literature: Polak *et al.* 2004, 190.

Houten 1 - Veerwagenweg
Date: 1st century AD.
Context: settlement.
Description: fragment of a right S-shaped fastener.
Literature: Nicolay 2007, 21, 290, pl. 7 (cat. no. 137.1).

Nijmegen 6
Date: Augustan.
Context: Roman fort - stray find.
Description: damaged right S-shaped. The reverse has a graffito that is difficult to read, but may say: >MAN I.C.ANTONI.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 277.
Literature: Deschler-Erb 1991, 140 (cat. no. 2.5); Haalebos 1994, 705; 2002, 406, fig. 8; Van der Veen 2020, 47, fig. 22.7; Willems/Van Enckevort 2009, fig. 10; Zandstra 2019, 144-145.

Nijmegen 7 - Canisius College
Date: Flavian.
Context: *canabae*.
Description: set of S-shaped fasteners attached to a central button.
Location: Museum het Valkhof, Nijmegen, find no. 35-3945.
Literature: Bogaers/Haalebos 1992, 19, fig. 8.1; Burandt 2019, fig. 17; D'Amato/Sumner 2009, fig. 159 bottom; Deschler-Erb 1996, 83; Haalebos 1994, 705; Hansen 2003, 73, 211 (cat. no. 9.30); Van der Veen 2020, fig. 23.1.

Nijmegen 8 – exact find spot unknown
Date: 1st century AD.
Description: left S-shaped fastener.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, inv. XXI.d.89.
Literature: Deschler-Erb 1991, 140 (cat. no. 2.5); Zadoks-Josephus Jitta/Gerhartl-Witteveen 1983, 23 (cat. no. 239).

Nijmegen 9 - *castra* - Ubbergseveldweg
Date: Flavian.
Context: Roman fort.
Description: left S-shaped fastener.
Inventory: pottery.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 21-136.
Literature: Deschler-Erb 1991, 140 (cat. no. 3.8); Haalebos 1994, 704; Zadoks-Josephus Jitta/Gerhartl-Witteveen 1983, 23 (cat. no. 240).

Nijmegen 10 - Hees
Date: 1st century AD, possibly Flavian.
Context: cemetery.
Description: right S-shaped fastener.
Remarks: examined by the author.
Location: Rijksmuseum van Oudheden, Leiden, inv. e1908/4.22.
Literature: Deschler-Erb 1996, 83; Hansen 2003, 211 (cat. no. 9.31); Nicolay 2007, 21, 203-204, pl. 7 (cat. no. 204.1).

Nijmegen 11 - *castra* - Kloostertuin
Date: end 1st century BC - 1st century AD.
Context: Roman fort.
Description: damaged right S-shaped fastener.
Inventory: fragment of hybrid armour (Nijmegen 5).
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum

G.M. Kam, Nijmegen, find no. 1962-I-1962.834.2.
Literature: Van der Veen 2020, fig. 22.6.

Nijmegen 12 - Canisius College
Date: end 1st century BC - 1st century AD.
Context: Roman fort.
Description: damaged right S-shaped fastener.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 55-3-5748.
Literature: Van der Veen 2020, fig. 22.11.

Nijmegen 13 - Canisius College
Date: end 1st century BC - 1st century AD.
Context: Roman fort - stray find.
Description: slightly concave central button with the base of a left fastener attached.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 38-6-4285.

Nijmegen 14 – Canisius College
Date: end 1st century BC - 1st century AD.
Context: Roman fort - stray find.
Description: damaged left S-shaped fastener.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 40-4590.
Literature: Van der Veen 2020, fig. 22.2.

Nijmegen 15 - Canisius College
Date: end 1st century BC - 1st century AD.
Context: Roman fort - stray find.
Description: damaged left S-shaped fastener.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 43-4881.

Nijmegen 16 - *castra*
Date: end 1st century BC - 1st century AD.
Context: Roman fort.
Description: left S-shaped fastener.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 1961-Via-1961/459.
Literature: Van der Veen 2020, fig. 22.5.

Nijmegen 17 - *castra (fig. 3.14)*
Date: end 1st century BC - 1st century AD.
Context: Roman fort.
Description: damaged right S-shaped fastener. At the front there is a graffito with: >SVPERI.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 1961-VIIa-1961/535.
Literature: Van der Veen 2020, 47, fig. 23.4; Zandstra 2019, 145.

Nijmegen 18 - *castra*
Date: end 1st century BC - 1st century AD.
Context: Roman fort.
Description: three matching S-shaped fasteners with two central buttons still present.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 1963-IV-1963/1302.
Literature: Van der Veen 2020, fig. 22.1.

Nijmegen 19 - *castra*
Date: end 1st century BC - 1st century AD.
Context: Roman fort.
Description: right S-shaped fastener with a keyhole opening.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 1963-I-1963/1096.
Literature: Wijnhoven 2016a, 83, fig. 13.

Nijmegen 20 - *castra*
Date: end 1st century BC - 1st century AD.
Context: Roman fort.
Description: damaged right S-shaped fastener.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 1963-1213.
Literature: Van der Veen 2020, fig. 22.4.

Nijmegen 21 - *castra*
Date: end 1st century BC - 1st century AD.
Context: Roman fort.
Description: partial right S-shaped fastener.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 1963-1235.
Literature: Van der Veen 2020, fig. 22.9.

Nijmegen 22 - *castra*
Date: end 1st century BC - 1st century AD.
Context: Roman fort.
Description: damaged right S-shaped fastener.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 1959-I-1959/144.
Literature: Van der Veen 2020, fig. 22.8.

Nijmegen 23 - *castra (fig. 3.14)*
Date: end 1st century BC - 1st century AD.
Context: Roman fort.
Description: left S-shaped fastener with a central button present.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 1960-IIb-1960/273.
Literature: Van der Veen 2020, fig. 22.3.

Nijmegen 24 - *castra*
Date: end 1st century BC - 1st century AD.
Context: Roman fort.
Description: damaged right S-shaped fastener.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 1958-6-1958-181.
Literature: Van der Veen 2020, fig. 22.10.

Nijmegen 25
Date: end 1st century BC - 1st century AD.
Description: set of S-shaped fasteners with their central button still present.
Location: Museum Het Valkhof, Nijmegen.
Literature: D'Amato/Sumner 2009, fig. 159.

Nijmegen 26
Date: end 1st century BC - 1st century AD.
Description: left S-shaped fastener.
Location: Museum Het Valkhof, Nijmegen.
Literature: D'Amato/Sumner 2009, fig. 160.

Nijmegen 27
Date: end 1st century BC - 1st century AD.
Description: left S-shaped fastener.
Location: Museum Het Valkhof, Nijmegen, find no. 108/173.
Literature: D'Amato/Sumner 2009, fig. 160; Van der Veen 2020, fig. 23.5.

Nijmegen 28 - Kops Plateau *(fig. 5.2)*
Date: 10 BC-AD 70.
Context: Roman fort.
Description: central button with a right S-shaped fastener.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 452-1-2.
Literature: Wijnhoven 2019a, 6.

Nijmegen 29 - Kops Plateau *(fig. 5.2)*
Date: 10 BC-AD 70.
Context: Roman fort
Description: heavily corroded set of S-shaped fasteners.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 433-1-26.
Literature: Wijnhoven 2019a, 6.

Nijmegen 30 - Kops Plateau
Date: 10 BC-AD 70.
Context: Roman fort - stray find.
Description: damaged right S-shaped fastener.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 305-170.

Nijmegen 31 - Kops Plateau
Date: 10 BC-AD 70.
Context: Roman fort
Description: left S-shaped fastener.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 254-1-77.

Nijmegen 32 - Kops Plateau
Date: 10 BC - Tiberian.
Context: Roman fort.
Description: left S-shaped fastener.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 254-4-304-140.

Nijmegen 33 - Kops Plateau
Date: 10 BC-AD 70.
Context: Roman fort - stray find.
Description: damaged right S-shaped fastener with a keyhole opening.

Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 305-1-44.
Literature: Wijnhoven 2016a, 82-83, fig. 12.

Nijmegen 34 - Kops Plateau
Date: 10 BC-AD 70.
Context: Roman fort - top soil.
Description: central button with a left S-shaped fastener.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 325-1.

Nijmegen 35 - Kops Plateau
Date: 10 BC-AD 70.
Context: Roman fort.
Description: base of a left S-shaped fastener.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 357-1-73.

Nijmegen 36 - Kops Plateau
Date: 10 BC-AD 70.
Context: Roman fort.
Description: right S-shaped fastener.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 412-3-200.

Nijmegen 37 - Kops Plateau *(fig. 5.2)*
Date: 10 BC-AD 70.
Context: Roman fort.
Description: right S-shaped fastener.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 306-129.
Literature: Wijnhoven 2019a, 6.

Nijmegen 38 - Kops Plateau
Date: 10 BC-AD 70.
Context: Roman fort - stray find.
Description: central button and washer with a partial right S-shaped fastener.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 260-2-168.

Nijmegen 39 - Kops Plateau
Date: 10 BC-AD 70.
Context: Roman fort - stray find.
Description: lightly damaged right S-shaped fastener.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 467-3-31.

Nijmegen 40 - Kops Plateau
Date: 10 BC-AD 70.
Context: Roman fort.
Description: right S-shaped fastener.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find. no. 293-1-9.

Nijmegen 41 - Kops Plateau
Date: 10 BC-AD 70.
Context: Roman fort - stray find.
Description: central button with a partial left S-shaped fastener.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 0-97.

Nijmegen 42 - Kops Plateau
Date: 10 BC-AD 70.
Context: Roman fort - stray find.
Description: damaged right S-shaped fastener.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 255-257.

Nijmegen 43 - Kops Plateau
Date: 10 BC-AD 70.
Context: Roman fort - stray find.
Description: top part of a right S-shaped fastener.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 0-101.

Nijmegen 44 - Kops Plateau
Date: 10 BC-AD 70.
Context: Roman fort - stray find.
Description: right S-shaped fastener broken in two.
Remarks: examined by the author.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find no. 456-1.

Nijmegen 45 - Hunerberg (Tooropstraat)
Date: Augustan - Claudian.
Context: Roman fort.
Description: left S-shaped fastener. The central button including stud and washer are still in place.
Remarks: pers. comm. Roderick Geerts, 2019.

Nijmegen 46 - Hunerberg
Date: Augustan - Trajanic.
Description: right S-shaped fastener.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find. no. 1951/156.
Literature: Van der Veen 2020, fig. 23.2.

Nijmegen 47 - Hunerberg
Date: Augustan - Trajanic.
Description: partial right S-shaped fastener.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find. no. 1962/833.
Literature: Van der Veen 2020, fig. 23.3.

Nijmegen 48 - Hunerberg
Date: Augustan - Trajanic.
Description: damaged pair of S-shaped fasteners.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find. no. 1963/1300.
Literature: Van der Veen 2020, fig. 23.6.

Nijmegen 49 - Hunerberg
Date: Augustan - Trajanic.
Description: right S-shaped fastener with a keyhole opening.
Location: Gelders Archeologisch Centrum Museum G.M. Kam, Nijmegen, find. no. 1991/5281.
Literature: Van der Veen 2020, fig. 23.7.

Utrecht 2 – *castellum* De Meern
Date: AD 41-75.
Context: south of the Roman fort - project LR 58
Description: central button with a left S-shaped fastener.
Location: Museum Castellum Hoge Woerd, Utrecht.
Literature: pers. comm. Erik Graafstal, 2020.

Vechten 4 - Houtense Vlakte
Date: 1st century AD?
Description: damaged right S-shaped fastener.
Remarks: examined by the author.
Location: Rijksmuseum van Oudheden, Leiden, inv. VF 797.
Literature: Deschler-Erb 1996, 83; Hansen 2003, 211 (cat. no. 9.29).

Velsen
Date: AD 15-28.
Description: damaged left S-shaped fastener.
Location: Rijksmuseum van Oudheden, Leiden, inv. g2008/6.1989-5a.
Literature: Bosman 1997, 59; Deschler-Erb 1996, 83; Hansen 2003, 211 (cat. no. 9.28).

Zuid-Holland
Date: AD 40-100.
Description: left S-shaped fastener.
Location: Provinciaals Depot voor Bodemvondsten provincie Zuid-Holland, Alphen aan den Rijn.
Literature: Van Ginkel/Vos 2018, 135.

PORTUGAL

Moura - Castelo Velho do Degebe
Date: 1st half 1st century BC.
Context: fortified settlement.
Description: damaged object, which may be part of an S-shaped fastener, but could have had another function.
Location: inv. CVD113/5-7/6976.
Literature: Mataloto 2014, 373-374, fig. 15.4.

ROMANIA

Târgu Mureş
Date: probably 3rd century BC.
Description: bronze button with triskele motif.
Remarks: formerly interpreted as horse harness elements or fixtures for clothing. Designation to mail armour is uncertain, and based upon the similarity with the buttons from Ciumeşti.
Inventory: small bronze button with triskele motif, probably belonging to a helmet.
Location: Muzeul Judeţean Mureş.
Literature: Berecki 2010.

SERBIA

Sremska Rača 2 – Sirmium
Date: end 1st century BC - 1st century AD.
Context: stray find.
Description: right S-shaped fastener with a keyhole opening.
Location: Musej Srema, inv. A 906.
Literature: Wijnhoven 2016a, 83, fig. 13.

Sremska Rača 3 – Sirmium
Date: end 1st century BC - 1st century AD.
Context: stray find.
Description: button that may have belonged to mail armour.
Location: Musej Srema, inv. A 762.
Literature: pers. com. Miroslav Vujovic.

SLOVENIA

Ljubljana - Colonia Iulia Emona
Date: Augustan.
Context: *castra - insula* XXXII area.
Description: slightly damaged right S-shaped fastener.
Literature: Deschler-Erb 1996, 83; Gaspari 2010, 91, fig. 52a; Hansen 2003, 211 (cat. no. 9.36).

SPAIN

Herrera de Pisuerga
Date: probably Augustan.
Context: stray find.
Description: damaged right S-shaped fastener.
Location: Museo de Palencia.
Literature: Aurrecoechea 2010, 83; Fernández Ibáñez 2010, 103, fig. 2.1; 2015, 327-328.

Puente Castro
Date: AD 50-150.
Context: *vicus*?
Description: damaged right S-shaped fastener.
Literature: Aurrecoechea 2010, 87, fig. 2.3.

Rosinos de Vidriales - Petavonium
Date: Augustan.
Context: Roman fort.
Description: left S-shaped fastener.
Literature: Aurrecoechea 2010, 83, 87, fig. 3.1.

Santo Tomé
Date: c. 208 BC.
Context: battle field.
Description: S-shaped object of uncertain function, possibly a mail fastener.
Inventory: all type of military equipment (c. 6,000) that indicate a place of battle: lance- and arrowheads, hobnails, slingshot, brooches, spurs.
Literature: Rivera 2013.

SWITZERLAND

Augst 1 - Augusta Raurica
Date: Claudian.
Context: settlement.
Description: right S-shaped fastener.
Inventory: ceramics.
Location: Römermuseum Augst, inv. 1992.8.C09758.1.
Literature: Deschler-Erb 1996, 83; 1999, 38, 147, pl. 15 (cat. no. 269).

Augst 2 - Augusta Raurica
Date: AD 15-50.
Context: Roman fort.
Description: partial right S-shaped fastener.
Inventory: ceramic, coin.
Location: Römermuseum Augst, inv. 1979.7888.
Literature: Deschler-Erb 1991, 19-20, 59, 140 fig. 40 (cat. no. 20; 2.6); 1999, 38, 147, pl. 15 (cat. no. 270); Hansen 2003, 211 (cat. no. 9.33).

Oberwinterthur - Vitudurum
Date: Augustan - Tiberian.
Context: *vicus*.
Description: set of S-shaped fasteners with a central button.
Location: inv. FK 2337.
Literature: Deschler-Erb 1991, 140 (cat no. 3.9); 1996, 82-83, 288, pl. 21 (cat. no. ME 305); Hansen 2003, 211 (cat. no. 9.35).

Vindonissa 2 - Windisch
Date: AD 15-101.
Context: area of the Roman fort.

Description: left S-shaped fastener with an illegible graffito.
Location: inv. 73:388.
Literature: Unz/Deschler-Erb 1997, 32, pl. 35, 83 (cat. no. 858).

Vindonissa 3 - Windisch
Date: AD 15-101.
Context: area of the Roman fort.
Description: left S-shaped fastener.
Location: inv. 3647.
Literature: Unz/Deschler-Erb 1997, 32, pl. 35 (cat. no. 859).

Vindonissa 4 - Windisch
Date: AD 15-101.
Context: Roman fort.
Description: central button with a damaged left S-shaped fastener.
Location: inv. 62:5527.
Literature: Unz/Deschler-Erb 1997, 32, pl. 35 (cat. no. 860).

Vindonissa 5 - Windisch
Date: AD 15-101.
Context: exact findspot unknown.
Description: set of S-shaped fasteners with a central button.
Remarks: Windisch, purchase Schatzmann, 1915.
Location: inv. 25296.
Literature: Unz/Deschler-Erb 1997, 32, pl. 35 (cat. no. 861).

Vindonissa 6 - Windisch
Date: AD 15-101.
Context: exact findspot unknown.
Description: right S-shaped fastener.
Location: inv. 25297.
Literature: Unz/Deschler-Erb 1997, 32, pl. 35 (cat. no. 862).

Vindonissa 7 - Windisch
Date: AD 15-101.
Context: exact findspot unknown
Description: damaged right S-shaped fastener.
Literature: Unz/Deschler-Erb 1997, 32, pl. 35 (cat. no. 863).

Vindonissa 8 - Windisch
Date: AD 15-101.
Context: area of the Roman fort.
Description: partial left S-shaped fastener.
Location: inv. 66:950.
Literature: Unz/Deschler-Erb 1997, 32, pl. 35 (cat. no. 864).

Vindonissa 9 - Windisch
Date: AD 15-101.
Context: area of the Roman fort.
Description: damaged left S-shaped fastener.
Location: inv. 66:1966.
Literature: Unz/Deschler-Erb 1997, 32, pl. 35 (cat. no. 865).

Vindonissa 10 - Windisch
Date: AD 15-101.
Context: area of the Roman fort.
Description: damaged left S-shaped fastener.
Location: inv. 17:410.
Literature: Unz/Deschler-Erb 1997, 32, pl. 35 (cat. no. 866).

Vindonissa 11 - Windisch
Date: AD 15-101.
Context: area of the Roman fort.
Description: left S-shaped fastener.
Location: inv. 1494.
Literature: Unz/Deschler-Erb 1997, 32, pl. 35 (cat. no. 867).

Vindonissa 12 - Windisch
Date: AD 15-101.
Context: area of the Roman fort.
Description: partial left S-shaped fastener.
Location: inv. 35:5546.
Literature: Unz/Deschler-Erb 1997, 32, pl. 35 (cat. no. 868).

Vindonissa 13 - Windisch
Date: AD 15-101.
Context: area of the Roman fort.
Description: damaged left S-shaped fastener.
Location: inv. 36:526.
Literature: Unz/Deschler-Erb 1997, 32, pl. 35 (cat. no. 869).

Vindonissa 14 - Windisch
Date: AD 15-101.
Context: area of the Roman fort.
Description: right S-shaped fastener.
Location: inv. 35:1543.
Literature: Unz/Deschler-Erb 1997, 32, pl. 35 (cat. no. 870).

Vindonissa 15 - Windisch
Date: AD 15-101.
Context: area of the Roman fort.
Description: right S-shaped fastener.
Location: inv. 66:1855.
Literature: Unz/Deschler-Erb 1997, 32, pl. 35 (cat. no. 871).

Vindonissa 16 - Windisch
Date: AD 15-101.
Context: area of the Roman fort.
Description: fragment of an S-shaped fastener.
Location: inv. 61:2508.
Literature: Unz/Deschler-Erb 1997, 32, pl. 35 (cat. no. 872).

Vindonissa 17 - Windisch
Date: AD 15-101.
Context: area of the Roman fort.
Description: fragment of a left S-shaped fastener.
Location: inv. 62:753.
Literature: Unz/Deschler-Erb 1997, 32, pl. 35 (cat. no. 873).

Vindonissa 18 - Windisch
Date: AD 15-101.
Context: area of the Roman fort.
Description: partial left S-shaped fastener.
Location: inv. 62:3366
Literature: Unz/Deschler-Erb 1997, 32, pl. 35 (cat. no. 874).

Vindonissa 19 - Windisch
Date: AD 15-101.
Context: area of the Roman fort.
Description: damaged base of right S-shaped fastener.
Location: inv. 25:241.
Literature: Unz/Deschler-Erb 1997, 32, pl. 35 (cat. no. 875).

Vindonissa 20 - Windisch
Date: probably Claudian - early Flavian.
Context: Roman fort.
Description: base of a left S-shaped fastener.
Location: inv.V.003.1/6937.1.
Literature: Trumm/Flück 2013, 650, 996, pl. 57 (cat. no. Bm93).

Vindonissa 21 - Windisch
Date: AD 15-101.
Description: fastener.
Literature: Unz/Deschler-Erb 1997, 32.

SYRIA

Dura-Europos 52
Date: *terminus ante quem* mid-3rd century AD, probably 1st century AD.
Context: settlement and Roman garrison town - J7-W1.
Description: damaged left S-shaped fastener.
Remarks: now lost.
Literature: James 2004, 120 (cat. no. 414).

UNITED KINGDOM

near **Barnard Castle**
Date: probably 1st century AD.
Context: metal detector find.
Description: left S-shaped fastener.
Location: privately owned.
Literature: Aurrecoechea 2010, 87; Bishop 1989a, 11; Deschler-Erb 1991, 140 (cat. no. 1.1).

Camerton – Eighteen Acre Field
Date: 1st century AD.
Context: probably from Roman fort.
Description: S-shaped fastener.
Location: Bristol Museum, inv. F684.
Literature: Beck/Chew 1991, 164, fig. 14.12; Deschler-Erb 1991, 140 (cat. no. 1.7); Fernández Ibáñez 2010, 103; Fox 1958, 130-131, pl. 75d; Hansen 2003, 210, fig. 24.7 (cat. no. 9.10); Spratling 1981, 15.

Chester 5
Date: Flavian.
Description: damaged S-shaped fastener.
Literature: Aurrecoechea 2010, 87; Bishop 1989a, 11;

Deschler-Erb 1991, 140 (cat. no. 1.2); Hansen 2003, 210 (cat. no. 9.7).

Colchester 4 – Camulodunum
Date: AD 54-61.
Context: industrial site next to the Roman fort - site iii, layer 4.
Description: right S-shaped fastener.
Inventory: coarse pottery, Gallo-Belgic wares, *amphorae*, two coins, copper alloy stud, needle, hinge, iron bar, small iron and copper fragments, lead fragment, slag, fragments of Roman tile.
Literature: Deschler-Erb 1996, 83; Hansen 2003, 210 (cat. no. 9.23); Niblett 1985, 34, 115, fig. 63.22, pl. 12; Robinson 1975, 164.

Colchester 5 – Camulodunum
Date: AD 54-61.
Context: industrial site next to Roman fort - rubbish pit.
Description: right S-shaped fastener.
Inventory: coarse pottery, Gallo-Belgic wares, *amphorae*, *terra sigillata*, glass fragments, coin, fragments of domestic and military equipment: iron fitting, chisel, ferrule, fragment of *lorica segmentata*, fragment of mail (Colchester 3), more than 80 iron and copper fragments, casting sprue, slag, fragments of crucibles, fragment of pellet of Egyptian blue, small pieces of sandstone, lamp fragment, fragments of burnt daub which could be a kiln or furnace.
Literature: Bishop/Coulston 2006, fig. 51.5; Deschler-Erb 1991, 140 (cat. no. 3.7); Hansen 2003, 210 (cat. no. 9.24); Niblett 1985, 36, 115, fig. 65.44, pl. 12.

Colchester 6 - Camulodunum - Culver Street
Date: AD 44-49.
Context: Roman fort.
Description: set of S-shaped fasteners with a central button.
Literature: Crummy 1987, 8; Crummy *et al.* 1992, 189, fig. 5.54 (cat. no. 1687); Deschler-Erb 1999, 38.

Ham Hill
Date: mid-1st century AD.
Context: Roman fort.
Description: right S-shaped fastener with a keyhole opening.
Location: Museum of Somerset, Taunton.
Literature: Fernández Reyes 2014, 114, 388, 453 (cat. no. HamHA1323a).

Hod Hill
Date: Claudian.
Context: Roman fort
Description: damaged right S-shaped fastener.
Location: British Museum, London?, inv. 92 9-1 543.
Literature: Beck/Chew 1991, 164, fig. 14.13; Brailsford 1962, 16, pl. 11 (cat. no. I37); Deschler-Erb 1996, 83; Hansen 2003, 211 (cat. no. 9.44); Spratling 1981, 15.

Kingsholm
Date: 1st century AD?
Description: S-shaped fastener.
Literature: Deschler-Erb 1996, 83; Hansen 2003, 211 (cat. no. 9.43).

London - Tooley Street
Date: 1st half 1st century AD.
Description: left S-shaped fastener with a central button.
Remarks: examined by the author.
Location: British Museum, London, inv. 1905,1106.6.
Literature: Beck/Chew 1991, 164, fig. 14.14; Deschler-Erb 1991, 140 (cat. no. 1.5); Fox 1958, 130, pl. 75b; Hansen 2003, 210 (cat. no. 9.9); Spratling 1981, 15.

Longthorpe
Date: Claudian.
Context: Roman fort.
Description: set of S-shaped fasteners.
Literature: Aurrecoechea 2010, 87; Beck/Chew 1991, 164, fig. 14.15; Bishop 1989b, 11; 1989b, 21-23; Bishop/Coulston 2006, fig. 51.3; Deschler-Erb *et al.* 1991, 140, fig. 7.1 (cat. no. 1.3); Frere/Joseph 19974, 59-60, fig. 31 (cat. no. 66a-b); Hansen 2003, 210 (cat. no. 9.8); Spratling 1981, 15.

The Lunt, Baginton 2
Date: Neronian.
Context: Roman fort - pit 74.
Description: right S-shaped fastener.
Location: Herbert Art Gallery and Museum, Coventry?
Literature: Beck/Chew 1991, 164, fig. 14.10; Descher-Erb *et al.* 1991, 140 (cat. no. 2.3); Fernández Ibáñez 2010, 103; Hansen 2003, 210 (cat. no. 9.21); Hobley

1973, 69, fig. 20.4; Spratling 1981, 15; Stephenson 2006, fig. 47.

Polden Hill
Date: AD 40-70.
Context: hoard.
Description: three copper alloy S-shaped fasteners (one set and one right fastener) with traces of gilding.
Inventory: terrets, bridle bits, enamelled horse trappings, shield bosses, brooches, bracelets.
Remarks: examined by the author.
Location: British Museum, London, inv. 1846,0322.109, 1846,0322.110, 1846,0322.111.
Literature: Beck/Chew 1991, 164, fig. 14.16; Brailsford 1975, 230, fig. 6j; Deschler-Erb 1991, 140 (cat. no. 1.4); Fox 1958, 130, pl. 75c; Hansen 2003, 210 (cat. no. 9.11); Spratling 1981, 15.

Unprovenanced from England 1 - possibly South England or Brough-under-Stainmore
Date: 1st century AD.
Description: left S-shaped fastener.
Location: British Museum, London.
Literature: Beck/Chew 1991, 164, fig. 14.11; Deschler-Erb 1991, 140 (cat. no. 1.6); Fox 1958, 130, pl. 75a (South England); Hansen 2003, 210, fig. 24.7 (cat. no. 9.6); Spratling 1981, 15 (Brough-under-Stainmore).

Usk 11 - Detention Centre Site *(fig. 3.14)*
Date: Neronian.
Context: Roman fort - pit.
Description: left S-shaped fastener.
Remarks: examined by the author.
Location: National Museum of Wales, inv. 82.10H.
Literature: Beck/Chew 1991, 164; Chapman 2005, 89; Deschler-Erb 1991, 140 (cat. no. 2.4); 1996, 83; Hansen 2003, 210 (cat. no. 9.22); Manning *et al.* 1995, 17-18, fig. 4; Spratling 1981, 15; Travis/Travis 2011, fig. 34.

UNPROVENANCED

Unprovenanced 6
Date: end 1st century BC - 1st century AD.
Description: left S-shaped fastener.
Location: privately owned.
Literature: Appels/Laycock 2007, 61, fig. AA6.48.

Unprovenanced 7
Date: end 1st century BC - 1st century AD.
Description: right S-shaped fastener.
Location: privately owned.
Literature: Appels/Laycock 2007, 62, fig. AA6.49.

Unprovenanced 8
Date: end 1st century BC - 1st century AD.
Description: left S-shaped fastener.
Location: privately owned.
Literature: Appels/Laycock 2007, 62, fig. AA6.50.

Unprovenanced 9
Date: end 1st century BC - 1st century AD.
Description: left S-shaped fastener with a keyhole opening.
Location: privately owned.
Literature: Fischer 2012, 165, fig. 204; 2019, 127, fig. 204; Wijnhoven 2016a, 83.

Unprovenanced 10 - lower Danube**:** Romania or Bulgaria
Date: probably 3rd century BC.
Description: bronze button with triskele motif of three stylised bird-like creatures in the plastic La Tène style. The function of the button is uncertain, but may have been associated with a mail coat.
Location: privately owned.
Literature: Müller 2011.

APPENDIX 4. FINDS EXCLUDED FROM THE DATABASE

Not all finds described as (fasteners or fixtures for) mail in the literature have been included in the database. The omitted artefacts are listed below, together with the reason why they are left out.

AUSTRIA

Oberleisterberg
Remarks: its shape makes it unlikely to have functioned as a fastener.
Literature: Karwowski 2014.

BULGARIA

Brunichevo
Remarks: this is probably scale armour.
Literature: Torbov 2004, 60, 61.

Bryastovetz
Remarks: this is probably scale armour.
Literature: Moralejo Ordax 2011, 293-294; Torbov 2004, 65.

Jankovo
Remarks: this is probably scale armour.
Literature: Hansen 2003, 61; Rusu 1969, 289; Torbov 2004, 60, 61; Van der Sanden 1993, 4 (cat. no. 2).

Kjolmen
Remarks: this is probably scale armour.
Literature: Torbov 2004, 60, 61.

DENMARK

Hjortspring *(fig. 2.10)*
Remarks: the iron rings are the result of podzolic precipitation and are not mail armour.
Literature: Bruce-Mitford 1978, 237; Dedyulkin/Shevchenko 2017, 51; Ehlton 2002/2003, 7; Fabian 2018, 39; Fredman 1992, 6, 29; Gilmour 1997, 32-33; 1999, 164; Hansen 2003, 63-65, 68, 161 (cat. no. B2); Jouttijärvi 1996, 53; Juncher 2016, 95, 99-100; Kaul 2003a, 153-154; 2003b, 217; Madsen 1997, 85; Malfilâtre 1993, 2; Müller 2003, 434, 436; Nicklasson 1989, 26, 29; 1991, 21; Novichenkova 2011, 277-278; Pauli Jensen *et al.* 2003, 316; Piggott 1955, 11, 38; Quesada Sanz/Rueda Galán 2017, 33-34; Quesada Sanz *et al.* 2019, 159; Randsborg 1995, 26-28; Rosenberg 1937, 47-48; Rustoiu 2006, 49-50, 52; Stead 1991, 56; Van der Sanden 1993, 4 (cat. no. 7); 2003/2004, 370, 372; Völling 1998, 562; Waurick 1979, 323, 326 (cat. no. 6); Wijnhoven 2014, 13.

Nydam
Remarks: no mail armour has been found at Nydam. These mail rings must be from another location.
Literature: Sim 1997, 360, 362-365; Sim/Kaminski 2012, 114, 117, 124-125, 127-128, 134, fig. 80, 88.

Vils Høj
Remarks: this mail coif has been assigned to the Roman Iron Age. Examination by the author leads to conclude that it is probably modern, because: 1) the current condition of the coif is unlike that found usually in archaeological mail; 2) the wire diameter is so consistent that it coincides with modern wire; 3) the object is entirely made from butted rings.
Literature: Burmeister/Derks 2009, 77; Fredman 1992, 10; Juncher 2016, 99; Nicklasson 1989, 30-31.

GERMANY

Bingerbrück
Remarks: the ring characteristics point to the Late Middle Ages or Early Modern period.
Literature: Blell-Tüngen 1877, 416-417; Hansen 2003, 166 (cat. no. C6); Kelly 1931, 269; 1934, 206; Matešić 2015, 214-215, 218; Rose 1906, 7.

Dangstetten 13
Remarks: this is probably not a fastener, but some sort of hook.
Literature: Beck/Chew 1991, 39, fig. 13. 4; Deschler-Erb 1991, 140 (cat. no. 3.2); Fingerlin 1986, 130, 349, pl. 6 (cat. no. 360.5); Hansen 2003, 75.

Thorsberg 32
Remarks: the two decorated roundels do not belong to a mail coat, but are probably part of a horse harness.

Literature: Blankenfeldt 2015, 253-265, 269-270, 274-277, 427-428, pl. 52-55 (cat. no. PA 456, PA 457); Engelhardt 1863, 27-29, pl. 6.1, 7.7; 1866, 46-47, pl. 6.1, 7.7; Matešić 2015, 220-222; Montelius 1888, 110, fig. 116; Raddatz 1987, 60, 63, fig. 27, pl. 95, 99 (cat. no. 407.2, 423); Rusu 1969, 289; Von Carnap-Bornheim 1997; Werner 194.

LUXEMBOURG

Titelberg 4
Remarks: uncertain that this is a mail fastener.
Literature: Metzler *et al.* 2016, 260, 635, fig. 470.2.

NETHERLANDS

Houten 2
Remarks: the ring characteristics point to the Late Middle Ages or Early Modern period.
Literature: Matešić 2015, 214, 218; Nicolay 2007, 21-22, pl. 7 (cat. no. 123.2).

Alphen aan den Rijn 5 (Albaniana)
Remarks: this is a hook of unknown function and unlikely to have been associated to mail armour.
Literature: Hagedoorn 2013, 56, fig. 3.85.

ROMANIA

Răcătău
Remarks: probably the same find as that from Răcătău de Jos, which is included in the database.
Literature: Hansen 2003, 61-62, 69, 163 (cat. no. B17).

Unprovenanced from Romania 1
Remarks: the provenance of this mail coat is uncertain, but its condition and overall appearance points to the Late Middle Ages or Early Modern period.
Literature: Borangic 2011a, 190-191, 226 (cat. no. 18).

RUSSIA

Guljaj Gorod *(fig. 2.8)*
Remarks: this is scale armour and not mail.
Literature: Minns 1913, 175, fig. 70.

SPAIN

Numantia
Remarks: this probably concerns pieces of chain and not mail armour, because: 1) the metal used (i.e. bronze); 2) the cross-section of the rings is square; 3) the rings are butted.
Literature: Aurrecoechea 2010, 87; Bishop/Coulston 2006, 63; Hansen 2003, 59-60, 165 (cat. no. 32, 33); Kelly 1931, 269; 1934, 206; Luik 2002, 73, fig. 78.43, 170.41-43; 2010, 65, fig. 1.2-5; Novichenkova 2011, 279; Quesada Sanz/Rueda Galán 2017, 34; Quesada Sanz *et al.* 2019, 157; Waurick 1979, 322, 326 (cat. no. 2).

UNITED KINGDOM

Birdoswald 2
Remarks: this is probably a curb bit for a horse, not a fastener.
Literature: Wilmott 1997, 201, 310, 359, fig. 227 (cat. no. 258).

Caerleon 10 - Prysg Field
Remarks: the ring characteristics point to the Late Middle Ages or Early Modern period.
Literature: Chapman 2004, 88 (cat. no. Mb01); Hansen 2003, 170-171 (cat. no. C46); Travis/Travis 2011, fig. 36.

Caerleon 11 - amphitheatre
Remarks: the ring characteristics point to the Late Middle Ages or Early Modern period.
Literature: Chapman 2004, 88 (cat. no. Mb02).

Caerleon 12 - British Telecom Site
Remarks: examination by the author showed that this is probably a piece of chain.
Literature: Chapman 2004, 88 (cat. no. Mb05).

Lydney
Remarks: although woven in a 4-in-1 pattern, this is probably not mail armour. The butted copper alloy rings belong to a circular sheet of bronze. The rings and sheet are thought to have been part of a ceremonial head-dress.
Literature: Hansen 2003, 53, 171 (cat. no. C47); Matešić 2015, 218; Wheeler/Wheeler 1932, 91, pl. 30b.

UNPROVENANCED

Unprovenanced 11
Remarks: this is probably a curb bit for a horse, not a fastener.
Literature: Fischer 2012, fig. 204; 2019, fig. 204.

Amsterdam Archaeological Studies is a peer reviewed series devoted to the study of human societies from prehistory to modern times, primarily through the study of archaeological remains. The series includes excavation reports from modern fieldwork; studies of various categories of material culture; and synthetic studies offering a broader view of societies in the past, thereby contributing to theoretical and methodological debates within archaeology.

Amsterdam University Press

Mail armour (commonly mislabelled 'chainmail') was used for more than two millennia on the battlefield. After its invention in the Iron Age, mail rapidly spread all over Europe and beyond. The Roman army, keen on new military technology, soon adopted mail armour and used it successfully for centuries. Its history did not stop there and mail played a vital role in warfare during the Middle Ages up to the Early Modern Period.

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Given its long history, one would think mail is a well-documented material, but that is not the case. For the first time, this books lays a solid foundation for the understanding of mail armour and its context through time. It applies a long-term multi-dimensional approach to extract a wealth of as yet untapped information from archaeological, iconographic and written sources. This is complemented with technical insights on the mail maker's *chaîne opératoire*.

Martijn A. Wijnhoven holds a PhD in archaeology from Vrije Universiteit Amsterdam. He specializes in ancient military studies and has published extensively on the analysis and reconstruction of ancient armour spanning from the Iron Age to the Middle Ages. His research combines methods from history, anthropology, and archaeology, rendering a holistic approach to material studies.

'Mail has been something of a Cinderella in the field of early martial equipment. Now, in this meticulous study, Wijnhoven has demonstrated and explored the extensive potential of the archaeological, iconographic and textual evidence. It makes a fundamental contribution to the study of ancient martial material culture, and has broader implications for the development and structuring of early European ironworking traditions.'

Prof. Simon James, University of Leicester

'Mail armour has been largely neglected by specialist literature, despite the important role that it played in Antiquity. This book fills in that research gap in an impressive manner. Not only does Wijnhoven pose the hardest questions about mail armour, but he also provides very satisfactory answers.'

Prof. Thomas Fischer, Universität zu Köln

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