Clockwise or Anti-clockwise? A Method for Distinguishing Roman from Medieval Mail Armour

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Abstract

Seemingly insignificant details in material culture can be highly informative, especially when studied from a long-term perspective. The direction in the overlap of riveted mail rings is one such detail. This feature can determine whether mail armour is Roman or Medieval. Roman mail has riveted rings with a clockwise overlap, while Medieval mail is invariably anti-clockwise. In addition, the direction of the overlap, together with the type of rings used in a mail coat, confirms the existence of an autonomous mail production in the Barbaricum, beyond the Roman Empire.

Workshop Traditions

At first glance, the rings on a coat of mail may look the same across any period or region, but on closer inspection it becomes clear that there are minute, unique differences among them. Some of these observed variations in ring characteristics can actually point to specific periods or provenance.[1] This may prove very useful, as many mail armour specimens lack archaeological (or historical) context, hindering our understanding of these artefacts.

The main mechanism underlying the observed differences is the way in which the mail maker approached his work. As any craftsperson can attest, there are several ways of making an artefact. The steps in the making process, the choices of manufacture, and the tools of production will all affect the final product. This is partly a mixture of conscious decision-making and creativity. However, most human decisions are subconscious,[2] and in the case of a craftsperson, these are often based on previous experience, particularly on how their craft was learned. That is, certain steps or tools are used simply because the craftsman as a pupil was taught to proceed in this manner. Individuality can come into play, especially whenever non-standardised items challenge the creativity and ability of the craftsperson. This applies much less to mail making, which is a highly repetitive task involving a predetermined set of steps and tools which are applied tens or hundreds of thousands of times to single garment, and many millions of times during a working lifetime.

Small variances in the *chaîne opératoire* of mail making and the tools used produce rings with slightly different characteristics. Because the production of mail was probably taught from a master craftsman to apprentice over many generations, it should be possible to recognise workshop traditions. This does not mean that we can identify

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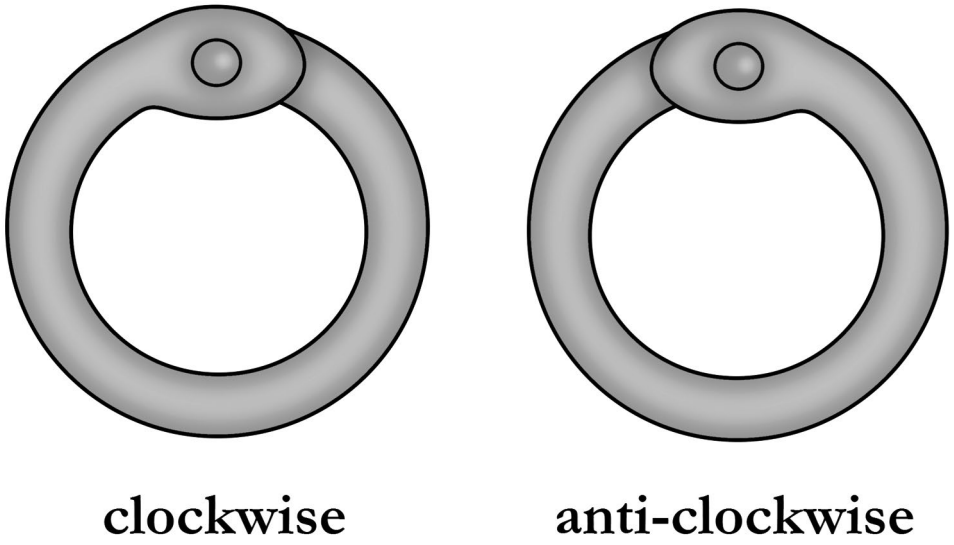

Fig. 1: The overlap of riveted rings can be positioned clockwise or anti-clockwise.

objects from a specific workshop, but that it may be possible to trace some styles of mail production to certain periods or regions.

When analysed from a comparative long-term perspective, the variations mentioned above can be highly informative. In this paper, I examine the available evidence from the invention of mail, around 300 BC, to the Middle Ages, circa AD 1000. Although the primary focus is on the first millennium AD, later mail will also be discussed.

Ring Types and Direction of the Overlap

Most of the mail coats from the period of interest are constructed out of a combination of two ring types arranged in alternating rows. The first type are the riveted rings, made from a small piece of metal wire, shaped into a circle with overlapping ends, and closed by a rivet. The second type are the solid rings, and as their name suggests, cannot be opened or closed and resemble metal washers. Although there are some examples of mail made entirely from riveted rings, for evident reasons there are none made solely of solid rings which cannot be interlaced.

The overlap in riveted rings can go in two directions, clockwise or anti-clockwise (fig. 1). There is no advantage whatsoever of one direction over the other, nor does it have any effect on the strength or construction of the final product. Hypothetically, a single coat of mail could be constructed from a combination of clockwise and anti-clockwise rings; however, that is never the case. All the rings in a single coat of mail always overlap in the same direction. Considering that one garment contains between 10,000 and 350,000 rings, this is hardly coincidental.

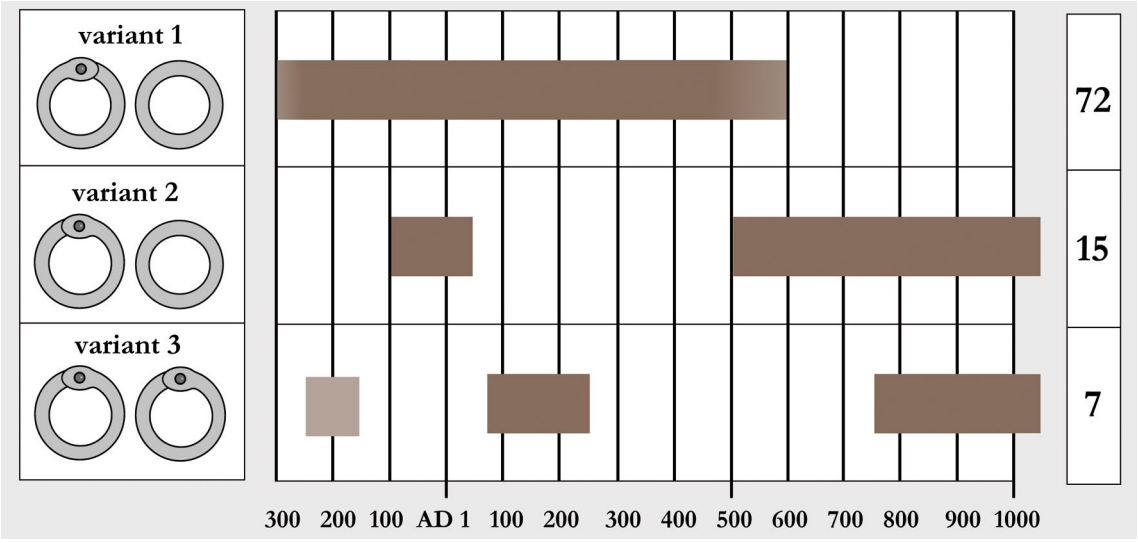

Fig. 2: Occurrence of the three observed mail variants through time. The number of finds of each variant is also shown.

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. As discussed below, these features allow us to: 1) distinguish Roman from Medieval mail; and 2) confirm the presence of an autonomous mail production beyond Rome's borders, in the so-called Barbaricum.

Available Data

The present information on ring types and the direction of the ring overlap has been gathered through the direct examination of mail artefacts by the author, complemented by a systematic review of the available literature. In total, I was able to record these features in 94 samples dating from the 3rd century BC to the 10th century AD.[3] Considering the importance and prevalence of mail armour on the battlefield during such a long period, this number may seem relatively low. In part, this is due to conservation (i.e. many finds are so corroded that the ring properties can no longer be observed), and in part because good descriptions and photographs of mail artefacts are often missing in the literature. Furthermore, the direction of the ring overlap has never been deemed important enough to be reported in publications and is generally absent in descriptions of mail.

The following variants were observed among the 94 examined specimens of mail:

- 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.

Fig. 3: Left: mail from Fluitenberg in the Netherlands (300–115 BC) made with solid and clockwise riveted rings. The rivets protrude several millimetres from the overlap. Right: fragment of mail from Piquía in Spain (100–50 BC) with solid and anti-clockwise riveted rings.

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=72) belongs to variant 1. Variants 2 and 3 are less common for the period under study, with 15 and 7 examples respectively. Figure 2 plots a timeline for each of the three variants. The finds are not evenly distributed over time, with most of them (72%) dating between the 1st and 5th centuries AD. Only a small part of the finds are from before (12%) or after (16%) that period.

3rd to 1st Century BC

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=8) between the 3rd and 1st centuries BC, although not the only one (fig. 3). During the 1st century BC, variant 2, consisting of solid and anti-clockwise riveted rings, is observed three times (at Radovanu in Romania, Piquía in Spain and Hedegård in Denmark).[4] Variant 3 is only observed a single time and remains uncertain as it concerns a fragment of mail without provenance that was attached to a Medieval helmet in the Veliko Tarnovo Museum of Archaeology, in Bulgaria.[5] It is clear that the helmet and mail do not belong together, but how they came to be associated is still unknown. The mail fragment has several fixtures attached to it, including a wheel-shaped fastener. Based on an iconographic analogy of this type of fastener, the mail has been tentatively dated to 250–150 BC.

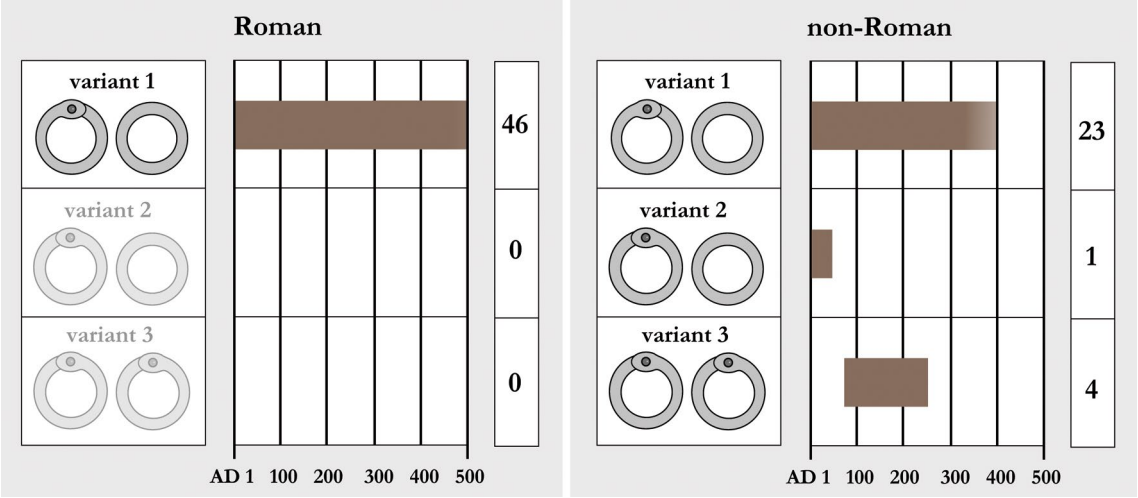

Fig. 4: Occurrence of the three mail variants observed during the 1st to 5th century AD in Roman (left) and non-Roman (right) contexts.

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 there was room for other traditions. The occurrence of all three variants may point to moderate standardisation in the mail making tradition at this point.

1st to 5th Century AD – Roman and non-Roman

Roman mail diverges from the pattern of the previous centuries (fig. 2 & 4). There is absolutely no variation among the 46 Roman specimens, all corresponding to variant 1, made from solid and clockwise riveted rings (fig. 5 left). 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 *certainly is not* Roman. The fact that that only variant 1 is found in the Roman Empire further attests to a high(er) level of standardisation as compared to the centuries BC.

There are a significant number of finds (n=28) from the same period that come from beyond Rome's borders. Unfortunately, the non-Roman finds from the 5th century AD 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 was only found in the find from Hedegård in Denmark already mentioned above and dated to 50 BC – AD 50.

Fig. 5: Left: Roman mail always consists of solid and clockwise riveted rings: an example comes from Künzing 2 in Germany, dated to AD 200–244. Right: mail fragment from Thorsberg 14 in northern Germany (AD 200–250) made entirely of anti-clockwise riveted rings.

More revealing is the presence of 4 objects displaying variant 3, made completely of anti-clockwise rings, without any solid rings (fig. 5 right). The earliest of them, dated to AD 70–260, comes from a grave at Gränby in Sweden and was deposited along with a shield boss and two swords.[6] The other three come from a bog deposit at Thorsberg in northern Germany, and date to AD 200–250.[7] Many of the thousands of military items deposited there were purposely destroyed,[8] and it is possible that these three fragments actually originated from the same garment.

The provenance of mail in the Barbaricum has been widely discussed. It has frequently been attributed to Roman production, and its presence beyond the Empire's borders has been explained as cases of war booty (notably during the Marcomannic Wars), trade, or gift exchange.[9] However, the occurrence of variant 3 in northern Germany and Sweden suggests that contrary to these ideas, the Barbaricum had its own workshop tradition, different from the Roman. This discovery provides the first solid evidence for an autonomous regional mail production in northern Europe. This does not mean that Roman mail was not found in the Barbaricum, but that there was a distinctively local production of mail as well. Neither does it mean that all examples of variant 1 beyond Rome's borders are Roman imports. As discussed in the previous section, the workshop tradition of variant 1 was already present during the Iron Age outside the territory of Roman Empire.

Fig. 6: Mail from the 6th century AD onwards has anti-clockwise riveted rings, whatever its origin. Left: close-up of a 15th century German coat of mail (inv. no. 29.156.68), made entirely from riveted rings. Right: close-up of a Turkish or Syrian mail coat probably from the early 16th century (inv. no. 14.99.28). This shirt is made of riveted and solid rings, each of them decorated with a concentric pattern.

6th to 10th Century AD, and beyond

Entering the Middle Ages, there is a radical change in the direction of the ring overlap in mail armour (fig. 2). Whereas the clockwise direction had been dominant up to that moment, suddenly all mail turned anti-clockwise. After this moment there is not a single find of variant 1, which had lain at the heart of the Roman mail making tradition. The latest possible occurrences of variant 1 are two mail neck guards, one attached to a Spangenhelm from Vézeronce in France, and another associated with an unprovenanced banded helmet from Egypt.[10] The helmet from Vézeronce is an isolated find that holds no clues to its age, but Spangenhelms 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 centuries 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. However, there

are currently not enough finds from the 4th to 7th centuries, from either within or outside the Roman Empire, to solidly test this idea. Especially lacking are finds from the Eastern Roman Empire dated to this period. If correct, one would expect variant 1 to have persisted at least somewhat longer in Byzantium. The mentioned mail guard from the Vézeronce helmet may have been made in Byzantium; indeed a substantial part of surviving Spangenhelms is assumed to have been produced by Byzantine workshops.[11] It, and the unprovenanced helmet from Egypt do indeed hint at the possibility that variant 1 survived longer in Byzantium, but their ages and origins are not clear enough to support a final conclusion.

Although this study only looked at the material evidence up to the 10th century AD in detail, something can also be said about the following 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. 6). This applies not only to European mail but is a worldwide pattern, seen also in Asia (Minor) and Northern Africa.[12] Given that the same is observed in mail from the 6th to 10th centuries, it is fair to assume that the overlap in riveted rings has invariably been anti-clockwise since the 6th century AD, up to the demise of mail in the modern period. 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.

The Reason for the Consistency

It remains to be answered why mail makers chose to consistently place the overlap of riveted rings in the same direction. This was not the decision of every single person who worked on a coat, but of generations of mail makers, allowing us to distinguish various traditions.

The answer must be sought in the *modus operandi* of the mail maker. The ring overlap must have been such an integral step to the mail-making process that, without thought, it always led to the same 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.[13] He suggested that the individual rings were driven through a tapering hole in a steel block using a punch whose head was shaped so to facilitate the ends of the ring to 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. The rings can be overlapped simply by placing them vertically on a 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 round.

The only factor that actually compels the direction of the overlap is the direction, in which the metal wire is coiled. When the coil is cut into loose rings, one can see

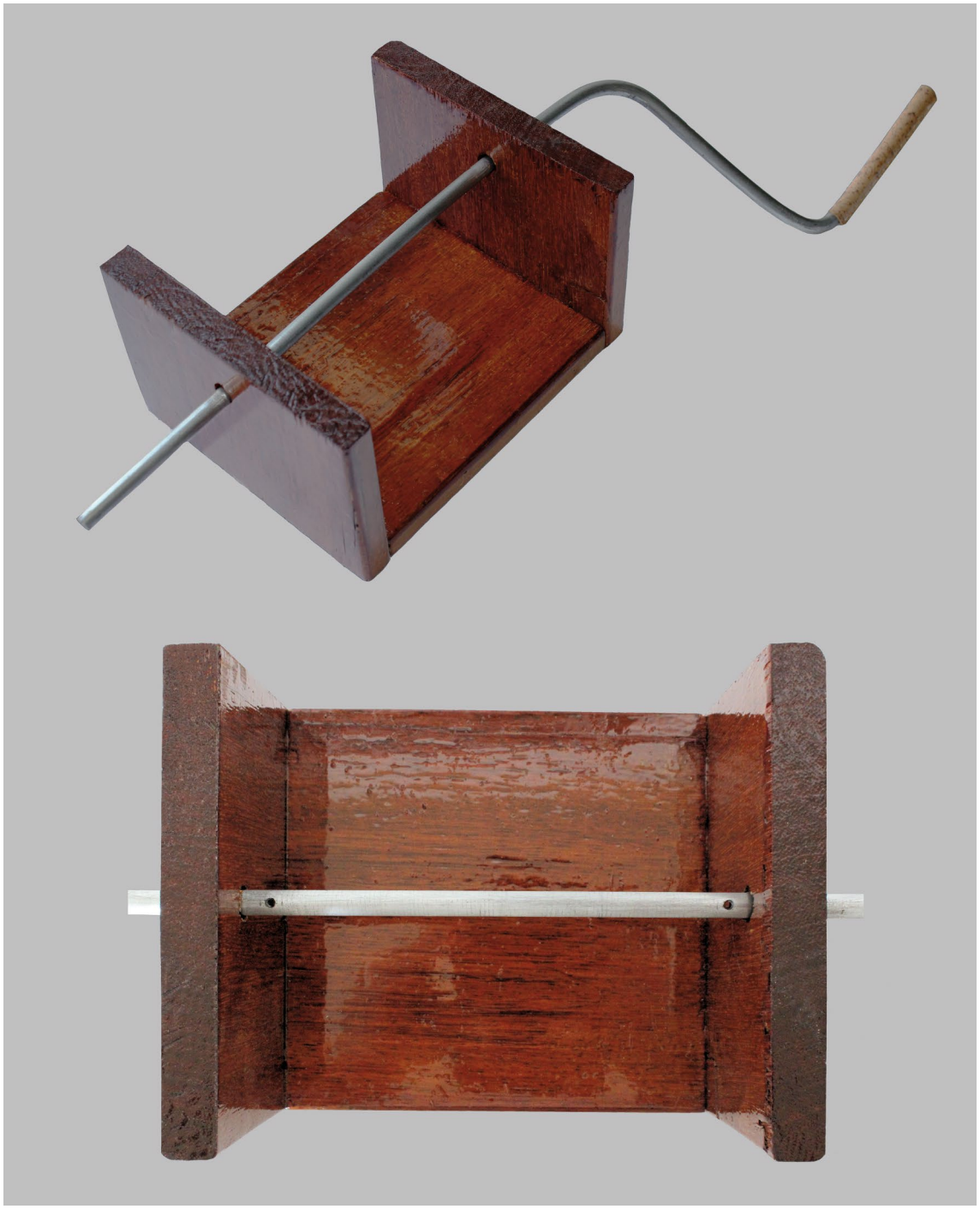

Fig. 7: A modern mandrel for winding coils made by the author. The rod contains two holes, one on each side of the mandrel. These holes help the metal wire to engage with the mandrel. The wire can be coiled from left to right or worked from right to left.

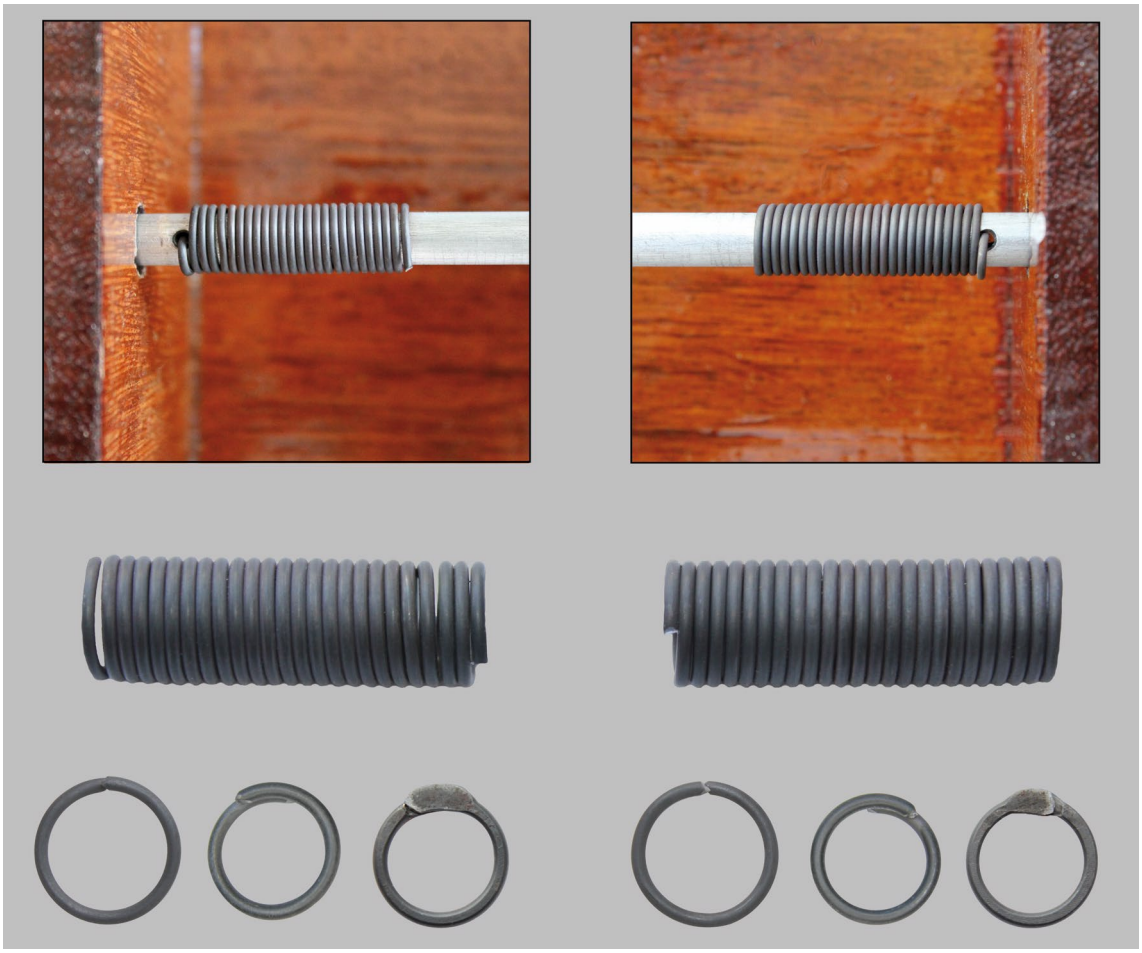

Fig. 8: The direction of the overlap depends on the direction in which the coil is wound. Top and middle: when the wire is wound from left to right on the mandrel, the result is anti-clockwise rings. When wound from right to left, the rings are clockwise. Subsequently, the coil is clipped into loose 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.

that the ends of each ring (seen from the side) are slightly out of line (fig. 8 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. While any rod could be used to coil wire, given the number of rings a mail maker would produce during a lifetime, it is likely that a specialised tool was employed, most likely a mandrel. This could be easily made

of vertical wooden blocks mounted on a base through which a rod was inserted. The modern mandrel shown in figure 7 has two small holes that engage the wire with the rod, facilitating the coiling process. The direction of the coil is determined by the starting point. When winding from the right side of the mandrel towards the left, the coil will be clockwise and so will the rings; when the coil is wound from left to right, both will go anti-clockwise (fig. 8). Therefore, it seems apparent that among the Romans, the choice of the starting point on the mandrel was on the right side, while in Medieval times it was on the left side.

There must have been some reason for the mail maker to always coil his wire in the same direction. Although it is very easy to change the starting point on the mandrel, the mail maker made sure that it stayed the same. The best explanation may have to do with the repetitive nature of making mail. After overlapping and piercing the overlap, the rings need to be opened again in order to weave them into the mail fabric. If the direction of the overlap is the same in all rings, these can easily be inserted into one another by the mail maker using the same motion, in a repetitive action that could (almost) be done with one's eyes closed. However, if the direction changes from ring to ring, the mail maker needs to be alert and adjust his movements accordingly. This is not impossible, but considering that a single mail coat contains at least tens of thousands of rings, it is unlikely, as it would slow the work down. There clearly is an advantage to having a consistent overlap in all the rings. When relying on another person, like an apprentice, to make the coils, the maker would have made sure that the right direction was preserved.

In theory, each mail maker could have chosen the direction in which to work, as long as it was consistent, but the archaeological record shows that, in practice, this was not the case. The answer to this probably lies in workshop traditions and the apprenticeship system. The importance of consistency was probably stressed during the training process, as well as the 'proper' way of doing things and making sure it is kept to, resulting in a tradition carried on from master to apprentice across generations and centuries.

Conclusion: Roman or Medieval?

The direction of the overlap of riveted rings, paired with the type of rings used, gives valuable insights into mail making traditions. It has allowed us to identify traditions, and also to tell material apart. Simply put, our formula reads: Roman mail has clockwise riveted rings, while Medieval and later mail contains anti-clockwise rings.

Appendix: Finds Included in the Study

Variant 1: Alternating Rows of Clockwise Riveted and Solid Rings

Austria
Biberwier (AD 300–400): Miks 2014, 223, pl. 70–72. Enns-Lorch (AD 180–450): Hansen 2003, 77, 173 (cat. no. C65); Matešić 2015, 211–212.

Bulgaria
Novae (AD 44–450): Wijnhoven 2015b, 4–15.

Crimean Peninsula
Gurzuf Saddle Pass 1 and 2 (2 finds from 30 BC–AD 50): Novichenkova 2009.

Croatia
Sisak (Roman period): Hansen 2003, 172 (cat. no. C56); Radman-Livaja 2004, 78–79. 130, fig. 18–19 (cat. no. 133–134).

Denmark
Agerholm (AD 210–320): Hansen 2003, 83. 175 (cat. no. C81). Brokær (AD 150–200): Hansen 2003, 83. 85. 175, fig. 27 (cat. no. C85); Jouttijärvi 1995; Waurick 1982, 115–116 (cat. no. 1). Vimose 1 (AD 150–220): Gilmour 1997, 32–33; Hansen 2003, 82–83. 175 (cat. no. C87); Jouttijärvi 1995, 103; Waurick 1982, 112–113. 115–116. 121, fig. 17 (cat. no. 4); Wijnhoven 2015a; 2015b, 1. 7–8. 13. Vimose 2 (AD 100–200): Engelhardt 1869, 12, pl. 4.4; Hansen 2003, 83–84. 175–176 (cat. no. C88). Vimose 3, 4, 5 and 6 (4 finds from AD 1–120): Engelhardt 1869, 12, pl. 4.2; Jouttijärvi 1995, 102.

Egypt
Unprovenanced (AD 395–700): Grancsay 1949, 276.

France
Chalon-sur-Saône (Roman period): Beck – Chew 1991, 45; Hansen 2003, 169 (cat. no. C28). Corent (130–120 BC): Demierre 2015, 157–160, pl. 14. Pontoux (100 BC–AD 100): Bailly 1978, 56; Beck – Chew 1991, 45. 163; Hansen 2003, 34. 42–43. 55. 162 (cat. no. B8). Sarry (AD 300–400): Chew 1993, 313, pl. 3.3; 4.3. Vézeronce (AD 480–610): Grancsay 1949, 276; Vogt 2006, 37–38. 271.

Germany
Bertoldsheim (AD 80–250): Garbsch 1984; Wijnhoven 2017, 186. 188. 193, fig. 8–9. Ellingen (AD 100–250): Hansen 2003, 167 (cat. no. C16); Matešić 2015, 218. Feldberg

(AD 150–250): Beck – Chew 1991, 163; Hansen 2003, 166 (cat. no. C5). Gnotzheim (AD 100–300): Herramhof et. al. 1986/1987, 286–287. Harzhorn (ca. AD 235): Fabian 2018, 40–41. Kalkar (Roman period): Janssen 1836, 126–127. Künzing 1 (AD 240–260): unpublished; Prähistorischen Staatssammlung München, inv. no. 1966, 1273b. Künzing 2 (AD 200–244): Hansen 2003, 53. 168 (cat. no. C25); Schönberger 1963/1964, 83. Sörup (AD 70–220): Drescher 1981, 186–190; Hansen 2003, 83. 179 (cat. no. C120); Jouttijärvi 1995, 103; Matešić 2015, 213; Waurick 1982, 115 (cat. no. 6). Thorsberg 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12 (12 finds from AD 200–250): Hansen 2003, 179, fig. 30.6–7 (cat. no. C123, C124); Matešić 2015, 208–221. 512–521, pl. 104–109 (cat. no. M 1142–M 1148, M 1157, M 1158, M 1163, M 1168, M 1172, M 1173, M 1180, M 1181); Raddatz 1987, 59–62, pl. 34.3–4, 94–96 (cat. no. 407, 407.1, 413.1, 417–419). Xanten 1 (AD 50–120): Lenz 2006, 19–20, pl. 17–18 (cat. no. 132A–B). Xanten 2 and 3 (2 finds from AD 1–120): Lenz 2006, 20, pl. 18 (cat. no. 133, 134).

Netherlands
Alphen aan den Rijn (AD 41–275): Hagedoorn 2013, 52 (cat. no. 3.16). Den Haag (AD 190–240): Beck – Chew 1991, 37; Hansen 2003, 53. 172 (cat. no. C61); Matešić 2015, 211; Waasdorp 1989, 159. 161, fig. 2; Wijnhoven 2017, 186. 188. 193, fig. 1. Empel – De Werf (AD 100–200): Nicolay 2007, 21–22. 121, pl. 7 (cat. no. 82.1). Fluitenberg (BC 250–100 BC): Sanden, van der 2003/2004; Wijnhoven 2010. Leiden (AD 80–300): Hazenberg 2000, fig. 25e; Wijnhoven 2017, 186. 193. Nijmegen – Canisiuscollege (AD 80–96): Wijnhoven 2017, 186. 193. Nijmegen – Rooie dorp (AD 70–104): Wijnhoven 2016, 77. 79, fig. 4. Nijmegen – Ubberseveldweg (19 BC–AD 97): unpublished; Gelders Archeologisch Centrum Museum G.M. Kam; put I, vondst 137. Nijmegen – Kloostertuin (19 BC–AD 125): unpublished; Gelders Archeologisch Centrum Museum G.M. Kam; put 1962-I, vondst CA.1962.834. Ouddorp (AD 35-180): Wijnhoven 2009; 2010, 150, fig. 12; 2016, 79, fig. 7. Vechten 2 and 3 (AD 5–270): Hessing et al. 1997, fig. 50; Wijnhoven 2017, 185–186. 187. 193, fig. 5.

Serbia
Bijele Crkve (Roman period): Hansen 2003, 166 (cat. no. C1); Matešić 2015, 211. 214–215. 218; Vujović 2017, 244; Wijnhoven 2017, 186. 193. Gamizgrad (ca. AD 311): Savić 2017, 42–43. 116, pl. 33.2; Vujović 2017.

Sweden
Öremölla (AD 70–220): Arwidsson 1934, 256–257; Hansen 2003, 83. 188 (cat. no. C213); O'Connor 1992, 1183, fig. 589g–h; Waurick 1982, 115–116 (cat. no. 5).

Switzerland
Vindonissa (AD 1–100): Hansen 2003, 173 (cat. no. C71); Unz – Deschler-Erb 1997, 63, pl. 83 (cat. no. 2428); Wijnhoven 2017, 185–187. 193.

Turkey
Dülük Baba Tepesi (AD 35–250): Fischer 2011, 107–108. 116, pl. 27.2; 2012, 71; Matešić 2015, 211; Wijnhoven 2016, 78–79. 85.

Ukraine
Mala Kopanya (100 BC–AD 100): Hansen 2003, 189 (cat. no. C219); Kotyhoroshko 2015, 211, fig. 41.19–20.

United Kingdom
Baldock 1 (AD 20–35): Gilmour 1997, 26. 28. 30–31; Hansen 2003, 34. 38–39. 43. 47. 49–50. 161 (cat. no. B6). Caerleon – Prysg Field (AD 200–300): Chapman 2005, 87 (cat. no. Ma01); Hansen 2003, 170–171 (cat. no. C46); Matešić 2015, 212. Caerleon – Amphitheatre (Roman period): Wijnhoven 2017, 186. 193. Caerleon – British Telecom Site (AD 200–220): Wijnhoven 2017, 186. 193. Carlingwark Loch (AD 80–200): Burgess 1955, 50, pl. 2; Capwell 2003, 23; Hansen 2003, 53, fig. 22.3 (cat. no. C33); Matešić 2015, 218; Piggott 1955, 8. 11. 38–40, pl. 2. The Lunt (AD 50–100): Beck – Chew 1991, 37; Hansen 2003, 170 (cat. no. C44); Hobley 1969, 116. 118, fig. 21.13; Matešić 2015, 211. 218; Wijnhoven 2016, 84; 2017, 186. 193. Newstead 1 (AD 80–180): Beck – Chew 1991, 163; Burgess 1955, 50; Capwell 2003, 23; Matešić 2015, 218; Piggott 1955, 11. 40; Waurick 1982, 111; Wijnhoven 2017, 186. 193. Newstead 2 (AD 138–161): Capwell 2003, 23; Hansen 2003, 59. 169–170 (cat. no. C36); Matešić 2015, 211; Wijnhoven 2009, 36–37; 2016, 78–79, fig. 2-3. Richborough Castle (AD 260–295): Biek 1963, 162–163, pl. 21; Wijnhoven 2017, 183. 186. 193. South Shields (AD 280–320): Croom 1998; Matešić 2015, 209. 218. St. Albans (ca. AD 55): Gilmour 1997, 26–30; Hansen 2003, 72. 171, fig. 22.1–2 (cat. no. C51); Matešić 2015, 209.

Variant 2: Alternating Rows of Anti-clockwise Riveted and Solid Rings

Czech Republic
Prague (AD 900–1000): Checksfield et al. 2012; Edge 2004, 22; Wijnhoven 2015b, 3.

Denmark
Hedegård (50 BC–AD 50): Hansen 2003, 83. 175 (cat. no. C82); Jouttijärvi 1995, 102–103; Kalsbøll Malfilâtre 1993; Matešić 2015, 218.

Germany
Gammertingen (ca. AD 570): Adams 2010, 96; Arwidsson 1934, 255–257; Böhner 1994, fig. 14; Checksfield et al. 2012, 233; Gröbbels 1905, 34–35, pl. 7; Riemer – Heinrich 1997, 54–55. 58–60; Stein 2003, 44–45, fig. 2; Vogt 2003, 27; 2006, 215, fig. 79. Planig (ca. AD 510): Adams 2010, 96; Böhner 1994, fig. 10; Hilgner 2010, 55, pl. 8.2; Vogt 2003, 11, 29; 2006, 37–38. 245–246.

Netherlands
Rhenen 1 (AD 575–600): Wagner – Ypey 2011, 381–382, fig. 80.

Norway
Gjermundbu (AD 900–1000): O'Connor 1992, 1185; Vike 2000, 8–18; Wijnhoven 2015b, 1. Smedenga i Ullensaker (ca. AD 600): O'Connor 1992, 1184.

Romania
Radovanu (100–1 BC): Borangic 2011, 185–186. 190–191. 223; Hansen 2003, 61–62. 69. 164 (cat. no. B25); Vulpe 1976, 208. 212, fig. 18.6–8; Wijnhoven 2015b, 1.

Spain
Piquía (100–50 BC): Quesada Sanz et al. 2018.

Sweden
Birka 1 (AD 900–1000): Ehlton 2002/2003. Birka 2 (AD 750–1000): Arwidsson 1934, 356. Helgö (AD 550–790): Fredman 1992, 23. 28. 44. Slite (AD 780–1100): O'Connor 1992, 1185, fig. 589l–m. Vendel (AD 520–600): Arwidsson 1934, 353; O'Connor 1992, 1183–1184, fig. 589a–e.

United Kingdom
York (AD 750–775): Böhner 1994, 545, fig. 43.1; Tweddle 1992, 929–935. 999–1009. 1057–1081.

Variant 3: All Anti-clockwise Riveted Rings

Bulgaria
Milhailovo (AD 900–1100): Petrov et al. 2015, 576; Zlatkov 2014. Unprovenanced from the Veliko Tarnovo Museum of Archaeology (250–150 BC): Dimitrov 2009/2010.

Germany
Thorsberg 13, 14 and 15 (3 finds from AD 200–250): Hansen 2003, 179–180 (cat. no. C125); Matešić 2015, 212. 215. 223. 513–514, pl. 104–105 (cat. no. M 1152–M 1156); Raddatz 1987, 61 (cat. no. 408).

Sweden
Gränby (AD 70–260): Arwidsson 1934, 256, fig. 12; Fredman 1992, 24. 48; Hansen 2003, 188 (cat. no. C212). Tuna (AD 780–1100): Arwidsson 1934, 256; Fredman 1992, 23. 41; O'Connor 1992, 1185.

Notes

[1] Edge 2004, 24.
[2] E.g. Morsella et al. 2016.
[3] The 94 finds, their age, and some of the key literature are summed up in the appendix.
[4] Borangic 2011, 185–186, 190–191. 223; Malfilâtre 1993; Quesada Sanz et al. 2018.
[5] Dimitrov 2009/2010.
[6] Arwidsson 1934, 256, fig. 12.
[7] Matešić 2015, 212. 215. 223. 513–514, pl. 104–105 (cat. no. M 1152; M 1153; M 1154).
[8] Lau 2010, 137–140.
[9] E.g. Adler 1993, 105; Kaczanowski 1994, 216–219; Raddatz 1959/1961, 52–54; Waurick 1982, 114–116.
[10] Grancsay 1949, 276; Vogt 2003, 11. 29; 2006, 37–38. 271.
[11] 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 Spangenhelms, that the helmet from Vézeronce likely comes from the Eastern Roman Empire.
[12] 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.
[13] Burgess 1953, 49–50, fig. 2.

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Fig. 1–2: drawing M. A. Wijnhoven. – Fig. 3: Left: photograph M. A. Wijnhoven. Right: photograph Fernando Quesada Sanz. – Fig. 4: drawing M. A. Wijnhoven. – Fig. 5: Left: photograph M. A. Wijnhoven. Right: photograph M. Höflinger, Archäologisches Landesmuseum, Stiftung Schleswig-Holsteinische Landesmuseen, Schloß Gottorf. – Fig. 6: photographs Metropolitan Museum of Arts. – Fig. 7–8: photograph M. A. Wijnhoven.

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