RING MAIL....BREAKING THE CHAIN

Since the question of "authentic" Dark age armour has been raised, this enquiry will take an objective look at various aspects chain mail; size, shape and material. This will lead us onto other relevant details, such as how links were joined together.

I have used as my starting point D. Tweddle's book "the Anglican Helmet from Coppergate" YAT 17/8. Here several dark age mail fragments are recorded from which I have transcribed the details in table 1 below. Included is the find site name, the diameter of the link, the diameter of the wire, how the link was joined, what the item was (mail shirt or aventail) and an approximate date of the item. All links are round section and of iron, unless otherwise stated.

TABLE OF VARIOUS RINGMAIL SIZES FROM DARK AGE SITES

Nº	SITE	ø Ring	ø Wire	Joinings	Item	Dating
1	VENDEL I, Uppland.	13.5mm 14.3mm 14.4mm	2.5mm 2.6mm 2.6mm 2.9mm	Not Known	Mail-Shirt	600/640
2	VENDEL III, Uppland.	9.5mm to 10.0mm 13.9mm	1.7mm to 2.2mm 2.2mm	Not Known Lapped & Riveted	Not Known	720/750
3	VENDEL X	10.3mm	1.8mm	N.Known	N.K.	520/600

4	VENDEL XI fragment a	9.47mm	1.5mm 1.6mm 1.7mm 2.0mm 2.1mm	Lapped (acw) & Riveted	Aven-tail.	520/600
	fragment b	6.4mm 7.5mm 7.6mm	1.0mm 1.0mm 1.2mm 1.4mm 1.5mm	One Lapped & Riveted The rest Not Known		
	fragment c	14.4mm 14.7mm 15.0mm	2.7mm 2.8mm 2.8mm	Not Known		
	fragment d	6.8mm 7.0mm 7.2mm	1.0mm 1.3mm 1.3mm 1.3mm 1.3mm	Two Lapped & Riveted The rest Not Known		
	fragment e	10.4mm	1.9mm	Some Lapped & Riveted The rest Not Known		
5	VENDEL XII, Uppland.	9.2mm 10.0mm 10.1mm	2.0mm 2.2mm 2.6mm 2.8mm	Not Known	Aven-tail	520/600
6	Akershus, Smedenga i Ullensaker. Rings in alternate rows of Lapped & Riveted and Not Known.	10.4mm 10.5mm 10.7mm 10.8mm 11.9mm	1.3 x 1.3mm 1.4 x 1.4mm 1.5 x 1.4mm 1.7 x 1.6mm 1.8 x 1.6mm	Lapped (acw) & Riveted	Not Known	600
		10.0mm 10.2mm 10.3mm 10.5mm 10.8mm	1.0 x 1.2mm 1.0 x 0.7mm 1.3 x 1.2mm 1.5 x 1.3mm 1.8 x 1.6mm	Not Known		

13	Slite graves 14.7 & 8, Gotland.	8.5mm 8.6mm 8.7mm 8.9mm 8.9mm 8.15mm 8.76mm	NK 1.7 x 1.2mm 1.1mm	Lapped & Riveted NK Lapped & Riveted	Iron Copper Alloy Copper Alloy	Viking or later
14	Väte, Tuna, Gotland.	8.5mm	1.3mm	Lapped & Riveted	NK	Viking?
15	Väte, Tuna, Gotland.	11.9 x 10.3mm 12.1 x 11.8mm 12.3 x 11.3mm	1.0 x 1.7mm 1.0 x 1.8mm 1.1 x 1.9mm	Lapped & Riveted (acw).	Mail or Chain. Square Sect-ion.	Viking?

In a second table below, I have considered the question "does the thickness of chainmail links get bigger as the diameter of the links increases"? To illustrate this I have emphasized the importance of link sizes and wire thicknesses and calculated the ratio of these dimensions to each other for all the examples. With this information it is easier to see maximum and minimum sizes for link diameter and thicknesses.

TABLE 2: RATIOS OF RING DIAMETER TO WIRE THICKNESS

No	Name	Approx. Dates	Average Ring Dia. Lower & Upper Limits	Average Wire Dia. Lower & Upper Limits	Ratio of Average Ring dia. to Wire dia.
1	Vendel I	600/640	13.5 / 14.4mm	2.5 / 2.9mm	5.16 to 1
2	Vendel IIIa Riveted b	720/750	9.5 / 10.0mm 13.9mm	1.7 / 2.2mm 2.2mm	5.00 to 1 6.32 to 1
3	Vendel X	520/600	10.3mm	1.8mm	5.72 to 1

7	Landshammer RAA 26 grave A, Södermanland	c12mm c8mm 6.5mm 6.7mm 6.8mm 6.8mm	1.5mm 1.8mm 1.5mm 1.8mm 1.2mm 1.2mm 1.2mm 1.2mm	Not Known Not Known Lapped & Riveted	Not Known	600/650
8	Valsgärde 6, Uppland.	9.2mm 9.2mm 9.5mm 9.8mm 10.2mm	1.6mm 2.0mm 2.0mm 2.0mm 2.1mm	Not Known	Aven-tail	600/680
9	Valsgärde 7, Uppland.	9.2mm 9.8mm 9.8mm 10.1mm 11.0mm	1.6mm 1.9mm 1.9mm 2.0mm 2.0mm	Not Known	Aven-tail	600/680
10	Valsgärde 8, Uppland.	12.5mm	1.8mm 2.1mm 2.3mm 2.3mm 2.4mm	Not Known	Aven-tail	560/600
11	Coppergate, Yorks.	7.67mm 7.86mm	1.07mm 1.16mm	Riveted (acw) Welded	Aven-tail	750/775
12	Gjermundbu, Ringerike. Rings in alternate rows of Lapped (acw) and Riveted & Not Known.	7.4mm 7.7mm 7.7mm 7.7mm 8.3mm 8.35mm	1.09 x 1.24mm 1.35 x 1.45mm 1.38 x 1.38mm 1.39 x 1.68mm 1.44 x 1.50mm 1.2 x 1.4mm 1.7 x 1.5mm 1.7 x 1.5mm 2.0 x 1.4mm 2.0 x 1.5mm	Lapped & Riveted Not Known	Mail-Shirt	Viking

4	Vendel XI Riveted a		9.47mm	1.5 / 2.1mm	5.26 to 1
	fragment b Riv.+Flat?		6.4 / 7.6mm	1.0 / 1.5mm	5.60 to 1
	fragment c	520/600	14.4 / 15.0mm	2.7 / 2.8mm	5.35 to 1
	fragment d Riv.+Flat?		6.8 / 7.2mm	1.0 / 1.3mm	6.09 to 1
	fragment e		10.4mm	1.9mm	5.47 to 1
5	Vendel XII	520/600	9.2 / 10.1mm	2.0 / 2.8mm	4.02 to 1
6	Akershus a Riveted	600	10.4 / 10.5mm	1.3 / 1.7mm	6.97 to 1
	b Flat?		10.0 / 10.8mm	0.85 / 1.7mm	8.16 to 1
7	Landshammer	600/650	12.0mm	1.5 / 1.8mm	7.27 to 1
	b		8.0mm	1.5 / 1.8mm	4.85 to 1
	c Riveted		6.5 / 6.8mm	1.2mm	5.54 to 1
8	Valsgärde 6	600/680	9.2 / 10.2mm	1.6 / 2.1mm	5.24 to 1
9	Valsgärde 7	600/680	9.2 / 11.0mm	1.6 / 2.0mm	5.61 to 1
10	Valsgärde 8	560/600	12.5mm	1.8 / 2.4mm	5.95 to 1
11	Coppergate Riveted	750/775	7.67mm	1.07mm	7.17 to 1
	Welded		7.86mm	1.16mm	6.78 to 1
12	Gjermundbu Riveted	C1000	7.4 / 8.3mm	1.17 / 1.53mm	5.81 to 1
	Flat?		8.35	1.3 / 1.75	5.48 to 1
13	Slite b Bronze?	Viking?	8.15mm	1.2 / 1.7mm	5.62 to 1
	c Riveted		8.76mm	1.1mm	7.96 to 1
14	Väte site 1 Riveted	Viking?	8.5mm	1.3mm	6.53 to 1
15	Väte site 2 Riveted Flat Links	Viking?	11.1 / 11.95mm	1.35 / 1.5mm	8.09 to 1

As you may have expected given the limitations in finds of dark age mail, as well as the difficulty in measuring the samples we have; the ratio of link size to thickness does not increase proportionally. To make it easier to appreciate please look at table 3 (graph).

In Table 3, each of the three diagonal lines represent a 'constant ring to wire ratio' and is accompanied by an appropriate illustration. Nearly every dark age mail chainmail link ratio falls between the upper and lower limits, whilst many fall on, or close to the middle line. At a glance it can be seen that ratios much more than 9.26 to 1, would result in mail that was so fine that it would hardly stop a blow, and almost certainly not a missile. With ratios much less than 4.17 it would be impossible to pass enough links through the hole in the centre to form it up into chainmail, not to mention the increase in weight of the item and the loss of flexibility.

In table 4 below, figures (A) to (F) illustrate two different sizes of rings all with different thicknesses of wire. Despite this, note that adjacent pairs have the same Ratio of RING DIAMETER TO WIRE THICKNESS, eg:

Figure (A) and (D) both have the same ratio: 9.26 to 1.
Figures (B) and (E) both have the same ratio; 5.83 to 1,
figures (C) and (F) likewise have the same ratio; 4.17 to 1.

These illustrations also (roughly) represent the upper and lower limits of Dark age chain mail ring sizes. Vendel XI, fragment b has a ring with a diameter of 6.44 mm; and illustrations (A, b & C) all have this ring diameter. However the Vendel XI, fragment b has an average ratio of 5.60 to 1; this means that figure (B) is the closest representation of this ring.

Vendel XI, fragment c, has a ring with a diameter of 15.0mm; and illustrations (D, E & F) all have this ring diameter. However the Vendel XI, fragment C has an average ratio of 5.35 to 1; this means that figure (E) is again the closest representation of this ring.

So despite a difference in ring size of nearly 9mm, the extreme ring sizes at Vendel have roughly the same ratio of ring diameter to thickness, that is 5.6 & 5.35 to 1.

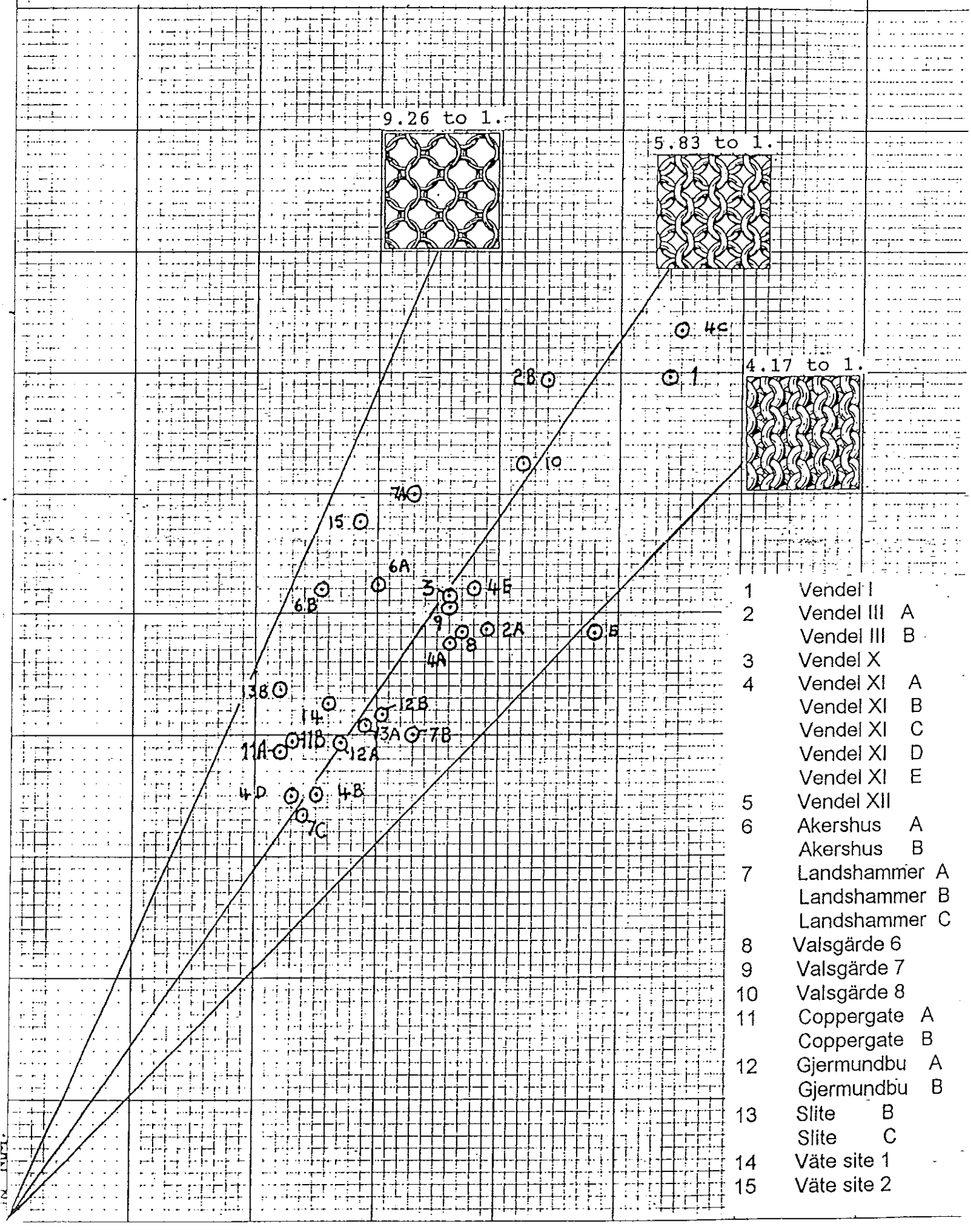
Altogether the ratios at Vendel vary between 4.02 & 6.32 to 1 and although this may seem to be a large difference, consider a link 12mm in diameter. If the wire thickness varied between 1.9mm and 2.98mm, the difference in ratios would be the same.

Figure (G) shows a ring at roughly the same diameter as the Coppergate Helmet links, 7.76mm. The Coppergate ratio however is roughly 7 to 1 and so must lie somewhere between the two ratios of 5.83 & 9.26 to 1.

Figure (H) shows a ring at roughly the same diameter as the Gjermundbu links, 7.85mm. The ratio is 5.83 to 1, which is comparable to that for the Gjermundbu find roughly 5.81 to 1.

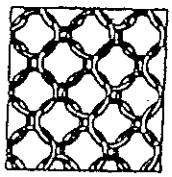
Altogether the ratios for all the possible Viking finds vary between 5.48 & 8.09 to 1 and although this may seem to be a large difference, consider a link 12mm in diameter. If the wire thickness varied between 1.48mm and 2.19mm, the

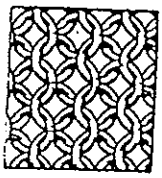
TABLE 3: GRAPH TO SHOW THE RATIO OF DARK AGE CHAINMAIL LINK DIAMETERS TO LINK THICKNESSES

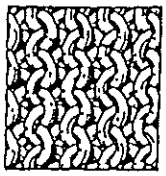


1	Vendel I
2	Vendel III A
	Vendel III B
3	Vendel X
4	Vendel XI A
	Vendel XI B
	Vendel XI C
	Vendel XI D
	Vendel XI E
5	Vendel XII
6	Akershus A
	Akershus B
7	Landshammer A
	Landshammer B
	Landshammer C
8	Valsgärde 6
9	Valsgärde 7
10	Valsgärde 8
11	Coppergate A
	Coppergate B
12	Gjermundbu A
	Gjermundbu B
13	Slite B
	Slite C
14	Väte site 1
15	Väte site 2

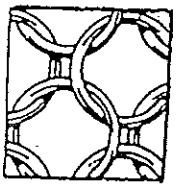
TABLE 4– FIGURES OF VARIOUS LINK SIZES & RATIOS

A) 

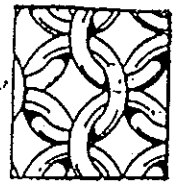
B) 

C) 

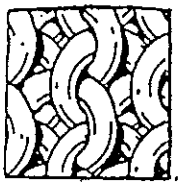
=6.4mmø

D) 

9.26 to 1

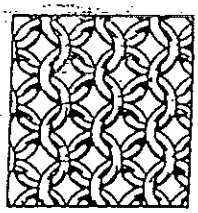
E) 

5.83 to 1

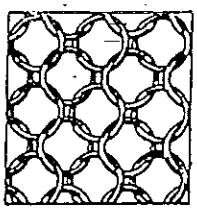
F) 

=15mmø

4.17 to 1

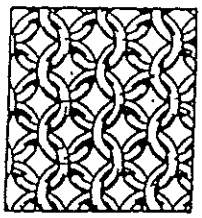
G) Coppergate 

5.83 to 1



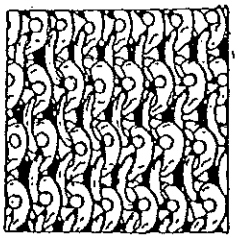
9.26 to 1

=7.76mmø

H) Gjermundbu 

5.83 to 1

=7.85mmø

I) Lapped & Riveted Mail 

difference in ratios would be the same. To put it another way, these ratios vary for a difference in wire thickness of under ¾mm!

The "square" sectioned links from Väte are more specifically "rectangular" in section. They are punched from sheet, lapped and riveted. However they total only three links and from a find that may be a chain in its own right, rather than off a fragment of ring mail. The date of the find is also unsure, it has been place between the Bronze age and the C17th!!. In no way can it be considered typical Viking age mail.

A similar caution must be applied to the copper alloy links from Slite. Again, these are only found on one fragment of uncertain age. There were probably used decoratively and as such the existence of complete articles of copper alloy mail should be viewed as unlikely.

Inevitably, this enquiry will lead us to conclude that all our reconstructed butted mail is unauthentic! In every examples examined a variety of methods were used to join the links; whether riveted, welded or punched from sheet but they were all solidly joined!

The Coppergate helmet was the only example of welded mail; reflecting just how valuable the item was. Visually, our butted mail looks the most similar to welded mail. Riveted mail has an appearance distinctive from welded/butted both because of the pronounced rivet heads and because in some examples (Akershus, Gjermundbu & Slite: definitely; Landshammer, Vendel III & Vendel XI: possibly) the riveted links are alternated with a link of "unknown" closure (fig. I table 4). Given the rarity/cost of welded links and the poor strength/unlikeliness of butted links; these unknown links were probably solid punched from sheet.

Cost is a delimiting factor here, rivetted or welded mail will push the price of such an outfit to around the £2000 mark. Another consideration is that we may have too much mail in our society. Just about the only unequivocal tenth century Viking mail is found in the Gjermundbu grave in Norway. It would be tempting to restrict the wearing of mail to authentically joined mail only. However the written (and drawn!) record does not agree with archaeological finds as the Bayeux tapestry and the Battle of Stanford Bridge record the wearing of many suits of chain mail.

RECOMMENDATIONS

SIZE:

Reference to tables 2 & 3 will show that although mail varies between 6.4mm and 15mm in ring diameter, most of the Viking mail falls in the band 7.4mm to 8.7mm. However, the incongruous Väte chain is up to nearly 12mm. and I recommend that this be accepted as the upper limit for the society.

Ideal ratios of link diameter to thickness fall between 9.26 and 4.17 to 1. This means that for 12mm. mail we should accept links no smaller than 1.3mm in diameter. By the same token, links should be no thicker than 2.88mm in diameter. However this limit need not be enforced because as we saw before, rings that become very thick for a given diameter become useless because the internal diameter becomes too small to pass all the adjoining links through.

Links larger than 12mm. and all mail with ring size to thickness ratios greater than approximately 9 to 1 should be banned, or at worst phased out by say 2000AD.

SHAPE:

There are no square sectioned links, at best there is the possibility of some flat rectangular sectioned links. These either alternate with lapped and riveted links or are riveted in their own right. Some modern imitation rectilinear section mail is made from spring washers. Some of these have distinctive pitting on their surface. This type of ring mail should be banned with immediate effect.

Plain square sectioned ringmail should also be banned, or at worst phased out by, say, 2000AD.

MATERIALS:

All mail is of iron links which varies in colour from a dull grey to ruddy brown. All replicated mail which has a distinctive appearance outside these guides should be banned.

Any copper or copper alloy rinks should be used only as decorative rows along the edge of mail articles. In view of their scarcity and dubious age their use should not be encouraged. Any existing copper based links currently employed in a decorative capacity, can be allowed to remain.

Some medieval literature describes gilded links of mail, that is iron links that have been covered in gold foil. Nowhere however, is there a description of galvanised mail. It is therefore recommended that all galvanised mail be banned with immediate effect.

Note; the galvanised plating can be removed by burning or tumbling in a cement mixer with sand. Once the plating has been removed, the mail can be used as long as the other restrictions have been applied.

JOINING OF MAIL LINKS:

Riveted chain mail suits and welded mail aventails should be encouraged as much as possible. However, it is unlikely that much riveted or welded mail will emerge. Butted round sectioned mail can be continued to be used providing all the above criteria are met with.

USE OF CHAINMAIL SUITS

I feel there should be some restriction on use, most logically this would be to the upper warrior classes; the Huskarl / Heimþegi or greater rank are the obvious choice. By implication, a prospective wearer of chainmail should have the rest of the kit to go with this rank, as well as achieving society status in the guise of the Drengr rank.

Samples of all new mail could be vetted before the go ahead is given by the Society Authenticity Officer, or appropriate deputy for the construction of a complete suit of mail.

ALTERNATIVE ARMOUR:

The only other armour that may have been possessed by the Vikings is Lamellar armour. This is a suit of metal plates thonged together, giving a similar appearance to roofing tiles (viewed from upside down!) They are easier to construct than ringmail and more authentic than reconstructed ringmail!

Archaeological finds of lamellar are not as rare as you might suppose. A fragment is known from Birka, and a complete suit from Gotland. As both of these come from the East of Sweden, it is likely that they were used only by Eastern or Slavic Vikings.

There is also a possibility that some of the Norman nobility may have worn lamellar at Hastings. Consequently it is recommended that the following restrictions be placed upon the wearing of Lamellar.

First of all an application and the submission of samples should be sent to the High Council. The Council can thus ensure that the armour is both as of authentic as possible construction, as well as the rest of the owners kit. Secondly any one wishing to wear lamellar armour must be of sufficient rank, status and racial type. Finally the Council will ensure the armour does not appear at a reconstructed Historical event where the appearance of such armour is unlikely.

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