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Two 15th century openwork braids of silk and metal thread from Riddarholmen Church and Alvastra Abbey in Sweden

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The Historical Museum in Stockholm holds two interesting Medieval braids, one from Riddarholmen Church and one from Alvastra Abbey. Both are made of red silk and metal thread, probably with a loop-manipulation braiding technique that can produce openwork braids resembling lace. The braid from Riddarholmen can be linked to funerary textiles, as it was found during the opening in 1915–16 of the purported tomb of King Magnus Birgersson Ladulås (Barnlock). The other braid was excavated in 1949 at Alvastra Abbey and is probably a fastening loop. In this study, we present the results of a technical and material comparison of the two braids.

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The Swedish Historical Museum holds two braids which have captured our interest. They are from two different sites, but display similarities in material and technique. One (SHM 19283:IB6) was found during the 1915–16 opening of the purported tomb of King Magnus Birgersson Ladulås (Barnlock), in Riddarholmen Church, Stockholm. The other braid (SHM 24183:1852) was unearthed in 1949 during an archaeological excavation of Alvastra Abbey in Östergötland.

The Riddarholmen braid was found in a tomb holding the remains of seven people in the chancel of the Riddarholmen Church (Fürst & Olsson 1921, p. 32). The braid was recovered in two fragments at a depth of 1–1.05 metres. One fragment lay in the north-western part of the tomb and the other in the centre (ibid., p. 24). Human remains were found both above and beneath the position of both fragments. It was impossible to determine which individual the braid had belonged to, because the contents of the tomb had been shifted around in connection with new interments. King Magnus died in 1290, and the other six individuals in the tomb were long taken to have been buried in the 14th century (Fürst & Olsson 1921, p. 39). However, the tomb was re-opened in 2011 as part of a project aimed at investigating (using DNA) the relationship between Magnus Birgersson and his supposed father Birger jarl who is buried in Varnhem Monastery Church. Samples were taken for radiocarbon dating, and the results showed that the remains are not as old as previously believed: the skeletons are now dated to the 15th century (pers. comm. osteologist Maria Vretemark, the Magnus Ladulås Tomb-Opening Project). This refutes the previous dating of the braid to the time and burial of King Magnus. Who, then, are the seven people buried in the tomb? The research team is pursuing this issue further and will hopefully be able to provide answers in the near future.

The Alvastra braid was found in the Cistercian Abbey at Alvastra. Founded in 1143, the abbey was dissolved in 1529 with the departure of the last abbot (Regner 2005, pp. 5, 209). The site was extensively excavated in 1949, and the braid was found in recording square YC:I (Catalogue, SHM 24183:1852). This square was formerly occupied by a *hospitium* building, and traces of a hearth foundation were uncovered. Unfortunately, the braid is difficult to date, as its find context is uncertain: no excavation diary was kept (Regner 2005, pp. 5, 272–273).

Comparing these two braids with other surviving ones made using the same technique, we found that most derive from liturgical textiles produced at Vadstena Convent in the 15th century. The Riddarholmen and Alvastra braids are both openwork, i.e. of a lace-like character (Speiser & Boutrup 2011). Only one other openwork braid in this technique has been found in Sweden: on a sudary made at Vadstena Convent. This sudary was most likely made for the consecration of Archbishop Jöns Håkansson in 1422 and is now kept in Uppsala Cathedral (Estham 2010, pp. 261–263). The dating of both the sudary and the skeletons in the " Magnus Ladulås" tomb to the 15th century makes it plausible that the Alvastra braid shares this dating.

Of the two studied braids, only the Riddarholmen specimen has seen publication before. A description of it by Agnes Branting forms appendix 6 of the major 1921 publication of findings from the "Magnus Ladulås" and "Karl Knutsson" tombs. Branting noted that the braid is made of silk and metal thread, more particularly gilded silver thread with a core of silk or linen, and she maintained that it is plaited in a way which "we now call bobbin lace", with small silk loops at the edge (Fürst & Olsson 1921, p. 226). Appendix 7 to the same publication presents G.A. Sellergren's studies of the tombs, including the braid. According to him, the metal thread, which he calls "brocade thread", is "impure gold thread, i.e. copper thread hammered flat and gilded" (Fürst & Olsson 1921, pp. 227–228). Sellergren's appendix also includes a drawing to show how the braid is constructed.

Upon inspecting the braid fragments ourselves, however, we were not convinced by Sellergren's explanation of the braid construction, nor by Branting's description of the braid as bobbin lace. As Branting and Sellergren furthermore disagreed in their statements about the material of the metal thread, we decided to carry out a thorough examination of the fragments, and to use modern analytical methods to determine their material composition. A similar examination was carried out for the Alvastra braid, and the results are presented below.

The openwork braid from Riddarholmen Church

The two fragments of the Riddarholmen braid are 15 and 31 cm long, and originate from a narrow (7 mm wide) openwork ribbon consisting of a central braid with picots sewn onto both sides (Fürst & Olsson 1921, p. 226).

The braid was made with eight elements, each consisting of two parallel threads. Four of the elements are of silk and four of metal thread. The silk threads are now reddish brown, but may originally have been bright red. They are two-ply and have a very low amount of twist in the S direction. The metal thread has a golden yellow silk core, also S ply, around which a flat, narrow strip of gilded silver has been wound in the S direction. In one end of the shorter ribbon fragment the metal threads bend back into the braid forming a bow. This bow appears to form the beginning of the braid while the silk threads seem to be wound around the bend (fig. 1).

The eight braid elements have been arranged symmetrically so that the central interlacing is formed by either silk or metal thread, while ele-

Fig. 1. The end of the smaller fragment of the Riddarholmen braid. Note how the metal thread bends back into the braid. Photo JB.

ments of the two materials cross each other at both sides. This well-known basic structure is today often called "Torchon ground" in bobbin lace terminology (Schuette 1963, p. 237; *Bonniers Store Håndarbejdsleksikon* 1995, p. 8). However, the present structure differs from bobbin lace in the use of paired parallel running threads in each element, and the way the paired threads turn at both sides.

Paired threads are not used in bobbin lace, probably because it would be too difficult to keep two elements parallel during braiding if they were wound on bobbins. The paired threads encountered here were likely produced using loops on the fingers. This way the paired threads are formed by the two shanks of the loop and they can be kept parallel at all times. The turning at the edges is then easily obtained by twisting the loops appropriately. The braid itself can be made by a team of two people, each holding two loops of silk on fingers of the outer hands and two loops of metal thread on the inner hands. The two then take turns interlacing between their own two hands and interlacing between each other's hands.

Another unusual feature is the combination of silk and metal threads in an openwork braid. The softness of silk makes it less suited for openwork. In other types of braids the combination of these two materials is more often seen, especially from the end of the 16th century. Only a few openwork braids combining silk and metal are known from before that period. One is on the previously mentioned sudary in Uppsala Cathedral (Estham 2010, pp. 261–263). Two other coeval braids of a similar construction are found on two pluvials in Portalegre in Portugal (Alarcão & Carvalho 1993, pp. 142–151) and on a sudary in Danzig that was lost during World War II (Mannowsky 1931, sudary no. 256, Taf. 149). In these other examples, the threads are not running paired. Instead, they are structurally comparable to instructions in 17th century manuscripts, and were most likely braided by a team of three or four people in orthodox loop braiding, as shown by Noémi Speiser (2000, p. 97).

The bright red and very well-preserved picots running along both sides of the braid from Riddarholmen Church are formed from two separate continuous threads (figs 2–3). The picots still retain most of their three-dimensional circular shape. There are two picots between each of the attaching overcast stitches, which fit into the braided structure by having the same slant as the outer ridges of the braid. The picot thread appears to be of undegummed silk, and the sewing thread used to attach the picots appears to be of a similar material, albeit with a lower twist. The silk gum, sericin (an amorphous protein covering the fibres in the cocoon), would have helped the picots to keep their shape, as it stiffens the material by glu-

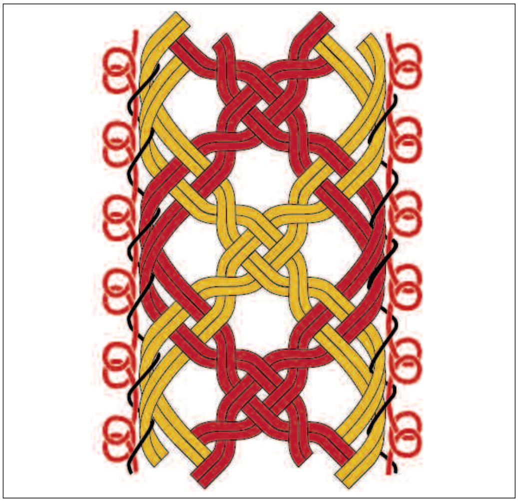

Fig. 2. Schematic drawing of the Riddarholmen braid. Note how the silk and metal threads are arranged, and how the threads run parallel and turn at the edges. The black lines indicate the sewing which fastens the picots to the braids. The slant of the overcast stitches lies parallel to the slant of the edges in the braid. Here the sewing is shown as more regular than it really is on the braid. Drawing JB.

Fig. 3. A section of the Riddarholmen braid, loops, and sewing thread. Photo JB.

ing the fibres together. The picot thread must have a high twist in order to form the almost circular curl of each loop, and under the microscope one can see that the twist of the picot thread is much higher than for the silk in other parts of the ribbon. In order to achieve the consistently round shape of the loops, the picot thread must have been wound around a metal rod, a needle, or a round thread. Exactly how and when the picots were made is, however, not clear – they could have been produced separately and then stitched to the braid, or made and sewn on in an integrated process.

A simple test with undegummed silk, slightly moistened, showed that it was easy to loop around a thin rod when given an S twist between the fingers. The resulting loops were relatively stable when taken off the rod thanks to the twist and the silk gum. The distance between the loops makes it probable that the loops were formed this way while sewing.

A metal thread sample from the Riddarholmen braid was analyzed without added coating under high vacuum in a JEOL JSM-7000F scanning electron microscope (SEM). Images were recorded both in secondary emission mode and in back-scatter mode. Elemental analysis was first carried out at 20 kV in order to detect all elements present. Next, elemental analysis of the thin gold layer was carried out at 6 kV in order

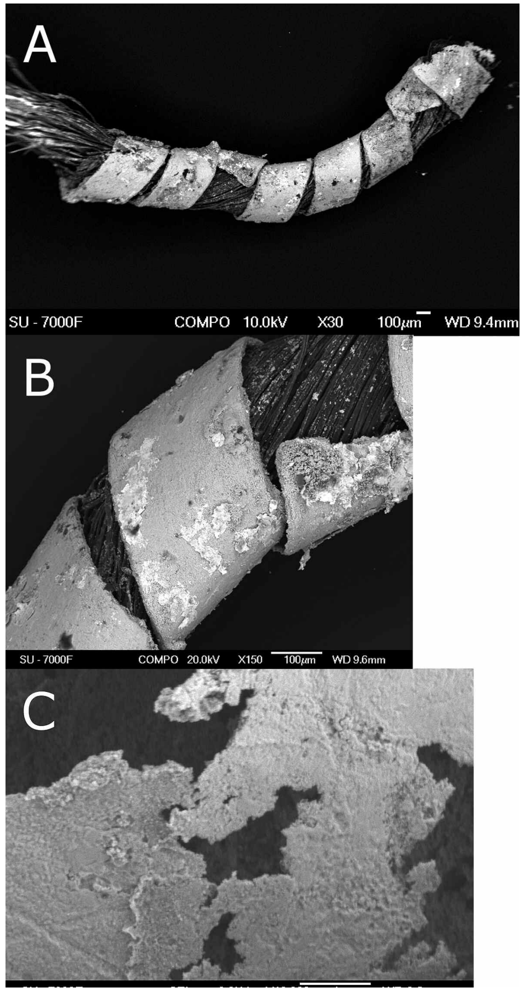

Fig. 4abc. SEM images of gilded silver metal threads from the Riddarholmen braid. a: the studied metal thread sample. b: close-up showing patches of gold coating on the silver strip. c: close-up of the extremely thin gold coating. Photo SW.

not to pick up a signal from the bulk silver underneath (Nord & Tronner 2000, pp. 274–279).

Back-scatter mode images of the metal thread (fig. 4) are useful for understanding the material composition. Both the metal strip and the core silk fibres appear to be in rather good condition. The metal surface displays spots of corrosion together with small patches of gold coating, i.e. remains of a gilded layer. The metal strip is approximately 15 µm thick, 0.32 mm wide, and consists of >99% silver. Silver sulphide and silver chloride are the main corrosion products. The gold layer is less than a micron thick and consists of about 85% gold and 15% copper, which corresponds to around 21 karat gold. No other elements – specifically, no silver or mercury – were observed in the gold layer. No gold was observed on the interior side of the metal strip, where preservation is usually better. This indicates that the strip was gilded only on the exterior side. The gold patches display a porous microstructure (fig. 4c) most likely caused by corrosion. It primarily attacks the less noble copper component, thereby increasing the relative gold content in the material. Hence, the original gold content in this gilded layer was probably less than the 21 karats currently observed.

Silk fibres from the ribbon were investigated with ATR infrared spectroscopy (FTIR) to investigate whether the silk had been degummed.

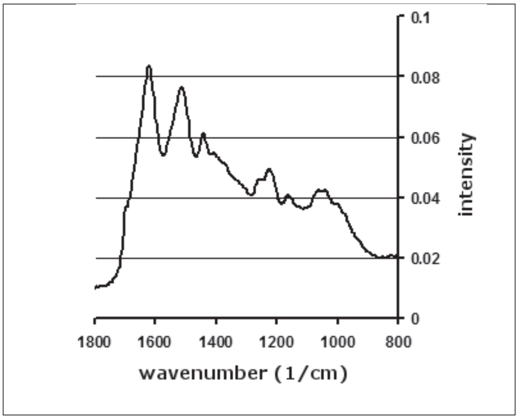

Fig. 5. Infrared (FTIR) spectrum, recorded with a diamond ATR cell, of silk from the picots of the Riddarholmen braid. The position and intensity of the bands in the 1800–800 cm-1 range are diagnostic of the sericin content in the silk fibre.

	Wave number intensity ratio		
Silk's origin	1070/1164	1400/1444	1650/1625
Metal thread	1.00	0.92	0.85
Picot	1.12	0.93	0.75

Tab. 1. Wave number intensity ratios obtained from infrared spectra for the two silk samples from the Riddarholmen braid.

Two samples were studied: one from the metal thread core and one from the picot border. Fig. 5 shows the 1800–800 cm-1 region of the IR spectrum for the picot silk fibre. According to Zhang & Wyeth (2010, pp. 626–631), the intensity ratios of the 1070/1165, 1400/1445, and 1650/1625 IR wave numbers are useful for evaluating the sericin content in a silk fibre. In tab. 1, these intensity ratios are shown for our two silk samples. The measured ratios are all in the range 0.75–1.1, which according to Zhang & Wyeth indicates intermediate sericin levels. As some of the sericin coating may have been lost over the centuries, and as it is likely that ageing and deterioration may affect the IR spectra of fibroin and sericin proteins, the results should be interpreted with some caution. That said, it appears plausible that the original sericin content was higher than currently observed, suggesting that both the picots and metal threads were made with more or less undegummed silk.

The openwork braid from Alvastra Abbey

The braid recovered in 1949 at Alvastra Abbey is very deteriorated and also very short: 5.5 cm long and 0.6 cm wide. It is braided with silk and metal threads. Both ends are folded in, probably in order to fasten it onto something by sewing. The braid is U-shaped and may have been used as a fastening loop (fig. 6). Most of the braid is compressed and the structure is difficult to see, except at the ends where it shows clearly. Most of the silk threads are missing, while the metal threads are better preserved. Small segments of silk are fixed between the metal threads, allowing the braid construction to be examined.

The structure of the Alvastra braid is the same as the Riddarholmen braid's. Thus, it is an openwork type braid, and the extra crossings characteristic for openwork braids are clearly visible. This braid too is made with parallel running threads. There are three crossings of the two-paired elements of metal thread left at both sides where the silk is missing (fig. 7).

Whether the paired elements once showed the same elegant turns as in the Riddarholmen braid cannot be absolutely determined, as the braid is too deteriorated and deformed. There are no traces of any attached picot similar to the one found on the other braid.

The entire braid was examined without coating under low vacuum (0.4 mbar) in a Philips XL 30 ESEM-FEG unit. Images were recorded in back-scatter mode, and elemental analysis was

Fig. 6. The braid from Alvastra Abbey. Photo: Gabriel Hildebrand, National Historical Museum.

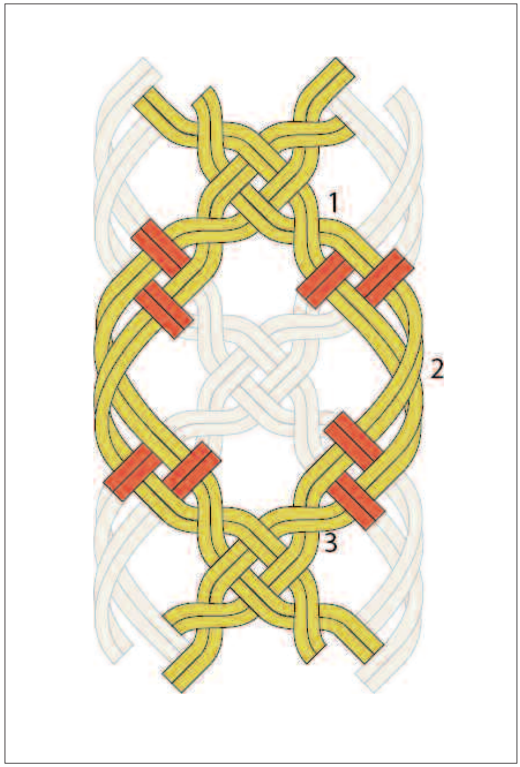

Fig. 7. Schematic drawing of the Alvastra braid. The missing parts are grey. The numbers on the drawing indicate the remaining crossings and the short red lines indicate the remains of silk thread. Drawing JB.

carried out using an acceleration voltage of 20 kV. In addition, digital microphotographs of this object were recorded with a standard stereo microscope (fig. 8a). While the core silk fibres are in good condition, the metal strips wound around them are covered with dirt and corrosion. In many places the strips have fallen off. An SEM image of a metal thread detail is shown in fig. 8b. The metal strips are 0.39 mm wide and consist of >99% silver, with no evidence of gold coating. The corrosion products were identified as silver sulphide and silver chloride. The deteriorated and fragile nature of the braid precluded taking samples. Hence, the thickness of the metal strips could not be measured, nor could the interior side of the metal strips be investigated.

Discussion and conclusions

In essence, the two braids from Riddarholmen Church and Alvastra Abbey are identically plaited, but only the Riddarholmen braid has picots sewn onto it. The metal threads from the two braids display a 0.06 mm difference in diameter, and only the metal threads from the Riddarholmen braid are gilded – the Alvastra braid metal threads are pure silver. The silk and metal threads for the braids were imported, but the braiding technique was known in 15th century Sweden and was practised, for example, by the nuns of Vadstena Convent. Thus, the braids may very well have been plaited in Sweden.

The studied braids are unusual for several reasons. The use of paired elements in openwork braids is a feature not observed elsewhere, and

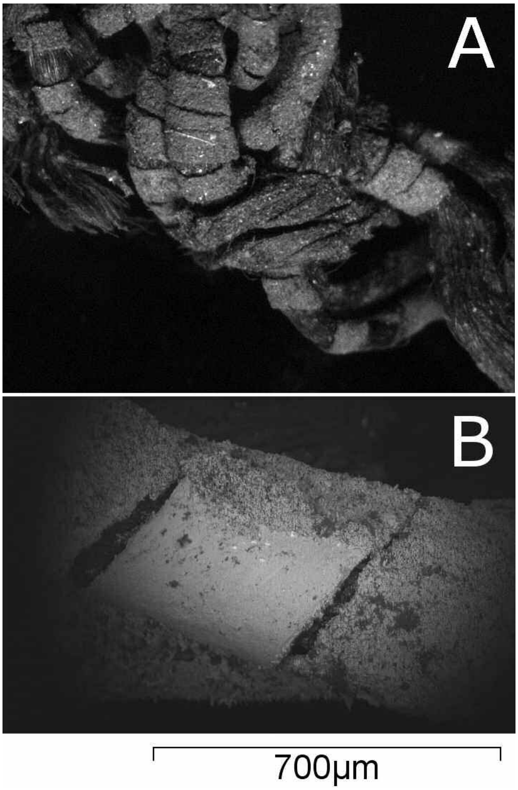

Fig. 8ab. Optical microscope image (a) and scanning electron microscope image (b) of details from the Alvastra Abbey braid. Photo SW.

the attached picot edges on the Riddarholmen braid are atypical: in other openwork braids such as bobbin lace, the picots are made from the braiding threads and form an integral part of the structure.

The earliest examples of metal embroidery, in Sweden and elsewhere, consist of round-section wires of pure gold or silver (Higgins 1993). During the 10th century, flat metal strips of solid gold or silver began to be used (Larsson 2007), and in the early mediaeval period gilded silver and silvered copper strips made their first appearance in Sweden (Geijer 1972). These strips are coated on one side only, but during the 16th century strips gilded on both sides were introduced and soon became the dominant type (Tronner et al. 2002, pp. 109–116). Thus, it is not surprising that the metal threads from the Riddarholmen braid are coated only on the outer side. The single-sided gilded silver strips were typically cut from a sheet of silver foil coated with gold, while double-sided strips were usually made from gilded then flattened silver wires.

The silver in Swedish metal threads is often very pure, close to 98–99% (Bergstrand & Hedhammar 2006, pp. 11–28; Larsson 2007). Central European metal threads from the 15th to 18th centuries have been reported to contain silver alloyed with up to 17% copper, while much smaller amounts of copper, 0.2% to 1%, are observed in the silver layers of 16th to 19th century Near Eastern metal threads (Muros et al. 2007, pp. 229–244 w. refs). Given the high quality silver in the studied metal threads, and given that local production of Swedish high-quality silver only began with the opening of the Sala silver mine during the 16th century, it appears plausible that the studied metal treads were imported from the Byzantine region.

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Textiltekniska termer

Bobbin	knyppelpinne
Bobbin lace	knypplad spets
Loop-manipulation braiding	slyngat band (band flätade med öglor på fingrarna)
Openwork braids	flätade band med öppna trådändar (inga öglor)
Orthodox loop braiding	flätning med öglor som går rakt igenom varandra till skillnad från *unorthodox loop braiding* där en ögla kan gå över en annan ögla
Picot	picot (liten ögla i kanten av en spets eller band)
Torchon ground	rutbotten (en typ av botten i knypplad spets)
Undegummed silk	silke som har kvar sericinet som producerats av silkesmasken för att hålla samman de två silkestrådarna som den gör kokongen av

Summary

The Swedish National History Museum holds two braids of red silk and metal thread, crafted in a loop-manipulation braiding technique. One was excavated in 1915–16 from a tomb believed at the time to harbour the remains of King Magnus Ladulås (Barnlock) in Riddarholmen Church, Stockholm. The other braid comes from an excavation at Alvastra Abbey, Östergötland, in 1949.

The braid from Riddarholmen Church is made with eight elements, each consisting of two parallel threads. Four of the elements are silk and four are metal thread. The same basic structure is present in the other braid from Alvastra Abbey. Whether the paired elements here show the same elegant turns as in the braid from Riddarholmen Church cannot be absolutely determined.

In the Riddarholmen braid, bright red picots running along both sides of the ribbon are formed from two separate continuous threads. There are two picots between each of the attaching overcast stitches. The picot thread appears to be of undegummed silk, and the sewing thread used to attach the picots is likely of a similar material. The silk gum, sericin, would have helped the picots to keep their shape, as it stiffens the material by gluing the fibres together. The picot thread displays a high twist, and in order to achieve the consistently round shape of the loops, the picot thread must have been wound around a metal rod, a needle, or a round thread. Exactly how the picots were made is however not clear. The braid from the Alvastra Abbey does not have or retain any picots.

The silk threads in the Riddarholmen braid are now reddish brown, but may originally have been bright red. They are two-ply and have a very low amount of twist in the S direction. Most of the silk is now missing from the Alvastra Abbey braid. The metal thread in the Riddarholmen Church braid has a golden yellow silk core, also S ply, around which a flat, narrow strip of gilded silver has been wound in S direction. The metal surface displays spots of corrosion together with small patches of gold coating, i.e. remains of a gilded layer. The metal thread from the Alvastra Abbey is made from silver strips with a silk core but no evidence of gold coating.

The results of the present studies and analyses of the braid from Riddarholmen Church are not compatible with the results from 1915–16. The Alvastra Abbey braid, which has not seen publication previously, was made with the same technique as the Riddarholmen braid, but using a different metal thread.

Both braids can in all probability be dated to the 15th century. The age of the Riddarholmen braid can be inferred from the recent 15th century dating of the human remains in the tomb. In principle, it cannot be ruled out entirely that the braid derives from the tomb renovation ordered by King Johan III in the late 16th century (Fürst & Olsson 1921), but the find location of the braid fragments – sandwiched between the human remains – makes this possibility unlikely. The dating of the Alvastra braid is based on its similarity to the Riddarholmen braid and to other 15th century braids among extant Bridgettine textile objects, as no stratigraphic information survives from the excavation.