

The Cap of St Birgitta of Sweden: research and conservation of medieval reliquary

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ABSTRACT

The article is about the documentation and conservation of a medieval reliquary known as the cap of Saint Birgitta of Sweden from the Cathedral of Turku, SW Finland. The object is made mostly of textile materials (silk, linen, nettle and cotton) but there are some membrane metal threads and leather parts. Optical microscopy was used in the identification of textile fibres and the XRF analysis for metal identification. Several materials have been radiocarbon dated. The main challenges for conservation were the poor condition of the object and the undocumented previous conservation in the 1920s. Ethical consideration was needed when evaluating the current construction and the shape of the object. The main conservation treatments were surface cleaning and supporting the fabrics of the object on support fabrics (silk or silk crepe) using couching stitches. The new support of buckram was made. The old unpleasant conservation stitches were removed, but the shape of the reliquary was partly preserved.

Keywords: textile reliquary, nettle, silk tabby, membrane metal threads, tablet-woven band, textile conservation

1. Introduction

The Turku Cathedral, in Southwest Finland, has quite a remarkable collection of medieval relics (see Map 1). The collection consists of approximately 90 items including several small textile-wrapped relic bones with *cedulae* (strips of parchments bearing usually a saint's name) and some bigger skull-shaped textile reliquaries or remnants of them without recorded authenticity. One of those, the reliquary of St Birgitta of Sweden¹ (1303–1378), is discussed in this article. The object is made mostly of textile materials (silk, linen, nettle and cotton) but it is adorned with some metal thread embroideries and metal coated leather strips. The article is based on my textile conservation dissertation (Karttila 2012) and it is a part of the on-going Relic project² (2007–) which aims to re-examine and authenticate the Turku Cathedral's relic collection using advanced scientific methods.

Most of the Turku cathedral's relics were kept in a late medieval wooden casket traditionally attributed to the Blessed Bishop Hemming (c. 1290–1366) probably for centuries. The interest in researching the relics rose during the restoration of the Turku cathedral in the 1920s and the results were published by the state archaeologist Juhani Rinne in 1932. Rinne attributed the reliquary to St Birgitta of Sweden. According to Rinne (1932, 356–357), the cap of St Birgitta was in poor condition. Three contemporary black-and-white photographs in the National Board of Antiquities' picture collection conform this.³ The time and dust, not to mention the treasure hunters and collectors of curiosities, had affected the condition of the object. It was conserved in the 1930s in the National Museum of Finland and, until recently, was stored among the other relics.

A reliquary, as an ecclesiastical object, is a material expression of the cult of relics. The textile reliquaries of the Turku collection can provide information about the material culture of the Middle

¹ The cap of St Birgitta discussed here is a reliquary and not a real cap. There is an actual piece of clothing known as the cap of Birgitta which is in the possession of the Marie Refugie convent in Uden in the Netherlands (Dahl and Sturtewagen 2008). This one is quite known especially among the re-enactors of the Middle Ages.

² The Relic project is led by Jussi-Pekka Taavitsainen the professor of archaeology at the University of Turku, Finland.

³ One of the photographs is published by Rinne (1932, 356).



1. Turku
2. Stockholm
3. Tallinn

Map 1. Placenames mentioned in the article of Karttila. Illustration: K. Vajanto.

Ages, especially in the textile materials point of view. Sumptuous reliquaries were an essential part of the presentation of relics in the medieval Catholic Church. Reliquaries were made of several materials, of which gems and gold were the most precious ones. Those materials reflected honour upon relics and created associations with the glory of Heaven. (Hahn 2010, 289, 309.) Thus the concerns of this article are with the materials of the reliquary of *St Birgitta* of Sweden: their original visual appearance and on the other hand the preservation and conservation of those materials.

The cap of St Birgitta is a valuable source of textile research for several reasons. The first one is that due to the Reformation in the kingdom of Sweden in the 1520s, the reliquary is still mainly in its medieval appearance, although it has lost most of its original glory. Therefore the materials of the reliquary are from the age before Reformation.⁴ The relics in active ecclesiastical use were repeatedly wrapped in new silk fabrics to protect them against the wear and tear of time (Ozoline 2009, 28; Hahn 2010, 291–292; Immonen and Taavitsainen 2011, 164). During the reformation, a lot of relics were destroyed. The Turku Cathedral is the only church in Finland where at least a part of the relic collection has preserved.⁵ The second reason is the previous restoration during which most of the original sewing stitches were unravelled and hence it has been possible to research the reliquary and its composition in detail layer by layer without ethical dilemma. The undocumented previous conservation causes also one of the main challenges for the interpretation of the object. During the re-examination of the cap of St Birgitta it was revealed that the conservator had most likely made some interpretations which did not follow the original structure of the reliquary.

Because contemporary (medieval) written sources about the relics of Turku Cathedral are scarce, the examination of the materials and the producing techniques can give some clues about the origin of the reliquary. Thorough documentation can also reveal the original appearance of the materials. Optical microscopy, XRF analyses and radio carbon dating results were available. They can provide more specific information relating to the reliquary's age, provenance and the chronology of possible alterations.

The article is divided in two sections: research and conservation. In practice, material research is an essential part of the conservation process. Detailed examination of the object is carried out before treatment to evaluate the condition. Condition survey expands understanding of the object's biography. The identification of materials helps in choosing suitable conservation treatments and materials. In conservation decision-making process it is important to access the object in its context and to evaluate the possible values and meanings it carries.

2. Material research

2.1 Visual and technical analyses

The materials were documented using the basic guidelines of the cataloguing of archaeological textiles (Jones et al. 2007; Walton and Eastwood 1988). The dimensions, weave techniques and thread counts of textiles were documented as well as the spinning directions and angles⁶ and the diameters of the yarns. Samples approximately 2–3 mm in length of both warp and weft yarns were collected from each textile fragment for fibre identification in a transmitted light microscope. Furthermore textiles appearance and visual impression were considered. Recently it has been pointed out that the standard analyses of archaeological textiles are necessarily not enough to describe the visual appearance

4 In Finnish history writing the Middle Ages (1150–1523/1570) starts and lasts later than for example in the western and central Europe.

5 A reliquary cross which contains the relic of St Mary Magdalene was found in the altar of Föglö Church in Åland during the archaeological excavation as part of the restoration of the church in 1966–1967. The relic is wrapped in silk fabric. (Immonen 2009, 72.) No reliquaries of metal have survived in Finnish churches mainly due to the confiscations of valuable ecclesiastical property during the Reformation process in the 16th century (Immonen and Taavitsainen 2011, 142).

6 The classification of the angle of the twist is the following: loose up to 10°; medium 10° to 25° and tight 25° to 45° (Emery 1994, 12).

Table 1. The qualification of fabrics based on the sum of thread density (Malmius 2001, 76).

Quality of fabric	Sum of thread density (threads/cm ²)
very fine	>30
fine	20–30
medium	14–19.75
coarse	<13.75

Table 2. The qualification of yarns according to their diameter.

Category	Diameter of yarn (mm)
very fine	<0.3
fine	0.3–0.4
fine-medium	0.45–0.6
medium	0.6–0.8
medium-coarse	0.8–1.0
coarse	1.0–1.2
very coarse	>1.2

of textiles. Features clearly visible to the naked eye are not visible in basic technical data of textiles which makes comparing textiles from different sites difficult. (Hammarlund and Pedersen 2007, 213; Hammarlund et al. 2008, 69, 86; Christiansen et al. in this volume.) One basic idea of sorting textiles according to their appearance is to find out in which purpose the textiles were originally produced and what social status they possibly carried.

The qualities of the textiles are clarified using the term sum of thread density. It is counted by summing up the average number of the warp and weft threads in a square centimetre (cm²). The bigger the number the finer and denser the fabric is. According to the classification based on archaeologist Anita Malmius (2001, 76) the textiles can be divided in four classes (Table 1).

It can be misleading to use thread count as a qualitative description without taking into account the diameters of the yarns (Hammarlund 2005, 115). For example, the ratio of diameters in warp and weft affect the texture of the fabric. Therefore the yarns of every fragment were classified according to Lena Hammarlund's classification (Table 2) (Hammarlund et al. 2008, 72).

The fibres were identified from their characteristic longitudinal morphology using magnifications of 200x and 400x. A reference sample of hand processed nettle (*Urtica dioica*) fibres was done to help the comparison of bast fibres. X-ray fluorescence (XRF) analyses⁷ were carried out to determinate the composition of metal threads and metal coating of leather strips. The method is non-destructive. The radio carbon dating was already performed on several materials of the reliquary by Professor Göran Possnert in The Ångström Laboratory at the Uppsala University, Sweden.

2.2 Results

2.2.1 The construction of the object

The reliquary is composed of several layers of fabrics: there are two layers of bottom fabrics and



Fig. 1. The cap of St Birgitta before the conservation in 2012. The measurements of the reliquary are c. 14 cm x 14 cm x 8 cm. Photo: A. Arponen.

⁷ The XRF-measurements were carried out by the author using Innov-X instrument in the Metropolia University of Applied sciences, Vantaa.

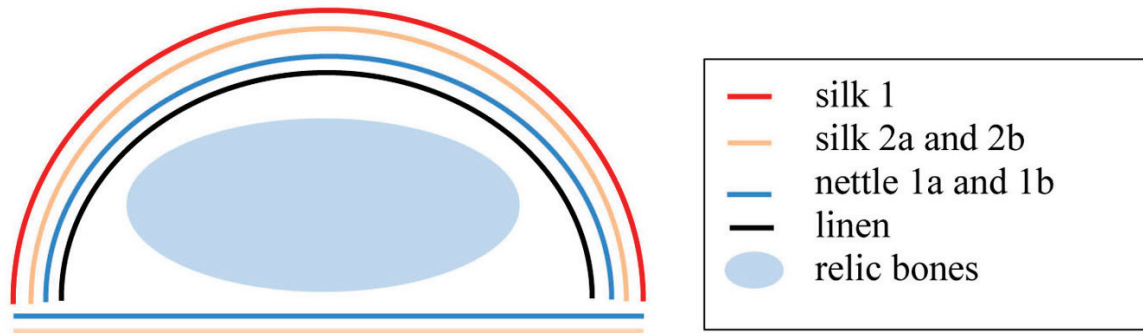


Fig. 2. The construction of the reliquary. The fabrics are named according to the material. Photo: M. Karttila

four coverings (Figs. 1 and 2). Inside there are many pieces of bone, each of which is wrapped by a piece of fabric. These small relic packages may have originally been sewn together as a shape of a calotte (the upper part of the skull) or possibly even a bigger structure (skull?) provided that some bones are missing or stuffing material is not in place anymore. However, the bone construction has given the shape to the reliquary. Also, a fragment of dress with triangular inserted gore was found inside the reliquary. The fragment, used probably as a stuffing material, is not discussed in the present article.

The reliquary is decorated with a two-coloured tablet-woven band and two white crossing bands with narrow metal-coated leather strips. On the tablet-woven band there are four rectangular leather pieces (originally metal covered) with metal thread embroidery.

The inner silk covering (silk 2) of the reliquary is mounted in place using some pleats and a seam which connects the short edges of the fabric. It also has a fold in the lower edge. Silk 1 has a seam running across it and the edges are fragmentary. Other fabrics are roughly cut fragments without any sewing or mounting. The textiles of the reliquary are presented in detail in the following chapters.

2.2.2 The radio carbon dating

The radio carbon dating results place the producing of the reliquary most certainly at the end of the 13th century (Table 3). Based on the results it seems possible that at least some of the decorative bands are somewhat later additions. It is worth taking into account that the dating results told the date of manufacture of a certain material, not the date of the producing of the reliquary. It seems probable that the materials of the reliquary are recycled and reused. The dating of relic bones is not completed yet. So far it seems that the oldest relic bones date between the years calAD 130–340. Also the dress fragment found inside the reliquary is remarkably older than the other textiles.

Table 3. The radio carbon dating results of the materials of the cap of St Birgitta.

Sample	Laboratory no.	¹⁴ C date BP	Calibrated range AD (95,4 % probability)
silk 2a	Ua-40732	815±30	1160–1270
silk 2b	Ua-42601	685±30	1260–1320 & 1350–1390
nettle 1a	Ua-42602	833±30	1150–1270
tablet-woven band	Ua-40729	831±30	1150–1270
cotton band	Ua-40730	613±30	1290–1410
leather strip	Ua-40731	632±30	1280–1400
leather piece on the tablet-woven band	Ua-42603	701±30	1260–1310 & 1350–1390

Table 4. The technical data of the silk fabrics of the cap of St Birgitta.

Fabric and weave	Size (cm)	Thread count (threads/cm)	Twist	Diameter of yarn (mm)
silk 1 (tabby)	17 x 13.5	31–33/24–30	I	warp: c. 0.1; 0.2; 0.3; weft: c. 0.4
silk 2a (tabby)	41.5 x 17	32–37/18–22	I	warp: c. 0.1; 0.2; 0.3; weft: c. 0.2; 0.4
silk 2b (tabby)	18 x 21.5	30–38/19–21	I	warp: c. 0.1; 0.2; 0.3; weft: c. 0.2; 0.4

2.2.3 Silk wrappings

The outermost textile layers of the reliquary are made of red silk fabrics (silk 1, silk 2a and 2b). They are all tabby-woven and the yarns have no twist in either system (i.e. reeled silk). All fabrics have warp threads of three different diameters (Table 4). It is worth noting that the cross section of the yarns without twist is not round, but rather flat. Thus the measurements are average values. However the finest yarn is approximately 0.1 mm in diameter. The second one is two times, and the third three times thicker. The diameters of both warp and weft threads range from very fine to fine. Based both on technical data and visual appearance the inner silk (2a) covering and the bottom silk (2b) are cut out of the same fabric.

Silk 2a and 2b

Although the tabby is the simplest weave, the weaver has managed to achieve checked and striped texture by using variable diameters and spacing of the warp and weft threads i.e. more open sections alternate with denser areas in both thread systems (Fig. 3). Hence the thread count is not even. The yarns with no twist create special shine on the surface of the fabric. This is evident especially in looser woven areas. Thus the variation of straight and irregular⁸ sections in the weave structure creates shiny and matt surfaces. The loom width has been over 41.5 cm, which is the current width of the fabric.⁹

There are some knots in the weft yarns which probably indicate the breaking of the yarn during the weaving (Fig. 4). It is also possible that the weft yarn has been less expensive and not so high quality silk thread. Based on the literature (Crowfoot et al. 2006, 19), the silk threads with slubs (i.e. fluff, dross or knots) formed during reeling were used for the weft in less costly fabrics.

The original colour of the silk fabrics has probably been something between red and pink. The pink colour is still visible inside the pleats and on the lower edge fold. Otherwise the fabric is very faded. The same pink colour can be detected on sewing threads of silk on the reverse of the fabric i.e. parts which have been protected from light. The dye analyses were not performed.

There are two pleats sewn on the right side using overcast stitches and silk thread. During the conservation the size and shape of the silk 2a became visible. Quite a big part of the fabric, including unravelled pleats, was folded inside the reliquary probably during the previous conservation. This interpretation is based on the fact that the folded part



Fig. 3. The checked and striped texture of the silk 2a is still seen. Photo: M. Karttila



Fig. 4. A knot in a weft yarn of the silk 2a. It can be seen as a tell-tale sign of a lower quality fabric. Photo: M. Karttila

⁸ The thread systems can be classified as straight and irregular systems. The straight system is characterised by threads with about the same amount of space between them and a right angle between the warp and weft threads. The appearance of the textile is even and regular. Irregular thread system occurs when warp and/or weft threads have a variable spacing. (Hammarlund et al. 2008, 73–74.)

⁹ The denser thread system is regarded as warp. In this case it is also the system in which the diameters of the threads vary more than in the other system.



Fig. 5. There are many holes and broken threads in the silk 2a and 2b.
Photo: M. Karttila

of the fabric is as faded as the parts which were visible in the 1920s appearance. The hidden part of the reliquary covering gives an important clue about the alteration of the reliquary. There is a fold in the bottom edge of the silk fabric and a small fragment of plant fibre fabric (lining?) sewn with silk thread using running stitches on the reverse. There are also stitch holes and pieces of cut threads still in place which were all documented. The silk 2a and b are both in poor structural condition with many losses (i.e. holes) and broken threads in the loose-woven sections of the fabric (Fig. 5).

Silk 1

The uppermost silk cloth of the cap of St Birgitta is very fragmentary and the original size and shape are not possible to be reconstructed precisely. It is badly faded to beige but the original bright red colour has survived under the decorative cotton bands. The appearance of the fabric differs from the other silks in some points. It has some ribbed (weft-faced) sections, the weft yarns are equal in diameter and it is a little bit denser than the silk 2a and b (Table 4). The thread system is straight, even though there are

variations in thread counts. The fragment consists of two pieces. There is a seam sewn reverses facing with bright red silk thread (2S) and relatively short running stitches. The seam might be evidence of primary use of textile.

2.2.4 Bast fibre wrappings

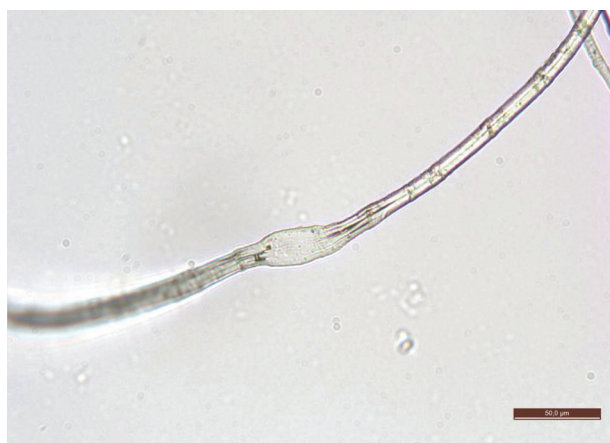
The inner fabrics of the reliquary are made of plant fibres. Two of them probably belong to the same textile (nettle 1a and 1b). The fabrics are tabby in nettle, woven of z-spun warp and weft threads. The thread count is c. 25/21 per cm. By the sum of thread density the fabrics can be classified very fine ones (Table 5). The diameters of the yarns vary in warp and weft. However all the yarns are classified as very fine ones. The use of thicker threads approximately every ten threads in both systems produces an effect of horizontal and vertical bands across the textiles, i.e. checked pattern. The fabrics have a 5 mm wide half-basket woven selvage at one side. They are irregular in shape and the edges are cut carelessly.

Both fabrics have originally been white. Fibres were identified as bast fibres according to the characteristic nodes. Fibres also have wide and flatten sections which are typical to nettle fibres (Fig. 6a) (Wülfert 1999, 277; Kirjavainen 2005, 98). The comparison to the reference material done of hand processed nettle fibres (*Urtica dioica*) proved the material as nettle (Fig. 6b). Visual appearance of the fabrics is light and thin and they are a little bit transparent.

The innermost fabric of the reliquary differs in material and appearance from the above mentioned. It is a balanced tabby in linen, woven of z-spun yarns in both systems. The thread count is 17/16 per cm and it can be classified as very fine textile but it is coarser than nettle textiles. The mean thread

Table 5. The technical data of the bast fibre fabrics of the cap of St Birgitta.

Fabric and weave	Size (cm)	Thread count (threads/cm)	Sum of density (threads/cm ²), quality	Twist, tightness of twist	Diameter of yarn (mm)
nettle 1b (tabby)	18.5 x 22	25/21	46, very fine	Z/Z, medium	warp: 0.1; 0.2; 0.3; weft : 0.1; 0.2
nettle 1a (tabby)	24.5 x 23.5	25/21	46, very fine	Z/Z, medium	warp: 0.1; 0.2; 0.3; weft: 0.1; 0.2
linen (tabby)	26 x 21.5	17/16	33, very fine	Z/Z, medium	warp and weft: 0.2; 0.4; 0.5



A



B



C

Fig. 6. A. Microscope image of nettle fibre from the fabric of the reliquary. B. Microscope image of reference nettle fibre. The sample was taken from nettle-wool thread. C. Nettle fibres from the metal thread of the reliquary.

Photos: M. Karttila

are s-twisted and they cover the core only partly. This already spun thread is once more z-spun around another thicker core in natural white linen (?) thread.¹¹ Visual observation of the thread under the optical microscope showed the presence of a tiny amount of gold on the tarnished blackish metal.

diameter is higher than nettle fabrics (Table 5). The diameters of the yarns in both systems vary but there is no systematic pattern on the fabric.

2.2.5 Decorative bands

A narrow tablet-woven band (c. 1.2 cm x 28 cm) covered a part of the lower edge of the reliquary. The warp threads (2S) are green silk and the weft is made of blue linen threads (2Sz) (Fig. 7). The colour of the silk threads is not even. The band is woven with 16 rectangular tablets with four threads in each and there are 19 weft threads per centimetre. It is a simple warp-twined band where all the tablets are turned together always in the same direction, forward. Usually the weft threads are not visible in tablet-woven bands because the warp threads lie close together (Karisto 2010, 26). In this case there is space between some warp threads – left on purpose – so that the weft threads made of different colour than warp threads are seen. The result is a two-coloured band with vertical stripes in the weaving direction.

The warp threads are not evenly spaced throughout the band. Nonetheless the weaver has most certainly used some sort of warp spreader, a rod with holes drilled through it, to keep the warp threads further from each other. Thus far I have only been able to find one example of a similar technique: a girdle from Vaalermoor North Germany (Collingwood 1996, 75).¹⁰

On the band there are four rectangular, originally metal coated, embroidered leather pieces (c. 1 cm x 3.4 cm), sewn in place with two stitches from each corner (Fig. 8). The leather is stiff, natural white and relatively thick. Parts of the metal thread embroideries and metal coatings are preserved only on two leather pieces. The stitch holes on the leather pieces are the only evidence of now lost embroideries. The stitch-hole patterns are quite similar on all leather pieces.

The embroidery threads are made of gilt silver membrane (gut) strips, which are wound around a nettle thread core (Fig. 6c). The strips

¹⁰ According to Collingwood (1996, 75) the girdle is from the Iron Age.

¹¹ In common, metal threads can be divided in two groups according to their morphology. 1. strips i.e. solid metal strips or metal coated strips made of organic materials. 2. solid metal wires. Usually the threads were spun around the fibrous core (yarn). (Járó 2009, 68–69.)



Fig. 7. The two-coloured tablet-woven band from the lower edge of the reliquary. The width of the band is c. 1.2 cm. Photo: M. Karttila



Fig. 8. The best preserved metal thread embroidery of the reliquary. The size of the leather piece is c. 1 x 3.4 cm. Photo: M. Karttila



Fig. 9. A detail of the metal-coated leather strips which are sewn on the cotton bands of the reliquary. The layer of yellow lacquer is preserved only partly. Photo: M. Karttila

XRF analyses indicate that the strips are made of silver and gold. Also, a small amount of copper was detected. However, the metal surface of the membrane is partly lost and so worn that the embroidery was documented (Rinne 1932, 357) as being made of small pearls. Still whitish nettle core of the metal thread and its tight spinning around the second core are also reasons for this interpretation.

In my opinion the embroideries resemble decorative filigree work which was in fashion, for example, in reliquaries made of precious metals in the 14th century (Van Os 2000, 138). It was typical to add precious stones to those works – there are two small coral¹² beads left sewn on one edge of a leather piece. The remnants of sewing threads are evidence of similar beads in the corners of every leather pieces. Coral was used as a decorative element for example in reliquaries, rosaries and ecclesiastical textiles in the Middle Ages (Egan and Pritchard 2002, 309; Estham 1991, 36). An example of quite a similar embroidery technique can be found on the mitre-shaped reliquary of St Rayner (Raniero) of Forcona, Italy, from the end of the 13th century.¹³ It has some filigree embroideries made of membrane metal threads on (at least partly) a gold foil coated parchment ground. The core of the metal thread is documented as white linen. (Blöcher 2012, 236–238.)

There are three pieces of white crossing bands (17 cm, 12 cm and 1.8 cm in length) on the reliquary. The bands are balanced (22/21 threads/cm) tabby in cotton, woven of z-spun warp and weft yarns. According to the sum of density the cloth can be classified as very fine. The diameters of the yarns range between 0.3 mm and 0.4 mm. The bands are approximately 1.1 cm in width and cut on the bias. The raw edges are folded under.

Two narrow decorative metal coated leather strips are sewn on the bands with linen thread (z2S) using overcast stitches. The XRF measurements indicated that the coatings of the strips are made of tin-iron alloy (Sn 59.30 % and Fe 40.70 %). The strips are lacquered yellow to imitate gold (Fig. 9).

¹² The identification of the material is based on visual observation.

¹³ Some other examples are the embroidery on gold sheet coated parchment on the mitre from Lower Saxony and the parchment ground for the embroidery on the Italian mitre of St Bonaventura (Blöcher 2012, 258–259; 303–304).

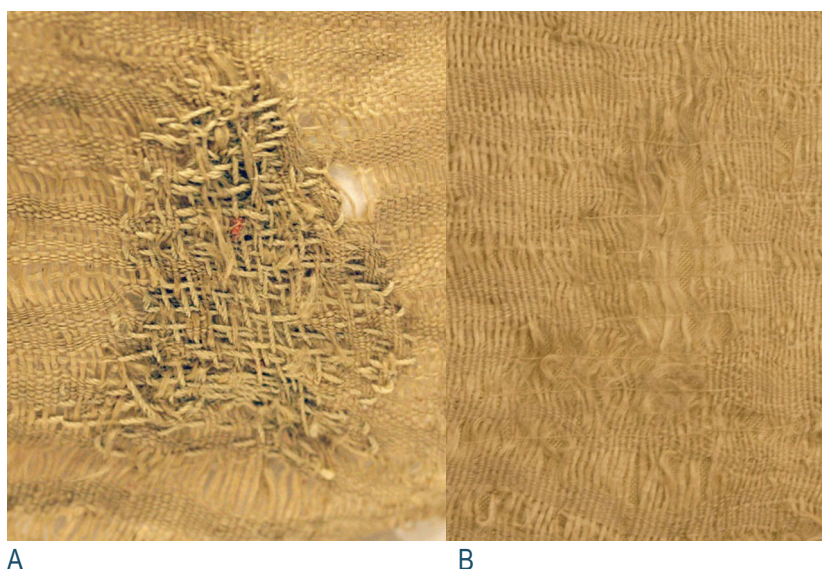


Fig. 10. A. A darned area in the silk 2a of the reliquary. B. The same area after conservation in 2012. The area was supported on silk fabric using silk thread and couching stitches. Photos: M. Karttila

3. Conservation

In the conservation decision-making process many values and meanings of the object affected on the conservation treatment choices. First of all the cap of St Birgitta with its relic bones is nowadays a museum object and not in religious use, it is not a subject of active veneration. However, it is worth noticing that the cult of saints is an essential part of Catholic faith.¹⁴ The historical and research values of the materials were considered. The high age of the object was also considered. Hence the main principles of the conservation were the minimal intervention, re-treatability and accessibility to researchers in the near future. Any treatments that could influence the results of scientific analyses were avoided. Furthermore the evidence of use and history of the object were considered valuable and worth preserving.

Visual examination of the reliquary prior to conservation indicated several darned repairs in modern beige silk thread and the alteration of the construction most probably done during previous conservation in the 1920s. It also revealed that a lot of the original stitches have been unpicked and a piece of fabric may have been cut off. There are no records of previous treatments of the reliquary to confirm the changes and unfortunately all three black and white photographs from the 1920s are taken from the same side of the reliquary. In the very beginning it was realised that the original shape of the reliquary was impossible to be recognised even though the pleats and fading patterns on the silk coverings gave some clues about the original appearance.

Both silk coverings (silk 1a and 2) of the reliquary were in poor condition structurally. Especially the silk 2 was very fragmentary with lots of losses. First of all the darned repairs from the previous conservation were removed, because they caused tensions which in turn had led to small tears in the fabric. They were also aesthetically unpleasant (Fig. 10a). The fragment was carefully surface cleaned by vacuuming. Small wax stains were left in place. They were regarded as an integral part of the reliquary's history as they are most certainly a result of medieval relic veneration – candles were burnt on the altars of the saints.

The contact humidification through a Sympatex membrane was used to ease out some creases and distortions caused by darning. The pH of the silk fragment was measured to evaluate the possibility for moistening the textile. The pH indicated that the fabric is only slightly acidic. Therefore there was no risk of the fibres disintegrating upon moistening as a result of over-acidification. An odour of incense was smelt during the humidification.

¹⁴ Some recent case studies about conservation of relics and textile reliquaries are published by Ozoline (2009) and Van Cleven and Van Eenhooge (2010).



A



B

Fig. 11. A. The edges of the silk crepline were stitched inside the buckram mount. B. The bast fibre fabrics in place and covered by silk crepline. Photos: M. Karttila

Both silk coverings of the reliquary needed structural support. Silk 2a was supported on the silk fabric (Habutai medium) with organzine silk thread (two strands) using couching stitches (Fig. 10b). The support fabric and thread were dyed (Lanaset, Ciba-Geigy) to match the colour.

Minimal treatments were given to the nettle and linen cloths of the reliquary. The inner most linen cloth was not surface cleaned at all allowing for the possibility for future study. Both nettle fabrics were vacuum cleaned because of some inactive mould on them. Previous conservation stitches (i.e. darning) were left in place in the bottom nettle fabric as an evidence of the object's life and history of conservation.

It was decided to conserve the reliquary to the same construction and shape it got as a result of the previous conservation. A metal wire structure which was added inside the reliquary to maintain and support the reliquary in the 1930s was replaced by a new custom-made buckram¹⁵ mount. The mount was slightly padded using polyester wadding and covered with undyed silk fabric. The lower (linen and nettle 1a) fabrics of the reliquary were secured in place on the mount by covering them with undyed silk crepline. The edges of the crepline were stitched inside the mount (Figs. 11a and 11b). Thus no stitches through the original textiles were needed to support them.

Silk crepline was chosen for supporting the outer most silk covering (silk 1) of the reliquary. In this case there are several advantages in choosing silk crepline for supporting. It was possible to apply silk 1 and also the decorative bands in their places without sewing them on the silk 2a. One compromise was accepted –the crepline covers the fine structure of silk 2a. On the other hand it provides some protection for the fabric underneath (silk 2a). The edges of the silk crepline were stitched inside the mount.

Both the bottom fabrics of the object were left to be stored separated. The research project goes on and for example the dating of relic bones is not finished yet.

4. Discussion

The art historians Sofia Lahti and Elina Räsänen (2008, 242) have argued that it is not possible to understand and interpret medieval images (for example reliquaries and polychrome sculptures) without taking account the visual factors of the materials they are made from. When studying medieval mate-

¹⁵ The buckram is a general name for the stiffened cotton or linen fabric and it is used for example by milliners. 20% wheat starch and strips cut of cotton-linen fabric were used. The strips were impregnated with a starch, put in place on the Ethafoam (polyethylene closed-cell foam) mould and left to dry into a hard shape. The buckram mount was made according to the directions of *Practical guide to costume mounting* (Flecker 2007, 210–212).

rial culture it is essential to know the social messages which different materials carried. In Europe during the early Middle Ages silk was available for only those with ties to the Byzantine and German imperial courts or the papacy. Silk was since then associated to power, wealth and high status. (Fleming 2007, 128, 132.)

Silk as a precious material was considered worthy of touching the sacred objects (Lahti and Räsänen 2008, 250). Thus it was a common practise to wrap relic bones in silk fabrics throughout the Christian world from the Early Church onwards. The silk fabrics of the cap of St Birgitta were certainly not the most expensive ones. To be precise, the relic bones are each wrapped in the bast fibre cloths and only the upper most cloths of the reliquary are made of silk. The materials of silk 2a and 2b – weft threads with knots – can be regarded as lower-quality. When comparing the silks of the reliquary to the multi-coloured pattern-woven samite and lampas fabrics or brocades with gold threads they are very simple in weaving technique and thus not so time consuming to weave. Nonetheless these low-grade fabrics have had an important recognised feature of silk: the fabulous shine.

There are some archaeological evidence for more or less similar one colour silk textiles as in the cap of St Birgitta from London's medieval excavations, as well as from the Viking settlements in York (Coppergate) and Dublin (10th–13th century). The latter are probably fragments of caps and scarves. The fabrics are considered to be produced in Baghdad (Wincott Heckett 2003, 106, 111) or in the Mediterranean (Muthesius 1995, 341). Comparison is difficult because the accurate descriptions of the visual appearance of those textiles are not published. On the other hand the fragments from London are relatively small and in too poor a condition to get an overview of their original structure. In addition, medieval silk textiles with yarns without twist have been documented in the Swiss monasteries and a couple of cathedrals (including Speyer and Durham) in relic context (Wincott Heckett 2003, 94–95). Among the discoveries, there are also silk tabbies which are woven of only z-twisted yarns. In some textiles only weft yarns are without twist.

The silk fabrics of the cap of St Birgitta may also have western origin. During the 13th century there was already silk fabric manufacturing at least in Italy and Spain. The weaving widths of the z/z silk tabbies of Dublin are 8–24 cm, which means that small looms were enough to weave them (Wincott Heckett 2003, 91, 119). Thus they can be local production and the twisted yarns indicate the tradition to twist yarns made of other more familiar materials, for example wool and linen. It is obvious that more research concerning early tabby silk fabrics in Europe is needed to locate the origin of the reliquary's silk pieces. The dye analyses might give some clues about the manufacturing place.

The investigation of the reliquary revealed some technical and material choices used to imitate more precious materials and to improve the visual impression of cheaper ones. The gold imitating lacquered tin-iron alloy coated leather strips sewn on the cotton bands are among the most interesting finds. Also, the gilt silver membrane metal threads are cheaper versions of threads made entirely of gold or gilt silver. Actually, the whole embroideries on the metal coated leather strips can be seen as an imitation of filigree metalwork.

The special weaving technique of the tablet-woven band which left the weft yarns visible can be seen as a way to save silk thread. In the other words wider bands were possible to weave using less silk yarns. The innermost fabrics of the reliquary (which are not visible) are made of linen and nettle. The value of nettle fabric is difficult to evaluate because its use as a textile material is not widely researched. A reason for this is probably the well-known fact that distinguishing between bast fibres is very difficult. In this case the nettle identifications are based on the similarity to the reference sample of hand processed nettle fibres. More advanced techniques based on the detecting of calcium oxalate crystals were not available.¹⁶ However, the whiteness and the shine of the nettle fibres might have affected the value of the fabric.

¹⁶ More about the possibilities to identify nettle fibres by detecting of calcium oxalate crystals, see Bergfjord and Holst, 2010.

The cotton bands (AD 1290–1410) are also worth considering. Was the material still rare in northern (or central) Europe and the value based on it? Or was it again the impression of whiteness which was highlighted by gold-looking leather strips? Among the relic collection of the Turku Cathedral there is also contemporary dyed (red) cotton fabric, which has probably been a lining of a reliquary (Arponen 2011, 243).

Most certainly the textiles in the cap of St Birgitta are recycled ones. The seam with no purpose on the silk 1, a fragment of dress with gusset as a stuffing material and old stitching holes can all be seen as evidence of possible primary use of the textiles. The roughly cut edges of the bast fibre fabrics may indicate the secondary use of discarded textiles. It is known that silk textiles were recycled for example for book covers and purses. They were also donated to the churches for sewing ecclesiastical textiles, for instance chasubles and altar cloths.¹⁷ These pious donations were also used to clothe the statues of the saints. The wrappers of many relic bones are also evidence of the reusing of textiles. (Fleming 2007, 142–143; Monnas 2007, 14.) For example, the archaeological finds from medieval London have pointed out that only fabrics that could not be recycled any more were discarded (Pritchard 2010, 132). Also, the cheaper textile materials were reused. For example, fragments of a woman's underdress and a child's shirt were used as stuffing material under the silk thread embroidery on a late medieval chasuble from the church of Rauma in Finland (Kania 2010, 256–260). The embroidery is probably German work (Pylkkänen 1956, 14). What might be the original use of the tablet-woven band or the cotton bands, if they have one? They could have been decorative bands of garments or ecclesiastical textiles. The tablet-woven bands were also used as girdles.¹⁸

A common feature of Turku relics and reliquaries is that differing dates have been acquired from relic bones and materials related to them. In some cases the sewing thread of a relic package is younger than the fabric itself. This is interpreted as an indication of continuous care taking of relics. (Immonen and Taavitsainen 2011, 164.)

Concerning the origin and attribution of the reliquary, it is only possible to make educated guesses. The attribution to St Birgitta of Sweden is unlikely (see Lahti 2003, 6). In my opinion, the reliquary might belong to the cult of St Ursula and her 11 000 virgins which spread from Cologne throughout the Catholic Europe from the 12th century onwards (Karttila 2012, 9–10). The making and selling of skull shaped reliquaries was a flourishing business from the 12th century onwards. The bones of St Ursula and the virgins were found and collected from a vast cemetery dating back to Roman times. (Van Os 2000, 28–29.) For example, there are 47 recently studied and conserved¹⁹ silk covered skulls associated with St Ursula and her companions left in the Herkenrode monastery in Belgium. According to the radio carbon dating results the skull reliquaries are made in the 13th and 14th centuries and their first appearance included a tight linen wrap with a tabby silk wrapping covering the entire skull, except a section of the forehead. (Sorber 2010, 5, 14.) The textile-covered skulls of St Ursula's companion in possession of the *Lqd nad Wartq* monastery in Poland have similar features. In some cases, individual textile-wrapped bones have been sewn together to create a skull-shaped structure. (Nowiński 2010, 265, 267.) The cap of St Birgitta and another skull shaped reliquary²⁰ in the collection of Turku Cathedral has similar features too.

The less expensive materials of the cap of St Birgitta can be seen as a feature of some sort of mass production of reliquaries. The documentation and conservation of the reliquary revealed that it might have been originally skull-shaped. The interpretation is based on the fact that the silk fabrics (silk 2a and 2b) of the cap of St Birgitta have similar pattern (shape) than the outermost fabrics in above mentioned skull reliquary have (Karttila 2012, 42; see Geijer 1954, 291). Nowadays there

17 Some examples of ecclesiastical textiles made of garments, see Nockert 1988.

18 More about medieval tablet-woven girdles found from London, see Egan and Pritchard 2002, 35, 48–49.

19 The relics were documented and conserved at the Royal Institute for Cultural Heritage (KIK-IRPA) in Brussels in 2007–2010.

20 The skull reliquary is traditionally attributed to St Henrik of Uppsala or St Eric of Sweden which both can be seen as local saints.

are not enough relic bones for that construction, but the reliquary was not intact when it was documented in the 1920s.

The materials and manufacturing techniques of the cap of St Birgitta could give some clues about the origin of the object. For example, the tin-iron coated leather strips on the cotton bands might be worth more researching. Tin foil was used onto panel paintings and polychrome sculptures to provide metallic surface texture in several workshops, for example in the Low Countries. It was sold ready-treated in different colours, for example gold, green and white (Nash 2010, 137). On the other hand there are some late medieval inlaid patchworks decorated with gilt leather strips from Finland, Sweden, Switzerland and the Netherlands (Franzén 2009, 37, 41). Anyway, the precise compositions of the metal coatings are not measured/published.

However, the Relic project is going to perform some stable isotope analyses to determine geographical provenances of relic bones and some textile materials. The results will shed light on the question of origin and attribution of the cap of St Birgitta.

5. Conclusion

Thorough documentation, material research and condition survey of the cap of St Birgitta of Sweden produced information about materials which were chosen to represent the holiness and glory of the particular relics. Several techniques to imitate more precious and expensive materials were discovered during documentation. The original appearance of those poorly preserved materials e.g. membrane metal threads and tin-coated lacquered leather strips, was also realised. The tin-iron coated metal strips are so far a unique find.

The practical conservation was carried out to make the reliquary structurally stable and visually more presentable (Fig. 12). The main challenges were the poor condition of the object and the undocumented previous conservation in the 1930s. Ethical consideration was needed when evaluating the current construction and the shape of the object. The custom made buckram mount provides extra support and gives the current shape to the object. After conservation the reliquary is more integral and aesthetically pleasant entirety. The origin and attribution of the reliquary remain still unanswered, but the future analyses will hopefully give more answers.



Fig. 12. The cap of St Birgitta after the conservation in 2012. Photo: M. Karttila

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