TECHNISCHE
UNIVERSITÄT
MÜNCHEN

STUDIENGANG RESTAURIERUNG, KUNSTTECHNOLOGIE UND
KONSERVIERUNGSWISSENSCHAFT

Technical Study of a Group of Pageant Armour

Bachelor's Thesis

Isabell Wagner

2013

Examiner: Prof. Dipl.-Restaurator ERWIN EMMERLING

Abbreviations

NMS	National Museum of Scotland, Edinburgh
Fig.	Figure
PATON	Sir Joseph Noël Paton
NOEL-PATON	Margaret Hamilton Noel-Paton, granddaughter of Sir Joseph Noël Paton
CT	X-ray computed tomography
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Abstract

A technical study of a group of pageant armour belonging to the National Museum of Scotland was carried out in order to provide more information on attribution and inform conservation treatment. Acquired in 1905 from Sir Noel Paton's collection, the armour consists of a shield, helmet, quiver and two sceptres. The history of the assemblage and its context was researched through Sir Noel Paton's catalogue, his diaries, his granddaughter's memories as well as comments of his coevals, along with the identification of any comparative objects to aid in determining its provenance. Materials and structure were characterized using X-ray, X-ray computed tomography, FTIR spectroscopy and polarizing and UV microscopy. The results indicate that the armour is most likely a 19th century reassembly of older elements of unknown provenance. The analysed surface coatings of shellac, wax and glue were considered when the treatment proposal was developed.

Zusammenfassung

Um genauere Informationen zu Herkunft und Verwendung einer Paraderüstung des National Museum of Scotland sowie über geeignete Restaurierungsmethoden zu gewinnen wurde eine technologische Untersuchung durchgeführt. Die Rüstung, welche aus Schild, Helm, Köcher und zwei Szeptern besteht, wurde 1905 mit der Sammlung Sir Noel Patons erworben. Zur Erforschung der Geschichte wurden neben Sir Noel Patons eigenen Beschreibungen und Tagebüchern auch die Erinnerungen seiner Enkelin sowie Berichte von Zeitgenossen herangezogen, um somit mehr über die Provenienz der Rüstung zu erfahren. Die verwendeten Materialien und der Aufbau der einzelnen Bestandteile der Paraderüstung wurden mit Hilfe von Röntgenaufnahmen, Computertomographie, FTIR Spektroskopie sowie Polarisations- und UV-Mikroskopie untersucht. Die Ergebnisse weisen auf eine Neuzusammenstellung älterer Elemente hin. Die nachgewiesenen Überzüge aus Schellack, Wachs und Leim wurden bei der Erstellung eines Restaurierungskonzepts berücksichtigt.

Acknowledgements

I would like to express my gratitude to Dr Ticca MA Ogilvie, for making this thesis possible by not only taking me back into the labs but also for making the CT possible and for keeping me on track during the writing.
I would also like to thank Professor Erwin Emmerling for encouraging me to come back and take up this challenge. I enjoyed great support throughout my studies, which I highly appreciate.
I would like to offer my special thanks to my supervisor Jill Plitnikas, who helped me in any way she could throughout the whole thesis till late night, lifted my spirits and kept me organised.
It was a great pleasure to work with Dr Lore Troalen, whom I owe my deep gratitude for fitting me into her tight schedule. I learned a lot in this time and would like to thank her for letting me work independently but providing help and spectra interpretation whenever I needed it.
I would also like to show my gratitude to Dr Godfrey Evans for sharing all the information and experience he collected over the years with me.
I would like to single out Dr Tobias Schwarz who carried out the CT scan. I am truly thankful as without his spontaneity and skills this thesis would lack crucial information.
It is a great pleasure to thank everyone else who helped me during this thesis: Ailsa Murray for the support with the UV-microscopy, Victoria Adams for the friendly help during the research, Alexander Grillparzer for answering all my questions quickly and precisely, Bill Crichton for the patience and support with the polarizing microscope, Peter Davidson for verifying the gemstones, Dr Esther Wipfler for advice with the iconography, Neil McLean for the photography, Flo, Kathi, Lari and Silvia.
My greatest thanks I owe my father, as without him my studies would never have been possible.

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1 A Group of Pageant Armour

When this rare assemblage first came into the collection of the National Museum of Scotland in 1905, it probably evoked as much curiosity as it does today. The shield, helmet, quiver and two sceptres were described as "Pageant Armour" as this was the purpose the donor, SIR NOËL PATON, believed they were made for.

According to the OXFORD DICTIONARY, the word *pageant* describes "*a public entertainment consisting of a procession of people in elaborate, colourful costumes, or an outdoor performance of a historical scene*"[1] and derives from the late middle English word "*pagyn*" which has, however, an unknown origin.[2]

This thesis attempts to explore the provenance of the assemblage, and the techniques, materials and alterations applied, in order to solve some of the mysteries surrounding the armour.

Fig. 1: Pageant Armour with the helmet viewed from above. [Courtesy of Neil McLean, NMS]

[1] http://oxforddictionaries.com, last accessed 16.08.2013, keyword: pageant.
[2] Ibid.

2 The Acquisition and Use History

> "[…] *there was no history attached to them. Probably, however, were proper means taken, their history might yet be recovered; for they must have formed part of a well-known collection. In the meantime no one can examine them in detail without feeling much interested in their possible antecedents* […]"[3]

PATON was right in anticipating that the armour would continue to pique one's curiosity regarding its provenance. However, although a number of curators attempted to take "*proper means*"[4] the origin of the assemblage has remained yet undiscovered. PATON provides a few clues when describing it in his catalogue, but there is no external documentary evidence to back up his statements. He states that "[t]*hese five articles were bought together in Edinburgh of a dealer who had just obtained them in Hamburg, as part of the loot brought from France by the German army in 1871*",[5] but also admits that "*beyond this fact there was no history attached to them*".[6] PATON must have acquired it between 1871 and 1879, as it appears in his "*Private Catalogue of armour, weapons and other objects of Antiquity*" which was printed in Edinburgh in 1879. His diaries have been searched for notes on his acquisitions regarding this armour, the dealer or the further history of the objects, but no further information has been revealed. Therefore his description is the only remaining information we have to go on, which, however, must be taken with caution.
Examination of the armour with X-ray computed tomography (CT) revealed scales lying at the bottom of the quiver. These were taken out and compared with the losses: Apart from one, which belongs to the quiver, none of the scales could be matched. This means that there is a high possibility of more objects of this style and material existing which were not acquired by PATON.
After PATON acquired the armour, he kept the assemblage in his house at 33 George Square in Edinburgh, where it served now merely decorative purpose amongst other pieces of his vast collection in a lively house. MARGARET H. NOEL-PATON sums up her childhood's memories in the "*old hoose*"[7], as she named it, at George Square. We know from PATONs descriptions of his collection, that the pageant armour was displayed in the drawing room, which "*held countless treasures of the 'storied past' (not only Scotland's) and the age of chivalry*".[8] Photographs give an impres-

[3] PATON, J. NOËL: *Private catalogue of armour, weapons and other objects of antiquity in the collection of Sir Noël Paton*, Edinburgh 1879, p. 49.
[4] Ibid.
[5] Ibid.
[6] Ibid.
[7] NOEL-PATON 1990, p. 69.
[8] Ibid.

sion of how the collection was displayed in his rooms: The walls were covered with arms and pieces of armour, and knights stand to either sides of the fireplace.

Fig. 2: West end of Noel Paton's dining room in 33 George Square [SCOTT-MONCRIEFF 1903, p. 12].

Not only has MARGARET NOEL-PATON given a description of the atmosphere present in her grandfather's home by mentioning that the drawing room "*was never just a museum. It was comfortable, lived in, warm; a happy room.*",[9] but also SCOTT-MONCRIEFF does so as he describes the dining room in his article on "*The late Sir Noël Paton's Collection"* in 1903:

> "*The walls were closely hung with weapons arranged with the greatest care, while on pedestals round the room stood seven mail-clad warriors keeping ceaseless watch over all. At any hour they looked well, but best perhaps in the evening when the firelight played over the polished steel and cast strange shadows on the walls. At such a time one wondered what the Maximilian Knight at the end of the room thought of the Swiss Knight next to him, or of the powerful, if rough, armour of the Scottish Knight opposite.*"[10]

[9] NOEL-PATON 1990, p. 69.
[10] SCOTT-MONCRIEFF, R.: *The late Sir Noël Paton's Collection*, in: Antiquarian Supplement to Scottish Art and Letters, Glasgow 1903, p. 3–4.

3 The Collector Sir Joseph Noël Paton (1821–1901)

Fig. 3: Sir Joseph Noel Paton [Wikimedia Commons].

Not only has the collection of SIR NOËL PATON been the subject of various articles, but also the collector himself. SCOTT-MONCRIEFF for instance, prefixes his description of the collection with compliments for PATON:

> "*It is impossible, too, to find a more delightful cicerone than Sir Noel Paton was. With what loving care he handled his treasures, pointing out their characteristics and the beauty of their work, telling stories of their history and of how they came into his possession, and throwing over all the glamour of his personality.*"[11]

LAKING also speaks kindly of Paton:

> "*It was the great privilege of the writer of this article to inspect the collection in its original setting under the kindly conduct of that courteous and handsome old gentleman, the collector. The reverence with which he handled his treasures and the brightening of his eyes as he told their history or of the struggle that any piece had cost him to acquire, proved the genuine enthusiasm his hobby aroused him.*"[12]

A closer picture of PATON and his life is provided by his granddaughter MARGARET HAMILTON NOEL-PATON. She tells us that SIR NOËL PATON'S origins can be found in Dunfermline, a town in the county of Fife. He was born in 1821 as son to JOSEPH NEIL PATON, a textile

[11] NOEL-PATON 1990, p. 3.
[12] Ibid., p. 153.

designer from Dunfermline, and Catherine MacDiarmid, who hailed from the Highlands.[13] Weaving linen damask was established in Scotland already by 1650 with the industry growing stronger until the 1800s.[14] PATON was born just before the first Jacquard machine came into use in Scotland and thus, when PATON joined his father in 1839, he experienced a successful period in the industry's history.[15] PATON helped his father, designing patterns for the weaving of damask, before he got a position as a designer for sewed muslins in Paisley which he held for three years.[16] His free time was dedicated to art and paintings in oil and in 1843 he entered the Royal Academy in London which he, however, left soon again.[17] He sympathised with the work of the Pre-Raphaelites, although he didn't share their enthusiasm for reality.[18] His success as a painter commenced when he contributed the cartoon "*The Spirit of Religion or The Battle of the Soul*" in 1845 to the Westminster Hall competitions and he became widely known through his oil paintings "*The Reconciliation of Oberon and Titania*" in 1847 and "*The Quarrel of Oberon and Titania*" in 1849.[19]

Fig. 4: The Reconciliation of Oberon and Titania 1847 [Wikimedia Commons].

He preferred religious and mythical subjects for his paintings, probably derived from the influences of his childhood: NOEL-PATON mentions that "*the artist and his brothers and sisters were,*

[13] NOEL-PATON 1990, p. 7–8.
[14] Ibid., p. 7.
[15] Ibid.
[16] CAW, JAMES LEWIS: *Sir Joseph Noël Paton*, in: Dictionary of National Biography, Second Supplement, Vol. III, London 1912, p. 78–79.
[17] Ibid., p. 79.
[18] Ibid.
[19] Ibid., p. 80.

as children, educated as Quakers"[20] and CHEAPE gives some information on PATONs grandfather, who "*collected old Ballads and stories*" and even "*printed ballads and religious controversies and his own rhyming history of Dunfermline*".[21]

Apart from being a painter PATON was also known for his vast collection of art. Looking back to his childhood he later recorded: "*The circumstances and surroundings of my boyhood made it all but impossible that I should be anything but an artist, my father's tendencies and pursuits being all in that direction.*"[22] But not only had his father pushed him in the direction of being a painter, but he also provided a role model of the collector. "[H]*is house in Wooers' Alley, where young Paton spent his earliest years, was a veritable museum crammed in every possible corner with treasures of art.*"[23] His father was a child of his time as collecting art reached a bigger scale in the 1800s with the founding of museums and a greater interest in history. During his life PATON collected mainly arms and armour which he displayed in his house at 33 George Square in Edinburgh. Eventually, in 1879, two hundred copies of the "*Private Catalogue of Armour, Weapons and other Objects of Antiquity in the Collection of Sir Noël Paton*" were printed in Edinburgh, which he prefixed with these words expressing his attachment to his collection and house:

> "*This Catalogue is designed only for my family and for those friends who may be supposed likely to feel some interest in objects from which I have derived much unalloyed pleasure, and many of which are endeared to me by early associations.* […] *My purpose has rather been, by recording the existing collocation of the respective objects, to preserve some impression of the internal aspect of a house of which I would fain hope some kindly memories may survive when its present occupant is gone where there is no reason to apprehend "Old Iron" is not.*"[24]

All this information provides a picture of a collector who had a passion for the history and interesting stories behind his objects, which likely led him to acquire some forgeries for his collection alongside great works of art. When it was acquired by the museum in 1905, art historians gained a closer, undisguised insight into the collection.

GUY FRANCIS LAKING for example provides an interesting view on the Royal Scottish Museum's newly purchased PATON Collection in his articles in the Burlington Magazine in 1910. His introductory words make clear that the collection of PATON not only bore some excellent artworks but also contained some forgeries amongst these:

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[20] NOEL-PATON 1990, p. 8.
[21] CHEAPE, HUGH: *Sir Joseph Noel Paton*, in: CALDER, JENNIFER (Ed.): *The Enterprising Scot. Scottish Adventure and Achievement*, Edinburgh 1986, p. 140.
[22] NOEL-PATON 1990, p. 8.
[23] Ibid.
[24] PATON 1879, p. 5.

> *"In the peaceful old house in George Square, Edinburgh – their original home – Sir Nöel's treasures seemed to combine in one harmonious assemblage; forgery lay next the genuine piece, borrowing the same respectability as its neighbor from the very atmosphere of its surroundings. The respect, however, which was shown to the unworthy when cherished in the bosom of their original master, fast vanished on their exposure to the searching light of the Museum Gallery and the severity of public criticism.*"[25]

LAKING had the opportunity to take a closer look at the collection which was displayed after PATON's death in "*a somewhat narrow corridor*",[26] probably the "*north-east corridor of the Museum*"[27] in the Scottish National Museum. His observations were published in three articles in the Burlington Magazine in 1910. Although LAKING unveiled forgeries among the objects, he also writes: "*The authorities are to be most heartily congratulated on the possession of the collection for*, […] *it was a fine investment*".[28] D. J. VALLANCE, Keeper of the Art and Ethnographical Department, also comments on the forgeries amongst the newly purchased collection: "*a rigid examination of the specimens was absolutely necessary. The bulk of the collection consists of original works of undoubted authenticity and value.* […] *But when the collection was bought by the Museum the terms of its purchase recognized that along with these a number of objects had to be taken which made little pretension to be other than models of older and genuine examples.*"[29] Interestingly, no special mention was made of the pageant armour by LAKING or SCOTT-MONCRIEFF at all at this time. This would suggest that either it was held in storage and therefore not seen by them or that it was on display but not considered worth mentioning which seems unlikely given the extraordinariness of the objects. Unfortunately, there are no records of exhibition, conservation or storage of the pageant armour after their acquisition by the museum.

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[25] LAKING, GUY FRANCIS: *The Nöel Paton Collection of Arms and Armour, Now in the Royal Scottish Museum,Edinburgh*, in: The Burlington Magazine for Connoisseurs, Vol. 17, No. 87 (1910), p. 148.
[26] Ibid., p. 153.
[27] Ibid.
[28] Ibid.
[29] VALLANCE, DAVID J.: *Annual report for the year 1911 by the acting director David J. Vallance, Esq. on the Royal Scottish Museum Edinburgh*, London 1911, p. 8.

4 Armour–Body Defence, Accessory and Collector's Item

To better understand the pageant armour, a closer look into the purpose and use of different types of armour is helpful. By the 16th century armour had developed into three different groups, depending on their purpose.[30] Battle armour is light and flexible and has a smooth surface. It was adjusted to meet different requirements such as battle with horses as well as close infighting with swords.[31] The second category is tournament armour which is highly specialized for the various uses in tournament and joust. It is heavy and was designed to protect specific areas of the body.[32] The third category is the very light and lavishly decorated armour which was used as parade armour. This was not made for battle, but for ceremonial occasions and personal embellishment, and "*projected an image rather than protected a body*."[33] With the increasing use of firearms during the 16th century the importance of the fully armored warrior decreased.[34] Fine armour, however, continued its existence as an expression of wealth, taste and social rank which therefore needed to correspond with the latest fashion and reflect the finest workmanship.[35] Gothic styles were abandoned and the Italian fashion came into focus.[36] PATTERSON describes the view on it: "*It was not just the architecture, literature and sculpture of the time that recalled glorious ancient traditions. Roman-style armour transformed Renaissance nobles into classical heroes*".[37]

This kind of armour was called *alla romana antiqua* or *all'antiqua*. This meant that elements of typical Roman armour were adapted and incorporated into the design of Renaissance armour. In the case of the ivory pageant armour at the National Museum of Scotland (NMS), Roman scale armour appears to have been imitated. Scale armour, known as *lorica squamata*, was used by the Roman army through a time period spanning over 800 years, although its

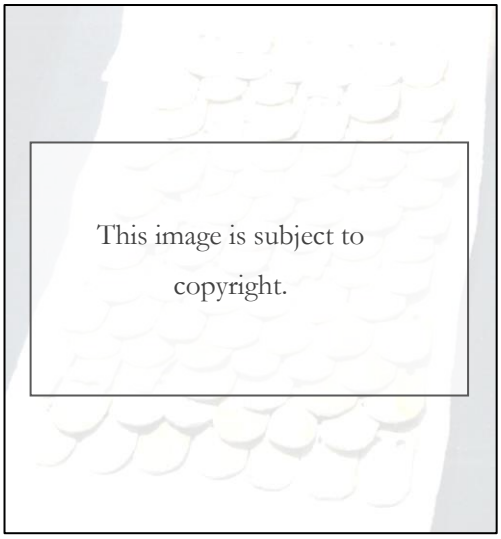

Fig. 5: Roman scale armour made of bone or ivory, found in Pompeii [D'AMATO 2009, p. 141].

[30] FLIEGEL, STEPHEN N.: *Arms and Armour. The Cleveland Museum of Art*, Cleveland 1998, p. 92.
[31] PATTERSON, ANGUS: *Fashion and Armour in Renaissance Europe. Proud Lookes and Brave Attire*, London 2009, p. 16.
[32] Ibid., p. 17.
[33] Ibid.
[34] FLIEGEL 1998, p. 91.
[35] Ibid.
[36] Ibid.
[37] PATTERSON 2009, p. 22.

origins reach back much further.[38] HILARY states that the metal used to build Roman armour was copper-alloy or iron, "*although in earlier periods any other resilient material may have been used, such as wood, thick, hardened leather* […] [or] *ivory.*"[39] The choice of ivory as a material for scale armour is established by a find of ivory or bone scale armour in Pompeii (Fig. 5).[40]

The previously mentioned fashionable pageant armour became a popular collector's item over time. In the Renaissance, collecting works of art and science was a means by which to express the wealth and power of one's family.[41] It was also an expression of the growing interest in education which spread across Europe at this time with growing collections of scientific instruments and all sorts of curiosities.[42] Collecting armour and weapons on a small scale was initially mainly done as a means of protection, never-the-less its purpose was surely also to display a family's wealth. One of the most outstanding collectors of that time was Archduke Ferdinand II (1529–1595) who gathered a vast collection of arms and armour in Ambras Castle, near Innsbruck, and who was already famous for it during his lifetime.[43] It was not an invention of the 16th century to collect armour, but the way to organise and display the collection was not known to that at that time.[44] Collecting armour was not restricted only to higher houses but was also seen in houses of lesser importance as PATTERSON establishes by citing contemporary sources describing the collections of some British houses, where armour was

Fig. 6: Portrait of a Warrior, Francesco di Simone Ferruci (1437–1493), Italian ca. 1475 [KARCHESKI 1995, p. 53].

[38] TRAVIS, HILARY; TRAVIS, JOHN: *Roman body armour*, Stroud 2011, p. 95.
[39] TRAVIS/TRAVIS 2011, p. 95.
[40] D'AMATO, RAFFAELE: *Arms and Armour of the Imperial Roman Soldier: From Marius to Commodus 112 BC–192 AD*, London 2009, p. 141.
[41] PATTERSON 2009, p. 78.
[42] Ibid.
[43] Ibid.
[44] Ibid., p. 79.

largely displayed in the hall or in a separate armoury.[45] As stated previously, the collecting of armour experienced a come-back during the 19th century with the growing interest in history at that time. The founding of museums and consequent increased demand for artworks also contributed to this fashion.

We can therefore see that NMS's pageant armour revisited an already existing type of armour, the *lorica sqamata*, but was built for a different purpose: Exhibiting fashionable armour in precious materials.

5 Ivory

5.1 Sources

Ivory (ger. *Elfenbein*, fr. *ivoire*, ital. *avorio*) is a Middle English word deriving from the Anglo-Norman French *ivurie*, which is based on Latin *ebur*.[46] It is used to describe the tusk and teeth of many mammal species such as elephant, mammoth, walrus, hippopotamus, whale and dolphin as well as those of members of the swine family like wild hog and boar.[47] The most commonly use of the word ivory, however is in reference to elephant ivory. There are two species of elephants (family of the *Elephantidae*): the Asian (or Indian) elephant (*Elephas maximus*) and the African elephant (*Loxodonta africana*) with its subspecies the savannah and forest elephant.[48] The tusks of the former can reach a length of 3.5 metres and a weight of 130 kilograms, although this is a rare sight today.[49]

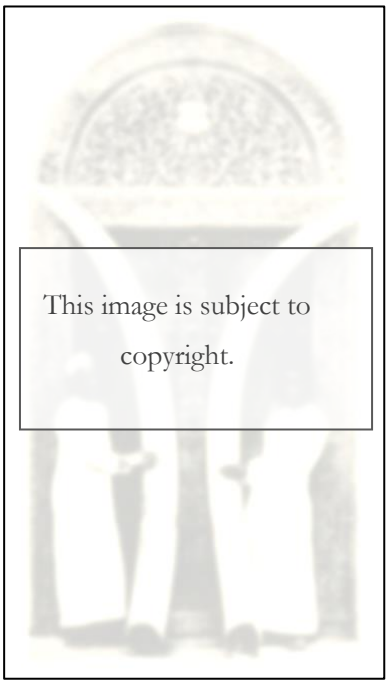

Fig. 7: Two ivory tusks in Zanzibar 1910 [HORNBECK 2010, p. 9].

Most common sources of ivory obtained from elephants are the upper incisors of the male (African and Asian) and the female (African) elephants. In addition, the upper incisors and canine of the hippopotamus (*Hippopootamus amphibious*); the upper canine of the walrus (*Odobaenus rosmarus*); and the left incisor of the male narwhale (*Mondon*

[45] PATTERSON 2009, p. 81.
[46] OXFORD DICTIONARY, keyword: ivory.
[47] PEDERSEN, MAGGIE CAMPBELL: *Gem and Ornamental Materials of Organic Origin*, Oxford 2004, p. 56.
[48] Ibid., p. 57.
[49] Ibid.

monoceros) have been used in the making of ivory objects.[50] Not only real ivory, however, but also simulants of ivory were used to produce works of art. The most common ivory simulant is bone, but also plastics like casein or cellulose nitrate, reconstituted material (moulded ivory dust), vegetable ivory (of nuts, esp. tagua nut) and minerals (ivorite) were used.[51]

5.2 Structure and Identification

An important part of any technical study is the analysis of materials to aid the conservation proposal and provide understanding of constructions. To carry out a proper analysis, however, a profound understanding of the material is necessary.

Ivory is composed of dentinal tubules embedded in a mineralised collagen matrix.[52] The dentinal tubules are laterally aligned to form axial sheets which are called microlaminae.[53] This alignment of the tubules, which run from the pulp cavity radially to the cementum, is different in every kind of ivory depending on the needs for strength and density.[54] The composition of the teeth of most mammals is similar and consists of three differing layers of hardness.[55] The outer surface of the tooth is covered with enamel, which is the most highly mineralised portion. It is derived from ectodermal epithelial cells and contains a protein called ameloblastin.[56] The greatest part of the body and roots of a tooth consist of dentine, which makes up the material we term as ivory. This is hydroxyapatite, a calciumphosphate ($Ca_{10}(PO_4)_6(CO_3)$) derived from the mesoderm, which contains collagen fibrous proteins and is characterised as tougher, more resilient and less brittle than enamel.[57] Dentine is produced by ondoblast cells, which are situated in the dentinal tubules around whose colla-

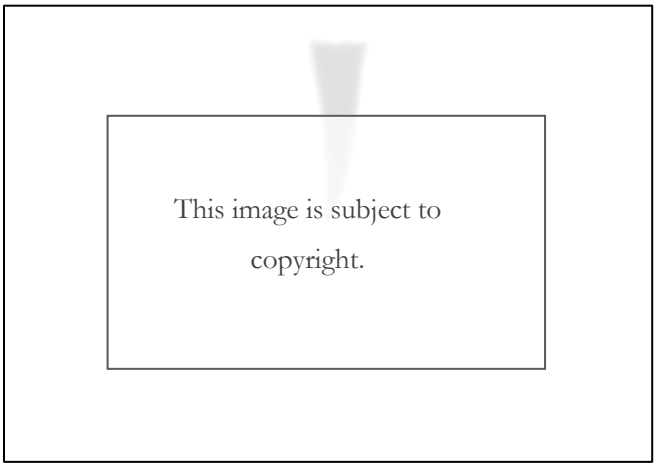

Fig. 8: Tusk morphology [ESPINOZA/MANN 1992, p.7]

[50] FLORIAN, MARY-LOU: *Protein facts. Fibrous proteins in cultural and natural history artifacts*, London 2007, p. 34.
[51] PEDERSEN 2004, p. 74.
[52] LOCKE 2008, p. 423.
[53] Ibid.
[54] Ibid.
[55] FLORIAN 2007, p. 34.
[56] Ibid.
[57] Ibid.

gen fibrils form a network.[58] Dentinal tubules "*run from the tusk axis to the external surface of the cementum*".[59] Dentine contains 59.6% inorganic component that is calcium phosphate, and 32.13% organic component, collagen and elastin, as well as 8.27% water.[60] The softest layer, covering the roots and crowns of teeth, is cementum.[61]

At the innermost layer of teeth, a pulp cavity can be found, containing blood vessels and nerves and varying greatly in size among the different animals.[62] Dentine grows at the border of the pulp cavity with the existing dentine, filling up the pulp cavity as the elephant ages.[63] The nerves contained in the pulp cavity extend to the tip of the tusk.[64] An elephant tusk is attached to the jaw by the root and soft tissue inside the cavity.[65] It can extend for approximately two-thirds of the tusk length and "*its presence or absence on a carved ivory artefact can indicate the part of the tusk that was used and the original length of the tusk.*"[66]

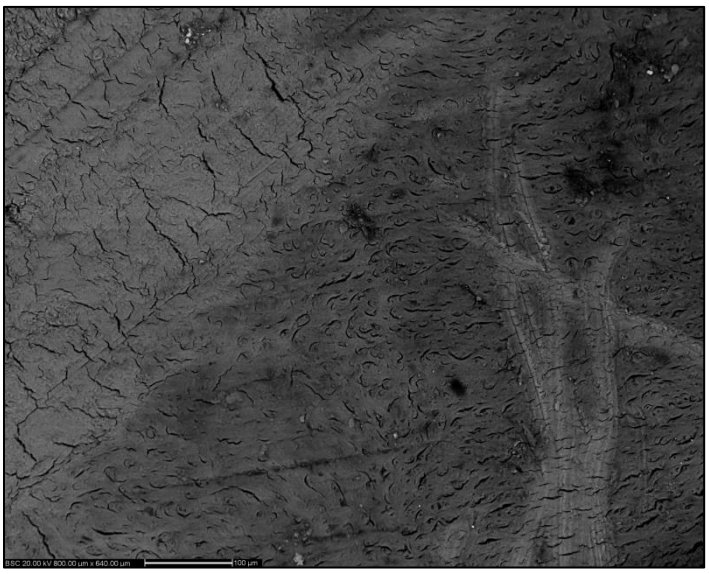

Fig. 9: SEM-BSC Micrograph of ivory surface of helmet A.1905.1144.2: cracks, scratches and dentine tubules (x150 at 18 mm working distance).

For the identification of ivory KRZYSYKOWSKA and EPINZONA/MANN have provided well researched guides to support the correct classification of object materials. As mentioned previously, the trade in ivory and illegal poaching linked to it has long been an issue. This has

[58] FLORIAN 2007, p. 35.
[59] HECKEL 2009, p. 76.
[60] FLORIAN 2007, p. 36.
[61] Ibid., p. 34.
[62] PEDERSEN 2004, p. 56.
[63] ZACHMANN 2009, p. 21.
[64] HECKEL 2009, p. 76.
[65] HORNBECK 2010, p. 2.
[66] Ibid.

meant that methods for identifying and dating ivory began to be well developed since the ban on the ivory trade was enacted in 1986. ZACHMANN provides an interesting overview of currently used techniques for the identification of different types of ivory, with a focus on distinguishing African and Asian elephant ivory.[67]

In order to identify elephant and mammoth ivory, the presence of Schreger[68] lines (also described as engine turning pattern) is most commonly sought. Schreger lines derive from two different types of dentin: peritubular[69] and intertubular[70] dentin, differing in the degrees of mineralisation and therefore in transparency.[71] .[72] A more detailed picture is given by LOCKE who investigated the structure of ivory and added a further identification aid, the "feather pattern". To understand this, he gives a detailed description of the correlation between dentinal tubules columns and cylindrical growth rings for the appearance of this pattern: "[…] *proboscidean ivory is made from dentinal tubules arranged in radial microlaminae embedded in a matrix having cylindrical growth rings.* […] *This structure is divided radially into segments that are subdivided circumferentially to form Schreger columns, the basic repeating subunit* […]. *Cylindrical growth layers and longitudinal Schreger columns are separate interlocking 3D patterns of structural organization superimposed on radial microlaminae. Tangential profiles of old ivory show the columns as longitudinal "feather pattern" lines crossed by the curved edges of the growth layers.*"[73]

Fig. 10: Feather-like pattern due to cracks along Schreger colums [LOCKE 2008, p. 233].

These Schreger lines offer a reliable method to identify elephant ivory and even distinguish it from mammoth ivory. ESPINOZA/MANN carried out a study on the outer Schreger line angles of extant and extinct species, giving a mean angle of 124.15 for extant (elephant) and 73.21 for extinct (mammoth) proboscidean ivory (Fig. 12).[74] She states, however, that at least five angles must be measured as the upper end of the mammoth concave/convex angle range and the elephant concave angle range can overlap.[75] If the

[67] ZACHMANN 2009, p. 25 ff.
[68] Named after the German anatomist Bernhard Gottlob Schreger, who first described them in 1800.
[69] Dentin that creates the wall of the dentinal tubules.
[70] Dentin that is located between the dentinal tubules.
[71] FLORIAN 2007, p. 35.
[72] Ibid.
[73] LOCKE, MICHAEL: *Structure of Ivory*, in: Journal of Morphology 269 (2008), p. 433–434.
[74] ESPINOZA, EDGAR O.; MANN, MARY-JACQUE: *Identification guide for ivory and ivory substitues*, Washington D.C. 1992, p. 13.
[75] Ibid., p. 12.

kind of ivory or the species is not certifiable, KRZYSZKOWSKA advises to use the term "*ivory, type indeterminate*".[76] Although it is likely that all of the ivory in the armour is of elephant origin, the unspecific term 'ivory' is used throughout this thesis because only a few elements were able to be positively identified as elephant. Upon the suggestion of Dr. (med. vet.) Tobias Schwarz of the Royal (Dick) School of Veterinary Studies, density urements of the helmet's ivory were taken and a mean value of 670,70 HU calculated. As no similar measurements taken on other ivory artefacts could be found in the literature, however, a comparison of this data could not be made.

Fig. 11: Drawing explaining the different surface patterns deriving from the alignment of dentinal tubules in a mammoth tusk [ÁBELOVÁ 2008, p. 228].

The CT imaging unit available at the Royal (Dick) School provides a resolution which is unfortunately not high enough to show fine structures such as the Schreger lines.

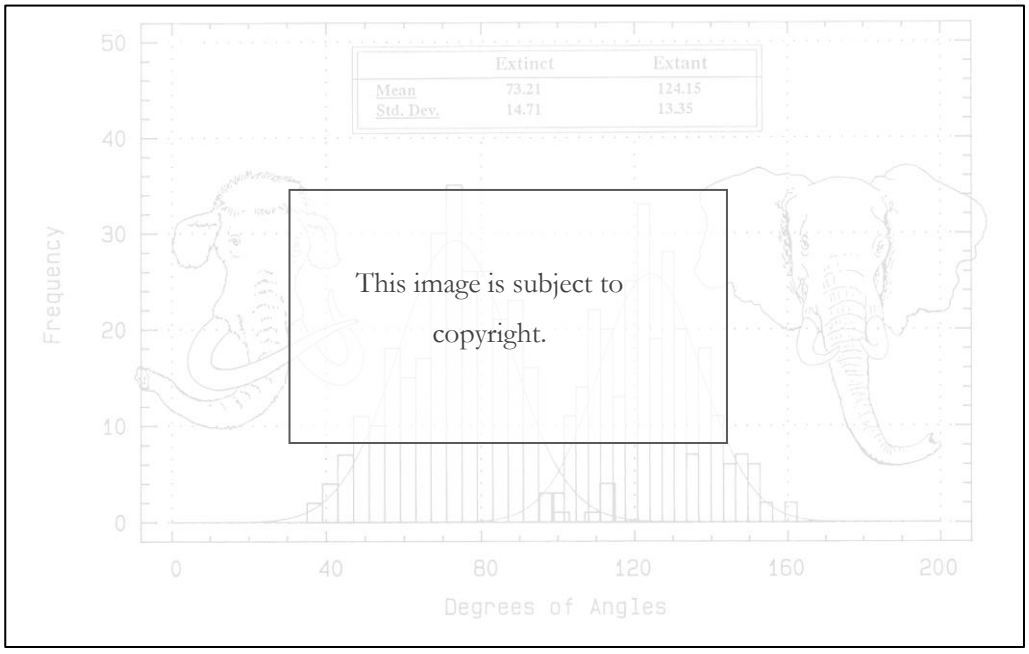

Fig. 12: Distribution of Schreger angles mammoth and elephant [ESPINOZA/MANN 1992, p. 13].

[76] KRZYSZKOWSKA 1990, p. 91.

6 The Armour in Detail

6.1 Shield (A.1905.1144.1)

Fig. 13: A.1905.1144.1.

Accession number	A.1905.1144.1
Measurements/weight	565 mm L × 410 mm W × 85 mm H; 3 kg
Materials	Iron, wool, wood, elephant ivory (Schreger lines)
Literature	PATON 1879, p. 48, Cat. No. 444.

6.1.1 Description and Symbolism

> „*Oval shield, in iron, encrusted with scales of ivory, and decorated with ivory relievos: consisting of a lion's head in the centre, from which the scales radiate; immediately above, a heart-shaped plaque, bearing in low relief the sacred Chrism, between what seems to be two "nuptial rings" and surmounted by a coronet, or antique crown; at base, and on either side of the shield, busts of Roman generals in profile, between four mullets of five points.*"[77]

In the middle of the shield a carved element in the shape of a lion's head is situated, which looks rather tame with its mane pointing upwards and its mouth closed. Above is another element, a more oval-shaped than heart-shaped plaque, which is crowned with leaves on its base. A "*sacred Chrism*", as PATON describes it, or christogram, is situated in the middle of the plaque on a carved crosshatched background with flames and a pair of nuptial rings on either side. These may be interpreted as supporting the christogram in terms of underlining the faith. The christogram originates from the 4th century. On the 28th of October 312 AD Emperor Constantine defeated Maxentius at the gates of Rome. Constantine claimed that Christ came to him in the night before and instructed him to write the first two Greek letters of his name on the shields of his soldiers.[78] The combination of these letters, Chi and Rho (☧), was regularly used by the Roman emperors in battles. The earliest archaeological evidence of this symbol is found on silver medallions dating back to 315 AD and was included in vexilla to form a so-called labarum which was first seen on coins from 327 AD.[79]

A "*mullet*", as PATON terms each of the four stars on the shield, is a heraldic term, meaning "*a star with five (or more) straight-edged points or rays, as a charge or a mark of cadency for a third son.*"[80] FOX-DAVIES explains that if more than one son inherits the coat of arms of his father, his will be distinguished from his brother's by marks of cadency: the second son holds a crescent, the third a mullet, the fourth a martlet, the fifth an annulet, the sixth a fleur-de-lis, the seventh a rose, the eights a cross moline and the ninth son a double quatrefoil.[81]

The Roman soldiers to the right and left of the lion's head look alike, with cloaks on their shoulders and helmets with open visors on their head. The soldier at the lower edge has a different type of helmet, however. He sports a crest which is reminiscent of a wyvern, although it lacks wings and feet. Between the soldiers, the four stars or mullets are applied.

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[77] PATON 1879, p. 48.
[78] DECKERS, JOHANNES: *Die frühchristliche und byzantinische Kunst*, Munich 2007, p. 26.
[79] Ibid., p. 27.
[80] http://oxforddictionaries.com, last accessed 16.08.2013, keyword: mullet.
[81] FOX-DAVIES 1909, p. 488.

6.1.2 Materials and Structure

The shield is constructed from an oval-shaped iron alloy sheet with its outer edge rolled up. On the obverse edge, a 1.5 cm wide strip of paper is visible (Fig. 18) which covers the edge of an underlying linen fabric (Fig. 114). This fabric is glued to the metal and extends towards the centre of the shield. Scales of ivory radiate out from the lion's head in the centre of the shield and are attached to the fabric with animal glue (Fig. 108). The lion's head is supported by two pieces of wood underneath (Fig. 21) and all the carved elements are secured with slotted screws from the reverse (e.g. Fig. 22). The holes for the screws were drilled from the obverse to the reverse. This was revealed in a CT image by the rim of the holes being folded towards the reverse (Fig. 23). Ivory identification was not straigthforward as the surface is heavily soiled and the scales are too thin to show any identification marks. Schreger lines were revealed, however, by removing the dirt on the side of a mullet with a latex sponge (Fig. 14). The angles measured were matched with the data provided by ESPINOZA/MANN, identifying it as elephant ivory. Schreger lines were also discovered on the lower edge of the soldier on the proper left side of the shield, although the lines are not as clearly visible (Fig. 17). It is likely that the same material was used for the entire object, although this could not be confirmed. The carving of the lion's head was limited by the thickness of the ivory available. This is most notable, for example, at the nose and eyebrows which are flat and dark in colour (Fig. 16). This may indicate the use of a part of the tusk close to the hollow part of the tusk for carving.

Fig. 14: A. 1905.1144.1, Schreger lines and cementum on mullet.

Fig. 15: „Bark" of elephant tusk, NMS, reference collection, no scale available.

Fig. 16: A.1905.1144.1, detail, lion's head with cementum and "bark".

The underside of the shield is covered with a red wool pile textile which is secured to the metal using animal glue (pile side against the metal) (Fig. 115). The handles are attached to the shield with slotted screws, with their edges being rolled up around a metal wire (Fig. 24). The long handle in the middle of the shield also has a thin layer of wood or similar material attached to it on either side (Fig. 25). The X-ray images reveal an interesting pattern of dark spots, visible along the short sides of the shield where the material is thinner than the surrounding metal (Fig. 20). These spots suggest density differences, which hint to the possible alteration of an existing shield's curvature. Furthermore, there are two metal pieces next to the

screw attaching the bottom soldier, which can be seen on the radiograph (Fig. 27). A CT image identifies these as two screw tips which remain inside the element (Fig. 26). This may be further evidence supporting the idea that the object was assembled from already existing components.

Fig. 17: A.1905.1144.1, detail of Roman soldier on proper left side: Schreger lines.

Fig. 18: A.1905.1144.1, detail, strip of paper along the rim of the shield.

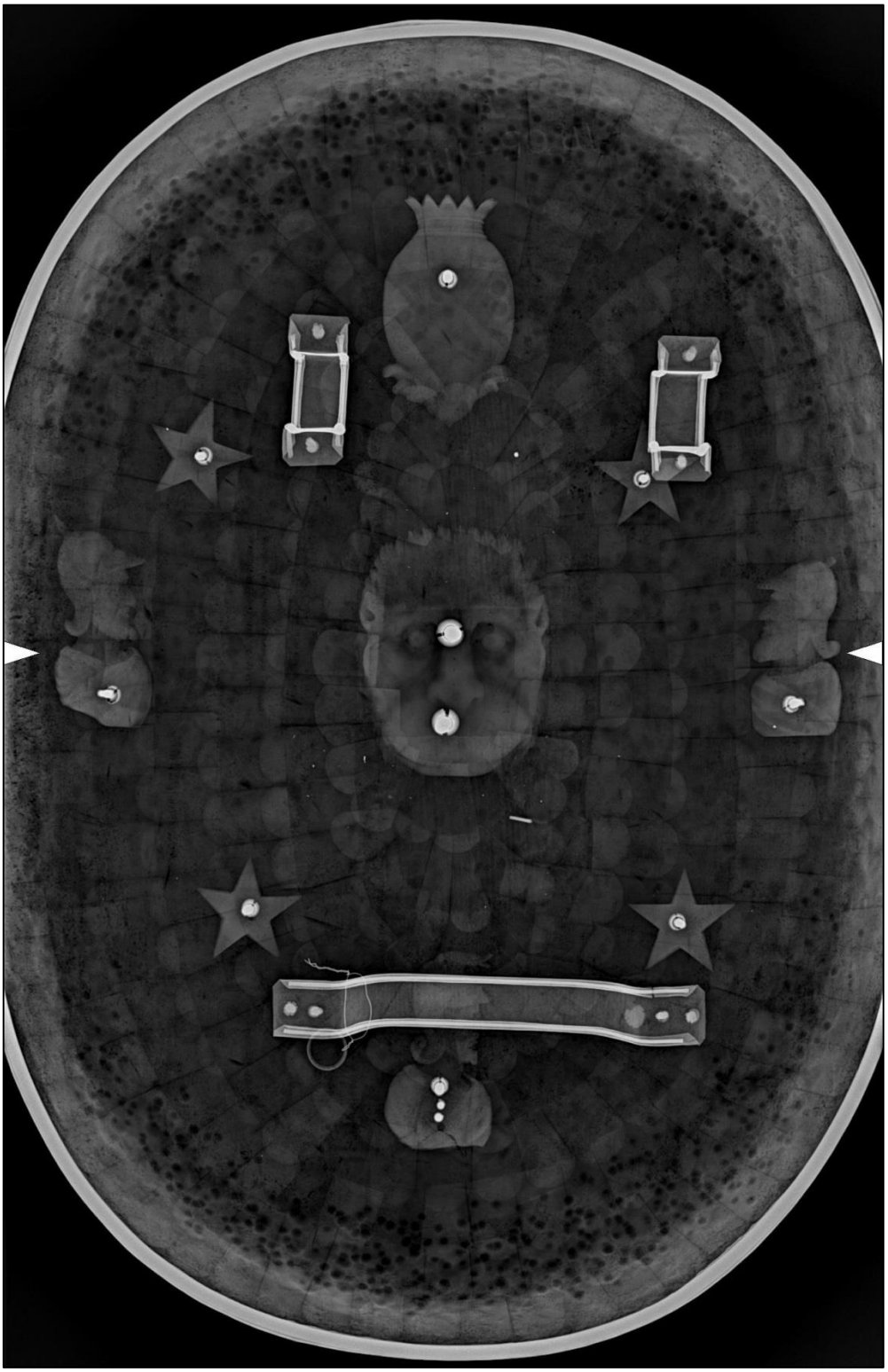


Fig. 19: X-radiograph of A.1905.1144.1, taken from reverse.

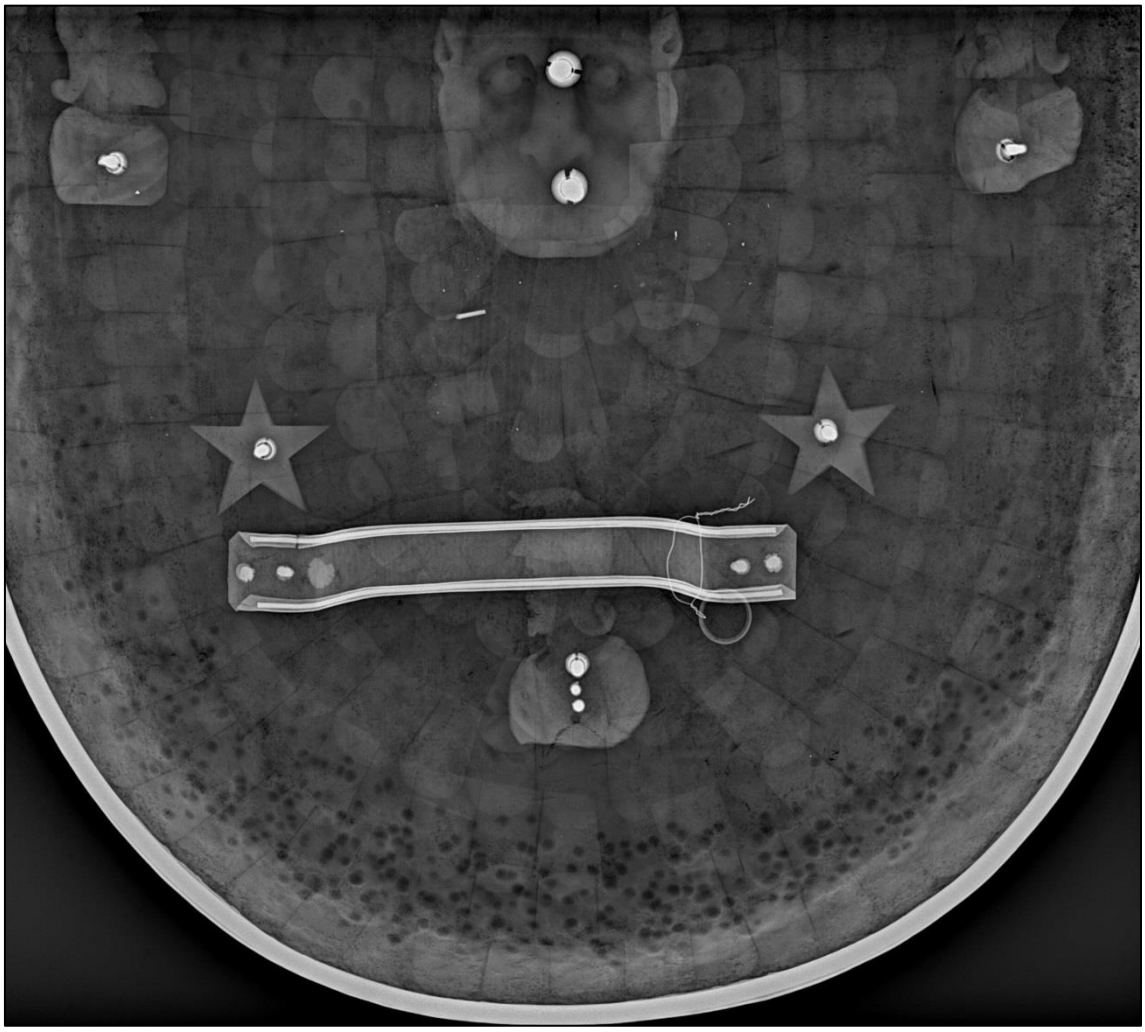


Fig. 20: X- radiograph of A.1905.1144.1, obverse. Note the small nail near the lion's head which does not show in visible light.

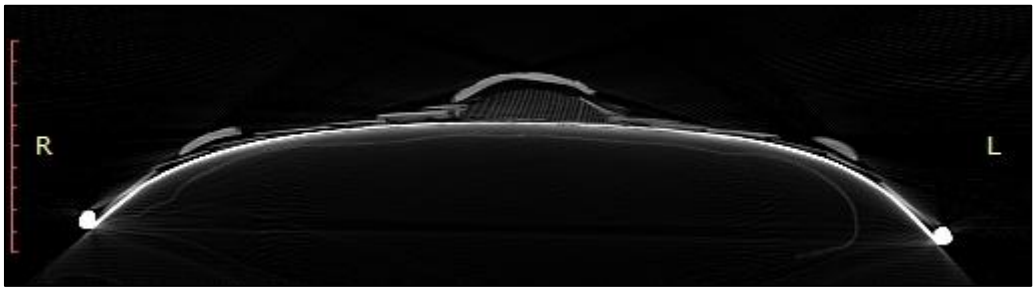


Fig. 21: 2D x-radiograpic plate of A.1905.1144.1, wooden support of lion's head visible.

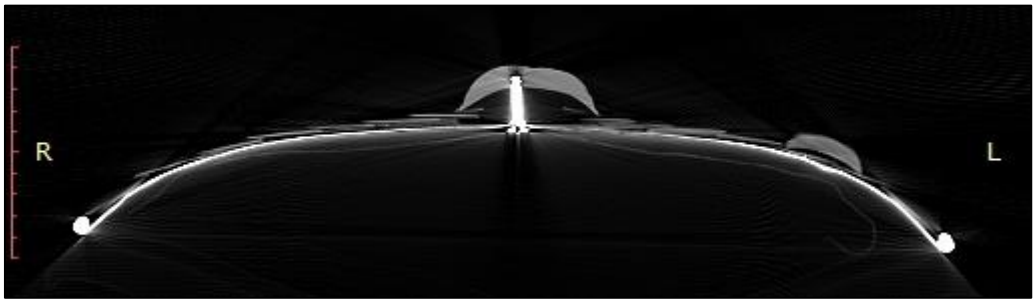


Fig. 22: 2D x-radiographic plate of A.1905.1144.1, slotted screw to secure lion's head.

Fig. 23: 2D x-radiograph of A.1905.1144.1, slotted screw with rim of hole pointing towards reverse.

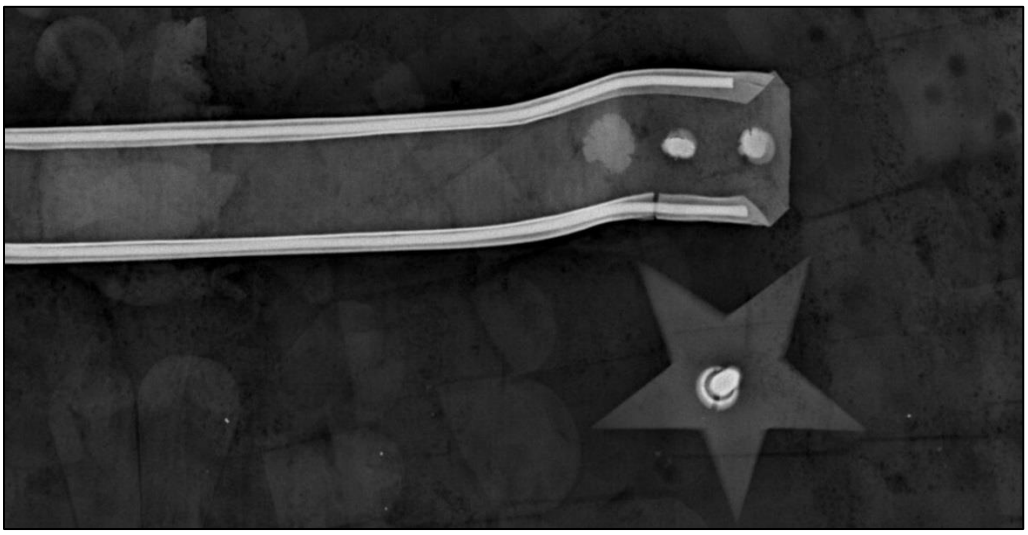


Fig. 24: X-radiograph of A.1905.1144.1, detail of handle with wire in rolled-up rim and lines indicating covering with wood.

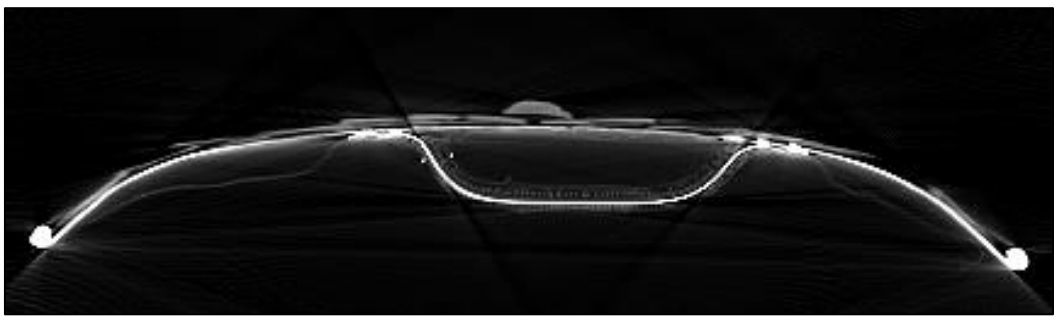
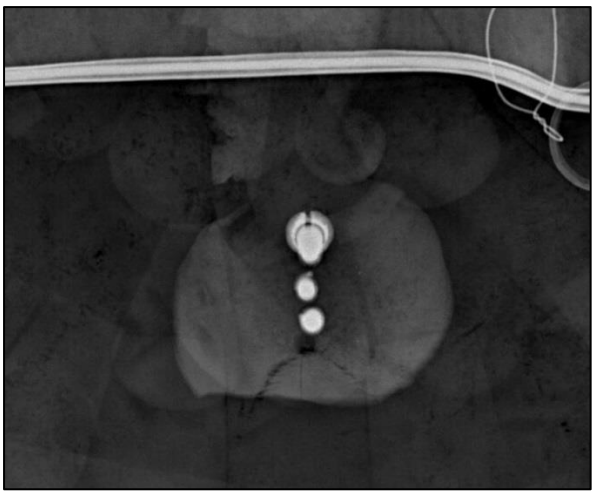


Fig. 25: 2D-radiograph of handle, showing wood.



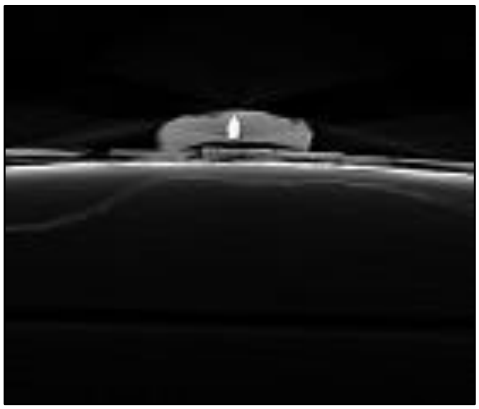


Fig. 26 (right): 2D radiographic plate of shield, detail, bust on lower part of shield showing a piece of screw inside the soldier's head.

Fig. 27 (left): X-radiograph of shield, detail, soldier's head on lower part of shield showing two metal pieces beneath the screw.

6.1.3 Condition

The surface of the shield is very soiled. The dirt is black in colour and has accumulated especially on the lower third of the shield. There seems to have been a past incident as well, as a pattern of droplets is visible (Fig. 29). Seven scales are detached and seven other ones are missing. The timing of this detachment and/or loss can be approximated from the appearance of the glue underneath. In some places the glue is very dark suggesting that the loss occurred before the soiling of the surface happened.

As stated previously there are no records on former condition or conservation within the museum's archives. The question of from where the armour received its extensive soiling of the surface and at what time this happened can therefore not be reliably answered. MARGARET NOEL-PATON, however, states that PATON's wife took care of the collection, "*armed with an oily rag* […] *to keep these burnished and bright.*"[82] It is unlikely that the armour would have been sold to PATON in this soiled state, or at least it would have been cleaned before being displayed in his rooms. The possibility exists, however, that the armour was deliberately soiled by the art dealer in order to mislead PATON. Light grey streaks found on the helmet which could derive from applying a grey material with a brush to it may be evidence of this. Alternatively, these could also be the result of insufficient cleaning while wiping the object. Most probably the armour's soiling is the result of later exposure to coal fires. A hint is given by NOEL-PATON when she describes the drawing room at his home as "*lived-in*"[83] and "*warm*",[84] which

[82] NOEL-PATON 1990, p. 69.
[83] Ibid.

points to heating in this room. A photograph in the "*Supplement*" shows the dining room with an open fire, and furthermore describes the effect of the light of the fire on the atmosphere of the room. The soiling could therefore have happened before the armour was acquired by the museum (as part of a collection of 700 pieces),[85] and may also be a reason as to why it hasn't been on display ever since. It is also possible that the armour became dirty from storage conditions within the museum, which would explain the very different states of soiling of the pieces. As the quiver and sceptres are more lightly soiled, they may have been wrapped or packed, while the shield and helmet were not.

Fig. 28: Slotted screw on reverse of the shield.

The metal seems to be in a stable condition as no active corrosion is visible. Around the screw holes, however, old corrosion products are visible which suggests a previous outbreak of corrosion or perhaps that the shield was already corroded when the new screw was driven in (Fig. 28). The ivory scales have few cracks and the colour ranges from bright white to yellow. They seem to have an even surface beneath the dirt. A surface coating is visible at the edges of the mullets and shows some loss (Fig. 31). There is a hole in the lion's head between its proper left eye and its nose (Fig. 30). The textile on the obverse, which is also slightly soiled, has detached from the metal around the rim.

Fig. 29: Lower third of shield, A.1905.1144.1, dark spots of dirt visible.

[84] NOEL-PATON 1990, p. 69.
[85] VALLANCE 1911, p. 8.

Fig. 30: A.1905.1144.1, detail, lion's head with hole between proper left eye and nose.

Fig. 31: A.1905.1144.1, detail, mullet with worn edges.

6.1.4 Comparative Objects

Research uncovered no similar shield in any other museum collections. However, a breastplate in the collection of the Hermitage in Amsterdam, has a strikingly similar appearance. The soldier in the centre of it sports a wyvern on his helmet. This same creature surmounts the helmet of the NMSs pageant armour. More details were given by VINCENT BOELE who states that "*the object came in 1885 from the collection of the Arsenal of the Winter Palace/State Hermitage Mu-*

seum. It is supposed to be made in Italy, end of 16th century. Steel, bone, height 42 cm."[86] The statements on whether ivory or bone was used are contradictory. Considering the size of the carvings the use of ivory is more likely.

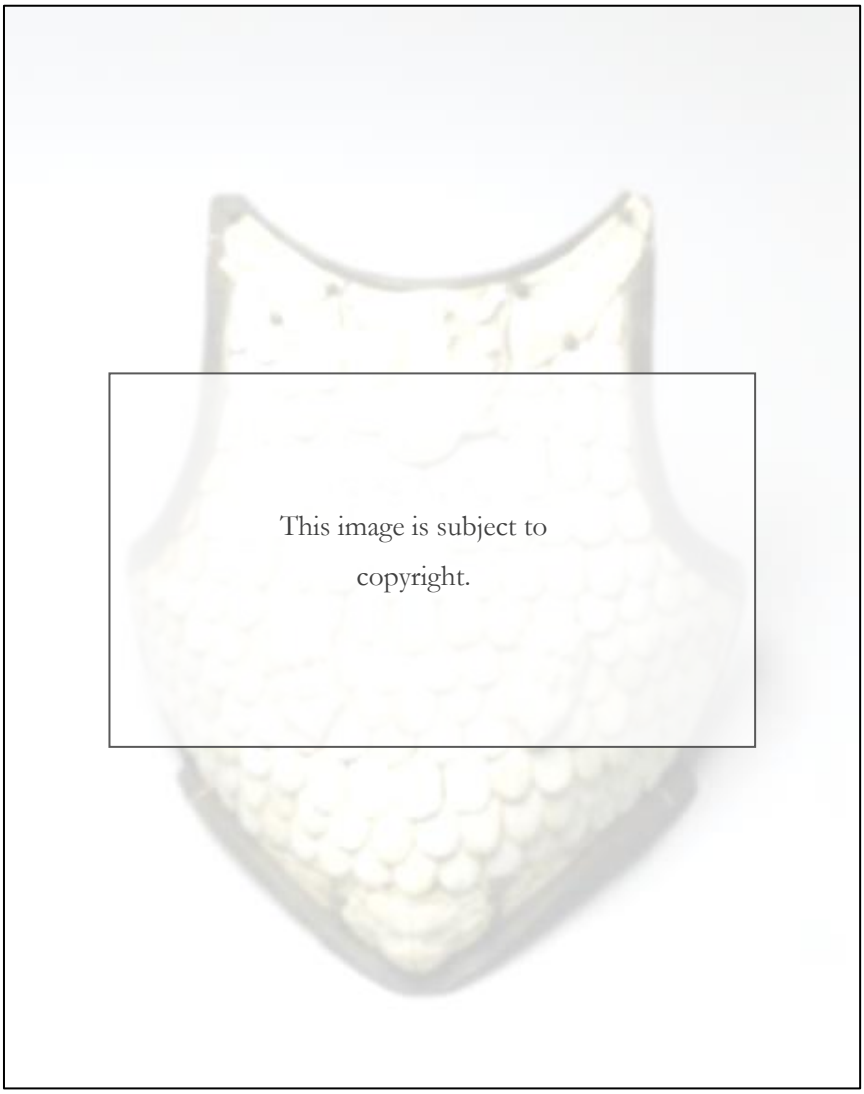


Fig. 32: Breastplate of a cuirass, Collection of the Hermitage Amsterdam [http://www.hermitage.nl/en/tentoonstellingen/alexander_de_grote/hoogtepunten.htm, last accessed 16.8.2013].

[86] Personal communication, 01.07.2013.

6.2 Helmet (A.1905.1144.2)

Fig. 33: A.1905.1144.2.

Accession number	A.1905.1144.2
Measurements/weight	320 mm L × 235 mm W × 285 mm H (metal helmet 280 mm L × 235 mm W × 210 mm H, 61 cm/24 inch circumference, 210 mm L × 180 mm W inside measurements); 2,8 kg
Materials	Iron, wool, wood, elephant ivory (Schreger lines)
Literature	PATON 1879, p. 48, Cat. No. 445.

6.2.1 Description and Symbolism

"*Casque or Burgonet, in iron, with cheek-pieces of pseudo-antique shape, encrusted like the above, with scales of ivory; frontlet and neck-guard carved with scrolls and heads of Roman soldiers. In front, a head in low relief, probably meant to represent Sol, all surmounted by a crest–a*

wyvern, in ivory; the whole somewhat resembling in design the beautiful Italian casque formerly worn by Francis I., now in the Musée d'Artillerie, Paris."[87]

At the front centre of the helmet is a decorative element in the shape of a face surrounded with rays that is probably meant to represent *Sol*. Along the helmet's crest is a wyvern with an open mouth; its body stretching along the crest to the back where it touches the helmet again and ends in a tripartite tail. In English heraldry a wyvern is clearly distinguished from a dragon with "*only two legs, the body curling away into the tail, and it is usually represented as resting upon its legs and tail*"[88] although "*the wyvern appears to be the form more frequently met with under the name of a dragon in other countries.*"[89]

Fig. 34: Different forms of wyverns in English Heraldry [FOX-DAVIES 1909, p. 226].

The wyvern bears an ornament on its head which was broken at its base but still preserved among other pieces associated with the armour. It has the shape of three feathers and is reminiscent of the heraldic badge of the Prince of Wales which consists of three white feathers emerging from a golden crown.

The frontlet bears the heads of two Roman soldiers in profile. On the proper left side is a bearded man wearing a helmet with an open visor and peculiar crest, which is only half visible. He is surrounded by acanthus leaves and faces to the proper left side. On the proper right side is the profile of another bearded Roman soldier, wearing a helmet with scrolled neck-guard and open visor. He is also surrounded by acanthus leaves and faces to the proper right side. The two parts of the frontlet are linked with a shell or palmette ornament which spreads over both sides.

[87] PATON 1879, p. 48.
[88] FOX-DAVIES 1909, p. 226.
[89] Ibid.

The proper left side of the neck-guard is decorated with an eagle's head with an open beak and protruding tongue. It is surrounded by acanthus leaves and a shell/palmette ornament links it to the proper right side where there is a lion facing it in profile, also surrounded by acanthus leaves.

6.2.2 Materials and Structure

The helmet is made from iron alloy. X-ray images reveal that this is an older helmet of a so-called Cabasset type, a common style from the end of the 16th and the early 17th century, which has been re-used (Fig. 43, Fig. 36).

Fig. 35: Helmet, Schreger lines visible at neck guard.

It has a pear stalk pointing to the rear at the apex of the skull. In addition there is a series of holes around the base of the skull which have no obvious purpose in the current composition. Previously, they would have served as holes for rivets which secured an interior leather lining to cushion the weight of the helmet and also held the cheek pieces in place.

The caps of such rivets were often shaped as stars or flowers in contrast to rivets which remain rough and unworked. The brim of the metal helmet was adjusted to its new shape by trimming the sides which is visible in its irregular edge (Fig. 44). As with the shield, the helmet is covered with ivory scales and decorative elements, which were difficult to identify due to the amount of dirt accumulated on the surface and the presence of a thick surface coating. On a previously-cleaned part of the neck-guard, Schreger lines were revealed under raking light. Elephant ivory was again identified by measuring the Schreger line angles. It appears likely that the other parts of the helmet are elephant ivory as well. Since this is an assumption, however, the term "ivory" without further specification will be used. To attach the ivory decorative elements, new holes were drilled into the metal. Along the top of the helmet, wood was attached to the metal by screws, which then served as a support for the wyvern. The wyvern itself is also secured by screws, whereas the ivory scales are attached to the wood with nails and glued to a

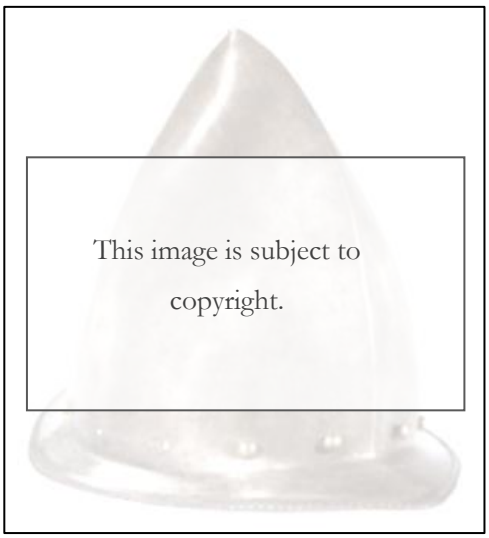


Fig. 36: *Cabasset*, Italy, late 16th century [www.christies.com, last accessed 17.08.2013].

linen fabric. The *Sol* at the front of the helmet is supported by two additional pieces of wood, also with ivory scales underneath. The *Sol* seems to be attached by what is likely an ivory rod (the detached foot of the wyvern has an ivory rod), which can be faintly seen in the CT images (Fig. 37).

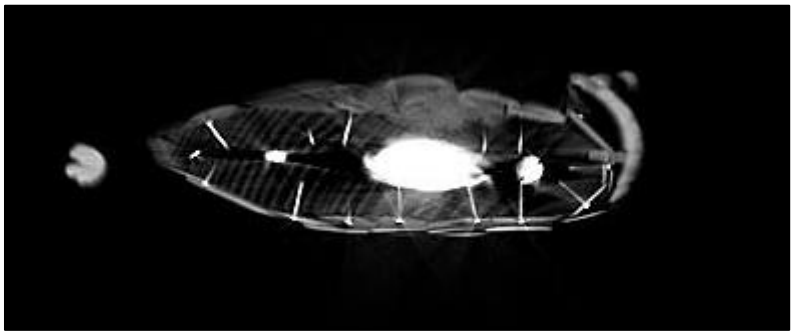


Fig. 37: Crest of helmet (2D radiograph): ivory rod securing *Sol* to wood.

These radiographs show the presence of 'ivory' dowels at other locations on the wyvern too. The wyvern is secured to the wood with one screw (at the front) and one dowel (where the tail touches the wood). It is made up of five separate parts, not counting the pair of wings and the claws. The tongue is inserted in the head and possibly glued.

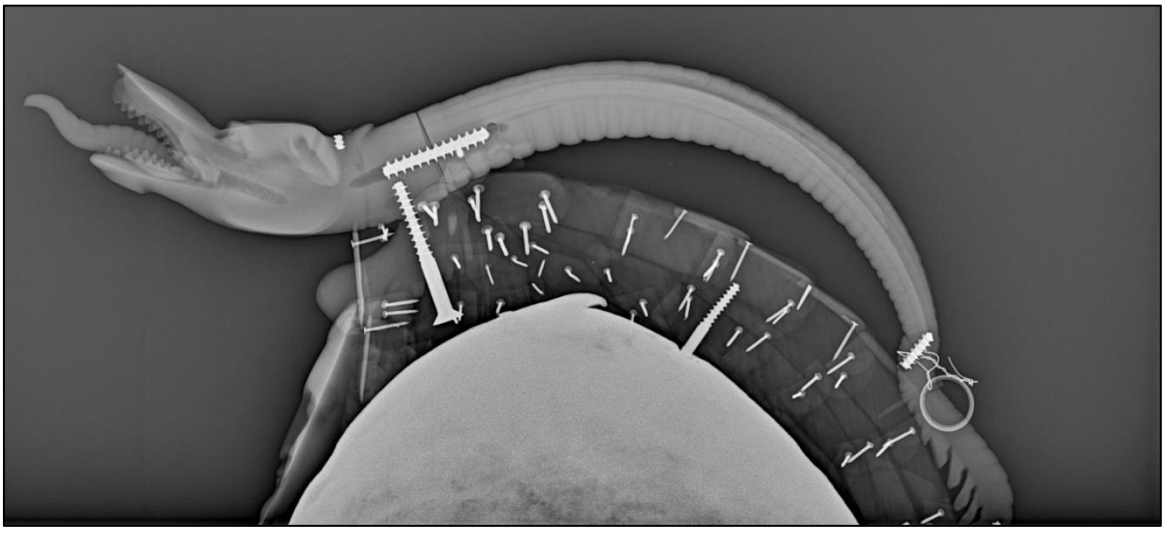


Fig. 38: X-radiograph of wyvern.

The head is attached to the body with a headless screw and must therefore have been assembled before the rest of the wyvern was secured to the wood. With the hole extending beyond the end of the screw, it is likely that an ivory dowel had previously been used. A dark spot to the rear of the screw indicates a dowel hole for the wing of the wyvern, while a bright spot underneath shows a broken screw. Behind the wyvern's ears a piece of screw can be seen be-

side a hole to the front and a hole filled with a dowel to the rear. At this point the plume of ivory was attached.

The tail of the wyvern is affixed to the body by a short headless screw and the tripartite tail end with a slotted screw.

ALEXANDER GRILLPARZER, metal conservator, classified the screws as modern wood screws because of the type of thread and pitch present. Furthermore traces of turning on a lathe can be seen on a screw head under the frontlet of the helmet (Fig. 40). The earliest date for these characteristics is the 19th century.[90]

Fig. 39: A.1905.1144.2, detail, broken ivory dowels, screws and nails to attach the elements to the helmet.

Fig. 40: Helmet, slotted screw under frontlet, lathe marks.

[90] Personal communication, 05.07.2013.

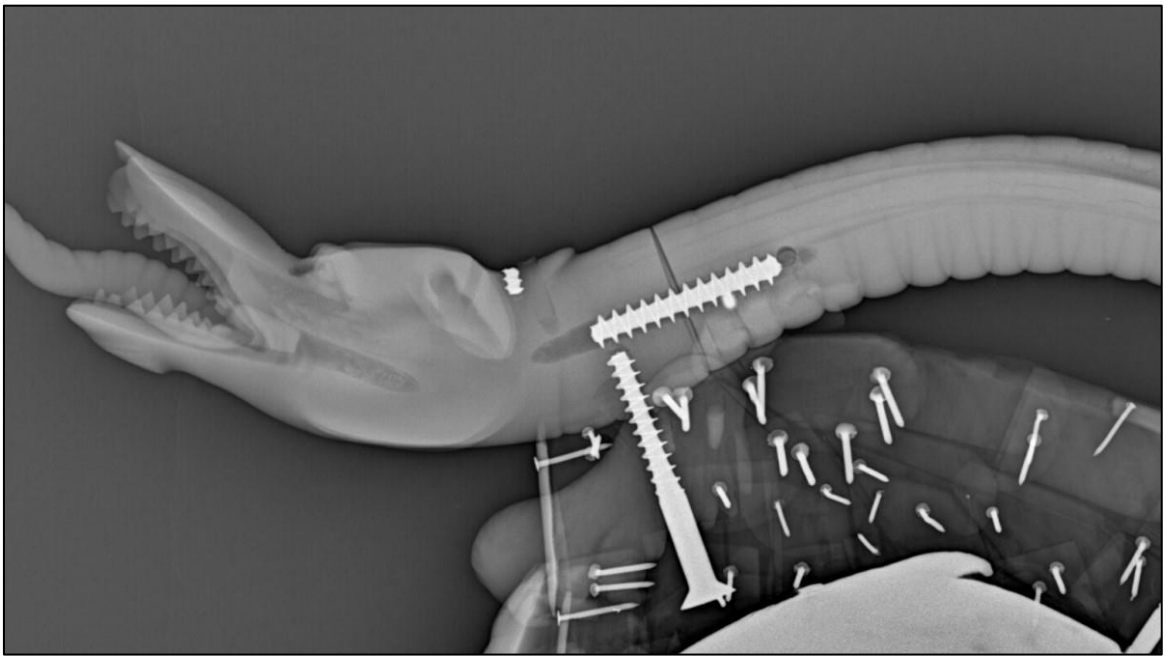


Fig. 41: X- radiograph of A.1905.1144.2, detail, head of wyvern.

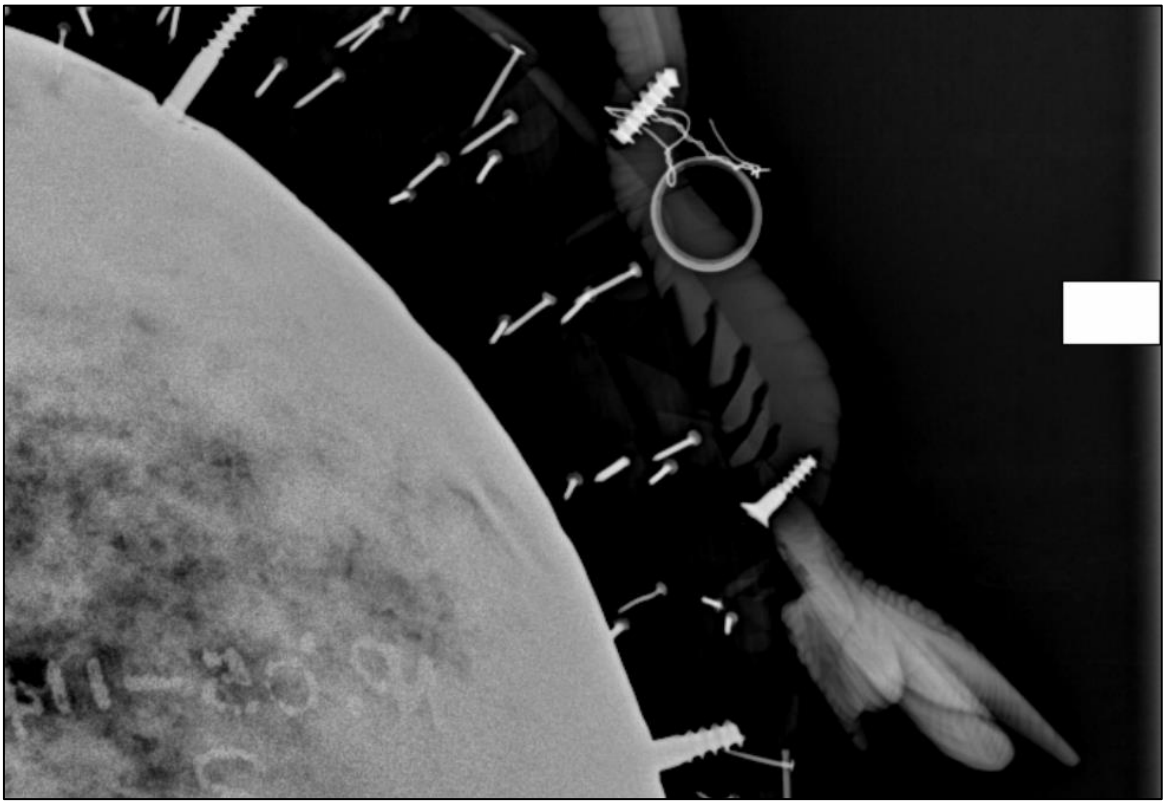


Fig. 42: X-radiograph of A.1905.1144.2, detail, tail and tail end of wyvern.

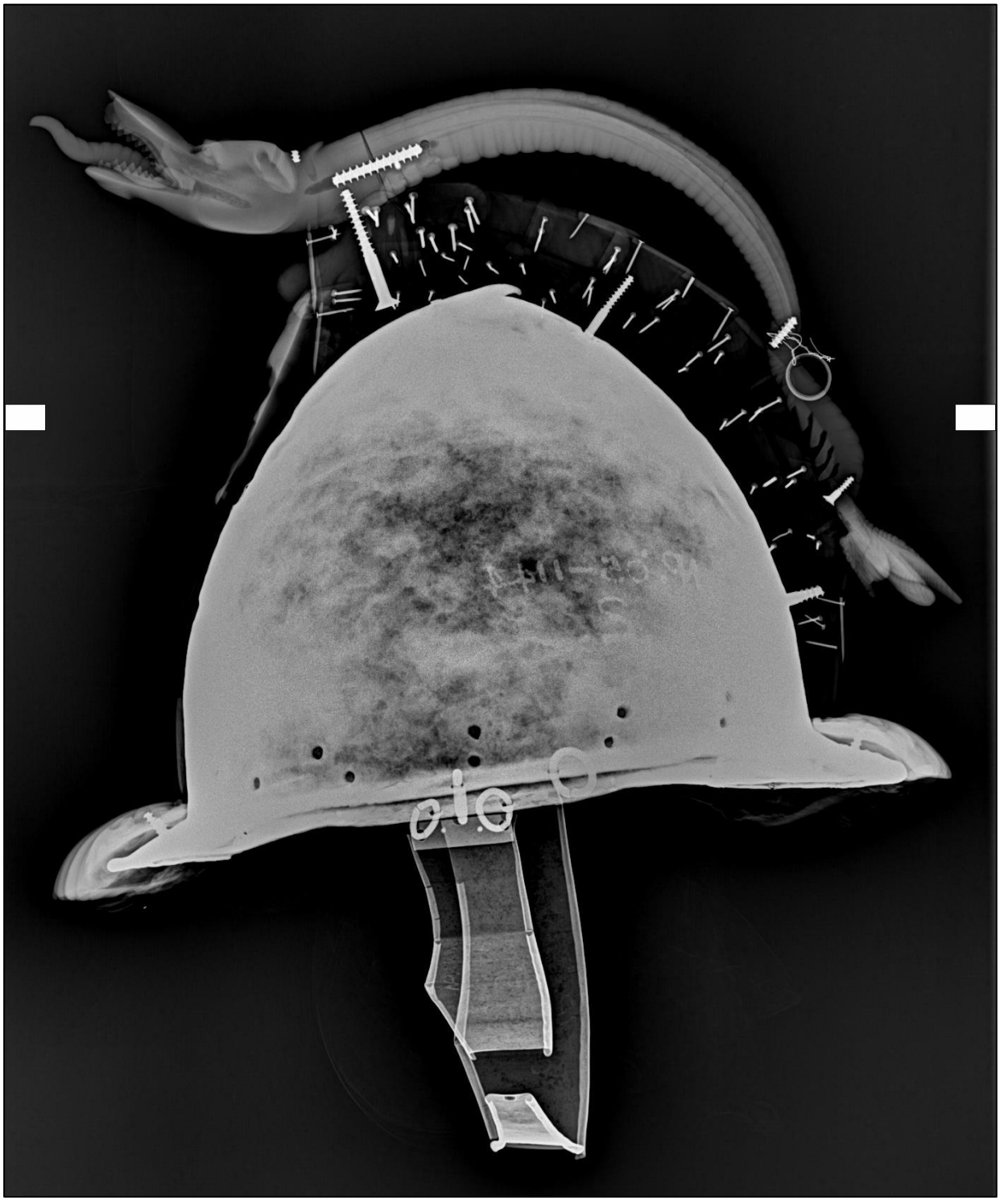


Fig. 43: A.1905.1144.2, X-radiograph.

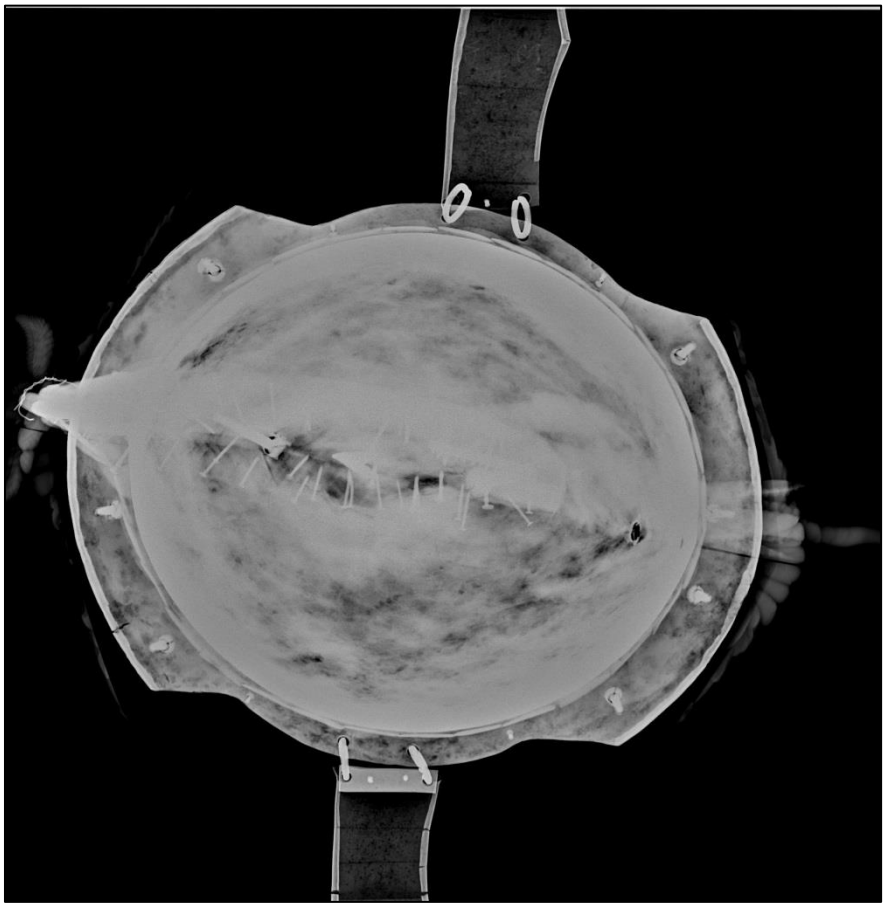


Fig. 44: A.1905.1144.2, X-radiograph, irregularly shaped brim along cut-out.

The ivory frontlet and neck-guard are screwed to the metal and a mixture of resin and wax is coarsely applied between the metal and ivory as well as metal and textile to provide a level surface. The presence of the resin/wax mixture on the textile suggests that it is original to when the helmet was assembled (Fig. 45). The NMS accession number may have been painted on the textile lining with lead white as it shows clearly on the radiographs.

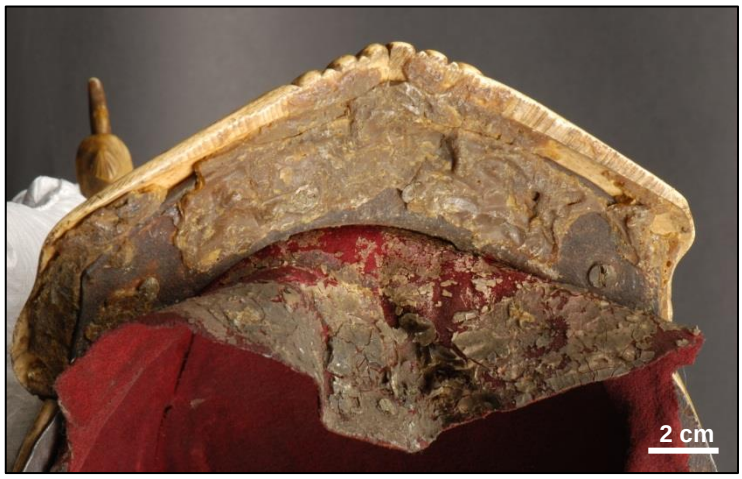


Fig. 45: A.1905.1144.2, detail, frontlet with coarsely applied material to metal, ivory and fabric.

6.2.3 Condition

The condition of the helmet is generally similar to that of the shield's, although it is not as extensively soiled. A crack runs through the metal of the frontlet at the proper left side (Fig. 33) and the metal along the bend of the proper right cheek piece is broken. There is a loss of eight scales as well as a detached foot, wings and head ornament of the wyvern.

Fig. 46: Bubbles on surface of helmet.

As part of a former investigation of the object, the proper right part of the neck-guard had been cleaned using ethanol and white spirit. Traces of previous surface coating could be discovered under the microscope, as well as small bubble-like irregularities on the surface of the ivory did show up. As a result, the possibility of the neck-guard being cast plastic was considered, however but the presence of Schreger lines refutes this (Fig. 35).

The red textile shows no signs of wear apart from at the apex, where there are marks which may have resulted from being displayed on a mount (Fig. 47).

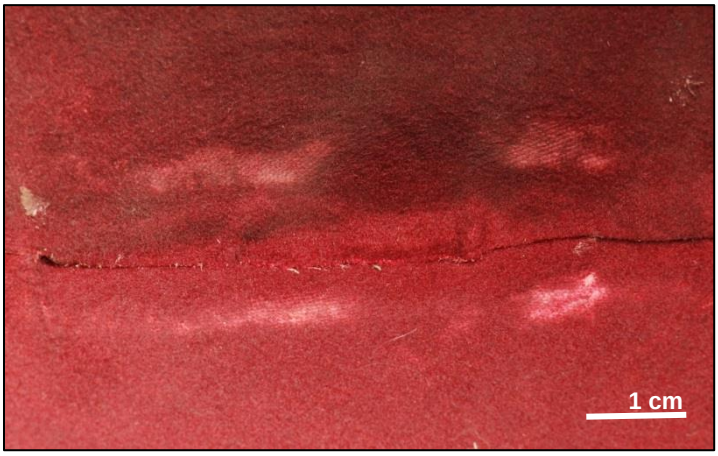


Fig. 47: A.1905.1144.2, detail, fabric on apex with wear marks.

6.2.4 Comparative Objects

Three comparative objects were found for the helmet: one was part of an auction at Sotheby's New York (Fig. 48), a second helmet is in private ownership (Fig. 50) and another is held in the Musée Goya in France (Fig. 49).

The helmet at Sotheby's is listed as an "*Ivory Helmet, late 19th century, centered by a heraldic shield with the motto of the Prince of Wales surmounted by a crown and flags above a Medusa mask flanked by winged dragons, overall fitted with leaf-tips, topped by a basilisk. Height 15½ in. (38.7 cm.)*"[91] Upon enquiry at Sotheby's, it was revealed that no further details on origin or technique of the helmet could be given. The helmet was purchased by an individual rather than a museum which means that further information is not easily accessible.

Fig. 48: Ivory helmet, late 19th century [SOTHEBY'S 1996, No. 85].

[91] SOTHEBY'S 1996, Cat. No. 85.

An impressively decorated helmet is held by the Musée Goya de Castres, which is described as "*Casque d'apparat en Ivoire de George II d'Angleterre*",[92] attributed to David Lemarchand (1674–1726). It is thought to have been altered in the 19th century as a tribute to George II of Great Britain and Ireland, Duke of Brunswick-Lüneburg and Prince-elector of the Holy Roman Empire. He ascended the throne in 1727 which is written on a plaque in Roman numbers: "MDCCXXVII". The crest of the helmet is decorated with a dragon (actually a wyvern), matching well with the story of Saint George killing a dragon and the dedication to King George II.

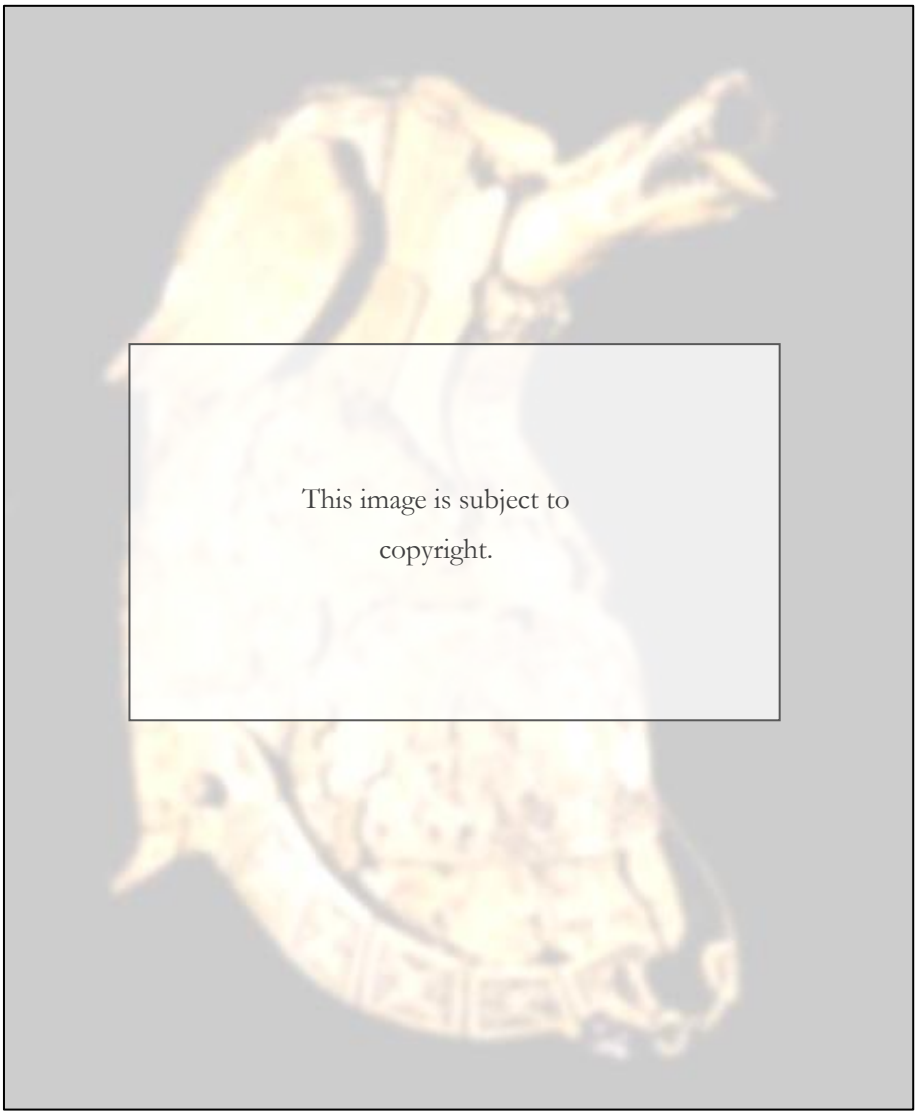


Fig. 49: Casque d'apparat en ivoire de Georges II d'Angleterre, Musée Goya, Accession number 894-2-54 [http://www.musees-midi-pyrenees.fr, last accessed 16.08.2013].

[92] BRUEL, BERNARD; AUGÉ JEAN-LOUIS: *Casque d'apparat en ivoire de George II d'Angleterre*, in: *L'Olifant. Arts decoratifs, sciences et techniques, arts graphices, en Midi-Pyrénées*, Toulouse 1995, p. 17.

Another helmet was discovered during the research but unfortunately no further details apart from one photograph could be revealed.

Fig. 50: Helmet of ivory, private ownership.

6.3 Quiver (A.1905.1144.3)

Fig. 51: A.1905.1144.3.

Accession number	A.1905.1144.3
Measurements/weight	490 mm L × 110 mm W × 145 mm H; 1,3 kg
Materials	Wood, metal, wool, elephant ivory (Schreger lines)
Literature	PATON 1879, p. 48, Cat. No. 446.

6.3.1 Description and Symbolism

"*Quiver, built in wood, also encrusted with scales of ivory, and carvings in relievo, of fine execution: consisting of, on the one side, a heart-shaped plaque, similar to that on the shield (No. 444), and, on the other, the bust of a Roman general, whose helmet bears for crest a wyvern-like creature. Round the mouth of the quiver is a bear hunt, executed with much spirit; under this, on a scroll, are engraved the letters, "S.P.Q.R.;" at base, ornamental scrolls and heads of Roman soldiers.*"[93]

[93] PATON 1879, p. 48.

The quiver is conically shaped and decorated in the same manner as the shield and helmet. The decorative element described as a heart-shaped plaque is more oval in shape and although now detached, it is present with the collection. It is of a similar appearance to the one found on the shield, although there are not as many leaves at the base and no surrounding flames. The Roman general on the opposite side wears a helmet with a rolled-up neck-guard and an elaborate crest surmounted by a wyvern or dragon.

Fig. 52: A.1905.1144.3, detail, Roman general.

Furthermore, a small label was found glued inside the mouth of the quiver. It is red, star-shaped and bears the number "446" written with black ink. This is the accession or catalogue number PATON gave the quiver.

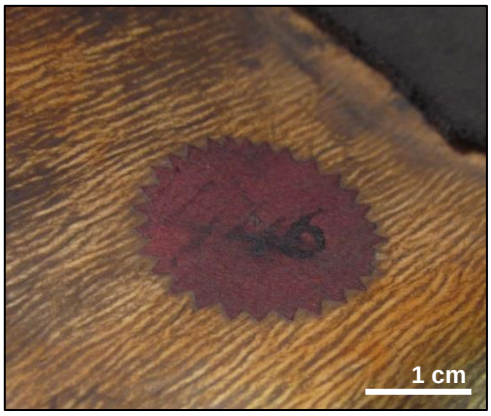


Fig. 53: Label on A.1905.1144.3.

Fig. 54: A.1905.1144.3, detail, bear hunt.

Fig. 55: A.1905.1144.3, detail, bear hunt.

6.3.2 Materials and Structure

As PATON states, the quiver is made from wood, which is confirmed with by the CT image. It shows that four pieces of wood were glued together in a conical shape beneath the ivory mouth of the quiver (Fig. 57). At the base of the quiver and at the mouth, which was produced from one single piece of ivory, Schreger lines are visible.

It is therefore anticipated that the quiver was entirely decorated with elephant ivory, although again this cannot be fully confirmed.

Fig. 56: A.1905.1144.3, detail of bear hunt, Schreger lines, no scale available.

Ivory scales cover the quiver and are secured to the wood with nails. The decorative elements as well as the mouth are held in place with ivory rods (Fig. 58, Fig. 59). The detached plaque element has a mixture of wax and resin similar to that found on the helmet's frontlet applied to its underside. An ivory base is inserted into and probably glued to one end of the wooden quiver with no further visible fixation. The decorative knob on its base is threaded so that it can be screwed on (Fig. 61). The loop for a carrying strap is fixed to the side of the wooden quiver with a headless modern screw (Fig. 61) and the inside of the quiver is lined with a black textile.

The CT and X-ray images also show that scales were hidden beneath the lining at the bottom of the quiver which can be taken out (Fig. 60, Fig. 62). These scales were removed with one of them being matched to a loss of the quiver. Unfortunately, the other scales could not be reintegrated, suggesting that perhaps there were more objects belonging to the ensemble of the quiver, shield and helmet in the past. The very different reverse of the scales with various tool marks could hint to later replacements.

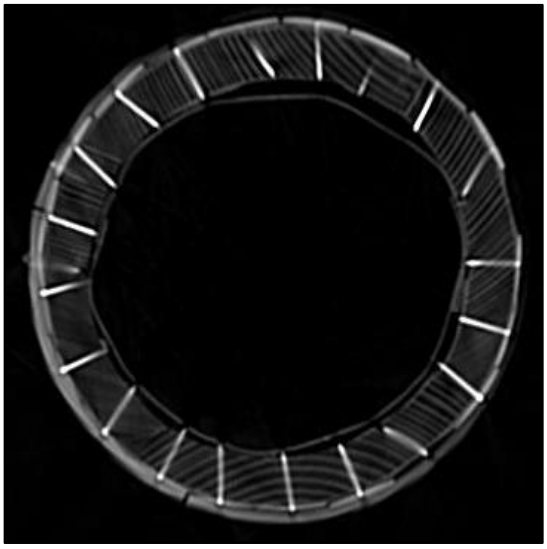


Fig. 57 (left): A.1905.1144.3, 2D radiographic plate, four pieces of wood forming the support.

Fig. 58 (right): A.1905.1144.3, 2D radiographic plate, nails to affix the scales.

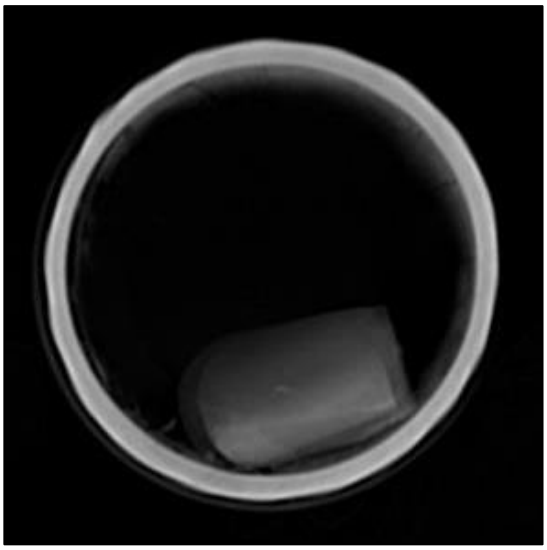


Fig. 59 (left): A.1905.1144.3, 2D radiographic plate, ivory dowels.

Fig. 60 (right): A.1905.1144.3, 2D radiographic plate, scales at the base.

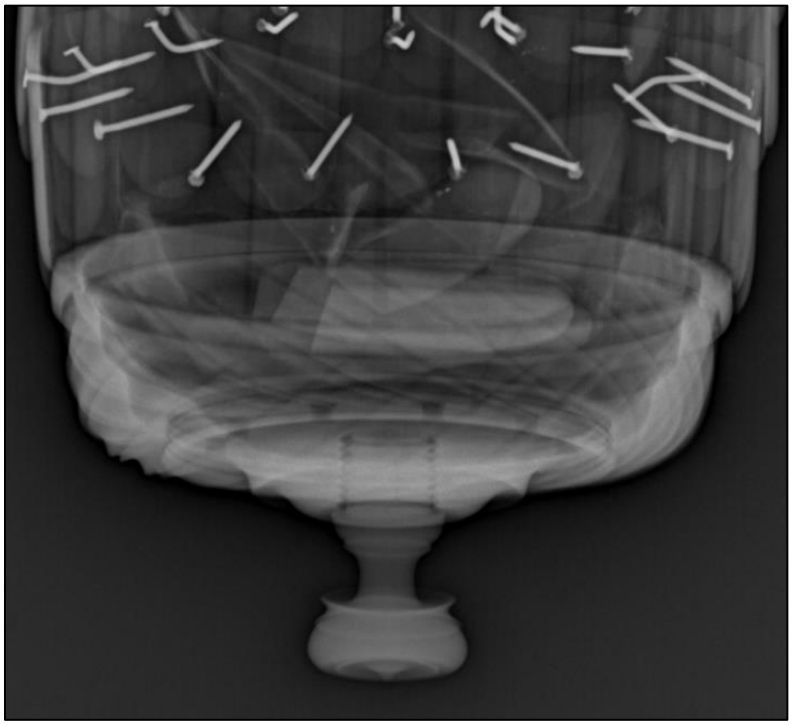


Fig. 61: A.1905.1144.3, X-radiograph, knob with thread and scales inside.

Fig. 62: Scales found inside the quiver.

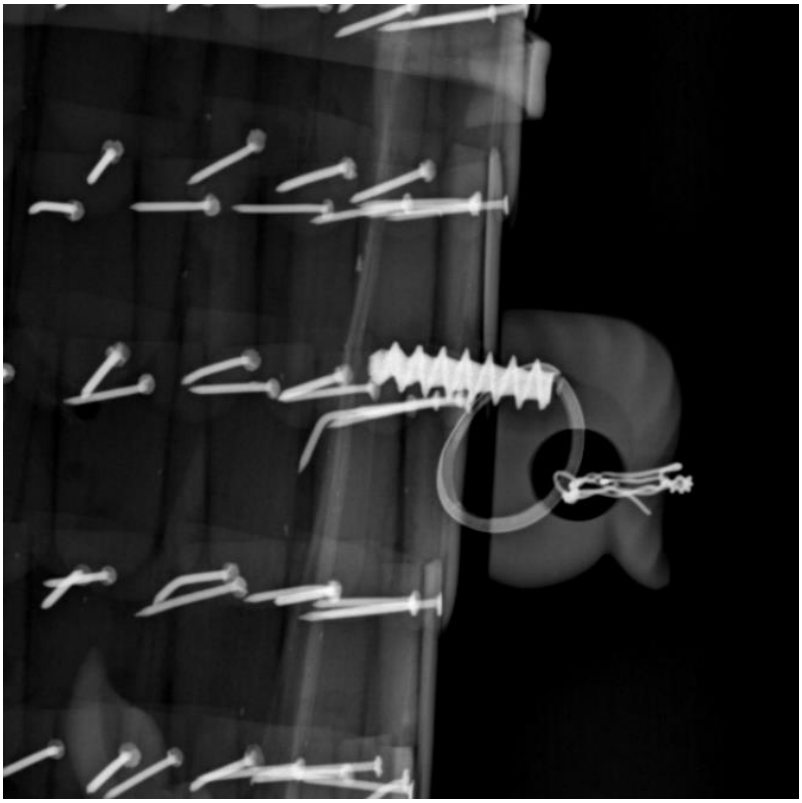


Fig. 63: A.1905.1144.3, X-radiograph, headless modern screw to fix the handle.

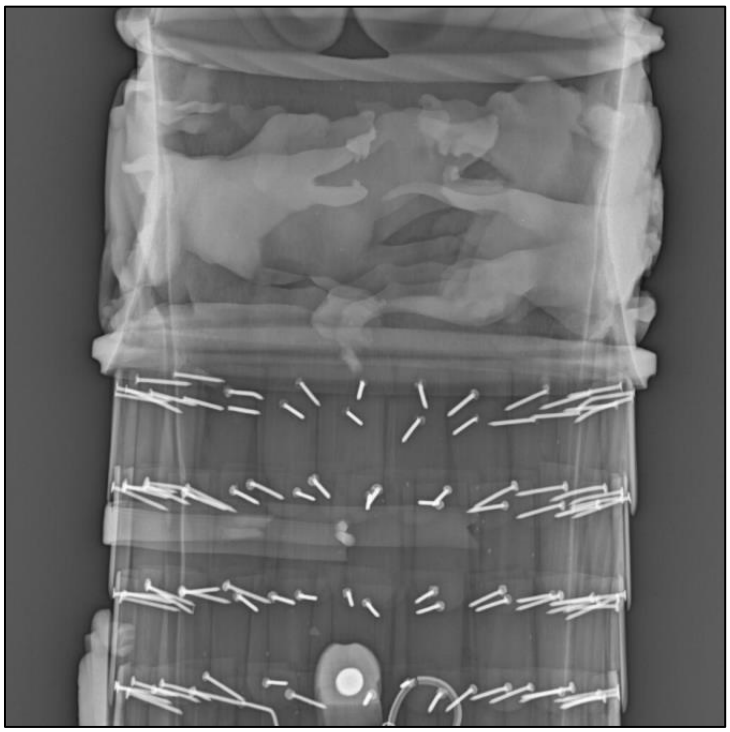


Fig. 64: A.1905.1144.3, X-radiograph, ivory dowels securing the bear hunt and S.P.Q.R. band to wood.

6.3.3 Condition

The quiver is in overall good condition. The surface soiling is not as extensive as it is on the shield and helmet. There are losses of single scales and decorative elements, which are, however, preserved and can be reattached. A crack runs through the ivory base of the quiver.

6.4 Sceptre (A.1905.1144.4)

Fig. 65: A.1905.1144.4.

Accession number	A.1905.1144.4
Measurements/weight	850 mm L × 40 mm W × 32 mm H; 880 g
Materials	Bone (Harversian canals), metal
Literature	PATON 1879, p. 49, Kat. No. 447.

6.4.1 Description and Symbolism

"*Carved ivory sceptre, of great grace of design and beauty of execution. It's extreme length is 34¼ inches, and it is divided, by fillets of varied ornament, into seven sections. On one side, at base, are the arms of the Dauphin of France, surmounted by a royal helmet; on the 2d section, the Imperial eagle crowned and displayed; on the 3d, two dolphins ornamentally arranged; on the 4th, the bust of an ancient warrior in profile–beardless and long-haired; on the 5th, a plaque with finely-executed front mask of Pan. The three higher sections are filled with scroll-work and other ornamentation. On the other side, at base, is the bust, in profile, of a Roman general; on the 2d sec-*

> *tion, an old French crown, under which occurs the date 1551 (the year of the accession of Henry II of France, when of course his son Francis, the husband of our Queen Mary, became dauphin); on the 3d section, dos-à-dos with the two dolphins, a well-designed dragon in violent action; on the 4th section the figure, in profile, of a man curiously costumed, with large circular ear-rings, and headpiece surmounted by a raven (?) which seems conversing him; on the 5th section a plaque, dos-à-dos with Pan, carved with a grotesque male head, in profile, of very characteristic design; the three remaining sections ornamented as on the other side–all surmounted by a foliated ball and a fleur-de-lis.*"[94]

PATON gives a very detailed description of this sceptre. Research into the figure of the "*curiously costumed*"[95] man did not uncover any comparable depictions in other fields of art or its iconographical meaning. The man is probably Oriental due to the particular style of his earrings. While DR. ESTHER WIPFLER of the Zentralinstitut für Kunstgeschichte München, associated the figure with a falconer, this does not seem very plausible as falconers are usually presented with the falcon on their arm rather than on their head and the bird is reminiscent of a raven.

Fig. 66: A.1905.1144.4, detail, man with bird on head.

[94] PATON 1879, p. 48–49.
[95] Ibid., p. 49.

Fig. 67 (left): Falconers, 1241–1248 [De arte venandi cum avibus, Frederick II, Wikimedia Commons].

Fig. 68 (right): Falconer on horseback, 1594 [http://www.britishmuseum.org].

6.4.2 Materials and Structure

The sceptre consists of a metal rod which links together seven carved bone body sections. The rod has a plate at base and a screw end at top. On the top and bottom end knobs are attached. The bottom knob can be removed revealing a repair: A round metal plate was fixed to the metal rod to allow the knob to be screwed on. The broken thread of section one was probably the reason for repair. As bone is hollow inside the top of the knobs had to be closed by first inserting wood and then a round piece of bone, which can be seen on the X-ray. This was carried out before the carving as the lines match extremely well. The top section in the shape of a *fleur-de-lis* is currently detached. Counting from the bottom, sections one and two are joined inside with two pieces of wood and two metal dowels one of which has a hatched surface. Pieces of wood were inserted to secure each joint. Inside the top knob the threaded end with a nut is visible. A short metal rod is inserted into the top knob to attach the *fleur-de-lis*. To disassemble the sceptre the top knob must be unscrewed, the nut removed and the carved bone sections removed by sliding them to the top section.

In contrast to PATON's description, the sceptre is made of bone, not ivory. This is apparent in the presence of arterial entrances, which are occupied by blood vessels when the tissue is living.[96] In addition, characteristic "Haversian canals" are visible as dark spots in cross-section and as canals in longitudinal section.[97] The *fleur-de-lis,* however, is made of proboscidean ivory, as Schreger lines could faintly be identified.

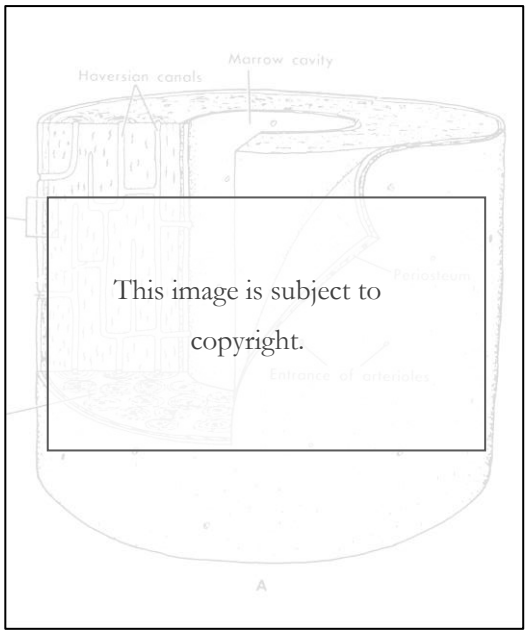


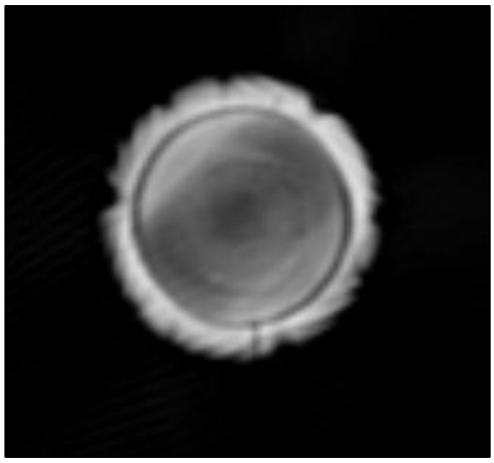
Fig. 69: Diagram of a mammalian femur leg bone [FLORIAN 2007, p. 38].

Fig. 70: A.1905.1144.4, detail of warrior's sleeve, Harversian canals visible.

[96] FLORIAN 2007, p. 37.
[97] Ibid., p. 38.

Fig. 71 (left): A.1905.1144.4, details, bottom knob.

Fig. 72 (right): A.1905.1144.4, detail, top knob.



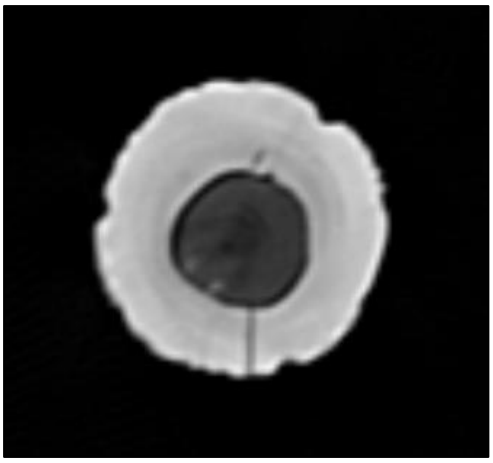


Fig. 73 (left): A.1905.1144.4, 2D-radiographic plate of bottom knob, carved bone filled with wood.

Fig. 74 (right): A.1905.1144.4, 2D-radiographic plate of bottom knob, metallic plate inserted as thread.

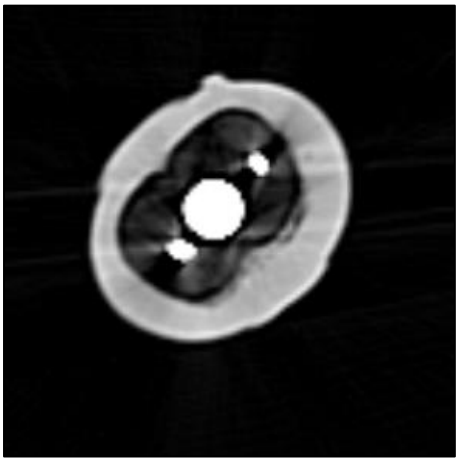


Fig. 75: A.1905.1144.4, 2D-radiographic plate of joint of section one and two, metal rod, dowels, wood and carved bone.

Fig. 76 (left): A.1905.1144.4, detail bottom knob, Fig. 77 (right): A.1905.1144.4, detail of metal plate, no scale available.

Fig. 78: A.1905.1144.4, bottom knob.

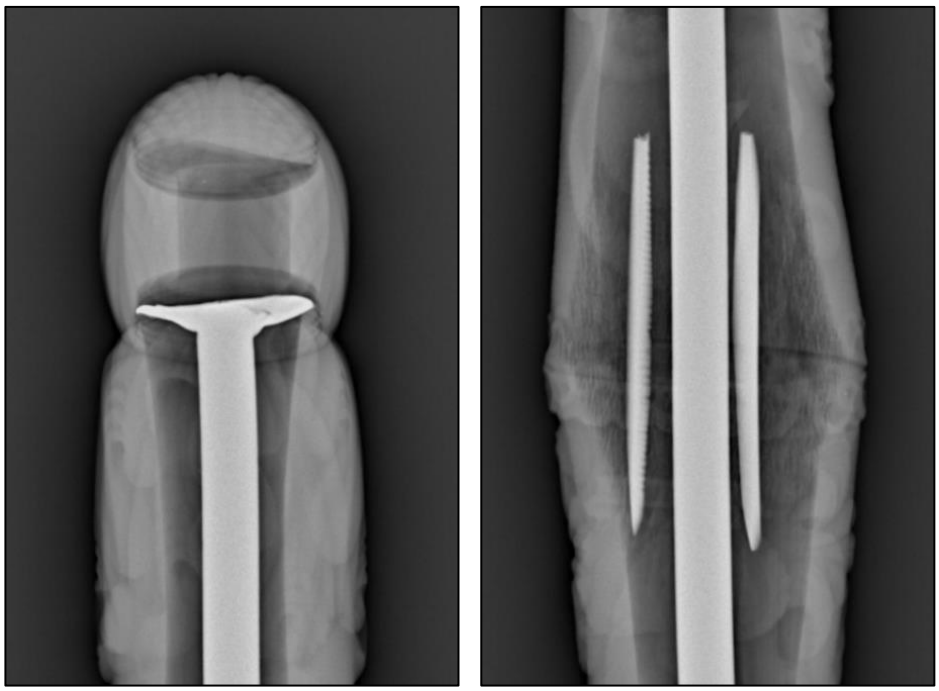


Fig. 79 (left): X-radiograph of A.1905.1144.4, bottom knob showing metal plate in detail, with inserted bone piece.

Fig. 80 (right): X-radiograph of A.1905.1144.4, metal rod and dowels (left with hatched surface) securing joint in between section one and two.

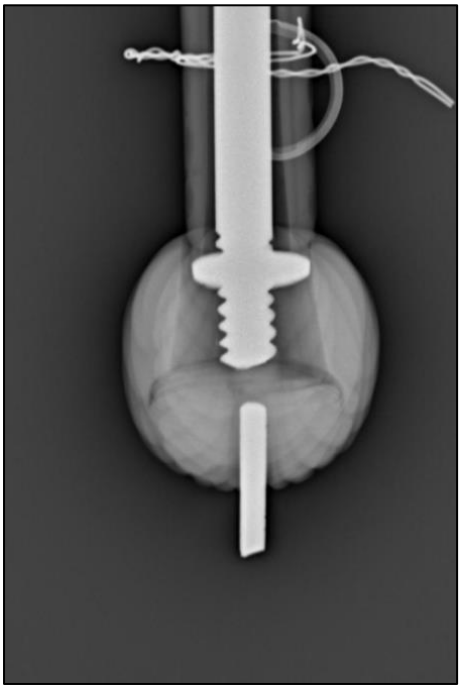


Fig. 81: X-radiograph of A.1905.1144.4, top knob with threaded rod, bone piece and small metal rod to secure *fleur-de-lis*.

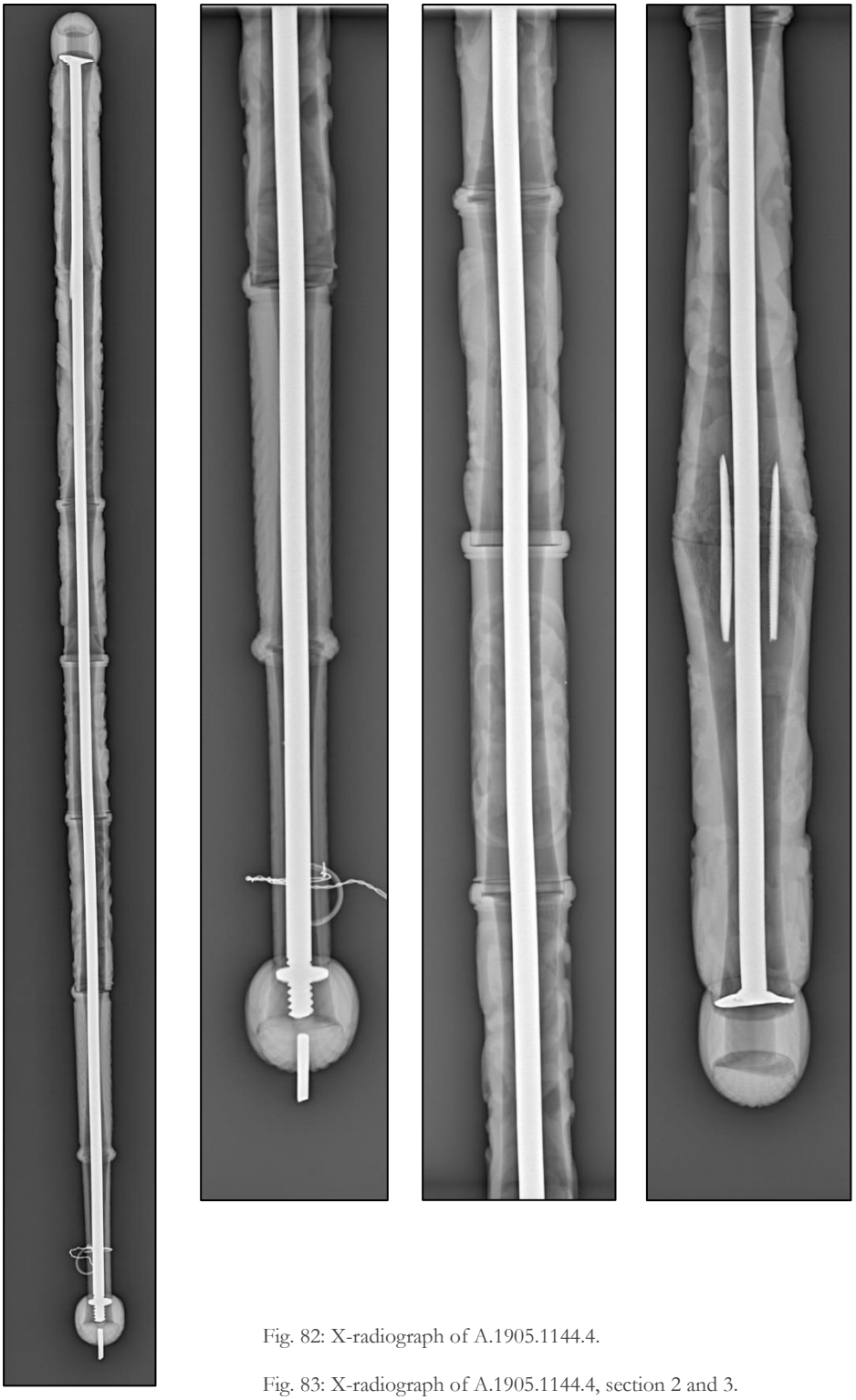


Fig. 82: X-radiograph of A.1905.1144.4.

Fig. 83: X-radiograph of A.1905.1144.4, section 2 and 3.

Fig. 84: X-radiograph of A.1905.1144.4, section 4 and 5.

Fig. 85: X-radiograph of A.1905.1144.4, section 6, 7 and knob.

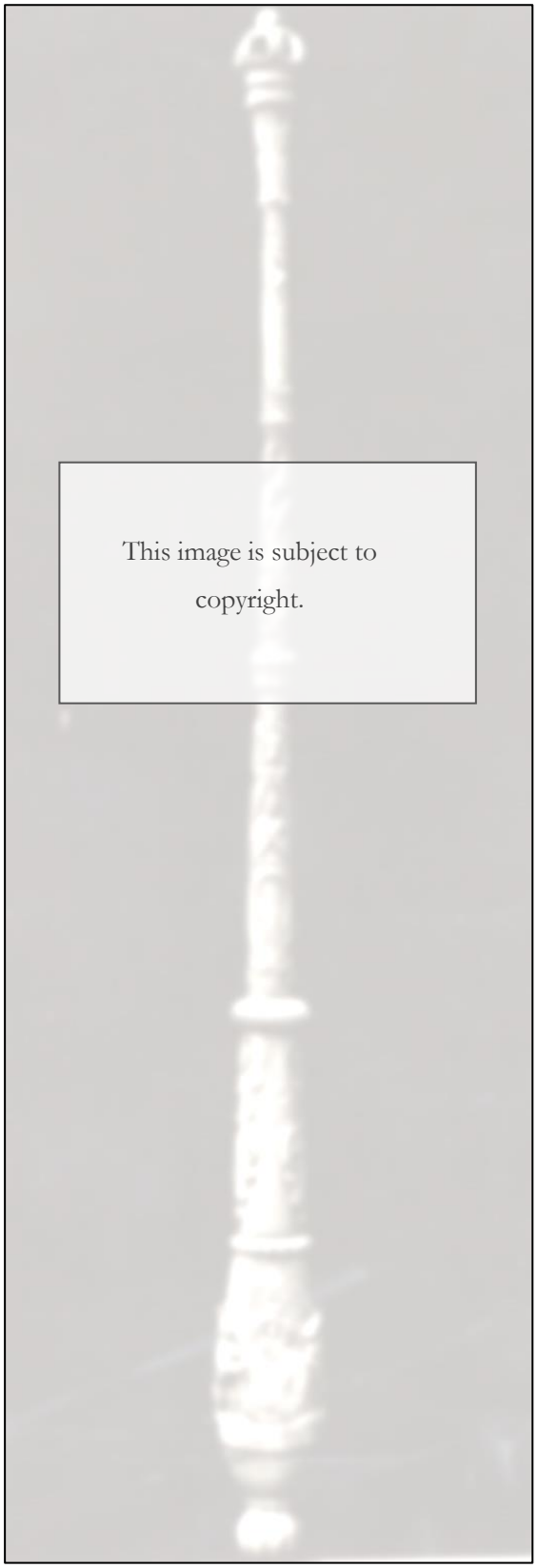
6.4.3 Comparative Objects

Two objects with comparable features to PATON's sceptres were identified. The first one is strikingly similar, with decorative elements such as the "*FM*" monogram and the man or woman with the bird on its head. The figure is carved on a prominent section of the scepter along with a man who is probably Francis II, the date 1558 and the inscription "*FM*". It is therefore likely that the figure with the bird is Mary Stuart. Why she would be depicted in that manner is not clear. It is part of a private collection (recently inherited). Unfortunately there is nothing more known about this sceptre.

Fig. 86: Sceptre private ownership, "FM".

Fig. 87: Sceptre private ownership, overall view.

Fig. 88: Sceptre private ownership, detail with date, figure with bird and figure with sceptre.



Another sceptre is in the collection of the British Museum (1944,1001.17). It is described as follows: "*Sceptre; ivory; openwork crown surmounting an elongated capital with acanthus decoration on the top of the rod that has four sections carved with mythological figures, creatures, foliage, fleur-de-lis, coat of arms and a date; sections separated by ornamental collars; ovoid handle with gadrooned terminal knob; handle carved in relief with Hanoverian Royal Arms; legend on scroll; reverse: an armoured figure on the sceptre.*"[98] Regarding the provenance and dating of the sceptre it states: "*The donor described this object as 'sceptre made for use in Hanover; as part of the regalia was allowed to leave the country'. However, it is now generally thought to be an assemblage of elements of Renaisssance to 19th century date with the inscription and date added later.*"[99]

[98] www.britishmuseum.org/research/collection_online, last visited 13.08.2013, Accession number 1944,1001.17.
[99] Ibid.

6.4.4 Condition

The sceptre is in overall good condition. Grey surface soiling is trapped in the Harversian canals, which stand out as dark spots. A few bigger darker spots are visible across the sceptre as well as scratches on the surface. A few racks run longitudinally. Between section five and six, a piece of the bone ring overlapping section five, is missing. The *fleur-de-lis* is detached.

6.5 Sceptre (A.1905.1144.5)

Fig. 89: A.1905.1144.5.

Accession number	A.1905.1144.5
Measurements/weight	730 mm L × 40 mm W × 30 mm H; 680 g
Materials	Bone (Harversian canals), metal, stone
Literature	PATON 1879, p. 48, Cat. No. 448.

6.5.1 Description and Symbolism

"*Carved Sceptre, in bone, set with garnets, turquoises and beryls. The extreme length of this sceptre is 31¾ inches, and like the foregoing it is divided, by carved fillets–in this case set with turquoises–set into seven sections, richly carved, but in a style of design and execution slightly later and less perfect; illustrating the rapid decline of art in France after the middle of the 16th century. On one side, on base section, are carved large, and in antique style, and set with turquoises and beryls, the letters, "F.M.;" immediately above these letters, on 2d section, is the old French*

crown–also set with turquoises,–surmounted by two scaly monsters. On section 3d is engraved an escutcheon, charged with a lion rampant, and surmounted by a Royal helmet plumed. Sections 4 and 5 are covered with fantastic Renaissance scroll-ornament; sections 6 and 7 being enriched with incised ornament, as in the case of No. 447, and set with turquoises. This sceptre is also surmounted by a fleur-de-lis, set with larger turquoises, springing out of a small oblate sphere set with turquoises, and resting on a circlet composed of sixteen garnets in antique setting; on the other side, in base section, are carved two lion's heads, vis-à-vis; on section 2, among scroll ornament, a large and well-designed fleur-de-lis; on section 3, dos-à-dos with the escutcheon, an oval plaque, engraved with the bust, in profile, of a young man, robed and crowned."[100]

The second sceptre is also described in detail by PATON. The monogram "*FM*" stands for the dual monarchy of Scotland (with the initials of Mary Stuart, also known as Mary Queen of Scots) and France (with the initials of Francis II, Dauphin of France).[101]

Fig. 90: A.1905.1144.5, detail, "*FM*" monogram.

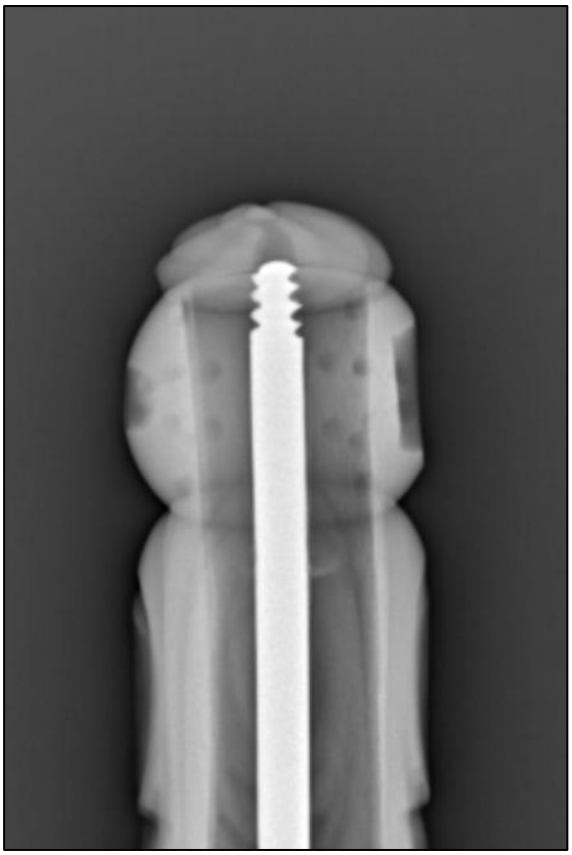
[100] PATON 1879, p. 49.
[101] http://collections.falkirk.gov.uk, last accessed 21.08.2013.

6.5.2 Materials and Structure

The sceptre is made of bone as can be seen by the presence of Harvesian canals.

PATON identifies the gems to be turquoise and beryl. Although the size of the stones is quite small, turquoise was confirmed by PETER DAVIDSON, curator of Minerals and Meteorites at the NMS. He could also agree to the possibility that the larger stones could be beryls although this he couldn't be confirmed. No garnets were found on the sceptre. Its structure is similar to the sceptre described previously, with a metal rod inside and wood along the joins. Metal dowels are also used to secure the wood at the widest part underneath the monogram as can be observed from the CT scans.

Fig. 91: A.1905.1144.5, detail, metal rod and wood.



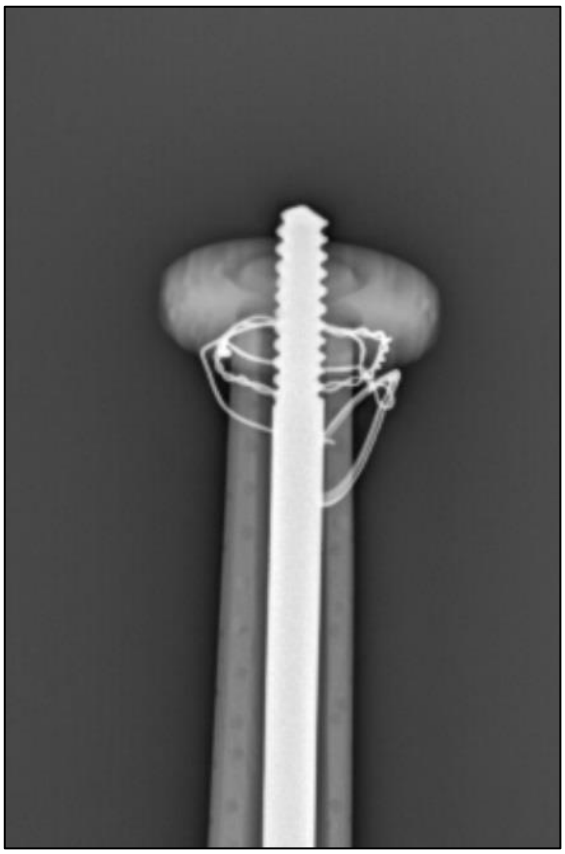


Fig. 92 (left): A.1905.1144.5, X-radiograph, threaded metal rod, bone cap and holes for garments.

Fig. 93 (right): A.1905.1144.5, X-radiograph of top plate with threaded metal rod.

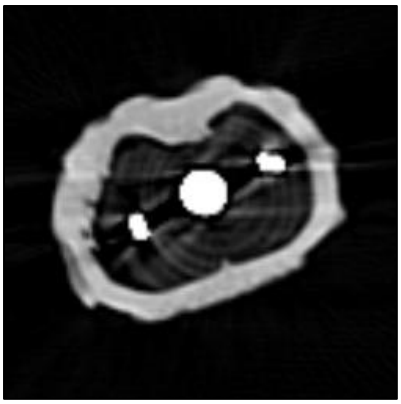


Fig. 94: A.1905.1144.5, 2D radiographic plate, wood and metal rod inside sceptre.

6.6 Surface coatings

Shield	Present	Location	Sample	Method	Spectra/ Images
Resin	No (?)	N/A	No	Visual Examination: Magnifying glasses.	N/A
Animal glue	Yes	On top mullet of proper left side.	Yes	FTIR	Fig. 113
Wax	Yes (?)	On scales, white accretions similar to those on quiver.	No	Visual examination: Magnifying glasses.	N/A

Fig. 95: A.1905.1144.1, shield, surface coating table.

Helmet	Present	Location	Sample	Method	Spectra/ Images
Resin	Yes, shellac.	Wyvern, Sol, frontlet, neck guard, cheek pieces, scales.	Yes	FTIR, Stereomicroscope.	Fig. 110
Animal Glue	Yes (?)	To right and left of tripartite tail.	No	Stereomicroscope.	Fig. 113

Wax	Yes (?)	On scales, white accre-tions similar to those on quiver.	No	Stereomicroscope.	N/A

Fig. 96: A.1905.1144.2, helmet, surface coating table.

Quiver	**Pre-sent**	**Location**	**Sample**	**Method**	**Spectra/ Images**
Resin	Yes	S.P.Q.R. band, scales	No	Stereomicroscope, UV light.	N/A
Animal Glue	No (?)	N/A	No	Stereomicroscope.	N/A
Wax	Yes	On scales, white accre-tions.	Yes	FTIR, Stereomicroscope.	Fig. 111

Fig. 97: A.1905.1144.3, quiver, surface coating table.

A few different types of materials have been identified as surface coatings on this pageant armour: shellac, wax and animal glue (Fig. 110, Fig. 111, Fig. 113). Small white accretions can be found on the scales which were analysed as wax, lying underneath the shellac coating (Fig. 98). There is therefore not only a range of different materials across the object but these have also been applied in several layers. The shellac coating was applied after the scales were put in position which can be seen by the round edge of shellac on the scales (Fig. 98). The shellac could have been applied before it came into the possession of PATON or afterwards as an action of protection or evening the surface appearance. It is more probable that it was applied before as the sceptres don't have a coating at all but came into PATONs collection at the same point of time. The wax found on the ivory, applied before the shellac, is therefore probably from a date previously to 1879.

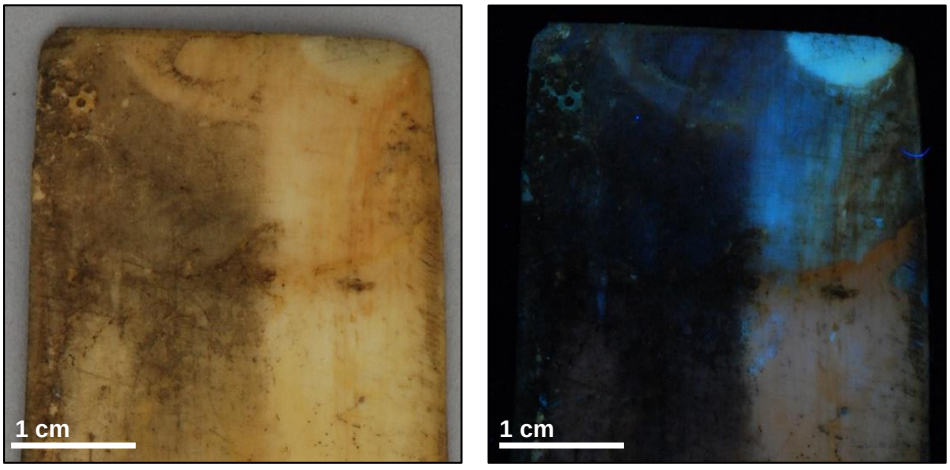


Fig. 98: Scale, half cleaned with shellac coating under visible light (left) and UV light (right).

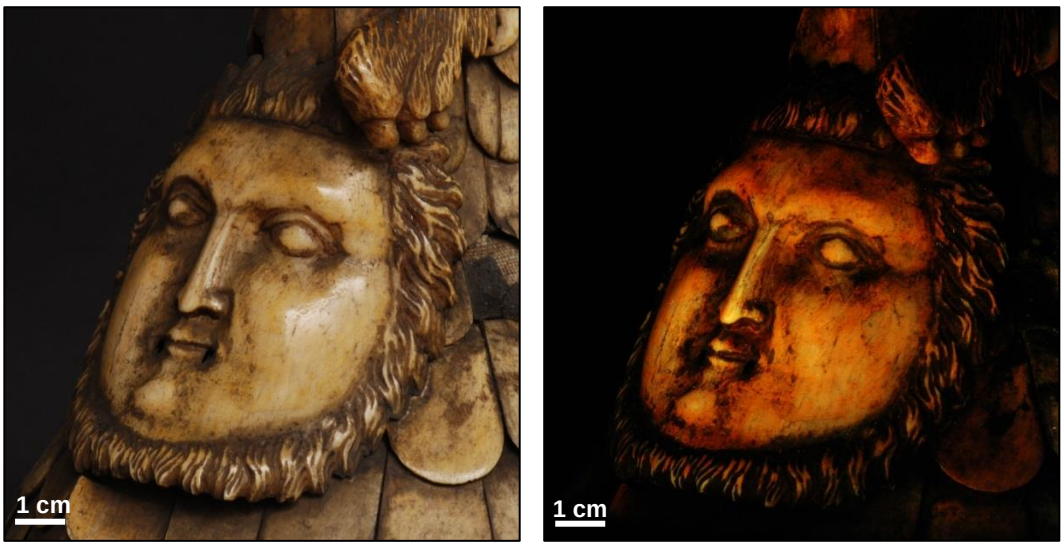


Fig. 99: A.1905.1144.2, detail, *Sol* with shellac coating, right photo under UV-light.

Fig. 101: A.1905.1144.3, quiver, detail, wax accretions in visible (left) and UV (right) light.

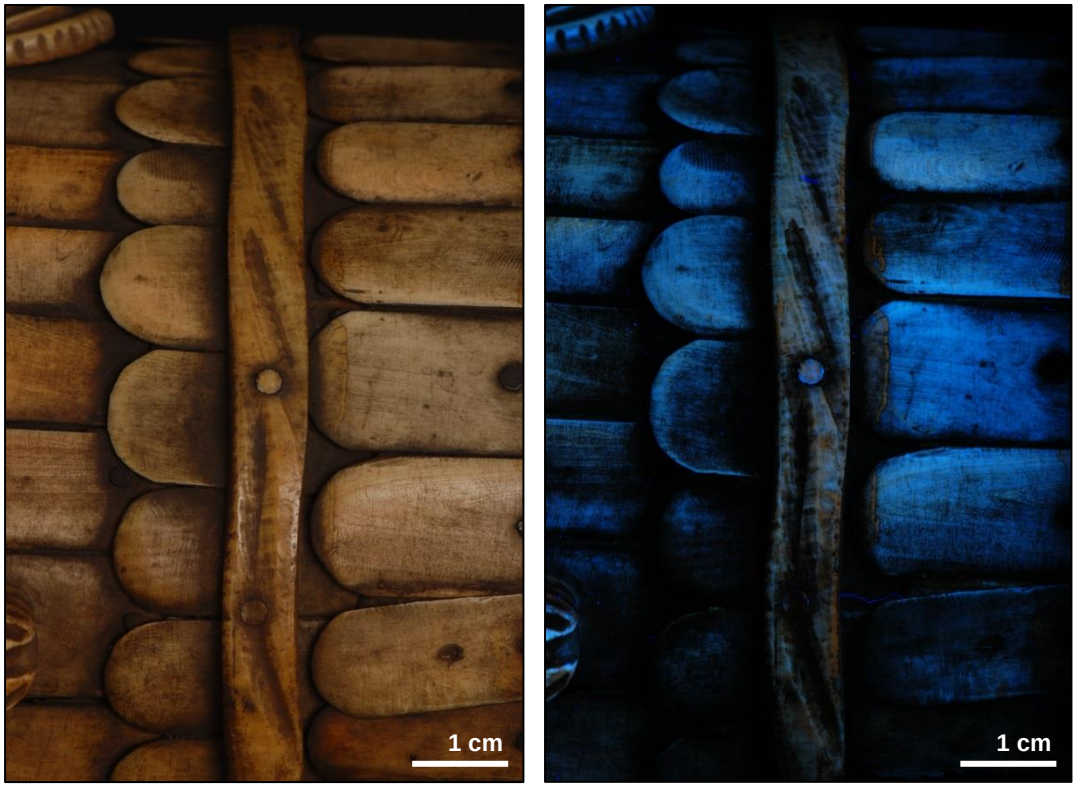


Fig. 100: A.1905.1144.3, quiver, shellac coating in visible (left) and UV (right) light.

7 Conclusions

7.1 Attribution

Although scientific dating, namely ^{14}C radiocarbon dating, of the pageant armour would help considerably in attribution, this was not feasible for a couple of reasons. First, the minimum sample size needed to date ivory is 1 g and removing this amount of ivory would be too destructive. Secondly, it is necessary for a sample to be taken from within the ivory to avoid surface contamination. Only a few components would be able to produce an uncontaminated sample (e. g. the wyvern) and again, this would be unacceptably destructive. Even if these requirements could be met, it is important to note that ^{14}C dating gives a terminus date for the elephant, and not for when the ivory was used in the construction of an object. As a result, attribution of the armour is only possible through evaluating its style and analysing the data on materials and structure which was uncovered during its technical examination. One further question to be answered is whether the armour belonged to the Dauphin, Francis II Also of interest is whether the armour belonged to one ensemble.

Although some aspects may be similar, there are many differences in materials, structures and style within the group of pageant armour. The sceptres were both built of bone, have no surface coatings, whereas the shield, helmet and quiver have a similar structure (ivory scales and decorative elements on metal or wooden support) and a surface coating. Therefore it is derived from these observations that the pageant armour was not constructed and kept as one ensemble.

As to the question whether the armour could have belonged to Francis II it is necessary to determine the source of this assumption, which can be found in PATON's description of the sceptres:

> "*Besides the usual more splendid sceptre, the French kings had one of ivory.*[…] *Is it probable that the Dauphin also used an ivory sceptre, and that No. 447, with its otherwise inexplicable decorations, undoubtedly of the workmanship of the time, was made for Francis II when Dauphin? Also, is it probable that the other sceptre, No. 448, with the jeweled initials, "F.M.," its crown, and escutcheon bearing the lion of Bourbon, or that of Scotland (though without the tressure), was made for him when he became King of France, or on his marriage with Mary, when he became King Consort of Scotland?*"[102]

[102] PATON 1879, p. 49.

It seems unlikely that the sceptres were in the possession of Francis II, the Dauphin of France, however, for several reasons. First, as shown before, a third scepter with similar carvings is in existance. The carvings and iconography are indeed connected to Francis II, but may have been created as a form of tribute to him. Why exactly Francis II was tributed by three sceptres is unclear. Second, PATON mentions ivory sceptres in the possession of French kings, whereas the two in his collection are made of bone.

Fig. 102: Francis II and Mary Queen of Scots 1558 [Wikimedia Commons].

PATONs assumptions of an attribution to Francis II range over the pageant armour as well:

> "*Following up the suggestions of the sceptres, it seems not improbable that the burgonet, shield, and quiver may have formed part of that equipment of "an ancient warrior," in which it is recorded Francis appeared, rowed in a galley, at one of the pageants exhibited in honour of his nuptials, and carried off his bride as a captive. Undoubtedly the things were made for some personage of importance; and, could it be proved that the above hypothetical history is correct, few remains that have come down to us would be more interesting to Scotsmen.*"[103]

That the armour was used as "*equipment of "an ancient warrior"*"[104] is very likely, although as for the armour having been produced for Francis doubts remain. First, Francis II was 15 when he married Mary Stuart, which means that the pageant would have taken place before that time. With the armour being heavy and big, it is unlikely that a boy of 15 or younger bore it, though not impossible. A wooden support would be more expected for a boy's pageant armour. Second, the quality of the construction of the objects seem ill matched for what would be expected for a Dauphin, unless we assume there was a need to assemble them in a great hurry. The scales do not match the curve of the shield very well; the coarsely applied wax/resin mixture between ivory, fabric and metal and the red textile inside the helmet and at the obverse of the shield with unfinished edges – all these are evidence of negligence. In addition, the use of

[103] PATON 1879, p. 50.
[104] Ibid.

a thin ivory piece for the lion's head suggests it was likely taken from an area adjoining the pulp cavity, which would be an odd choice for such an important carved element.

There is no doubt that the armour must have been produced for a person of importance as ivory was ever an highly appreciated material and the carvings, especially the bear hunt of the quiver and the frontlet/neck-guard of the helmet are particularly finely executed. Although the trade in ivory was at a peak in the 19th century and readily available in Europe with it being used for handles of umbrellas and walking sticks, combs, buttons, billiard balls, artificial teeth and also piano keys, it is unlikely that such a piece of art was produced only for the art market. It is more probable that the ivory elements were carved in the 16th century and reassembled in the 19th century. Several details point to this. The textile underneath the scales and the wood appear to be of quite a recent age, but a telling argument is the use of modern screws alongside existing ivory or wooden dowels. Examination of the X-ray images of the crest of the helmet makes this clearer: there are screws used besides broken ivory dowels. Also, the glued joint at the broken wing of the wyvern appears identical to the exposed glue beneath the scales. One might want to counter that this is just how all soiled animal glue looks, though the possibility stands that the wing was already broken and fixed when the helmet was reassembled. The thesis would therefore be that the carvings were taken from an older ensemble and fixed on a similar shaped but new support.

The provenance of the armour is not determined. As to the sceptres, the association with France is probable due to the iconography. Allowing that this is likely a tribute to Francis II, the point of origin is thus likely to be France. However, the breastplate held by the Hermitage Amsterdam is said to be Italian work. Therefore, due to stylistic similarities, Italy as country of origin can also be assumed for the pageant armour.

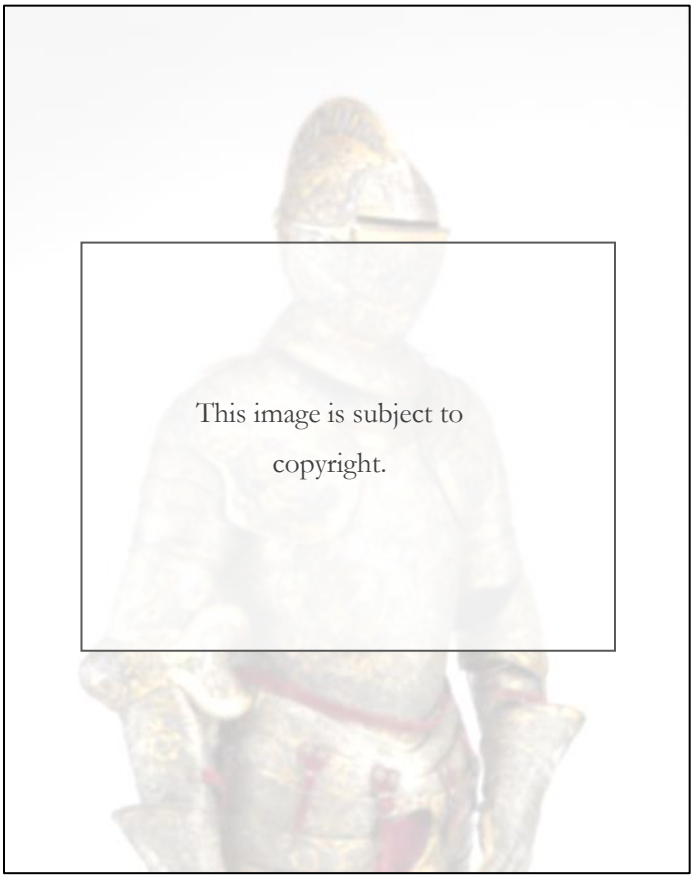


Fig. 103: Pageant armour of Henry II of France, father of Francis II, French 1555 [METROPOLITAN MUSEUM OF ART].

Fig. 104 (right): Breastplate, Italian, 1540–45 [METROPOLITAN MUSEUM OF ART].

Fig. 105 (left): Helmet, Italian 1550 [METROPOLITAN MUSEUM OF ART].

7.2 Treatment Proposal

7.2.1 Cleaning

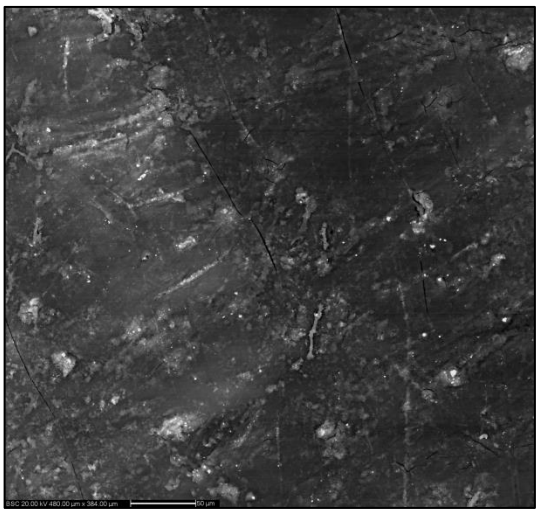
The extent of cleaning must be carefully considered as the object has, besides an extensive soiling also many different coatings. With ivory being a hygroscopic material, the coating with shellac provides an effective barrier layer against humidity fluctuations. It can, however, also be a source of damage for the ivory as it causes tensions by restricting its ability to adjust to dimensional changes. The removal of all layers of surface coating was carried out in a former episode of conservation work, on the proper left side of the helmet's neck-guard. The outcome is, however, not satisfying with the surface appearance being now quite uneven. Considering that parts of the coating might date back to the 19th century and older and with the armour being stored in controlled conditions, removal of the coating does not seem necessary. However, ageing products of the shellac could be responsible for staining of the ivory. It is therefore suggested that the surface dirt is removed and the parts of the armour are then compared to each other. In instance the shellac is then distracting, or otherwise affects the overall picture, a removal or reduction of it can be still carried out.

With all parts of the armour being heavily soiled, cleaning will be necessary. The origin of the dirt has already been discussed above, and even in the case that there had been a deliberate soiling for the sale of the armour to make it look older, the dirt should be removed for conservation reasons. The complexity of the surface coating makes the cleaning somewhat complicated as a decision to what extent the cleaning should be carried out must be made. The analysis revealed coatings with shellac, wax and animal glue which affect the search for the right cleaning method. Dry cleaning tests were carried in 2011 out by a NMS conservator, testing make-up sponge (PU), white and yellow chemical sponges (Akapad, latex), Groom Stick (natural rubber) and latex sponge (wall master, latex), with the latter giving the best results. It is therefore recommended that cleaning should start with using a soft sable brush and a conservation low suck vacuum cleaner to remove the loose dirt. Further dry surface cleaning could then be carried out using a natural latex sponge. If the cleaning effect is not yes sufficient, moving on to solvent cleaning may be necessary. As the surface may react sensitively to solvents such as ethanol (shellac), water (animal glue) and white spirit (wax) the surface must be observed closely before applying any solvents. It is recommended to examine the surface after dry cleaning under UV-light as this gives a further idea of which coatings are present. The coating with animal glue showed a distinctive delamination.

The cleaning of ivory has been discussed critically in various articles. TOM STONE recommends after vacuuming cleaning with a barely damp cotton swab of water with a soap such as Orvus WA Paste (sodium lauryl sulfate, near-neutral pH, anionic synthetic surfactant).[105] His advice is to dampen the surface only a few seconds and then to clean the surface a second time to remove remnants of soap.[106] A broad study on the effects of solvents on ivory was carried out in 1986 by MATIENZO and SNOW investigating a standard cleaning technique using diluted HCl. It could be proven that this harms the surface of ivory and leads to the formation of amino acid salts.[107] Furthermore, less polar solvents such as toluene caused visible changes whereas polar solvents such as ethanol and acetone caused none.[108] The use of polar, non-aqueous solvents would therefore be the least harmful to ivory, although this would likely remove or affect the shellac coating. As some scales have a wax coating the removal of dirt without damaging the wax surface should be aimed for. JOHANNA LANG recommends the use of PVA (Polyvinylalcohol) sponges and deionised water with anionic surfactants in case pure water isn't sufficient.[109]

It is therefore recommended to clean the surface of the ivory with a barely damp PVA sponge using deionised water if the dry cleaning does not offer satisfyingly results. The contact of water with ivory should be kept to an absolute minimum and the surface dried as soon as possible. The surface must be examined carefully for the presence of an animal glue coating beforehand. The cleaning should be carried out under stereo microscope.

[105] STONE, TOM: *Care of Ivory, Bone, Horn, and Antler*, in: CCI Notes 6/1, Ottawa 2010, p. 2.
[106] Ibid.
[107] MATIENZO, L. J.; SNOW, C. E.: *The chemical effect of hydrochloric acid and organic solvents on the surface of ivory*, in: Studies in Conservation 31 (1986), p. 138.
[108] Ibid.
[109] LANG, JOHANNA: *Zur Oberflächenreinigung von Wachsarbeiten*, in: EIPPER, PAUL-BERNHARD (Ed.): *Handbuch zur Oberflächenreinigung*, Munich 2011, p. 228.



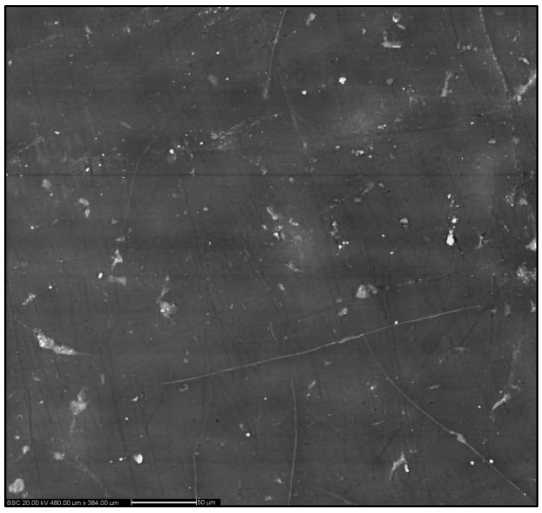


Fig. 106 (left): SEM-BSC Micrograph (x 250, 18 mm working distance) of the uncleaned shellac surface. Cracks in the coating as well as accumulations visible.

Fig. 107 (right): SEM-BSC Micrograph (x 250, 18 mm workingdistance) of the cleaned shellac surface (using deionised water and a PVA sponge).

7.2.2 Reattaching Parts

Detached parts of the object such as scales, the *fleur-de-lis* or parts of the wyvern should be matched with their former positions and reattached. As ivory is a hygroscopic material care must be taken with the removal of animal glue residues. Considering the sensitivity of the surface coatings to different solvents, the use of an aqueous gel is suggested. This would keep the amount of water to a minimum. The choice of adhesive is also influenced by the hygroscopicity of ivory and the sensitivity of the coatings to different solvents. With shellac being soluble in ethanol and acetone,[110] an adhesive should be sought which avoid these.

To join the broken cheek piece, a wire of stainless steel could be inserted into the rolled-up rim and fixed by gluing.

7.2.3 Replacement of Missing Parts

To make a piece of art more readable and complete, replacement of missing pieces can be considered. The armour does not lack many parts apart from some of the scales and a part of a plaque. The dark colour of the glue remnants where the scales have been is a bit visually disruptive. It is therefore recommended to decide after the cleaning of the object whether the gaps where scales have been will be filled with replacement scales. It is generally advised, however, to make replaced parts clearly visible as such, by marking them using a material of different fluorescence or other methods. Otherwise, given that the object has already been altered, it would otherwise hinder future research.

[110] http://cameo.mfa.org/wiki/Shellac, last accessed 16.08.2013.

7.2.4 Storage and Display

As mentioned above ivory is a composite of inorganic and organic materials, and water. As ivory desiccates over time, its susceptibility to fluctuations in humidity increases with age.[111] Signs of deterioration due to low humidity will include delamination of the layers of dentine and cracks in all planes in relation to gaps in formation.[112] As ivory is an anisotropic material it is also prone to warping, as dimensional change occurs in particular in the radial direction[113] Ivory is also a porous material and can therefore be easily stained, either for decorative effect, but also by dirt and grease related to handling.[114] As mentioned previously, ivory may become discolored when in contact with metals such as iron or copper or rubber. Ivory yellows when stored in the dark which is due to products formed during natural aging. These products will be bleached when exposed to light.[115]

Ivory should therefore be protected from sudden changes in temperature and relative humidity (RH) and be kept in constant conditions within an optimum range of 45–55 % RH and a temperature not greater than 25 °C.[116]

Direct sunlight or spotlights should be avoided and illumination kept below 150 lux with UV component restricted to 75 μW/lm.[117]

In storage, contact with materials such as rubber or metals may stain ivory, therefore these must be avoided and the object should be wrapped in unbuffered, acid-free tissue paper and placed in a sturdy, custom-built storage box.

8 Appendices

8.1 Experimental Conditions

Microscopy

For surface examination a Leica MZ6 with a Leica EC3 camera.

A Leica Orthoplan was used for the examination of fibres with the photos being taken with a Nikon D700.

111 HORNBECK 2010, p. 6.
112 Ibid.
113 KÜHN, HERMANN: *Erhaltung und Pflege von Kunstwerken. Material und Technik, Konservierung und Restaurierung*, Munich 2001, p. 402.
114 HORNBECK 2010, p. 6–7.
115 KÜHN 2001, p. 403.
116 STONE 2010, p. 2–3.
117 Ibid., p. 3.

For the cross sections a Zeiss Axiotech HBO 50/AC with a Qimaging GO 3 CLR device was used. An Excitation (TBP 400/495/570), Beam Splitter (FT 410/505/585) and Emission (TBP 460/530/610) filter was used for UV examination.

Scanning Electron Microscopy

Observations were carried out using a CamScan MX2500 Scanning Electron Microscope operated in controlled pressure mode (Envac, 30 Pa) and coupled to Energy Dispersive X-ray analysis (EDX) with Noran Vantage system and Vista software. Images were recorded using the Backscattered Electron Detector (BSC). The samples were placed directly onto a holder on the stage and examined without further preparation (i.e. no coating).

The specific conditions were:

- 20 kV accelerating voltage
- × 50 to × 500 magnification for imaging at 18-20 mm working distance
- 4 quadrant fluorescence back scatter electron detector (BSC)
- Analysis were carried out at a working distance of 35 mm
- Spot size 5 for analysis and imaging
- Fully open lower aperture.
- 40 - 60 Pa chamber pressure
- Si(Li) energy dispersive X-ray analysis (EDX) placed at 35 degrees
- 150 s counting time for EDX with a dead-time of 30 %

Selected areas were analysed using the EDX system at various magnifications, all using the spot mode. Various spectral images, spectra and images were recorded.

FTIR Spectroscopy

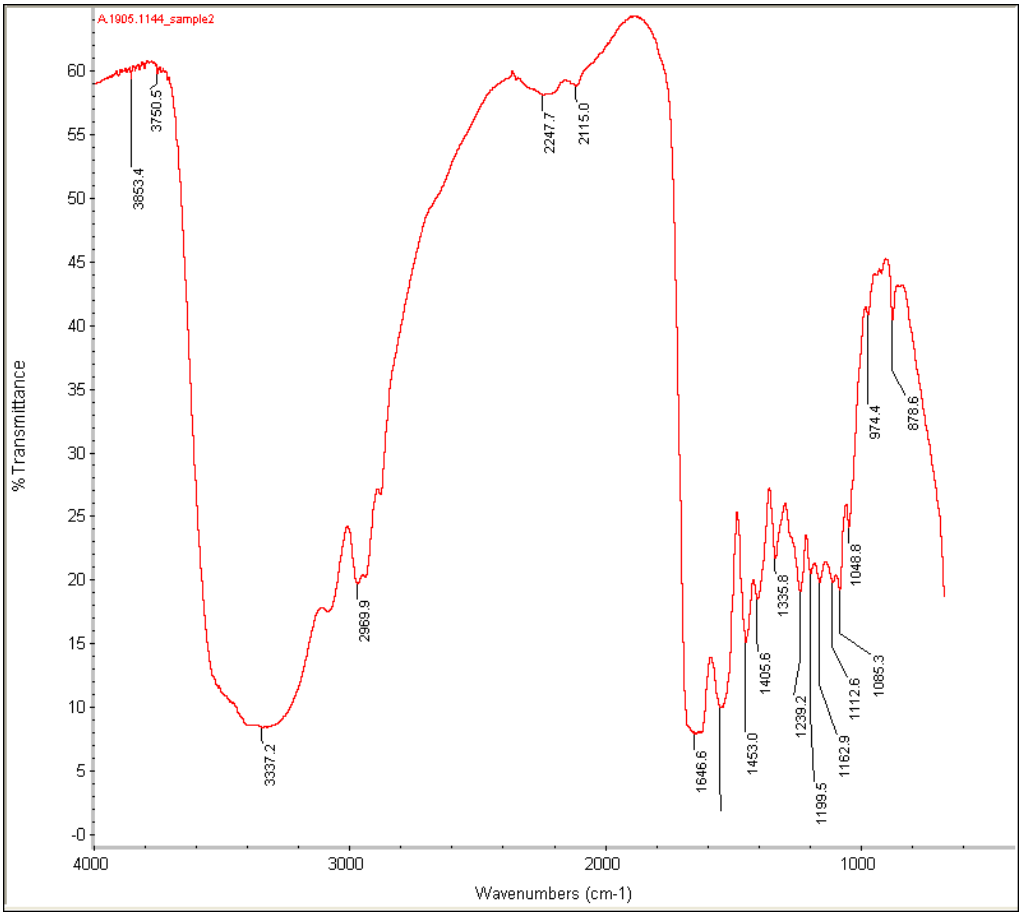
Analysis was carried out using a Thermo Scientific Nicolet iN10 with Liquid Nitrogen cool MCT detector. Data collection was managed by OMNIC™ Picta™ interface. Mid-Infrared Fourier transform spectra were recorded using a compressed Diamond Cell unit, using the transmission mode.

Spectra were captured over the range 4000-400 cm^{-1}, using 64 scans and with a resolution of 4 cm^{-1}.

8.2 Spectra

Sample 2, taken from A.1905.1144.2 (glue used to secure scales):

Animal glue.



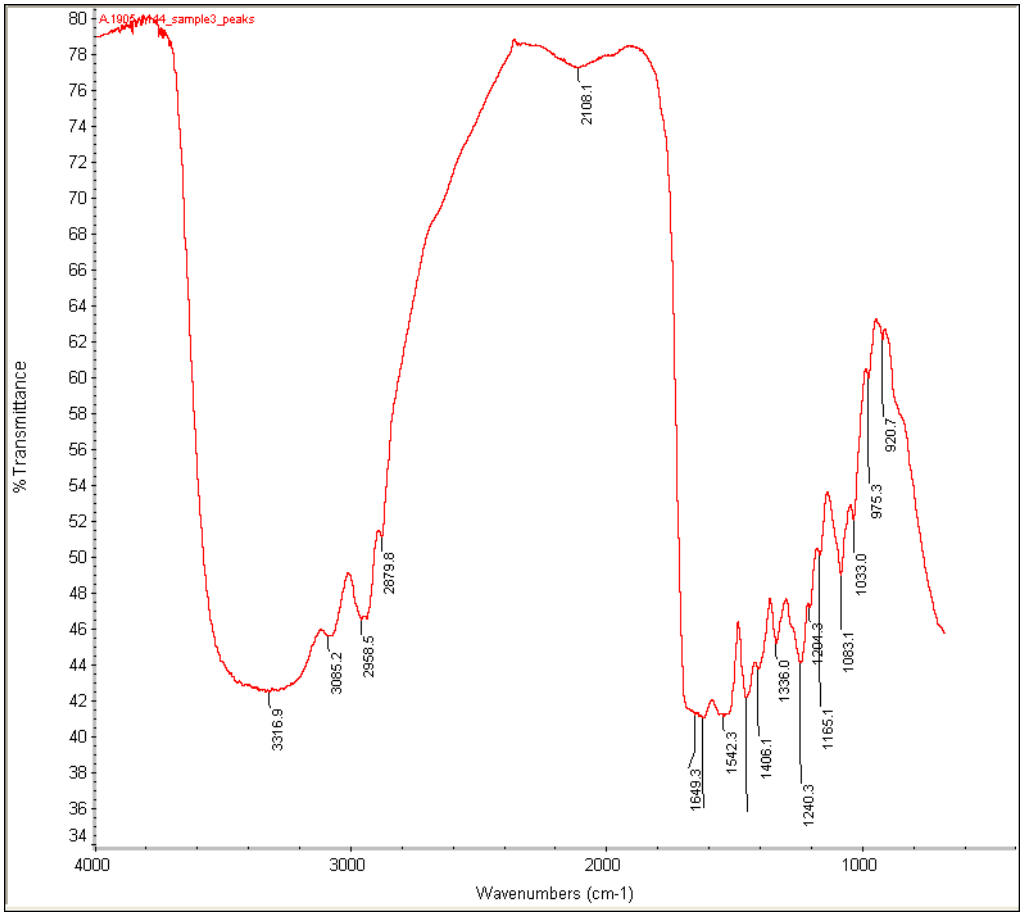
The fingerprint of glue material presents characteristic proteinic IR vibration bands, with the N-H stretching and C-N-H bending bands. These are identified in the table below according to DERRICK et al., 1999.

Peak position (cm^{-1})	**Bond Stretch/Vibration**
3337.2	N-H stretching band
2969.9	C-H stretching band
1646.6	C=O stretching band
1547.6	C-N-H bending band
1405.6	C-H bending band

Fig. 108: Sample 2, FTIR spectrum: animal glue.

Sample 3, taken A.1905.1144.2 (helmet, glue used to attach lining to metal, fragment found under helmet with textile still attached):

Animal glue.



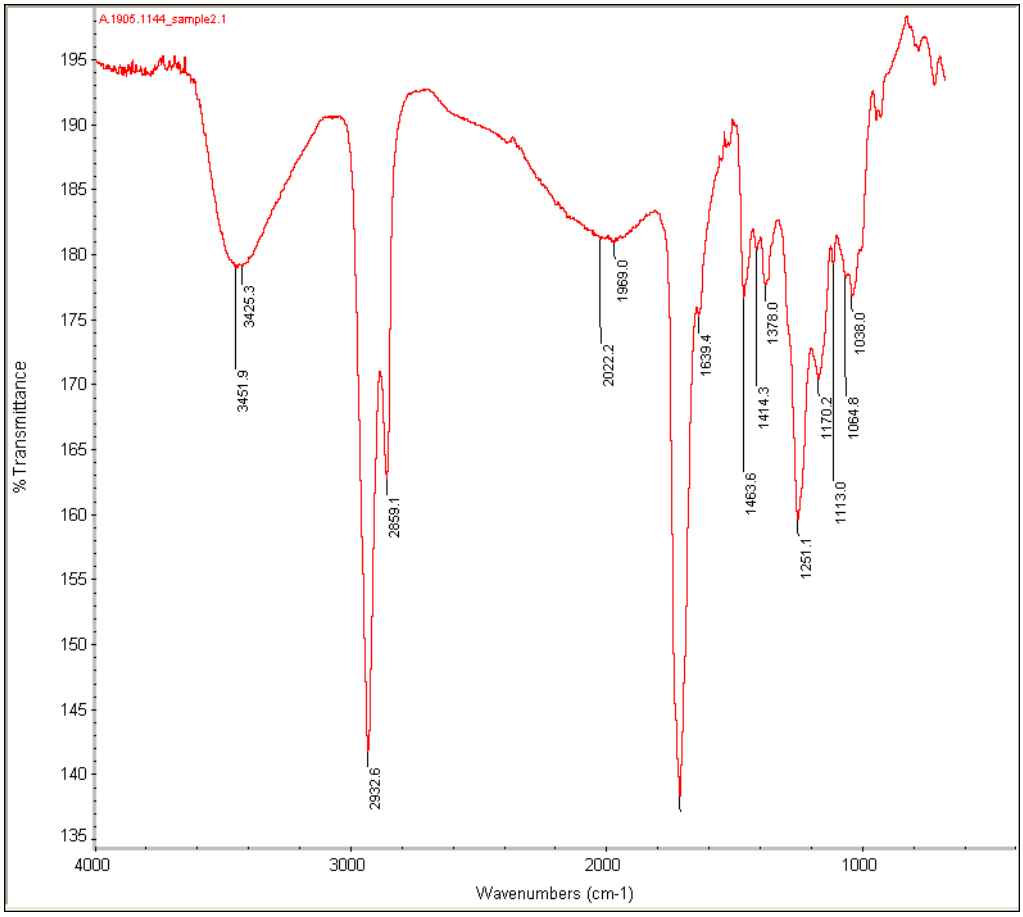
The fingerprint of glue material presents characteristic proteinic IR vibration bands, with the N-H stretching and C-N-H bending bands. These are identified in the table below according to Derrick et al., 1999.

Peak position (cm^{-1})	**Bond Stretch/Vibration**
3316.9	N-H stretching band
2108.1	C-H stretching band
1618.7	C=O stretching band
1542.3	C-N-H bending band
1336.0	C-H bending band

Fig. 109: Sample 3, FTIR spectrum, animal glue.

Sample 2.1, taken from A.1905.1144.2 (helmet, surface coating on wyvern),

Shellac.



Shellac is a complicated mixture of aliphatic and sesquiterpenoid components (MILLS/WHITE, 1994), based on derivate compounds from jalaric acid and laccijalaric acid. The main IR vibration bands characteristic of shellac are identified in the table below, according to DERRICK et al. 1999.

Peak position (cm^{-1})	**Bond Stretch/Vibration**
3451.9	O-H stretching band
2932.6	C-H stretching band
2859.1	C-H stretching band
1713.5	C=O stretching band
1639.4	C-C stretching band
1463.6	C-H bending band
1378.0	C-H bending band

1251.1	C-O stretching band
1170.2	C-O stretching band

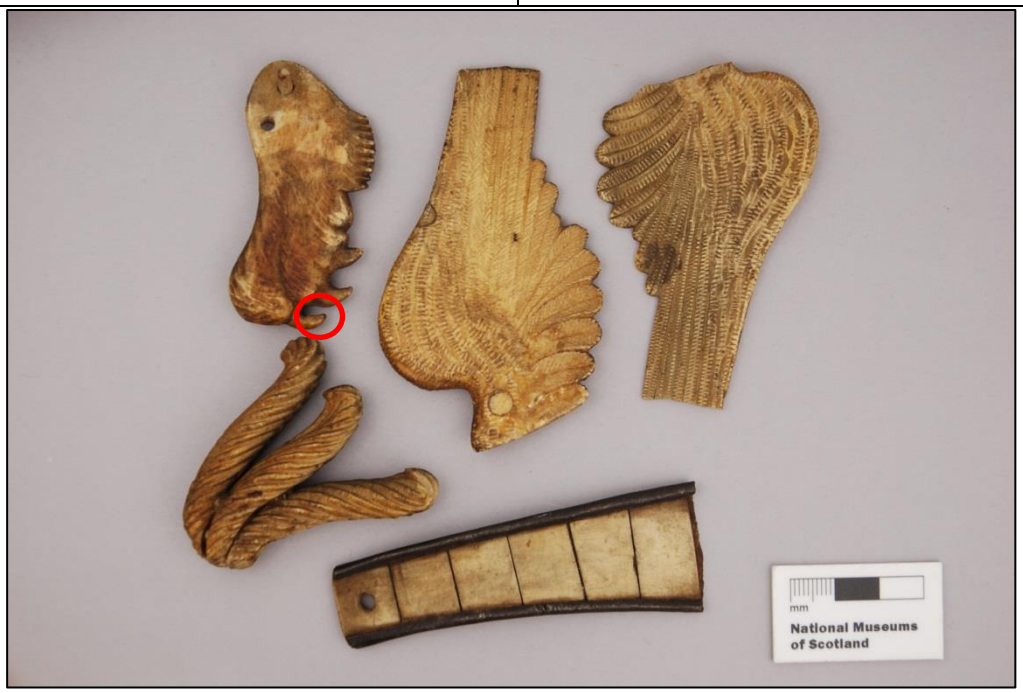
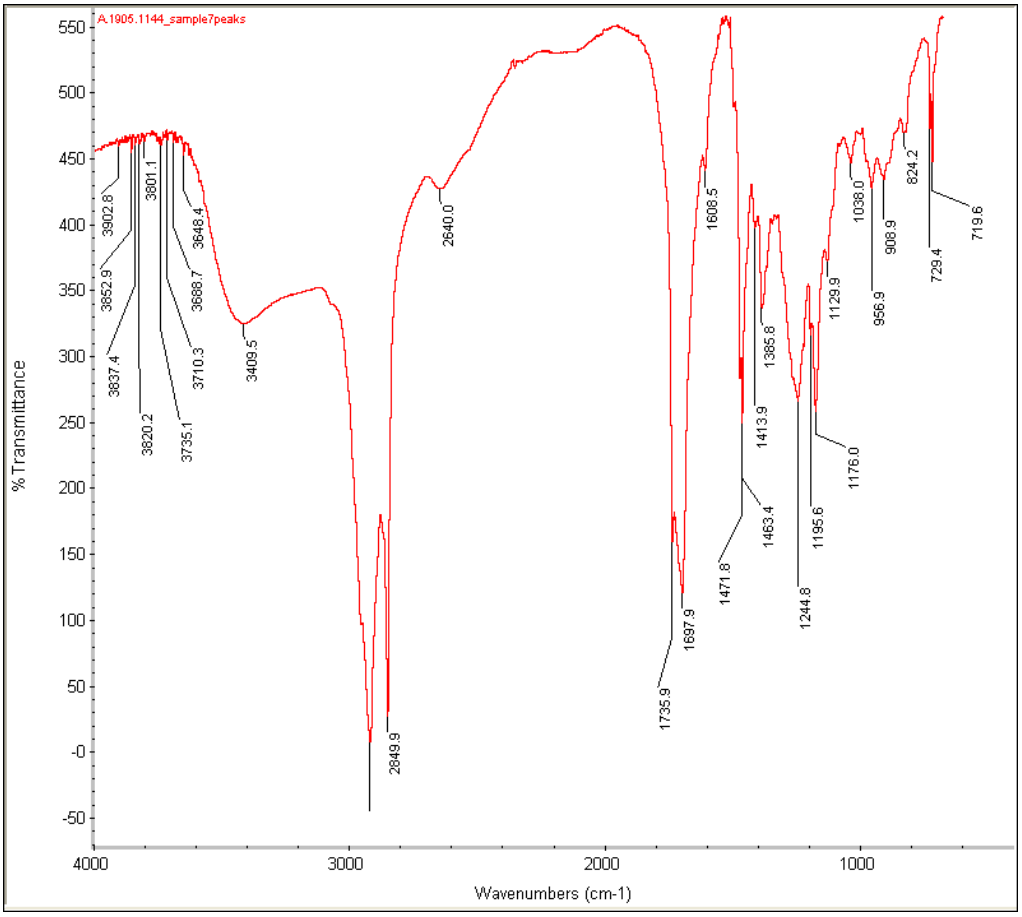


Fig. 110: Sample 2.1, FTIR spectrum, shellac.

Sample 7, taken from A.1905.1144.3 (quiver, dots),

Wax/resin.



The main contribution in the spectra are the vibration bands of a natural waxy material (beeswax or carnauba?) characterised by the strong doublet at 2920-2850 cm^{-1} corresponding to long C-H vibration bands. The strong C=O vibration band at 1697 cm^{-1} relates more closely to the additional contribution of an unidentified natural resin, possibly diterpenoide type.

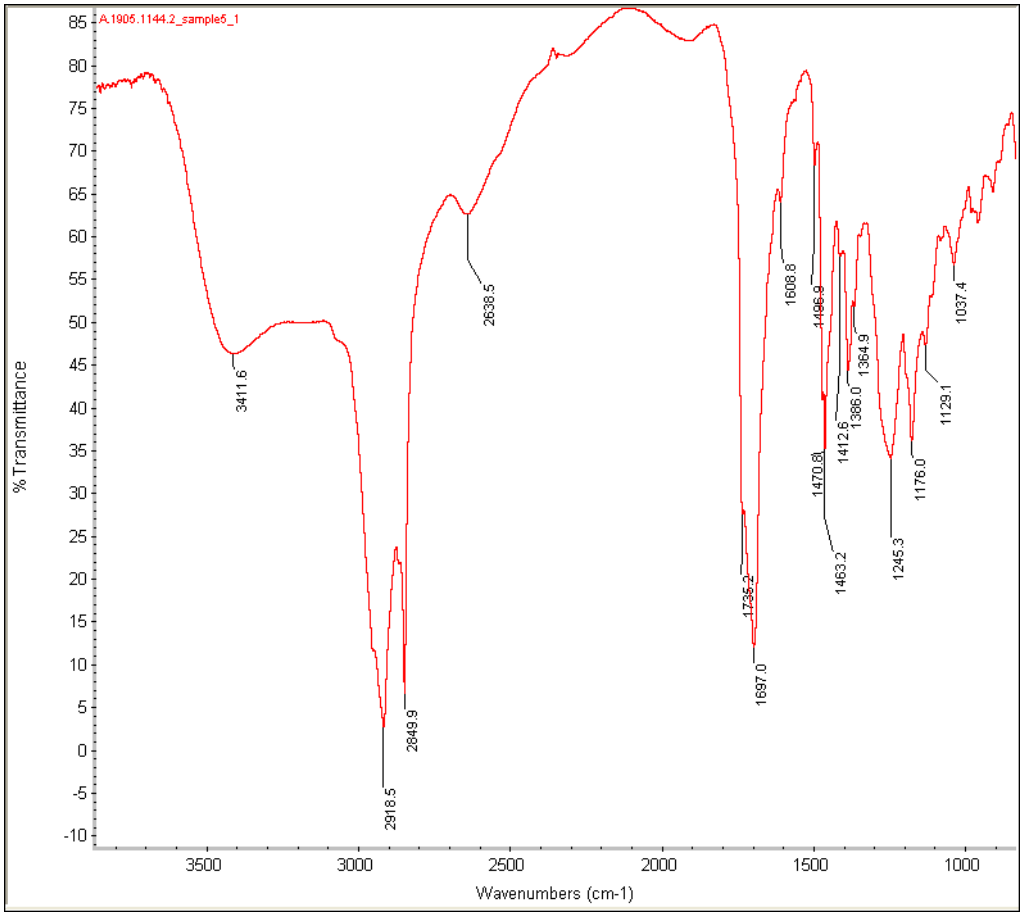
Peak position (cm^{-1})	**Bond Stretch/Vibration**
3409.5	O-H stretching band
2918.3	C-H stretching band
2849.9	C-H stretching band
1735.9	C=O stretching band
1697.9	C=O stretching band (resin)
1463.0	C-H bending band

1385.8	C-H bending band
1244.8	C-O stretching band
1174.6	C-O stretching band

Fig. 111: Sample 7, FTIR spectrum, wax/resin.

Sample 5, taken from A.1905.1144.2 (helmet, between textile, metal brim and frontlet),

Wax/resin.



The main contribution in the spectra are the vibration bands of a natural waxy material (beeswax or carnauba?) characterised by the strong doublet at 2920-2850 cm^{-1} corresponding to long C-H vibration bands. The strong C=O vibration band at 1697 cm^{-1} relates more closely to the additional contribution of an unidentified natural resin, possibly diterpenoide type.

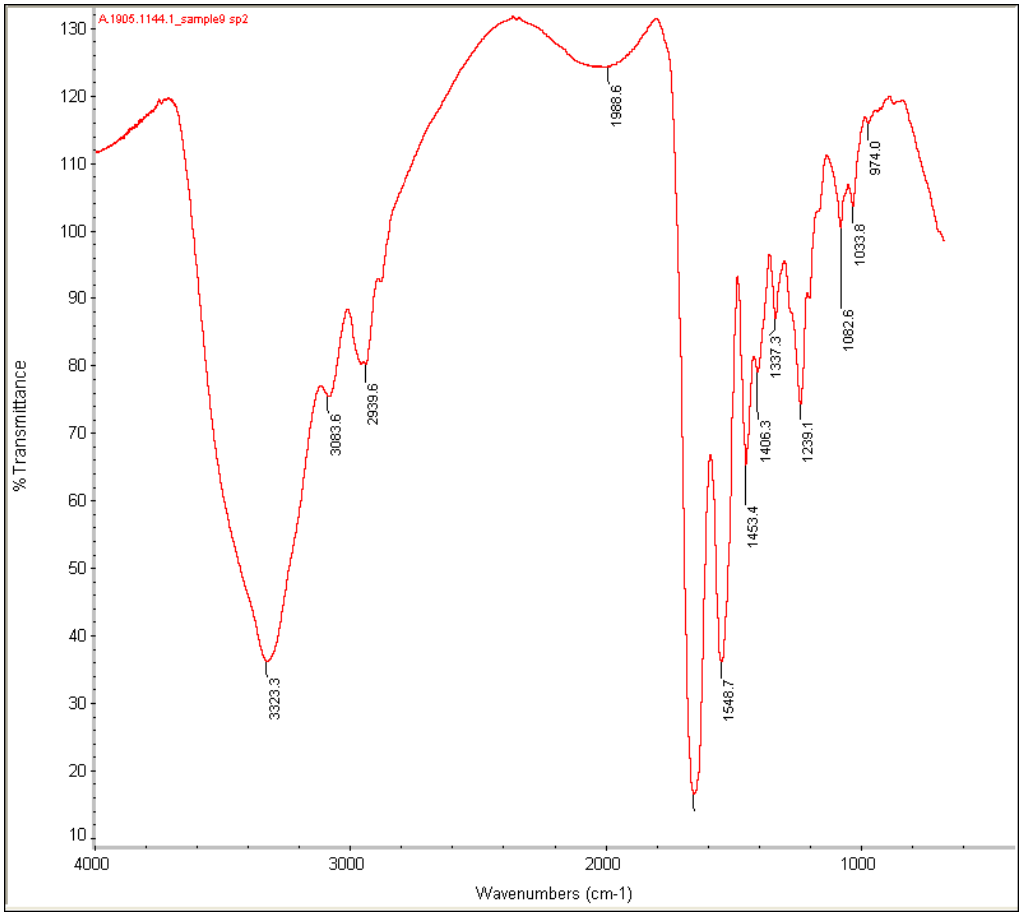
Peak position (cm^{-1})	**Bond Stretch/Vibration**
3411.6	O-H stretching band
2918.5	C-H stretching band
2849.9	C-H stretching band
1697.0	C=O stretching band
1471.1	C-H bending band

1463.2	C-H bending band
1386.0	C-H bending band
1245.3	C-O stretching band
1176.0	C-O stretching band

Fig. 112: Sample 5, FTIR, wax/resin.

Sample 9, taken from A.1905.1144.1 (shield, coating on mullet),

Animal glue.



Important vibration bands related to a proteinic material are identified in the table below, according to DERRICK et al., 1999.

Peak position (cm^{-1})	**Bond Stretch/Vibration**
3323.3	N-H stretching band
3083.6	C-H stretching band
2939.6	C-H stretching band
1632.0	C=O stretching band
1548.7	C-N-H bending band
1453.4	C-H bending band

Fig. 113: Sample 9, FTIR, animal glue.

8.3 Fibre Identification

A.1905.1144.2 (helmet, sample of lining underneath scales):

Linen.

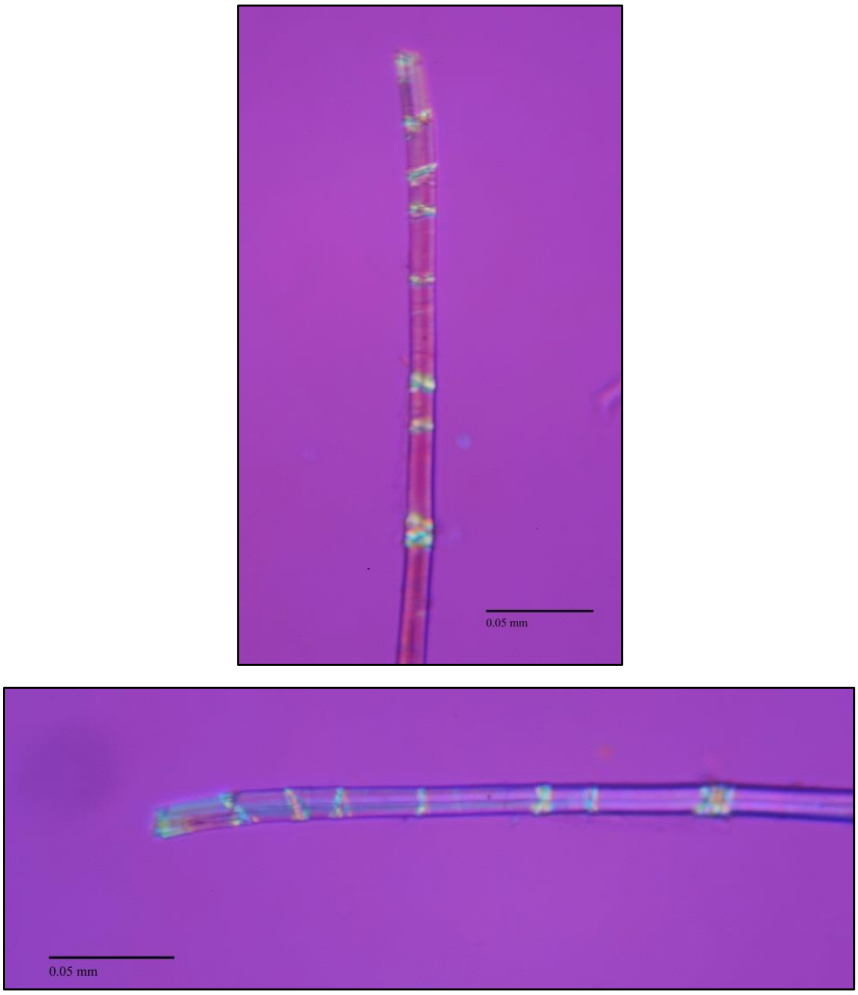


Fig. 114: A.1905.1144.2, Herzog test shows characteristic colouration of linen with crossed polarizers and λ-plate.

A.1905.1144.2 (helmet, red lining)

Wool.

Fig. 115: A.1905.1144.2, wool structure is characterised by the presence of scales on the surface.

8.4 Cross Sectional UV Analysis

Sample 1: A.1905.1144.3, quiver

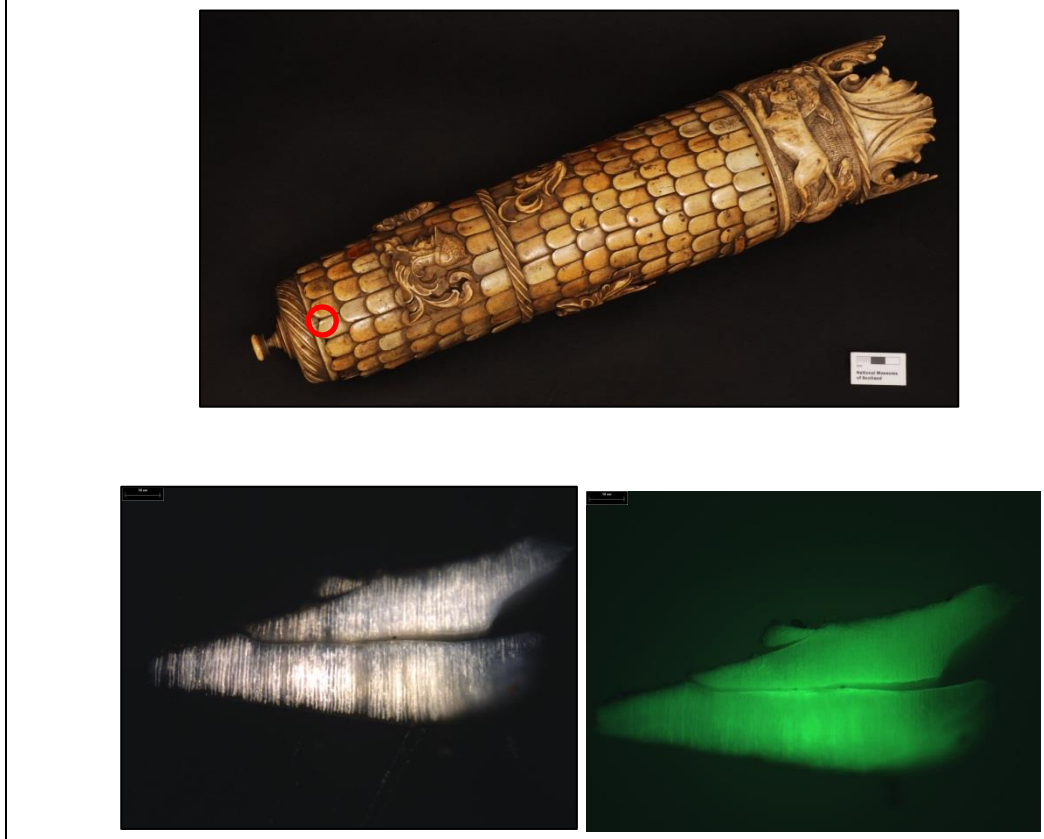


Fig. 116: Cross section Sample 1, visible light and UV.

Sample 2: A.1905.1144.1, shield

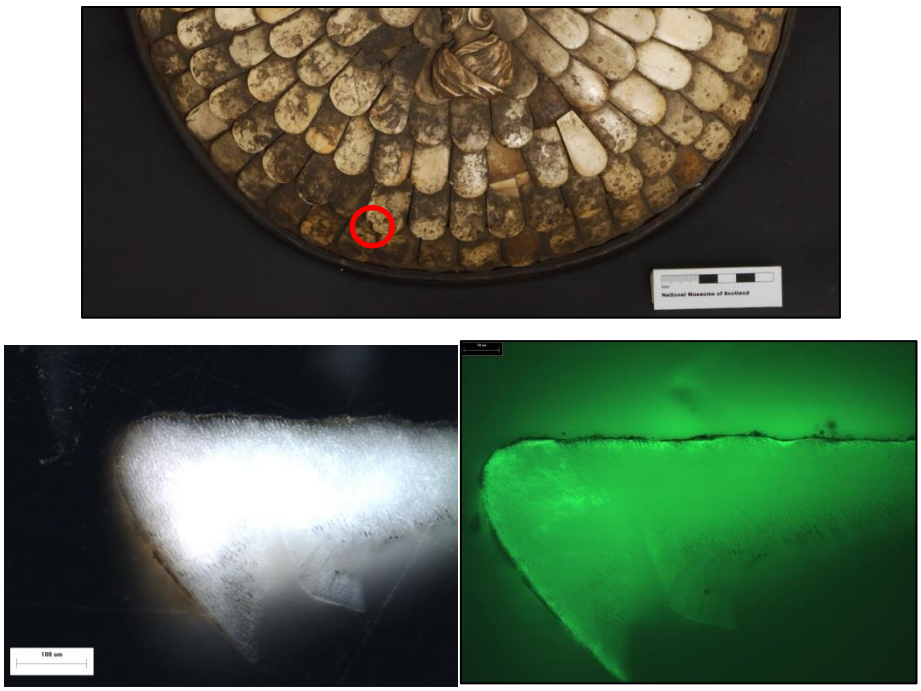


Fig. 117: Cross-section, sample 2, visible and UV, shellac fluorescing under layer of surface dirt.

Sample 3: A.1905.1144.2, helmet

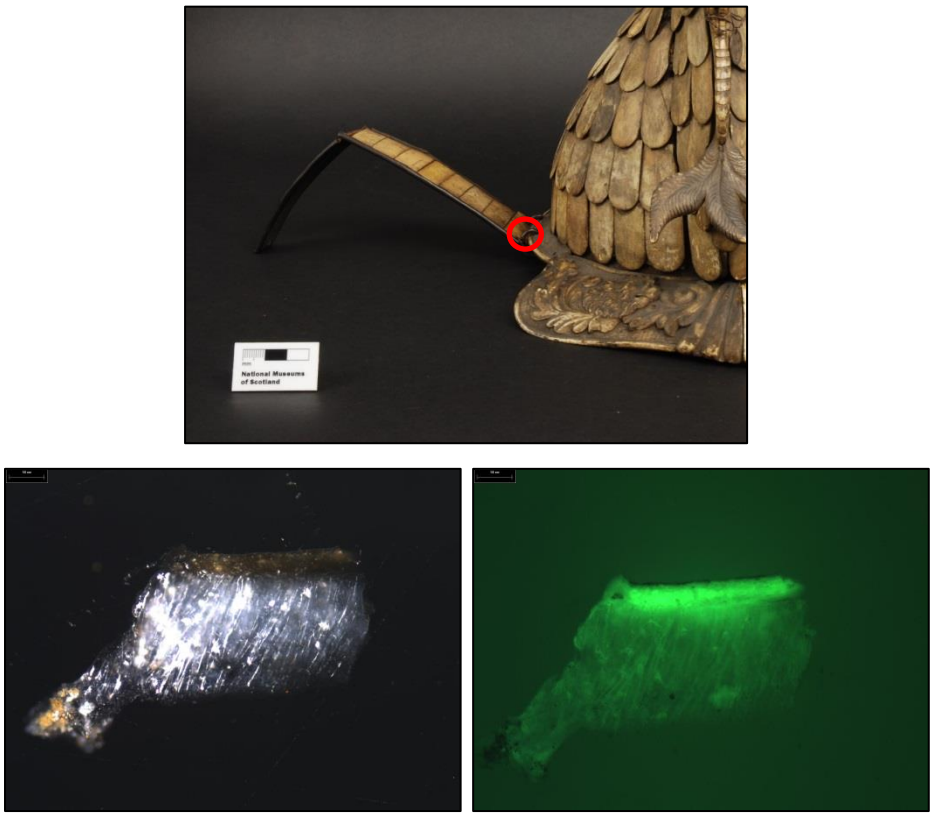


Fig. 118: Cross-section, sample 3, visible and UV light, brightly fluorescing shellac coating.

Sample 4: A.1905.2, helmet

Fig. 119: Cross section, sample 4, visible and UV light, thin fluorescent layer under soiled surface.

8.5 Glossary[118]

burgonet	a kind of visored helmet
casque	helmet
escutcheon	a shield or emblem bearing a coat of arms
fleur-de-lis	a stylized lily composed of three petals bound together near their bases
proboscidean	a mammal of the order *Proboscidea*, which comprises the elephants and their extinct relatives
scrimshaw	adorn ivory or shells with carved or coloured designs
tressure	a thin border inset from the edge of a shield, narrower than an orle and usually borne double
tusk	a long pointed tooth, especially one which protrudes from the closed mouth

[118] OXFORD DICTIONARY

9 References

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Declaration of Originality

I hereby declare that this thesis and the work reported herein was composed by and originated entirely from me. Information derived from the published and unpublished work of others has been acknowledged in the text and references are given in the list of sources.

Munich, 26th of August

Isabell Wagner

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