Proceedings of the 11th Interim Meeting of the ICOM-CC Leather and Related Materials Working Group

Laurianne Robinet, Carole Dignard, Theo Sturge

LEATHER2019

6–7 June 2019
Les 6 et 7 juin 2019
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Editors / Comité éditorial
Laurianne Robinet, Carole Dignard, Theo Sturge

ICOM-CC ICOM international council of museums – committee for conservation

CRC Centre de recherche sur la conservation

MUSÉE DU QUAI BRANLY JACQUES CHIRAC

Paris 2019

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Foreword

The Leather and Related Materials Working Group is one of the 22 Working Groups of the Committee for Conservation of ICOM (ICOM-CC). Gathering over 150 members, its objective is to promote the dissemination and sharing of knowledge on the conservation of skin-based objects including leather, parchment, furskins and related materials (bone, horn, etc). For over 30 years, this group has organised regular conferences, entitled Interim Meetings, to allow members and more widely all interested professionals to meet, share and discuss their work regarding the conservation of skin-based objects.

On the 6th and 7th of June 2019, the 11th Interim Meeting of the ICOM-CC Leather and Related Materials Working Group took place for the first time in Paris, France, within the Musée du quai Branly - Jacques Chirac. This conference was organised by the Research Centre for Preservation (CRC) together with the Conservation department of the musée du quai Branly - Jacques Chirac and the support from the conservation school from the conservation department of the Institut national du Patrimoine (INP). Prior to the conference, visits were offered to participants in various institutions in Paris or close by: the conservation workshop of the musée du quai Branly, the zoological specimen collection of the National Natural History Museum, the Research Centre for Preservation, the conservation workshops and laboratory at the Institut national du Patrimoine, as well as the skin-based collection and laboratory of the Music museum.

Our main objective was to make this event accessible to a wide audience, in particular young professionals and students, but also to encourage the participation of French-speaking professionals. For that reason, we offered reduced registration fees and simultaneous French-English translation. This was made possible thanks to the financial support of three public institutions, the Ministry of Culture, the National Scientific Research Council (CNRS) and the French National Museum of Natural History (MNHN); two professional networks, the Domaine d'Intérêt Majeur *Heritage and Ancient Materials* (DIM-Map) and the Fondation des Sciences du Patrimoine (FSP); as well as ICOM France with the General Delegation for the French Language and the Languages of France, and Hermès. Their support permitted greatly reduced registration fees for the conference, contributing to its success, thus we are really grateful to them.

Furthermore, to host a conference on skin and leather heritage, the musée du quai Branly - Jacques Chirac is an ideal place, considering the richness of their collections in this area. We would like to thank the teams and people within the institution that helped with the event organisation and allowed us to welcome participants in the best conditions. We also wish to express our deep gratitude for the support and enthusiasm of the people from the Institut national du patrimoine (INP), the Centre de recherche sur la conservation (CRC), the Music museum and the National Museum of Natural History (MNHN) that got involved in the organisation and offered guided tours within their respective institutions to the participants before the conference.

The meeting was a real success with over a hundred participants coming from 15 countries, mostly from Europe, with many students and young professionals. The Interim meeting was marked by a great diversity regarding the skin-based materials presented, the fields concerned and the professions represented. We welcomed 21 oral presentations and 15 posters related to archaeological leather, scientific development, fur and skin, gilt leather, new conservation approaches or technical history. At the end of the first day, guided tours of the permanent exhibition at the musée du quai Branly were offered to the participants, followed by a cocktail dinner on a boat cruise in the heart of Paris.

Along the two days it was interesting to notice the presence of recurring issues or approaches such as studies assessing the impact of past conservation treatments or the wide application of proteomic analysis to identify the animal species of the skin, due to the improved sensitivity of the technique. The conference was also an opportunity to discover innovative conservation practices such as the use of nano-formulas for cleaning and consolidating leather, the development of new textured materials for leather restoration or the use of anoxic housing for furs.

These postprints gather all the conference contributions, presented either as full papers or extended abstracts written in French or English. We wish you pleasant readings and look forward to the next Interim Meeting.

On behalf of the scientific and organising committees,

Laurianne Robinet
Coordinator of the ICOM-CC Leather and Related Materials Working Group
Leather and parchment department at the Research Centre for Preservation

Éléonore Kissel
Conservation department of the musée du quai Branly - Jacques Chirac

Avant-propos

Le groupe de travail Cuir et Matériaux Associés est l'un des 22 groupes de travail du Comité pour la Conservation de l'ICOM (ICOM-CC). Rassemblant plus de 150 membres, il a pour objectif de favoriser la diffusion et le partage des connaissances autour de la conservation des objets à base de peau, ce qui inclut les cuirs, le parchemin, les fourrures et divers matériaux connexes (os, corne, etc). Depuis plus de trente ans, ce groupe organise régulièrement une conférence, appelée « réunion intermédiaire », pour permettre à ses membres et plus largement à tous les professionnels intéressés de se rencontrer, d'échanger et de partager leurs travaux autour de ces matériaux.

Les 6 et 7 juin 2019, la 11ème réunion intermédiaire du groupe de travail Cuir et Matériaux Associés de l'ICOM-CC s'est déroulée pour la première fois en France, au musée du quai Branly - Jacques Chirac à Paris. Cette conférence a été organisée par le Centre de Recherche sur la Conservation conjointement avec le pôle Conservation-Restauration du musée du quai Branly - Jacques Chirac, et le soutien de l'Institut national du Patrimoine (INP). En amont de la conférence, des visites à Paris ou à proximité ont été proposées aux participants de la conférence : l'atelier de restauration du musée du quai Branly - Jacques Chirac, la zoothèque du Muséum national d'Histoire naturelle, le Centre de Recherche sur la Conservation, les ateliers de restauration et le laboratoire de l'Institut national du Patrimoine, ainsi qu'une visite des collections en cuir et du laboratoire du Musée de la Musique.

Dès sa conception, nous voulions rendre cet évènement accessible au plus grand nombre, favorisant ainsi les rencontres entre professionnels et étudiants issus de différents pays. De plus, pour encourager plus largement la participation des professionnels francophones et leur permettre d'exprimer leurs travaux dans leur langue, nous avons proposé une traduction simultanée français-anglais. Cette démarche a été rendue possible grâce au soutien financier de nombreuses institutions, notamment nos tutelles, le Ministère de la Culture, le Centre national de la recherche scientifique (CNRS) et le Muséum national d'Histoire naturelle (MNHN) ; des réseaux professionnels, le Domaine d'intérêt majeur *Matériaux anciens et patrimoniaux* (DIM-MAP) et la Fondation des Sciences du Patrimoine (FSP), ainsi que l'ICOM France, par le biais de la délégation générale à la langue française et aux langues de France, et la maison Hermès. Leurs contributions ont permis de réduire grandement les frais d'inscription de la conférence, ce qui a concouru à son vif succès. Nous leur en sommes très reconnaissants.

D'autre part, pour accueillir une conférence centrée sur le patrimoine en cuir et peau, le musée du quai Branly - Jacques Chirac est un lieu idéal au vu de la richesse de leurs collections dans ce domaine. Nous remercions les différentes équipes et personnes au sein de l'institution qui ont œuvré à la mise en place de cet évènement, et ont permis un accueil dans les meilleures conditions. Nous souhaitons également vivement remercier l'implication et l'enthousiasme des personnes au sein de l'Institut national du Patrimoine (INP), du Centre de recherche sur la conservation (CRC), du musée de la Musique, du Muséum national d'Histoire naturelle qui ont participé à l'organisation de la conférence ou ont accueilli les participants lors de visites en amont de celle-ci.

La réunion a remporté un vif succès avec plus d'une centaine de participants venant de 15 pays, principalement d'Europe, dont de nombreux étudiants et jeunes professionnels. Cette rencontre fut marquée par une grande variété, du point de vue des matériaux à base de peaux présentés, des domaines touchés, ainsi que de la diversité de professions représentées : restaurateurs de cuirs, de documents graphiques, de matériaux ethnographiques, de textiles, de naturalia, mais aussi des archéologues, des conservateurs, des historiens, et des scientifiques issus de différents domaines. Ces deux journées, qui ont accueilli 21 interventions orales et 15 posters, furent une belle opportunité de faire cohabiter cette diversité, de mettre en lumière des domaines peu évoqués et étudiés, comme cela est le cas pour les spécimens naturalisés, en favorisant les rencontres entre ces différentes spécialités et en encourageant les transferts de connaissances. Au terme de la première journée, les participants ont eu le plaisir de découvrir le musée du quai Branly - Jacques Chirac au travers de visites guidées des espaces d'exposition permanents, suivi d'un cocktail dinatoire sur une péniche.

Il fut intéressant de noter la présence de certaines problématiques ou approches récurrentes, notamment les études visant à évaluer l'impact des procédés de restauration ou de conservation passés. De même, on a noté un fort développement de l'utilisation de l'analyse protéomique pour l'identification de l'espèce animale, avec quatre interventions sur ces deux journées. De plus, cette technique qui était jusqu'alors surtout utilisée sur les parchemins est à présent étendue à l'analyse des cuirs, parfois dégradés, ce qui révèle le gain en sensibilité de la technique. Ces journées furent aussi l'occasion de découvrir des pratiques innovantes en matière de conservation-restauration telles que l'emploi de nano-formulations pour le nettoyage et la consolidation des cuirs, le développement de nouveaux matériaux texturés pour la restauration des cuirs ou l'emploi du conditionnement anoxique des fourrures.

Ces actes rassemblent ici l'ensemble de ces interventions présentées soit sous la forme d'articles complets ou de résumés étendus, en français ou en anglais. Nous vous souhaitons à présent une agréable lecture, et vous donnons rendez-vous à la prochaine rencontre du groupe de travail.

Au nom des comités scientifique et d'organisation,

Laurianne Robinet
Coordinatrice du groupe de travail Cuir et Matériaux Associés de l'ICOM-CC
Pôle Cuir et Parchemin du Centre de Recherche sur la Conservation

Éléonore Kissel
Pôle conservation – restauration du musée du quai Branly - Jacques Chirac


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Paris 2019
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QUAI BRANLY
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Paris 2019


La conservation
restauration de
collections de pea
cuirs et matériau
associés
MUSÉE DU QUAI BRANLY - JACQUES CHIRAC

Archaeological Leathers
Cuirs archéologiques

La Collection de Cuirs Archéologiques Coptes du Musée du Louvre : Focus sur des Objets Exceptionnels

Dominique Bénazeth, Céline Bonnot-Diconne, Florence Calament

Résumé

La collection des objets coptes en cuir du département des Antiquités égyptiennes du musée du Louvre (plus de 200 pièces) fait l'objet de campagnes de restaurations régulières. L'objectif est de présenter ces objets en cuir de façon alternée, afin de renouveler les présentations et faire connaître au public ces pièces souvent exceptionnelles. Collectées pour la plupart au début du 20ème siècle, leur état de conservation est très variable. Origines, datations et traitements subis sont des données rarement précisées pour ces objets. La restauration pour exposition a donc été l'occasion de faire des découvertes et des remises en cause historiques et techniques. Les interventions sur plusieurs paires de chaussures et un étui à calames sont évoquées afin de montrer les difficultés de la consolidation et de la remise en forme de cuirs découverts à l'état sec et qui présentent une très grande fragilité. La présence de décoration à la feuille d'or, de décors incisés ainsi que de teintures a rendu complexe ce travail. Enfin la politique de mise en valeur de ces objets du quotidien qui fascinent le public est également exposée.

Mots-clés

Cuir, Copte, Étui, Chaussure, Sandale, Mule, Égypte

Introduction

La collection de cuirs archéologiques du département des Antiquités égyptiennes du musée du Louvre comporte plus de 200 pièces, d'une grande diversité d'origine et de typologie. Pour faire connaître au public ces pièces souvent exceptionnelles, tout en garantissant leur conservation, leur présentation est périodiquement renouvelée. La collection fait ainsi l'objet de campagnes de restaurations régulières, qui ont permis des remises en forme mais aussi et surtout des découvertes techniques.

Histoire d'une collection

L'intérêt d'une collection de cuirs archéologiques comme celle du Louvre est de suivre l'histoire de l'objet depuis son entrée au musée mais aussi et surtout jusqu'à son lieu de découverte et/ou de fabrication. Seules ici sont prises en considération les pièces manufacturées dites « coptes », c'est-à-dire essentiellement d'époque byzantine (Ve – VIIe siècle) voire datées entre la fin de la période romaine (IVe siècle) et la période post-conquête arabe (jusqu'au XIe siècle environ). Elles sont entrées au Louvre principalement à l'issue d'anciens partages de fouilles avec l'Égypte (désormais plus en vigueur) et par acquisitions à titre onéreux.

Ces dernières ont été réalisées auprès de collectionneurs ou d'antiquaires, pour la plupart bien connus dans le milieu de l'égyptologie (la provenance exacte des pièces est alors rarement indiquée, nous n'avons au mieux qu'une origine géographique). Les premiers objets entrés par achat remontent à la première moitié du XIXe avec les collections Henry Salt (1826) et Antoine Barthélémy Clot-Bey, médecin français installé au Caire (1852-1853) **(Figure 1)**. D'autres achats ont été effectués au Caire au début du XXe, auprès d'antiquaires célèbres comme Maurice Nahman (1926 et 1929) ou Joseph Khawam (1928)[1]. Plusieurs pièces enfin, proviennent de l'ancienne collection de Wladimir de Grüneisen, représentant à Rome de l'Institut impérial Nicolas II et grand amateur d'art classique et byzantin ; elles ont été acquises en 1930.

Celles entrées au musée en partage de fouille sont de loin les plus nombreuses, pourtant le contexte archéologique

[1] Une chaussure droite et une paire complète, à décor de cuir doré, sont réputées provenir d'une sépulture copte (du Fayoum ou d'Akhmim ?).

Figure 1 : Paire de sandales (inv. E 2747), collection Clot-Bey (achat en 1852-1853) © 2010 Musée du Louvre/Georges Poncet.

Figure 2 : Peigne et son étui en cuir (E 12571), fouilles d'Antinoé en 1905 (tombe du « fonctionnaire à la pourpre ») © 2014 Musée du Louvre/Georges Poncet.

précis fait le plus souvent défaut et nous possédons peu d'éléments tangibles pour la datation en particulier. Deux sites sont représentés de manière assurée : celui de Deir el-Médineh dans la région thébaine avec les fouilles de Bernard Bruyère (en 1929 et 1930)[2] et surtout, très majoritairement, Antinoé en Moyenne-Égypte, dont les vastes nécropoles ont été fouillées par l'archéologue Albert Gayet (1856-1916) de 1896 à 1911[3]. Plus d'une soixantaine de pièces en cuir ont ainsi une origine bien tracée : campagne de fouille déterminée et souvent précision d'une tombe donnée, donc d'un quartier de nécropole **(Figure 2)** ; à cela s'ajoute le fonds entré par cession du musée Guimet au Louvre dans les années 1940 (numérotation « MG »), soit une cinquantaine de pièces supplémentaires, dont la plupart doit également provenir d'Antinoé. Il faut encore signaler un don de Louis Batissier (1851-1852), le legs Raymond Weill (en 1950 sous réserve d'usufruit, rentré au Louvre en 1992 seulement) et en dernier lieu un don ponctuel de Jean Marcel Roudillon (1972). Enfin, environ un quart des objets de la collection se trouvent sans mode d'acquisition connu, qu'ils soient entrés très anciennement au musée sans informations précises ou qu'ils aient perdu leur numéro d'inventaire (on les trouvera numérotés sous la forme « SN », « N » ou « AF »).

L'autre grand intérêt de cette collection est sa diversité typologique. En effet, si la grande majorité de ces cuirs archéologiques se compose évidemment de chaussures de tous types ayant appartenu à des adultes comme à des enfants (sandales, mules, chaussures à lacets, bottes ou bottines, etc.), sous formes d'exemplaires complets mais aussi fragmentaires (semelle, empeigne, tige), il existe également d'autres catégories d'articles en cuir : ce sont notamment des étuis à calames ou à peigne, ou encore des pièces d'ornement vestimentaire comme un bandeau de tête ? (en cuir ajouré et partiellement doré, peut-être peint, Akhmim ?) et divers éléments de ceintures, certains avec leur boucle métallique et des restes textiles.

Un certain nombre de pièces encore sont constituées de matériaux composites, avec un décor ou un élément en cuir. Parmi ces derniers par exemple, un manchon de cuir qui était adapté à l'extrémité d'une manche de vêtement en laine avec application de soierie **(Figure 3)** ; une corbeille à couvercle réalisée en palmier tressé (type *phœnix*) recouvert de cuir doré et découpé avec décor de poissons, agneau et croix et une inscription en bordure supérieure « la bénédiction du Seigneur Jésus-Christ » (provenant d'une sépulture de moine au Fayoum ?).

Pour terminer enfin cette rapide présentation, mentionnons un curieux petit objet atypique : une alène en fer

[2] Une sandale trouvée dans le remblai d'une cave (cour n°290 du secteur est) et une paire de chaussures fermées provenant des déblais de la sépulture 359 ou 360) ; ces exemplaires dont la datation est très incertaine vu leur contexte sont probablement d'époque tardive, contrairement à d'autres, qui datent du Nouvel Empire (xviiie dynastie).

[3] Pour un historique des campagnes fouilles et une étude de la dispersion du matériel archéologique : Calament 2005.

Figure 3 : Manche de laine avec son manchon en cuir et ses applications de soierie (E 29377), fouilles d'Antinoé en 1896-1898 (tombe B 264) © 2013 Musée du Louvre/ Georges Poncet.

forgé, provenant des fouilles d'Henri Henne à Edfou (1921-1922) et datée de l'époque islamique, à l'extrémité de laquelle se trouve un enroulement de cuir servant vraisemblablement de protection à son utilisateur.

Différentes recherches, menées à la section copte du département des Antiquités égyptiennes, ont débouché sur des restaurations et abouti à des publications ; par exemple l'étude pluridisciplinaire d'un mobilier et d'un trousseau funéraire complet, provenant d'Antinoé et conservé au musée de Grenoble[4], qui comprend une paire de sandales ornées dont la restauration a été le prélude à de nombreuses interventions sur les collections du Louvre.

Étude et conditionnement des objets

En 1994, dans la réserve du département égyptien, V. Montembault, restauratrice, entreprit un énorme travail de tri et d'identification des fragments. Parallèlement, elle confectionna des boîtes non acides sans couvercles (**Figure 4**, à gauche) et réalisa quelques restaurations, pour la première fois documentées[5]. Nous avons inventorié un certain nombre de pièces qui ne l'avaient jamais été et effectué des recherches sur les dépôts anciens consentis à des musées en régions. Tout cela a été couronné en 2000 par la publication des chaussures du département des Antiquités égyptiennes (Montembault, 2000) qui a suscité d'autres études sur les chaussures égyptiennes anciennes, devenant une référence régulièrement citée par les auteurs.

Par la suite, nous avons sollicité l'Institut Royal du Patrimoine Artistique (Bruxelles) afin d'obtenir des repères chronologiques. Des prélèvements minimes suffisent au comptage du carbone 14, qui a permis de situer dans le temps la production d'un étui à calames, de l'étui de peigne (**Figure 2**), du manchon (**Figure 3**), de cinq chaussures, six sandales (dont celles des **Figures 4** et **8**), une mule (**Figure 9**) et des liens en cuirs d'une corbeille en vannerie. Ces analyses se poursuivent d'année en année.

En 2014, dans le cadre d'un chantier des collections orchestré par la restauratrice M-C. Nollinger, 183 objets en cuir[6] furent confiés à A. Bouckellyoen, restauratrice d'objets ethnographiques. Elle inscrivit les numéros d'inventaire sur des bandelettes de papier japon, teintées à l'aquarelle, puis collées avec un adhésif vinylique Cette

Figure 4 : Le conditionnement avant et après le chantier des collections. © D.Bénazeth.

Figure 5 : Le marquage pendant le chantier des collections. © D.Bénazeth.

[4] Calament et alii. 2012, en particulier p. 31-32 et pl. 15.

[5] Des interventions antérieures restent à jamais anonymes, sans dates, ni rapports précisant les produits employés. Des traitements lubrifiants semblent avoir été appliqués mais aucune archive n'en révèle la nature.

[6] Objets entiers ou fragmentaires, paires, lots de fragments.

technique permet un marquage lisible sur des surfaces hétérogènes (**Figure 5**). Les étiquettes historiques ont été conservées (**Figure 1**).

Le conditionnement en tessonniers a conservé les plateaux faits antérieurement en y ajoutant des calages amovibles en mousse de polyéthylène (**Figure 4**, à droite)[7]. Ce chantier a précisé les matériaux[8], les techniques d'assemblage et de décoration du cuir[9] et dressé un état sanitaire de la collection. Aucune infestation active n'a été détectée. Une moitié de la collection présente des degrés variables d'instabilité, constat utile pour établir les futurs programmes de restauration.

Exemples et apport des restaurations

Longtemps, la restauration des cuirs archéologiques dits « secs » a été considérée comme limitée voire impossible. Sans doute la fragilité du matériau, l'absence de spécialistes et le peu d'intérêt pour ce type d'objets ont-ils contribué à cette situation. Pourtant des remises en forme, des consolidations et des reconstitutions peuvent souvent être proposées.

Ainsi **un étui à calames (E 21249) (Figure 6)** devait être prêté au début de l'année 2015 (Exposition Berlin et Londres). Long d'environ 21 cm, il est large de 8 cm et haut de 4 cm. Un étui similaire a été daté grâce au C14 entre 540 et 615 ap. J.-C. Bien qu'incomplet[10], il présente un décor incisé très intéressant, représentant un saint militaire comparable au saint Philothée d'un étui semblable et de même provenance (Antinoé, inv. AF 5158). Constitué de plusieurs éléments, la nécessité d'exposition exigeait des consolidations suffisantes et un éventuel support de manipulation. Rassembler les fragments était indispensable pour permettre une lecture du décor et la compréhension de l'objet. Néanmoins, l'un des trois fragments disjoints ne pouvait être rapproché des bords du fragment le plus grand en raison d'une lacune majeure située dans la partie supérieure droite de l'étui. Afin de pouvoir repositionner ce fragment qui comportait une agrafe métallique assez pesante, il fallait reconstituer la partie disparue de l'étui. Un cuir de chèvre de tannage végétal, teinté en bordeaux (il s'agit de la teinte de fond visible sur l'étui) a été sélectionné. La portion restituée a été découpée très précisément à la forme des bords de la lacune. Elle adhère, bord à bord, au cuir ancien par un fin doublage (avec un intissé polyester, collé avec un film de Beva 371, réactivé à la spatule chauffante). Avant le positionnement du doublage, de très petites quantités de pâte de Beva 371 teintée dans la masse (pigments naturels) ont été insérées pour faire un joint parfait. Une réintégration colorée (avec des couleurs acryliques) a été effectuée pour rendre cette incrustation plus discrète. Il a été décidé de ne pas reconstituer les motifs manquants. Sombre, le cuir a sans doute été lubrifié à une date inconnue, ce qui pourrait expliquer son état de rigidification actuel et son obscurcissement. En l'absence des logements intérieurs, il était nécessaire de prévoir un soutien pour l'étui. Il est conçu en mousse polyéthylène garni de Tyvek et peut aisément se retirer pour observer l'objet. L'étui est restitué dans une boîte en plexiglas. Un logement en mousse polyéthylène permet de maintenir l'objet en place. Pour son transport ou en dehors de toute présentation, l'étui est stocké dans les meilleures conditions.

Figure 6 : E 21249, étui à calames, avant et après restauration. © C.Bonnot-Diconne.

Découvertes par Albert Gayet sur le site d'Antinoé, **les chaussures E 32044**[11] (**Figure 7**) devaient être présentées dans le cadre d'une exposition prévue en septembre 2013 au Musée des Tissus de Lyon (« Antinoé, à la vie, à la mode »). Datées au carbone 14 dans la fourchette 420 - 570 après J.-C., elles sont longues de 16 cm pour

[7] Les récentes restaurations ont encore perfectionné la conservation des œuvres dans des contenants capitonnés, permettant des manipulations sécurisées. Ainsi la boîte de la figure 7 a été remplacée par un conditionnement sur mesure lors de la restauration des chaussures.

[8] Le cuir est parfois associé à des fibres textiles, des fibres végétales, du papier, du métal.

[9] Cousu, tressé, incisé, doré, repoussé, ligaturé, brodé, ajouré, appliqué, poinçonné.

[10] Il manque la partie arrière, la pointe et les logements intérieurs.

[11] Voir Montembault, 2000, p.144-145.

Figure 7 : E 32044, chaussures, avant et après restauration. © C.Bonnot-Diconne.

6 cm de largeur environ, et étaient entreposées dans une boîte ancienne. Dans un mauvais état de conservation, le cuir était très sec et cassant, ce qui avait conduit à leur fragmentation. Semelles et dessus étaient déformés voire écrasés et les parties hautes n'étaient plus solidaires du semelage. Des portions importantes de ces chaussures avaient disparu et, étonnamment, une des semelles d'usure conservées dans la boîte ne pouvait pas leur appartenir. Il a donc été convenu avec l'équipe de conservation qu'elle ne serait pas réemployée dans le nouveau montage réalisé. De nombreuses consolidations ont donc été **nécessaires.** En l'état, il était impossible de replacer les dessus sur les semelages en raison des manques existants. A l'aide de papier calque, nous avons reconstitué par projection les portions disparues de la chaussure droite. Un cuir de chèvre de tannage végétal a été découpé selon les besoins. La portion restituée adhère, bord à bord, au cuir ancien par doublage et comblement avec de la Beva 371. Une « bordure à cheval » faite d'une bande étroite de cuir noir a été collée sur le bord supérieur de la partie reconstituée afin de donner l'illusion du montage disparu. Les dessus, réalisés originellement en une seule pièce et fermés par couture au niveau du talon, ont pu être remis en forme sous atmosphère humide. Ils ont été lentement réhumidifiés dans une chambre climatique pour permettre leur manipulation et leur restituer leur volume original. Les divers fragments ont ensuite été réassemblés par collage ou par couture quand c'était possible. Pour le pied droit, une nouvelle semelle d'usure a été fabriquée en cuir moderne. Elle a été assemblée : par couture à la partie du dessus en cuir moderne et par doublage au cuir ancien. Il n'a pas été utile de créer des embauchoirs car les claques n'ont pas besoin de soutien interne.

Les sandales E 13887 (Figure 8) ont été acquises en 1929 à M. Nahman, collectionneur et antiquaire au Caire. Il s'agit d'une paire en cuir noir et rouge avec une décoration à la feuille d'or et un décor incisé d'un élégant motif de lapin. Les lanières sont faites de cuir rouge tressé et/ou enroulé, munies à intervalles réguliers de « bagues » de cuir doré[12]. Le papyrus présent dans la semelle a été daté au C14 et indique entre 540 et 650 après J-C. Il s'agit d'une pointure 31 (point de Paris), ce sont donc des chaussures d'enfants. Le musée souhaitait les exposer dans le cadre des collections permanentes du Musée du Louvre. Or le cuir était sale et poussiéreux et les objets étaient très fragiles. Globalement sec et cassant, le cuir noir semblait plus dégradé que le cuir rouge. Une des semelles d'usure était cassée en deux près de la cambrure. Toutes les lanières tressées étaient déformées et écrasées. Plusieurs « bagues » de cuir doré avaient disparu et, sur la sandale la plus dégradée, la lanière arrière droite était manquante sur une dizaine de centimètre. Des portions étendues de cuir rouge avaient disparu en occasionnant la perte du décor incisé et des difficultés de lecture. Les fibres végétales qui servaient d'intercalaires entre la semelle première et celle d'usure étaient sales et soulevées.

Figure 8 : E 13887, sandales, avant et après restauration, dont détail du décor incisé avec motif de lapin. © C.Bonnot-Diconne et dessin © V.Montembault.

Des tests ont été conduits pour estimer les possibilités de nettoyage et ont montré que le cuir n'avait pas de tendance à la gélatinisation. Il a donc été possible de nettoyer légèrement les dessus des premières avec des cotons roulottés imprégnés d'eau déminéralisée. En fait la couche de lubrifiant posée à une date inconnue protège cette surface. Les semelles étaient très encrassées et ont révélé une couleur rouge/rosé intense. De nombreuses consolidations étaient nécessaires. Nous n'avons pas opté pour une consolidation générale car l'emploi de produits dilués pourrait gêner de futures analyses. Les consolidations sont donc très localisées. En fonction des besoins,

[12] Voir Montembault, 2000, p.110, n°52.

nous avons utilisé de la Mowilith DMC2, du Plexisol P550 ou de la Beva 371 (en pâte ou en film). De fins et étroits doublages ont été appliqués au revers des zones fragiles et des déchirures : il s'agit d'intissé polyester collé avec un film de Beva 371, réactivé à la spatule chauffante. Nous avons reconstitué une lanière tressée pour la partie qui manquait. Elle est réalisée dans un cuir de chèvre de tannage végétal, teinté en rouge. La portion restituée adhère, bord à bord, au cuir ancien par doublage et est insérée dans l'épaisseur du semelage par collage (Mowilith DMC2). Une réintégration colorée a été effectuée pour la rendre plus discrète. Pour remettre en forme les lanières, il était nécessaire de prévoir un soutien. Or il ne fallait pas masquer le décor incisé. Nous avons opté pour un fil métallique gainé de polyéthylène transparent. Il est fait d'une seule longueur mais qui se divise en deux sur le dessus du pied pour rejoindre l'arrière de chaque sandale. Le fil est maintenu en place grâce à de petites portions de fils polyester. Les sandales sont restituées dans une boîte en carton neutre. Des supports amovibles avec logements en mousse polyéthylène découpés sur mesure ont été réalisés. La restauration a permis de révéler que sur une de ces sandales, il existe une réparation ancienne à l'avant de la lanière arrière gauche (près du serpentin enroulé).

Ces interventions sont en effet souvent l'occasion de découvertes techniques sur l'histoire des artefacts.

Par exemple, **les mules E 13888**[13] (**Figure 9**), bien que se ressemblant beaucoup, présentaient quelques différences techniques, nous avons donc proposé d'entreprendre des analyses et notamment des radiographies X avant l'intervention de restauration. Elles ont été apportées au CHU de Grenoble pour être radiographiées et scannées. Les rayons X ont montré une différence très nette de conception technique du décor doré entre les deux mules (**Figure 8**). Le métal qui constitue le décor incrusté de la mule 1 est très dense et il cause un « bruit » très important pour les prises de vue au scanner, gênant la visibilité. Alors que la feuille d'or, observable sur l'autre mule, est trop fine pour être vue distinctement. Le scanner a permis, quant à lui, de faire des coupes précises qui montrent le système de montage des mules (couches du semelage et du dessus). On peut donc supposer qu'il s'agit de deux objets de facture proche qui ont été accolés pour constituer une paire, sans doute au moment de leur acquisition ou dans la précédente collection Nahman.

Figure 9 : E 13888, mules après restauration et radiographies. © C.Bonnot-Diconne.

Mise en valeur de la collection

La connaissance approfondie de la collection permet sa mise en valeur auprès du public, dans les expositions permanentes ou temporaires. L'exposition permanente se situe au secteur Denon, dans les salles coptes ouvertes en 1997 et celles de l'Orient méditerranéen dans l'Empire romain, inaugurées en 2012. Deux vitrines y sont consacrées au costume et présentent par roulement bottes, chaussures et sandales. Une chaussure syrienne en cuir du 3e siècle ap. J.-C. est présentée avec des objets égyptiens d'époque romaine[14]. Des étuis à calames sont distribués dans trois vitrines, dont les thèmes respectifs (écriture, magie et iconographie chrétienne) sont illustrés par la fonction ou le décor de ces trousses de scribes.

En 2016 fut inauguré au Pavillon de l'Horloge un nouveau parcours sur l'Histoire du Louvre. Des restaurations récentes illustrent la vie des collections. La première présentation du département égyptien (**Figure 10**) fut celle de sandales. La forte lumière nous a contraints à réduire le temps d'exposition à trois mois. Nous avons ainsi changé à six reprises le contenu de la vitrine. Sur un « feuilletoir numérique », le visiteur pouvait consulter à sa guise l'art de se chausser ou les pratiques funéraires des anciens Égyptiens, qui plaçaient les chaussures dans leurs tombes. Le savoir-faire des cordonniers était démontré à travers la facture de l'objet et son décor. Les dégradations étaient pointées et la nécessité d'une intervention, illustrée par les gestes spécifiques de la restauration. D'autres options de navigation présentaient la richesse de la collection du Louvre et son catalogue.

[13] Voir Montembault, 2000, p.142-143.

[14] Mission F. Cumont à Doura Europos, 1922-23 ; département des Antiquités orientale, AO 28297.

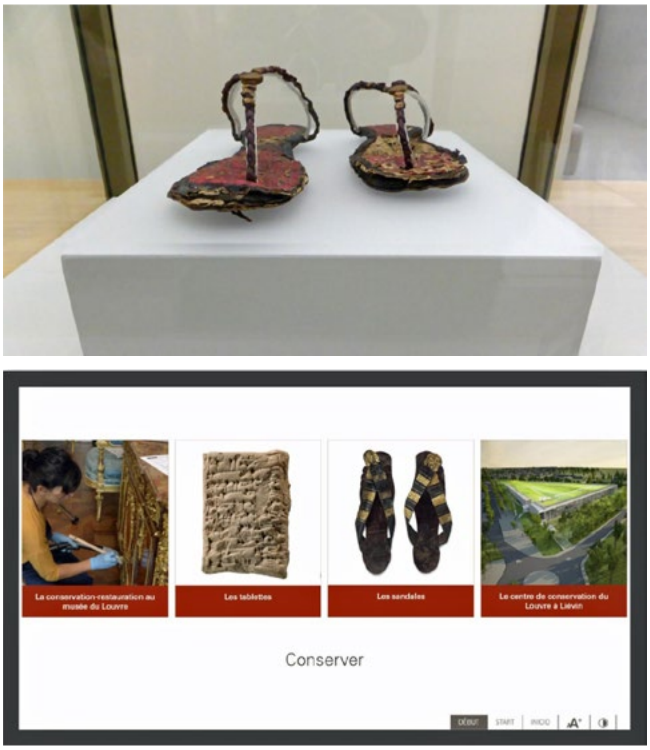

Figure 10 : Vitrine de la salle d'actualité au Pavillon de l'Horloge © Lucie Cuquemelle et feuilletoir. © Musée du Louvre.

Les expositions temporaires sont l'occasion de montrer de belles pièces et quelquefois de les restaurer. Si un catalogue est prévu, cela permet en outre de les publier. Ce sont donc des événements importants pour la diffusion des connaissances et la mise en valeur de la collection. Durant les dix dernières années, nous avons choisi de faire figurer, dans les expositions que nous avons montées[15], les objets suivants :

- exposition itinérante en France (2009-10) : étui à calames E 12619 ; chaussures E 12364 ; chaussures d'enfant E 13946 ;
- à Colmar (2011) étui à calames E 27083 et chaussures d'enfant (cuir doré) E 12564 ;
- exposition itinérante en Catalogne (2011-12) : sandales E 12560 et E 2747 (**Figure 1**) ;
- à Lyon (2013) lien en cuir de la jambière en laine et soie E 29180 d'Antinoé ; étui à calames de Pamias AF 5158 ; chaussures ; extrémité de manche en laine et soie E 29377 (**Figure 3**) ; chaussures E 32044 (**Figure 5**), E 32045, E 32046, E 32059, AF 12174. L'atelier 'costumes et habillement' de l'Opéra national de Lyon a réalisé des copies de chaussures pour les reconstitutions de costumes.
- à Berlin et à Londres (2015-16) : étui à calames E 21249 (**Figure 6**).

[15] Voir les références, dans l'ordre chronologique.

Conclusion

L'exposition de ce type de mobilier est très appréciée des visiteurs car ils y voient des découvertes originales, qui touchent à l'intime et à la vie quotidienne. La transmission au public, aussi bien qu'aux chercheurs, repose sur la préservation de la collection et sur son étude. C'est le partage de compétences entre les restaurateurs et les conservateurs du musée qui permet cette valorisation. Les résultats obtenus au Louvre nous encouragent à poursuivre dans cette voie de collaboration.

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Ein Gott. Abrahams Erben am Nil. Juden, Christen und Muslime in Ägypten *von der Antike bis zum Mittelalter* et *Egypt: faith after the pharaohs* (Berlin et Londres 2015 - 2016), p. 198 et 196, n° 211.

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Matériaux

«non tissé» Polyester Reemay, «non-tissé» mono filament, fixé thermiquement sans aucun additif chimique. Très stable au vieillissement, insensible aux variations atmosphériques, stable dimensionnellement, très résistant à la chaleur (utilisable jusqu'à 175°C), excellente résistance aux solvants, huiles, solutions salines, acides et bases.

Mowilith DMC2, dispersion aqueuse d'un copolymère à base d'acétate de vinyle et ester butylique de l'acide maléique, exempt de plastifiants.

Plexisol P550, résine acrylique à base de Butyl-métacrylate en solution à 40% dans l'éther de pétrole 100°/140°C.

Beva 371 Original Formula, adhésif conçu par le Pr. Gustave Berger. Il est à base d'éthylène vinyle acétate, de paraffine, de résine cétonique, à 40% du contenu dans des solvants aliphatiques et aromatiques.

Beva 371 film, film d'adhésif à base éthylène/acétate de vinyle suivant la formule BEVA.

Biographies

Dominique Bénazeth est conservateur général du patrimoine à la section copte du département des Antiquités égyptiennes du musée du Louvre. Elle programme annuellement les restaurations et les datations au radiocarbone. Elle a dirigé le chantier de fouille à Baouît (Moyenne-Égypte) de 2003 à 2007 et enseigne à l'École du Louvre.

Céline Bonnot-Diconne est restauratrice du patrimoine, spécialisée sur le cuir. Elle a créé et dirige le Centre de Conservation et de Restauration du Cuir (2CRC, Moirans, France). Elle a été pensionnaire à la Villa Médicis et a été nommé Maître d'Art en 2015. Depuis 25 ans, elle conserve et restaure des objets en cuir archéologique, découverts à l'état sec ou gorgé d'eau. Également titulaire d'une maîtrise d'archéologie, elle réalise des études de collections à la demande des archéologues.

Florence Calament est conservateur en chef du patrimoine au département des Antiquités égyptiennes du musée du Louvre, section copte. Docteur en histoire de l'art et archéologie et titulaire d'un diplôme de langue copte à l'Institut catholique de Paris, elle s'est intéressée notamment à l'histoire des collections coptes du Louvre et participe depuis 2006 aux campagnes de fouille à Baouît en tant qu'épigraphiste.

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The Turku Market Square Excavations Case Study: Species Identification of Archaeological Leather Shoes from Finland Using Peptide Fingerprinting

Tuuli Kasso

Abstract

Organic finds are rare in Finland due to the poor material preservation caused by acidic soil. Therefore, the recent excavations in Turku have produced a phenomenal interest and group of finds, and this paper gives an overview of the preliminary work made on the archaeological leather. Here a zooarchaeological approach is applied to the leather finds, to identify the animal species used for leather shoes in 16th-18th century Turku as a viewpoint for shoemaker's choice of material and craft. The preliminary results of the first 30 samples indicate that the protein preservation is poor, drawing attention to the sampling strategy. From the 30 samples, most left unidentified, the differentiation between goat, sheep and cattle requires more attention. Interestingly enough, all the probable species identifications were from the uppers of a shoe. The possible rabbit and reindeer skins might give evidence for wider leather-sourcing for shoemaking outside from the leather produced via standard animal husbandry practices in Early Modern Age Finland.

Keywords

Palaeoproteomics, ZooMS, Zooarchaeology, Archaeological Leather, Shoemaking, Craft, Finland

Introduction

Turku is a city on the Southwest coast of Finland at the mouth of the Aura River. Turku, as a city, was founded at the end of the 13th century, making it the oldest city in Finland. Due to the building of a new car-park under the current modern Market Square of Turku, large rescue-excavations by Muuritutkimus Oy took place from May 2018 to the early 2019. Through the excavation the urban archaeological layers of 17th-19th century Turku were studied, with over 7000 m^3 excavated, of which 1600 m^3 archaeologically studied. The sheer massive volume of the excavations gave new challenges considering the selection and preservation of findings from the site.

The Finnish soil is mostly podzolic and its acidity causes that the preservation of organic material in archaeological contexts is often very poor in Finland. However, due to the alluvial clay of the Aura River in Turku area, the soil is very rich in clay and lower in pH, creating the ideal anaerobic wet conditions to preserve organic material well on an area otherwise with little to no organic finds. (Kibblewhite *et al,* 2015.) In addition to the large volume of findings due to the scale of the excavation, the long usage period of the city naturally increases the finds as well. After the great fire of Turku in 1827, a new grid pattern for the city was established, sealing the past layers beneath it.

One major group of findings from the site is leather. During the excavation buckets of leather were found every day, and this required that everyone on the site would follow the correct protocol following the handling of organic finds. The leather was kept wet in a cool environment until further handling, documenting and discard/conservation. With over 1500 leather finds, some of these holding 8kg of leather scrap under one cataloguing number, a strict valuation was established as no museum in Finland could hold nor afford the conservation and study of all of the objects.

The finds were categorized for i) conservation ii) drying and preservation iii) drying and discard. The need for conservation was estimated based on the further research potential, condition and multi-materiality of the object, whereas the drying process was conducted ii) via freeze-drying or iii) in room-temperature. Regardless, each item would be cleaned, documented and catalogued before any additional steps.

From complete shoes of adults and children, harness of a horse to scraps from shoemaker, the leather finds are extremely comprehensive **(Figures 1 and 2)**. Currently, the focus of the research on the leather material has been limited to smaller contexts. Smaller *loci* have been chosen based on supporting by historical evidence and documentation of the context. To mention, archival research has enabled the linking of some contexts to e.g. a shoemaker's shop known to have operated in Early Modern Age Turku.

Figure 1: A child's shoe, before conservation © Muuritutkimus Oy.

Figure 2: A shoe with a wooden heel, before conservation © Muuritutkimus Oy.

The traditional tools of researching shoes (such as typology) and leather speciation (e.g. hair follicle patterns) can benefit from the newer tools, such as palaeoproteomics and Zooarchaeology by Mass Spectrometry, ZooMS. ZooMS identifies the animal species from collagen type I and its structural differences, caused by the variation in the amino acids in the protein, unique to each animal species. This is called the peptide mass fingerprint, PMF. These collagen peptides are analysed with a MALDI-TOF mass spectrometer, and results compared to a database. The protocol used in this study follows mainly that of University of York for ZooMS (Fiddyment *et al*, 2015), with an additional NaOH wash to remove humic acids from the leather and a gelatinization step prior to trypsin digestion to increase the amount of collagen in the sample. All the samples were processed at the University of Copenhagen protein labs, which follows a protocol to reduce any proteinaceous contamination. The MALDI-TOF-MS measurements were made by the University of York.

The benefits of ZooMs are the small sample size required, simple preparation protocol and fast analysis of the results with a low operational cost. The hair follicle patterns were quite distorted or lost, but the general good preservation of the leather from the Turku site gave expectations for good collagen preservation. Work by Grömer (Grömer *et al,* 2016) and Ørsted Brandt (Ørsted Brandt, 2018) suggests that different types of animal leather were used for shoemaking, like the soles of shoes were made from cattle, uppers from goat and ties from sheep skins. In consideration, this is likely not an economic choice but links to the manufacturing of the shoe as leather from different animals have distinct qualities, e.g. cattle skin is much thicker compared to goat and sheep, making it more durable for the sole of the shoe (Ørsted Brandt *et al,* 2018). As leather is assumed to have been rather bountiful in the North, the recurrent birchbark soles in between the leather soles of the shoes in Turku as well were not an economic choice, but likely a functional addition to increase the insulation of shoe against the cold. Therefore, studying the materials of the shoes can increase our information about shoemaking in the past, local livestock and the animal-human relationship.

The three main livestock animals in Finland used for leather were cattle, sheep and goat. The biggest advantage of cattle was gained during its lifetime – milk, pull force and manure. The osteological analysis (Bläuer, 2014) of cattle bones from Turku showcases young animals become scarce amongst the slaughtered animals after the medieval period, due to the tightening nutrition conditions. For leather this means larger animal skins, but also their less availability for market. Sheep were butchered at an early age in Turku during the Early Modern Age period. Adult sheep would have been killed for meat before the quality of the meat decreases with age (Bläuer, 2014). However, even with poor quality mutton, the animal would provide hair for wool, leather and tallow. Sheep skin is high in fat, making it more flexible, but paradoxically the thicker the wool, the thinner the skin, affecting its durability.

Early Modern Age Finnish goats were smaller, killed for their meat and the extensive use of their horns. As for goat skins, it was used for chamois, a very popular material for clothing in the 17th and 18th centuries (Bläuer 2014). For a pair of chamois trousers, up to three goat skins were used. If goat skins were preferred for clothing, that could also apply to shoes.

For a preliminary screening technique and before applying the method in a large scale to the Turku leather finds, a batch of 30 samples were analysed. Currently ca. 100 samples have been taken, and despite the volume of leather finds from Turku, the smaller subset of samples is analysed first as recommended by Hendy (Hendy *et al,* 2018) to evaluate the feasibility for further analysis. All the samples were taken prior to conservation, or further handling, to exclude modern contamination and kept frozen until the ZooMS anaysis. The samples were selected to represent all parts of the shoe, to test whether the hypothesis of the use of different animal skins in shoemaking applies also for Early Modern Age shoes in Turku. With the rising rate of using new zooarchaeological tools that require small, yet destructive samples, after Pálsdóttir *et al.* (2019:2) it must be noted that any archaeofaunal collections are not endless.

Results and discussion

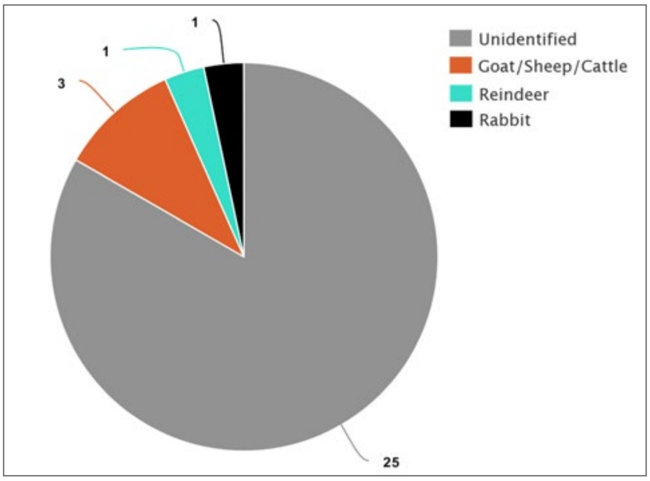

Figure 3: Species identification results © The Globe Institute.

Out of 30 samples, 25 were left unidentified **(Figure 3)**. The identified samples are all from uppers from a shoe, with three samples being probable goat/sheep/cattle, impossible to distinguish with the lack data from the samples. In addition, there is one rabbit and one reindeer skin. Even with a large percentage of unidentifiable species, the results suggest that the preservation of the collagen in the Turku leather is poorer than hoped for. Repeated freezing and thawing of samples affects the protein quality, indicating the weight of the cold Finnish climate reversing the benefits of anaerobic clay soil. Physico-chemical changes through time cause diagenesis, reducing the concentration of endogenous proteins (Hendy *et al.* 2018). This draws focus on the sampling strategy. Following the ethical guidelines of sampling cultural heritage material, all the samples were taken from already damaged areas not distorting any educational or historical value of the object. Subsequently to preservation conditions, this increases the possible weak quality of the sample. For the initial batch, the leather was subsampled to 10-15 mg pieces, and the future runs will be made with larger sample sizes for higher collagen yields in addition to replication of samples for a better definition of the results, respectively.

The reindeer skin is interesting as located in the Southwest of Finland, reindeer are not a familiar sight in Turku, being these days present only at Lapland. At that, some historical notes mention that reindeer herding was present on more southern sites in Finland still in the 17th and 18th centuries. For shoes, reindeer is an interesting choice as the hairs in the reindeer fur are hollow, giving a superior coat against the cold. There was no fur in the leather sampled, so was reindeer equally bountiful as cattle that it could have been used for meat, furs and leather, removing the heat-providing hairs? The rabbit skin does not comply well for using local raw materials, as rabbits are a late 20th century introduced species in Finland. Yet, the possibility of rabbit skin trade to Finland cannot be excluded.

Conclusion

The taste and choice for using animal skins for leather has been affected by available livestock and as mentioned, food needs and trends. Yet cattle skin would seem as the most obvious reason for leather craft for its thickness and durance, leather was always an adjunct produce to foodstuff. Though ZooMs have been found superior for species identification over traditional methods (Ebsen *et al,* 2019) the differences of the preservation of organic material and collagen in the environmental conditions should always be qualified prior undergoing large-application of a destructive methodology (Ebsen *et al,* 2019, Hendy *et al,* 2018, Kibblewhite *et al,* 2015, Ørsted Brandt *et al,* 2014). ZooMS provides an excellent tool for the prescreening of the material, and in this case, showcased that to study the choice of animal skins in Early Modern Age Turku shoemaking, next step is one size bigger.

Acknowledgements

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Biography

Tuuli Kasso has a BA in Conservation (Metropolia University of Applied Sciences), a BA and an MA in Archaeology (University of Helsinki) and MSc in Archaeological Sciences (University of Oxford). Currently she is a PhD in Science fellow at The Globe Institute, University of Copenhagen. In her research she combines a scientific approach to retrieve biomolecular information from historical material to study past husbandry methods, craft and trade. Her PhD research is funded under The Marie Skłodowska-Curie actions (MSCA) and the Niemi Foundation.

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Modified Methods for Species Identification of Archaeological Skin-based Objects: Dealing with Degradation and Improving Standards

Lucy-Anne Skinner, Rebecca Stacey, Anne Lama, Krista McGrath, Caroline Cartwright, Barbara Wills

Abstract

Skin-based artefacts survive, from tombs, graves and settlement sites in Egypt and Sudan dating back to the 3rd millennium BC. A PhD research project, based at the British Museum and University of Northampton, has used traditional microscopy and analytical techniques to identify (ID) the animal origin of leather and to investigate the processing methods used by ancient craftspeople in the Nile Valley. Traditional techniques used for taxonomic ID, such as comparison of skin grain and recognition of hair follicle pattern, are quite well understood within archaeological and conservation fields but the results are subjective and techniques are not standardised, nor are they always applicable or easy to use on degraded archaeological material which may originate from animals living in different climatic zones from the reference material.

This paper will describe the workflow and methodologies adopted to identify taxonomy of ancient Egyptian and Sudanese leather and skin objects, incorporating traditional microscopy-based methods and biomolecular methods, namely protein mass fingerprinting ZooMS (Zooarchaeology by Mass Spectrometry), to generate robust, reliable and well-corroborated results. The artefacts studied in this project are held in museums and archaeological collections at the British Museum, Egyptian Museum in Turin, and the National Museum of Sudan. The paper will also describe and illustrate the types of degradation exhibited which can impede the research and the challenges encountered when working on this material in diverse heritage environments.

Keywords

Taxonomic Identification, Microscopy, Biomolecular Analysis, Dermal Cross-section, Grain Pattern, Hair Scale Pattern

Introduction

Traditional methods for determining the taxonomic identification (tID) of ancient skin, centre on examination of morphological features such as the dermal cross-section (Michel, 2010), the grain-surface (Haines, 1981), and residual hair (Appleyard, 1978; Wildman, 1954), by comparison with reference material. In recent years, biomolecular methods, such as DNA sequencing and protein mass fingerprinting (PMF) have been adopted for tID as they become more accessible within the heritage field (Ebsen et al, 2019). ZooMS (Zooarchaeology by Mass Spectrometry), a PMF technique exploiting small genus-specific differences in the amino acid sequence of Type I collagen (Buckley et al, 2009), has been applied to collagen I from parchment (Fiddyment, 2015) and to waterlogged archaeological leather from Northern Europe (Brandt et al, 2014; Ebsen et al, 2019). Nevertheless, to date, no large-scale program of tID has been carried out on leather from desiccated archaeological environments.

This paper presents a holistic approach to tID of archaeological leather from the Nile Valley. The objects studied are part of collections at the British Museum, Museo Egizio, Turin and National Corporation of Antiquities and Museums, Sudan.

The work combines biomolecular analysis with traditional microscopy of multiple morphological features to develop a systematic approach to tID that increases the likelihood of successful outcomes (**Figure 1**). Modifications to some traditional microscopy methods have been made for ease of use and to tackle inherent subjectivity of the techniques, for example standardising imaging settings.

Methods

The workflow diagram below (**Figure 1**) documents the project structure with the numbered segments explained further in the following section.

Primary assessment

Primary assessment of the leather artefacts involved:

- checking object identifier numbers
- cross-referencing with catalogue information, establish approximate date and find spot

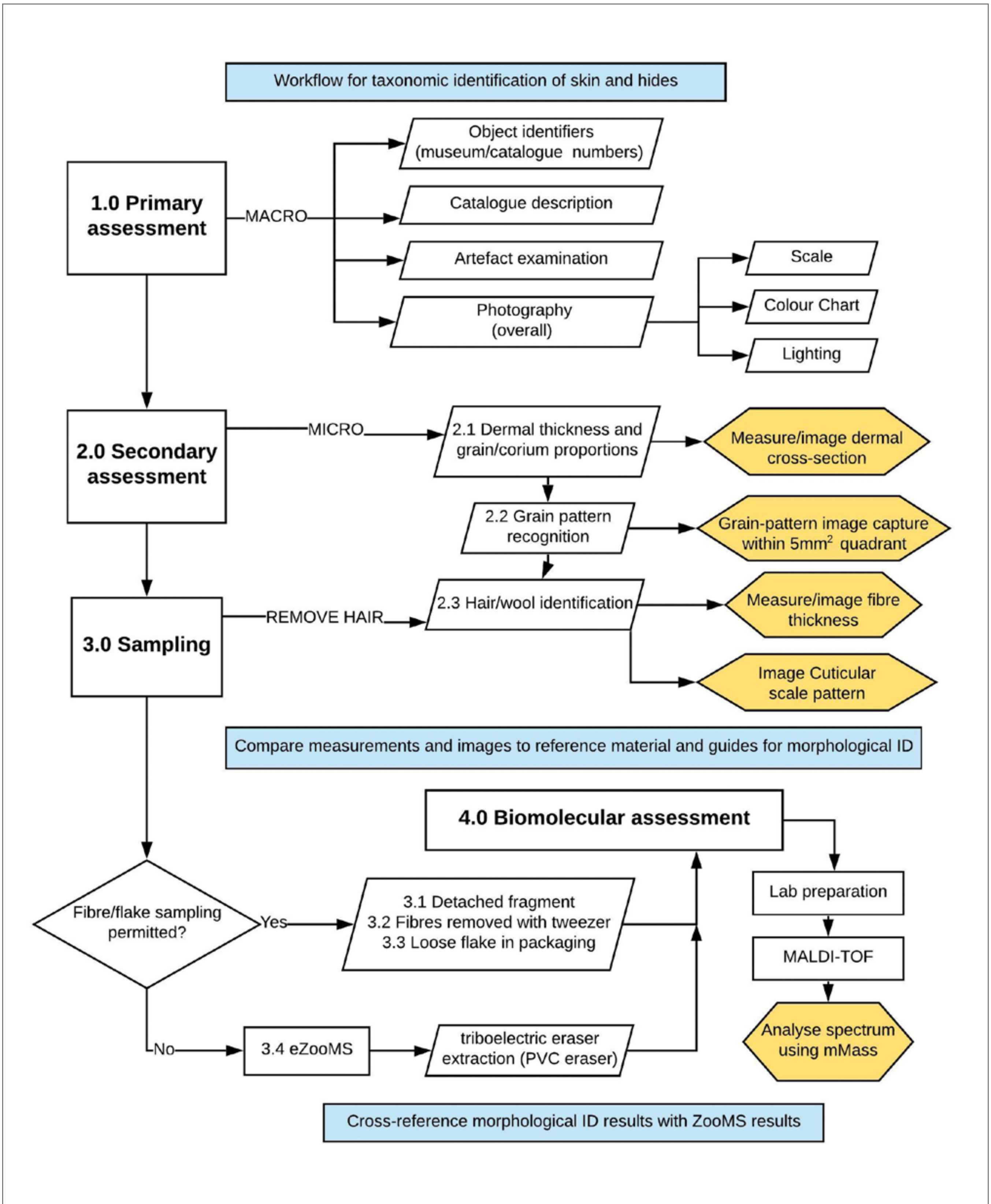


Figure 1: Workflow for taxonomic ID of skin and hides

- examination of each side (if possible) determination of object function, number of parts, and condition
- macro-photography[1]

This information was recorded in the custom-made database[2]. Artefacts were sensitive to environmental changes, thus, to limit movement, handling and relative humidity changes, primary assessment was carried out in the conditioned storage areas[3], instead of moving objects to the Department of Science.

Secondary assessment

Established morphological identification techniques were used in the secondary assessment (outlined in the workflow in **Figure 1**) based on visualisation, imaging and measurement of physical features on a micro-scale, and comparison with reference images/samples (Haines, 2006a).

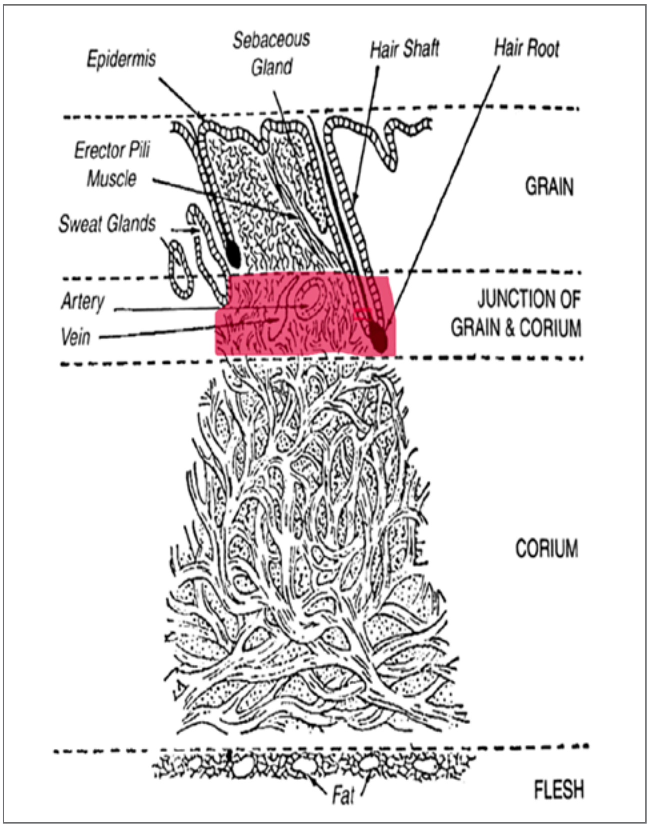
Dermal thickness and grain/corium proportions

Mammalian skin comprises a complex matrix of collagen molecules, forming bundled fibres as illustrated in **Figure 2a** (Haines, 2006b). The dermis is the portion of the skin remaining once the epidermis and the flesh layers are removed, consisting of two sections, the grain layer[4] and corium[5] – merging at the grain/corium junction. **Figure 2b** shows how thickness of the dermis and the grain:corium ratio varies according to animal type, as do angle of weave and density of the collagen fibre-bundles (Michel, 2010).

With each leather artefact, dermal characteristics have been recorded alongside measurement of the grain:corium proportions of overall dermal thickness.

Grain-pattern recognition

The grain-surface of mammalian skin is a compact layer which remains after skin processing has removed the hair and the epidermis. The undulating grain-surface is invaginated with hair follicle holes. Grain-pattern



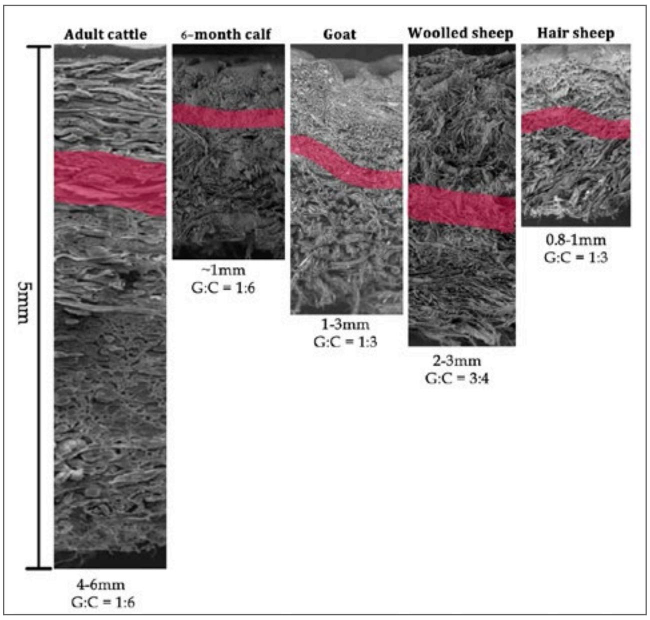


Figure 2a: Labelled dermal cross-section (adapted from Dempsey, 1957, p17) showing grain:corium junction (pink); Figure 2b: Scanning electron micrographs comparing the overall thickness of leather made from different animals and the varying proportions of grain:corium (G:C) and position of the junction (pink)

[1] Portable, battery powered LED light blocks, X-lite colour checker, 10cm scale and neutral background material were used for production of reference photographs.

[2] A Filemaker Pro database has been used to compile object records.

[3] In Ancient Egypt and Sudan department at the British Museum.

[4] Papillary layer.

[5] Reticular layer.

is a record of primary (1°)[6] and secondary (2°)[7] hair distribution, density and angle/direction of hair growth (Haines, 1981). **Figure 3a** is a photomicrograph and **Figure 3c** is a diagrammatical map of the follicle holes on adult cattle leather, showing large follicle holes, all of similar diameter. **Figure 3b** is a photomicrograph of the grain-pattern on hair-sheepskin, accompanied by **Figure 3d**, a diagramatical map, also of hair sheep-skin, showing large 1° hair follicle holes below clusters of small follicle holes from 2° hairs. The grain-map in **Figure 3e** is of goatskin which is similar in appearance to hair-sheep but tending to be less clustered, forming rows.

Grain-surfaces on all the artefacts have been examined, and whenever grain-patterns could be observed, images were captured and compared with each other and to known reference samples (Haines, 1981, Haines 2006a, Dempsey, 1957).

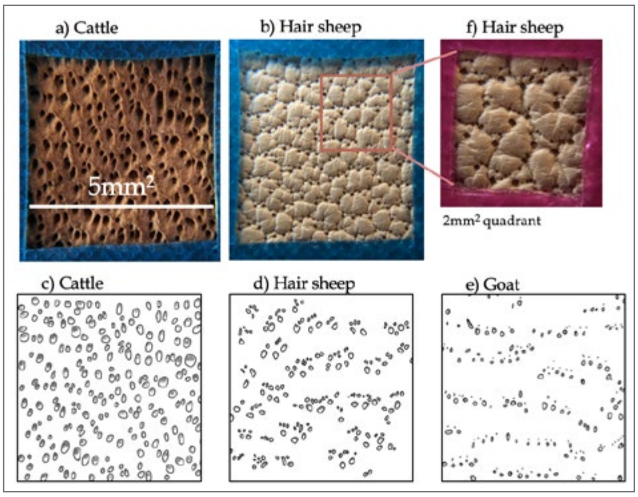


Figure 3: a) Adult cattle grain-pattern within 5mm² quadrant; b) Hair-sheep grain-pattern within 5mm² quadrant; c) for increased clarity – a follicle map of adult cattle - 5mm² quadrant d) follicle map of hair-sheep - 5mm² quadrant e) follicle map of goatskin - 5mm²; f) hair-sheep grain-pattern within 2mm² quadrant

To produce consistent, comparable images, grain-surfaces were orientated with hair-follicles angled towards the bottom/front of the image, and lighting (if a separate light source was used), illuminating from the back to front of the image.

Dino-lite microscope and Apexel clip-on macro-lens were used for capturing micro-photographs. Additionally, for comparison of microscopes, several artefacts were transported to the Department of Science and grain-patterns were imaged using the Keyence digital microscope, at ×20, ×30 and ×50 magnification.

Low magnification, between ×12 - ×30, and consistent magnification, is recommended for grain-pattern identification (Haines, 1981, Haines 2006a, Dempsey, 1957, Ebsen et al, 2019). However, selecting one suitable magnification was not possible because the clip-on macro-lens magnifies solely at ×12 or ×24, whereas Dino-lite and Keyence magnify in increments of ×20, ×30 or ×50. Lack of consistent magnification posed issues for comparison of grain-pattern images between microscopes and institutions, necessitating the development of a standardised method for calibrating images captured using different microscopic devices.

The problem was solved by imaging through a 5mm² micro-quadrant, as in **Figure 3a**. A 5 mm² area could be measured out with the Keyence and the Dino-lite microscope using the integrated digital-scale. The same effect was achieved with the clip-on magnifier, by superimposing a 5 mm² micro-quadrant inside the field of view - similar to a textile fibre-counter (Batcheller, 2005). Grain-pattern images were captured by focusing within the 5 mm² area, with the edges of the micro-quadrant providing the scale - as seen in **Figure 3a** and **3b**. 5 mm² was selected as the most versatile size - large enough to gain a general overview of the grain-pattern.

However, a 2 mm² (pink) micro-quadrant was found to be more effective than 5 mm² for imaging the smallest follicle holes and assessing follicle density and size (as demonstrated by **Figure 3f** which shows further detail of the hair-sheepskin grain-pattern in **Figure 3b** inside a 2 mm² quadrant. Colour-coding the two sizes of micro-quadrant circumvents confusion when viewing images.

An alternate method for capturing grain-pattern images was proposed by Harris and Piquette (2015), involving Reflectance Transformation Imaging (RTI). This was tested on several artefacts in this project, using a RTI dome capture system (Earl et al, 2011). The artefacts imaged were placed individually inside the dome, with the lens zoomed in as far as possible, in order to achieve maximum magnification. Compiled images were viewed using the opensource RTI viewing software.

6 Guard hairs – longest/thickest hair.
7 Underfur – fine insulating hairs.

Hair identification

Composed primarily of the protein keratin, mammalian hair has a hard, translucent cuticle, with overlapping scales on the outside, as depicted in **Figure 4a**. The main structure of hair is the cortex, with a central medulla, which can be solid or formed of cellular voids (Appleyard, 1978; Wildman, 1954).

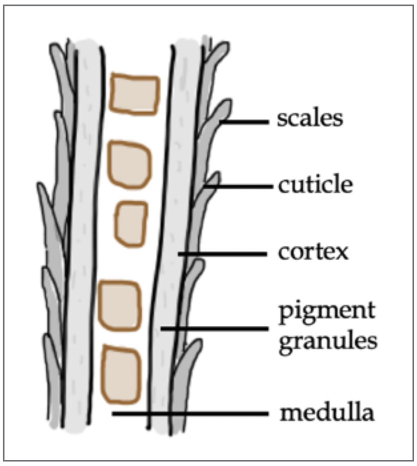


Figure 4a: Cross-section through mammalian hair

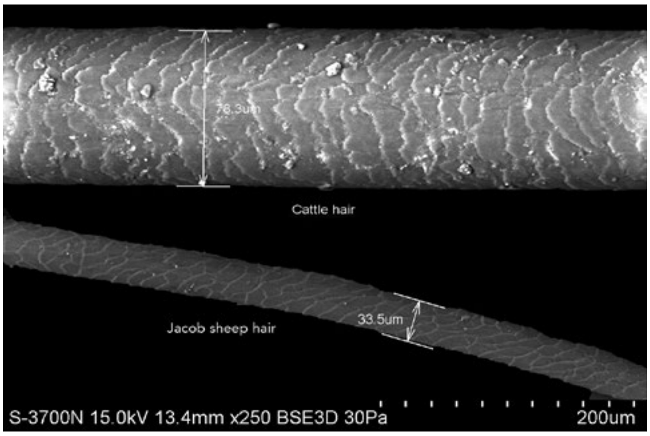


Figure 4b: VP-SEM image of modern cattle hair and Jacob sheep wool fibre 250×

Hair diameter, proportions of cortex, medulla and cuticular scale-pattern vary between species, and between 1° (guard) hair or 2° hair (underfur). Hair identification, developed for the textile industry (Hausman, 1920, Wildman, 1954, Appleyard, 1978) and by archaeological textile specialists (Ryder, 1973), focus on these differences. In **Figure 4b**, the modern cattle hair above is 78.3 μm diameter, with 'irregular waved' shaped scale cuticles and 'close-margins' between the scales; the Jacob sheep wool fibre beneath has 'irregular mosaic' scale-cuticles and is 33.5 μm diameter. The differences between the two animal hairs are clear.

Residual hairs on twenty leather artefacts have been examined and compared at 200× magnification using the Keyence microscope. In select cases where sampling was possible, individual hairs have been mounted and imaged using the VP-SEM[8] using 250× magnification and 500× magnification. Images were compared with reference hair samples.

Sampling

Sampling for grain-pattern recognition: Sampling is not necessary, so this is a non-destructive technique.

Sampling for hair ID: In select cases, individual hairs were detached using pointed tweezers and imaged using VP-SEM. However, traditional techniques, such as taking scale-casts from the hair-cuticle (Appleyard, 1978), were untenable with the fragile ancient hair.

Sampling for ZooMS on leather: Four methods were adopted for micro-sampling around 200 artefacts.

- Edges of detached fragments offer the cleanest sites for micro-sampling.
- Pointed tweezers for precise extraction of several collagen fibres from exposed edges/flesh surface.
- Tiny flakes found in packaging/mount with the artefact.
- Triboelectric (electrostatic energy) extraction (eZooMS) – Collagen fibres collected by surface rubbing with a PVC eraser (Fiddyment et al, 2015). eZooMS was used if the artefact did not have suitable (inconspicuous) places for sampling. Clean, fibrous-looking areas are preferable. The 37 artefacts from the Museo Egizio in Turin were sampled exclusively using eZooMS.

Samples were placed into sterile 150 μl Eppendorf tubes and ZooMS carried out at BioArCh, University of York.

Biomolecular methods

Ancient DNA (aDNA) sequencing from mammalian skin can yield high-resolution genetic inference relating to the tID (Teasdale et al, 2017). For instance, the Dead Sea scrolls have been identified as ibex and goatskin (Burger et al, 2001). However, tanning and skin processing causes diagenesis of aDNA meaning it does not survive as well as collagen, in archaeological leather. Also, PCR favours

[8] A variable pressure scanning electron microscope (VP SEM), Hitachi S-3700N was used in 3D mode, employing the backscatter electron (BSE) detector, at 15 kV, and the SEM chamber partially evacuated (30Pa) in order to suppress charging. The preferred working distance was around 15mm.

long-chains of well-preserved DNA (such as modern contamination) over less well-preserved aDNA. Moreover, DNA sequencing is more time consuming and costly than ZooMS, and requires larger samples from the substrate (Buckley, 2010). aDNA sequencing was not accessible and so has not been attempted as part of this project.

Protein mass fingerprinting (ZooMS) was adopted for the project, after initial testing of the technique with ancient Egyptian leather produced promising results. ZooMS works by enzymatically cleaving the chains of amino acids in collagen at known locations into smaller peptide fragments and uses MALDI-TOF, to identify differences in mass of particular peptides, (Buckley et al, 2009, Fiddyment et al, 2015).

The samples were prepared using the parchment protocol (Fiddyment et al, 2015) adapted slightly for leather by rinsing dry samples[9] to remove humic acids, tannins and colourants (for further details of the lab protocol contact BioArCh, York). Analysis was carried out using MALDI-TOF[10] and spectral analysis was performed using the open-source software mMass (www.mmass.org) (Strohalm et al 2010). The intensity and m/z value of spectra were scrutinised manually for the presence of peptide markers of known masses, for different animal types (Ebsen et al, 2019).

Discussion

Evaluation of methodologies

The primary assessment (1.0 in workflow, **Figure 1**) needs no further explanation but was an important prerequisite for amassing data gathered in the secondary assessment (2.0 in workflow), sample descriptions (3.0) and results from the bio-molecular assessment (4.0), allowing the data recorded to be easily accessed and compared.

Assessment of dermis cross-section for taxonomic ID, specifically of ancient Egyptian and Nubian leather

Dermal-thickness and grain:corium proportion (2.1 in workflow) provide a rough indication of animal skin type. However, this method does not provide definitive tID, because many animals have skin of similar thickness, density and proportions, and these properties change throughout the animal's life. Moreover, ancient Egyptian/Nubian animal skins may have had different characteristics/dimensions from modern animals of the same genus. Nevertheless, measurement of the skin thickness and proportions may narrow the options for tID and has been a reliable diagnostic tool for the thickest leathers, such as adult cattle, if over 3 mm, because other than cattle (discounting patently thick hides such as hippopotamus and elephant), animal skins are generally less than 3 mm[11]. Many of the single-layer soled sandals measuring 3 mm or more have also been identified using grain-pattern ID or ZooMS as cattle hide. Nevertheless, dermal cross-section analysis cannot stand alone as a method of identification otherwise information may be overlooked, such as the possible exploitation of large antelopes or horse hides for leather making (Brewer, 1994).

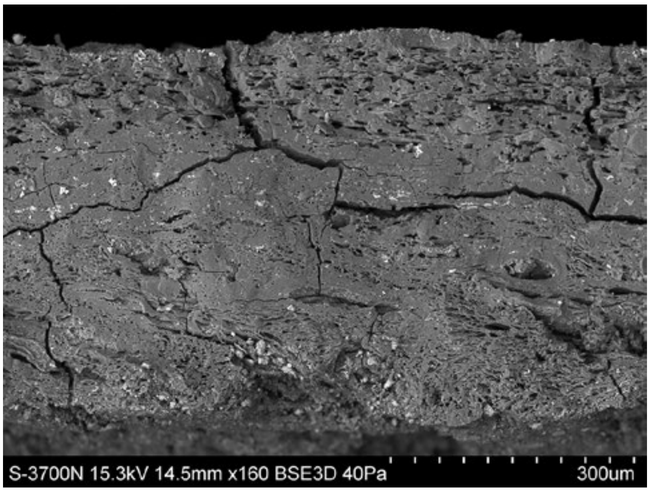


Figure 5: Dermal cross-section of a Late Antique leather manuscript (EA10391)

Other impediments included fibres in the cross-section being full of dirt, grease or a conservation resin, obscuring the structure. Furthermore, original skin processing (shaving or stretching) may have reduced the skin thickness, or the ancient skin changed dimensions as it degraded. The example in **Figure 5** shows the cross-section of an early Medieval leather manuscript, probably from Western Thebes. The leather has

[9] Rinsing four times (once in 200µL of NaOH, (sodium hydroxide) and three-times in 200µL of 50mM NH_3CO_3, (ammonium bicarbonate)).

[10] MALDI-TOF (Matrix-Assisted Laser Desorption/Ionization-Time-Of-Flight) calibrated Ultraflex III (NLD1; Bruker Daltonics) instrument in reflector mode, at the University of York.

[11] In some cases, other ID methods did not yield any results. However, in no case was a fragment of thick leather identified as originating from any animal other than cattle.

reduced in overall thickness, cracked and essentially lost its fibrous structure, making the corium and grain hard to distinguish.

Assessing grain-pattern for taxonomic ID, specifically of ancient Egyptian and Nubian leather

The benefit of grain-pattern recognition for tID of Egyptian and Nubian leather (2.2) was the convenience of the technique. Using only a magnifier, clipped-on to a smart phone camera, good quality images of grain-surfaces have been captured, at low magnification (~12× or ~24×), even from difficult to access parts of artefacts, while working in storerooms or study-rooms.

Figure 6a: Surface image of a Nubian cattle hide from a Kerma Classique (1802-1640BC) grave lining at Abu Fatima, Sudan, with surface grazed by insects

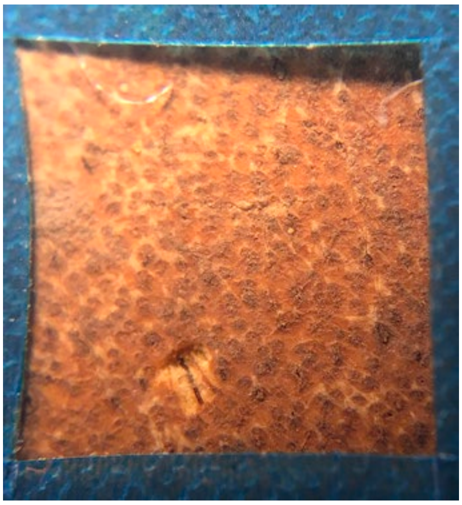


Figure 6b: Surface image of a cattle hide from the base of a sole from a New Kingdom (1600-1100BC) sandal, unknown provenance (EA4396)

Adoption of the 5 mm^2 micro-quadrant has had two benefits. When using the low-grade optics of the clip-on lens and focusing the camera inside the quadrant, image blurring and distortion was mostly cropped from the edges of the image (although **Figure 6a** and **b** still show some inward bowing). Another benefit of the micro-quadrant is mitigation of user-error. Provided the micro-quadrant is within view, any suitable magnification can be used. The micro-quadrant has enabled grain-pattern images to be calibrated against each other and compared even when captured using different microscopes. **Figure 6a** and **6b** were captured using a smartphone, 5 mm^2 micro-quadrant and clip-on magnifier. The leather in these two was evidently processed differently, from different parts of the body and differentially preserved. However, the follicle size and densities are alike, indicating that the cattle used to produce the leather may have been of similar breed and age.

Figure 7a: (EA4405) Surface image of a partially denatured goatskin. Keyence image (5mm^2)

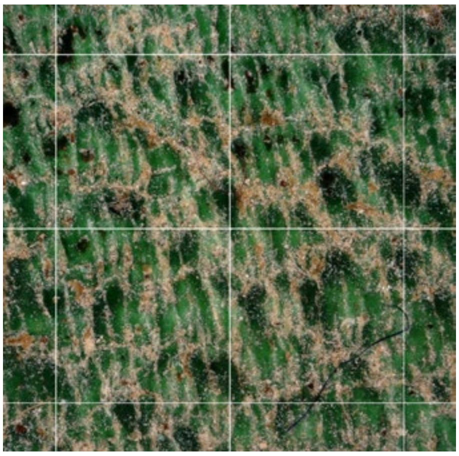


Figure 7b: (EA36778) Surface image of a green pigmented layer obscures grain-pattern. Keyence image (5mm^2)

tID by grain-pattern recognition relies on the presence and visibility of diagnostic morphological features. Inherent complications include the purposeful removal of grain-surfaces during skin-processing (typical for ancient Nubian garment leather) or grain-surfaces being covered with a pigmented layer and/or dirt (**Figure 7b**). Another pitfall specifically concerning ancient Egyptian and Nubian leather is that animal breeds have evolved and changed through time, so grain-patterns of modern animals may not resemble their ancient counterparts. Also, some grain-patterns are relatively difficult to tell apart (e.g. hair-sheep and goatskin follicle-maps in **Figure 3d** and **3e**).

The leather on the left side of **Figure 7a** demonstrates how denatured/gelatinised leather appears darkened, pitted and distorted, with increased particulate matter accumulated in follicle holes (gelatinised collagen is tacky at elevated humidity), making grain-patterns difficult to discern. Other artefacts had historic coatings (such as British Museum leather dressing) obscuring grain-patterns (Raphael et al 1984).

Beyond the initial tests described above, RTI was not used for grain-pattern recognition because the resolution was not good enough, using the dome-system, to illuminate follicle-holes[12]. Micro-RTI (Goldman et al, 2016) may be a valid alternative but has not been further explored.

In the future pattern recognition software may enable automated tID from standardised grain-pattern images[13]. This would remove the subjectivity inherent in morphological tID.

Assessing hair scale-cuticle pattern for taxonomic ID, specifically of ancient Egyptian and Nubian leather

Hair (2.3 in workflow, **Figure 1**) is generally of limited application for tID of leather, since it is normally removed during skin-processing. Nevertheless, some Egyptian and Nubian artefacts have residual hair attached, either intentionally or due to incomplete skin-processing. **Figure 8a** is a 5 mm^2 image of a sandal sole. The hide is 4 mm thick indicating it is from an adult animal and has visible hair-stubs, possibly remaining because the surface was shaved not scudded[14]. A residual hair removed for imaging using VP-SEM (**Figure 8b**) identified it as cattle-hair (similar to the scale-pattern of cattle-hair in **Figure 4b**), with a fibre thickness of 57.3 µm, which is approximately 20 µm finer than a modern cattle hair, perhaps indicating that this cattle breed was well adapted to a hot climate with fine, short hair[15].

Hair scale-patterns are difficult to view without a microscope capable of high-magnification and depth of field. These requirements are prohibitive for many researchers, without access to costly instruments such as the VP-SEM and Keyence digital microscope.

Figure 8a: Surface image of a leather from a sandal sole from 11th Dynasty (~4000BP) with hair stumps (EA41674)

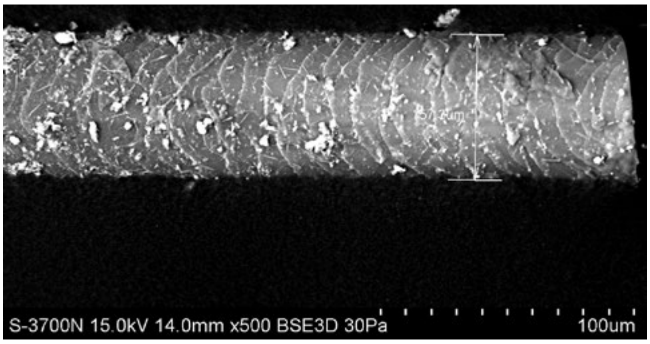


Figure 8b: SEM image of hair from (EA41674). Salt and dirt deposits on the surface

In a few cases, hair was more diagnostic for tID than grain-pattern ID and ZooMS. **Figure 9** is from EA10414a, an early Medieval manuscript (probably) from Thebes[16]. The poor condition of the grain-surface ruled out grain-pattern ID. In contrast, residual hair was in good condition (hair is composed primarily of keratin - more resistant to decay than collagen (Bertrand, 2014)). ZooMS identified EA10414a as *Ovis aries* genus (sheep) (Buckley et al, 2010), but could not distinguish between woolled-sheep and hair-sheep.

Primary hairs on EA10414a measured 33 µm thick and secondary hairs 11 µm thick were noted. By comparison, Jacob sheep wool fibres (see **Figure 4b**) are about 30 µm thick. The fineness of EA10414a's fibres suggest this skin is from woolled not hair-sheep – otherwise kemp fibres

[12] RTI was used for other applications - clarification of the direction of fibres and hair growth across a hide.

[13] As part of the research project - Beasts to Craft – automated tID methods for parchment, are being developed (pers. Comms. Collins, 2019).

[14] Scudding is the action of scraping a hide, using a blunt-bladed knife, to pull out entire hairs from the root.

[15] Figure 4b hair is an unknown English domestic cattle breed.

[16] https://www.britishmuseum.org/research/research_projects/all_current_projects/the_hay_cookbook.aspx.

would be present (which can be over 100 μm in diameter (Ryder, 1987)).

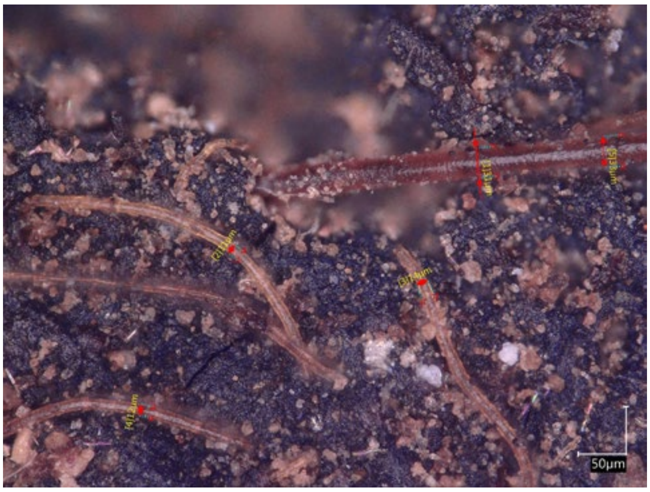


Figure 9: Surface image of an early Medieval manuscript (EA10414) imaged by Keyence digital microscope (×200 magnification)

This difference is significant because the type of sheep bred by ancient Egyptians has implications for animal husbandry practice. *Ovis platyura aegyptiaca* is an ancient Egyptian sheep breed, depicted in tomb-paintings, with twisted horns and a similar appearance to modern Egyptian woolled-sheep, suited to grazing in the Nile river valley (Brewer, 1994). In contrast, pastoralists living on desert land, tend to prefer hardy desert sheep, with long legs and coarse hair-coats, bred to endure intensive solar radiation and prolonged migration in search of grazing and water (Mufarrih, 1991).

Despite the resilience of keratin, hair-cuticles remain vulnerable to abrasion from use or biodeterioration. The Egyptian/Nubian hair typically exhibited some damage to the hair-shaft as well as encrustations of soil, salt and fungal hyphae on the cuticle. The scale cuticle of hair from EA21727 in **Figure 10**, was largely obscured by fungal hyphae. Cleaning the hair was not attempted but might in some cases be possible.

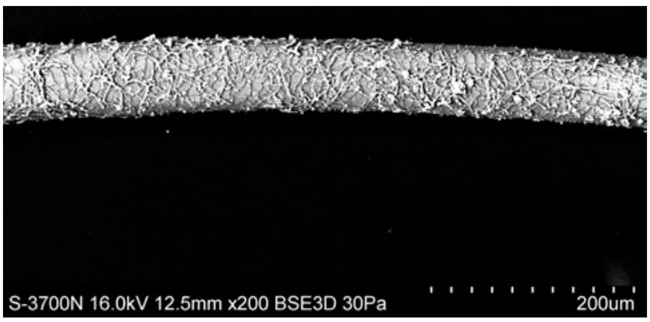


Figure 10: SEM image of hair from leather slipper with fur-lining from Greco-Roman period (EA21727)

Assessing bio-molecular methods for taxonomic ID, specifically of ancient Egyptian and Nubian leather

ZooMS has provided tID to the taxonomic rank of genus for 60% of the project samples. These are all either cattle (*Bos taurus*), goat (*Capra aegagrus*) or sheep (*Ovis aries*) (probably all domestic animals, although ZooMS cannot distinguish between wild and domestic breeds), with several examples from the Late Antique period from the Equidae family (horse or donkey) and one of camel. A further 20% could not be classified using ZooMS to beyond 'family' Bovidae (cloven-hoofed, ruminant mammals). As sheep, goat and cattle are all in the Bovidae family, this result does not significantly narrow the possibilities. Distinguishing between sheep and goatskin by ZooMS relies upon assignment of two diagnostic collagen peptide markers between 3000-3100 m/z (Buckley et al, 2010). Unfortunately, these large peptides have not always survived in the degraded ancient collagen, so may remain undetected using MALDI TOF, reducing the chance of distinguishing between sheep and goat using ZooMS.

Nevertheless, overall the ZooMS success rate has been good, considering deterioration and the significant age of the artefacts. ZooMS was indispensable for identifying tID of leather lacking hair and grain-surface such as "grain-off" garment leather from Nubia. EA2564 is a loincloth, with an Egyptian findspot and has been tentatively identified as gazelle skin using ZooMS – based on a difference between the mass of a single peptide (gazelle – 1550 m/z and sheep, 1580 m/z). Some sources suggest that during the pharaonic era in Egypt there may have been a taboo against wearing garments of wool or sheepskin directly on the skin (Vogelsang-Eastwood, 2000) so gazelle leather may have been a viable alternative. Waterer (1956) and Forbes (1957) identified gazelle-skin loincloths, but without scientific verification. Hence, this ZooMS result is significant to our understanding of ancient Egyptian society and warrants further investigation of leather loincloths – possibly by aDNA sequencing or more in-depth protein analysis using LC-MS.

A further four loincloths failed to produce ZooMS results – perhaps due to contamination from contact with decomposing human remains. In these cases, rinsing the samples during lab processing was ineffectual. Nevertheless, rinsing collagen before extraction, (footnote 9), has been successful in removing many contaminants effectively, producing well-resolved ZooMS spectra.

Improved success-rates with ZooMS were also detected by improving sampling precision. The spectra with highest intensity (m/z) peaks and least contamination were acquired by tweezer extraction of clean leather fibres. The samples which produced the least useful results were from unidentifiable flakes found in the mount or packaging, exhibiting contamination from human collagen and keratin. eZooMS was less effective than expected, because archaeological leather is often dirty, and eraser rubbing will pick up this contamination. Moreover, tribo-electric (static) effect has been found to be ineffective for attracting collagen from gelatinised, non-fibrous matrices. This was particularly notable for eZooMS sampling of the heavily denatured Museo Egizio, Turin artefacts.

Conclusion

The intention of this paper was to critically assess the available methods for identifying the species or genus of animal skins used to make leather in antiquity and the pros and cons of available methods. Ways of improving the robustness of conclusions have also been explored by standardising the investigation through establishing a workflow which creates a reproducible interpretation sequence.

A key outcome was the demonstration that tID projects are unquestionably enhanced through incorporating more than one investigative technique. The benefits of taking a holistic view of the artefact in question, looking at physical properties (dermal thickness, grain-pattern and residual hair shafts), the intended function, find-spot location and environment, and approximate date of production are illustrated by this study. This work also offers a tool that can be adapted by researchers working in varying conditions, with only basic access to equipment.

The advanced age and high level of degradation of many of the artefacts made their reliable tID a challenge (though not insurmountable) when multiple sources of evidence were considered collectively.

Acknowledgements

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Materials

Dino Lite - Dino-Lite Premier AM7013MZT4 digital handheld microscope

Apexel Professional HD 12X/24X Advanced Macro Lens (Amazon.co.uk) - Clip on magnifier for smartphone.

Biographies

Lucy-Anne Skinner is an archaeological conservator, organic materials specialist and current PhD candidate on the topic of ancient Egyptian and Nubian skin-processing, at the British Museum and the Institute of Creative Leather Technologies, University of Northampton. Previously Lucy worked for over ten years as a conservator of archaeological and historic leather and other organic materials, in Egypt, Sudan, Norway, Antarctica and in the UK and a teaching Fellow in Art Conservation at Buffalo State College, NY. Lucy is interested in improving the understanding of leather and skin processing methods, deterioration mechanisms and how these may be related to each other.

Rebecca Stacey has a background in analytical chemistry, applied to ancient organic materials. She began working at the British Museum in 2001 as an organic scientist. Rebecca's expertise is in the characterisation of amorphous natural organic materials such as varnishes, adhesives and residues of food, medicines and other unguents; with a particular interest in natural products such as resins, gums and waxes, tars and bituminous materials. Her research applies chemical analysis to address questions concerning the source, production, use and alteration of these materials.

Anne Lama has obtained her BSc (Hons.) in Leather Technology from Bangladesh Collage of Leather Technology, University of Dhaka, Bangladesh. She successfully completed her MSc Leather Technology and PhD at the University of Northampton, UK. Her PhD research focused on the growth and proliferation of bacteria in tannery effluent. Following her PhD, she worked at the Leather Conservation Centre researching on historic leather, then joined BLC Leather Technology Centre as a leather technologist. Currently she's working at the Institute for Creative Leather technologies, University of Northampton as a Senior Lecturer.

Dr **Caroline Cartwright** is a Senior Scientist in the Department of Scientific Research at the British Museum. Her areas of scientific expertise cover the scanning electron microscopical identification and interpretation of organics such as wood, charcoal, fibres, macro plant remains, shell, ivory and bone, including for CITES (Convention on International Trade in Endangered Species). She has led many teams of archaeological specialists on archaeological projects to the Middle East, Africa, the Caribbean and Europe. Reconstructing past environments, charting vegetation and climate changes, and investigating bioarchaeological evidence from sites, museum collections and data, form important aspects of her research.

Barbara Wills is experienced in the conservation of a wide range of organic materials and specialises in the treatment of objects made of leather, human remains, basketry materials and from ancient Egypt. She has published widely and enjoys exchanging skills, contributing to workshops and University course units.

Krista McGrath has a background in biology and anthropology, with postgraduate research focusing on ancient DNA degradation. She was the Genomics and Proteomics Technician at BioArCh in the Dept. of Archaeology at the University of York for five years. Krista works in biomolecular archaeology, identification to studying diets and pathogen loads and is interested in the development and optimization of methods for materials analysis.

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The Conservation of Archaeological Leather from Tuva (Southern Siberia, I mill. BC)

Varvara Busova

Keywords
Conservation, Leather, Tuva, Early Iron Age, Archaeology, Scythian Time, Xiongnu Era

Introduction

This report aims for presentation of some experience in field conservation/restoration of leather items and the questions related to it. All materials are taken from burials from the 8th till 2nd century B.C. and belong to the Scythian and Xiongnu epoch. Almost all of them were found in the excavations of the Tuvinian Archaeological Expedition of the Institute for the History of Material Culture in Tuva (Southern Siberia). The condition of preservation is different in each case: wet or dry soil, archaeological objects from museum collections or objects that have survived only due to the contact with items made of copper alloys. In the case of contacts with copper alloys arise more questions. We are trying to take samples for analysis in the field before the conservation: archaeologists and the restorers can gain important information from these samples (X-radiography, scanning electron microscopy of fur, X-ray fluorescence analysis, radiocarbon dating, etc.).

Over the past 30 years the archaeological research process in Tuva was led by the Leningrad Department of the Institute of Archaeology (from 1984 to 1993) and by the Tuvinian Archaeological Expedition of the Institute for the History of Material Culture RAS (authors of works V.A. Semenov and M. E. Kilunovskaya). Expeditions have accumulated a large collection of fragments from burial mounds of the Scythian time (late 8th till 2nd century BC). These fragments of products are made of organic material like textile, leather, fur and felt. Also, there are materials accumulated from the Flooding Area on Central Tuvinian territory from the burial ground of the Xiongnu era (2nd century BC - 1st century BC). In most cases, the investigated burial sites were looted in ancient times and the preservation state of the found items does not allow a direct interpretation of their purpose. Already at the stage of field conservation, and then in the process of restoration, we are obliged to choose a completely individual approach to preserve each object. In the process of chemical, biological and physical destruction of archaeological materials, such important properties as plasticity and strength of the leather disappear over time. In Central Tuva, where we are working, the daily temperature changes are quite big (from 13°C at night to 45-50°C in the afternoon) and the humidity changes during the day between 20% and 80%. Even with the external dryness of the soil (sand), the soil is wet at a depth of 1,5 m because of the groundwater and doesn't have time to dry completely for the three weeks of the year, when the groundwater level is lowered.

Discussion

The most important thing is to take samples in the field before any conservation process. We gain experience when it is possible to carry out analyses before and also after certain stages of treatment, but the result cannot be called completely reliable. In the restoration process of the previously restored leather purse from the Holash b. 83 (4th till 3rd century BC), it became clear that thin leather substrates under the carved appliqués were covered with red paint, as well as the entire lower part on the front side. X-ray fluorescence analysis was performed using the Tornado M4 spectrometer (Bruker) which confirmed the presence of Fe_2SO_4 pigments (iron oxide, hematite, ochre). Many other leather items of the Scythian time on Tuvinian territory were covered with red ochre by the ancient masters: belts, bags, amulets, scabbards for knives. Using X-ray diffraction analysis will help us to learn more about the exact composition of coatings and deposits of pigments. For example, on a leather sword sheath from the Niya site cinnabar HgS was found as a pigment (Kramell et al., 2016).

The episodic accumulation of fur fragments (presumably: fur coats), mostly preserved due to contact with copper alloy items, allowed electron microscope scans (the Institute of ecology and evolution RAS, together with Dr. O. F. Chernova). There was hair from seven fur samples from Scythian time barrows from Central Tuva. As a result of the comparative morphological and statistical analysis of the tested hair fragments' microstructure, it was possible to determine that the hair of the sample found at the burial site of Kosh-Pei I (b. 2) belonged to the hare L. Timidus (hare); samples from the burial grounds Sulug-Hem I (b. 2), Sausken 3 (b. 11) and Sipuchii Yar (b. 3, 4, 5) belonged to a Przewalski horse; hair samples from burial sites in the valley of the river Eerbek (Eki-Ottug 1 (b. 5) and Bai-Dag 6 (b. 6)) were similar to the mix of hair of Przewalski's horses, the extinct horse E. lenensis and of the Bashkir breed. Hair samples from the coat found at the burial site Saryg-Bulun (grave 5) were identified as rodent hair, a representative of the family of jerboa (Dipodidae) (Chernova and Busova, 2016).

Here are some examples of the conservation and restoration of objects from archaeological excavations in Tuva. The first one was related to wet archaeological leather. A leather wallet from b. 83, Holash burial ground (Semenov, 1997: 15-19, dated by 4th-3rd century B.C.) was conserved in 1995 with glycerin on water-alcohol solution and packed in a plastic bag, which made it impossible to conduct further research and even more so, to present it at the exhibition **(Figure 1)**. In 2014 we started the process of reconservation: polyethylene glycol (PEG 400) – 25%, water-alcohol solution 3-4% Preventol Rl 80, distilled water – 65%. The leather fragments were in closed containers for 4-6 weeks. Daily checks of the plasticization process were conducted and the solution alternated as appropriate (output glycerine). Then freeze-drying was carried out in the freezer for 5 weeks (vacuum sublimation). The losses were replaced with the help of glue Lascaux 303HV only in those places where the edges could be destroyed in the future during transportation, etc. **(Figure 2)**. This work was carried out under the direct supervision of the restorer of the highest qualification N.P. Sinitsyna (The Grabar Art Conservation Centre).

Figure 1: Leather purse from Holash, 83 before conservation © Institute for the History of Material Culture Russian Academy of Sciences

Figure 2: Leather purse from Holash, 83 after conservation © Institute for the History of Material Culture Russian Academy of Sciences

Working with dry skin: The leather headgear of a child mummy (burial 5, Saryg - Bulun) with a spiral ornament on slim light skin (Semenov and Kilunovskaya, 1990: 41-43). It was quite deformed, with multiple losses. It was decided to use the method of remote humidification. After a few days, the object had become flexible and had a form. In order not to lose moisture outside the desiccator again, a special dressing based on beeswax was used. In most cases, with the help of remote moisture and minimal intervention it is possible to reshape deformation and strengthen the subject. The replacement of the losses was done with the help of glue Lascaux 303HV and japan tissue (it's not finished yet).

The biggest difficulty of our work is the is the other fraction/contingent of items, that is a whole group of archaeological leather items that are fragmentarily preserved in burials. These fragments have been preserved by contact with products made of copper alloys like daggers, knives, axes, arrows and belt buckles. This skin has lost its plasticity and retains its shape only because there was a gradual replacement of organic parts with copper chlorides. Trying to remove copper is dangerous for the integrity of the item because the whole object can collapse. Viewing these difficulties mentioned, you could conclude, that there is no way of treating it?

Conclusion

The most reasonable is not to give any methodical recommendation but a list of examples for each category of objects the conservation specialist has to work with in the field or in the laboratory. This has long been a constant practice. In Russia, there is no specific direction for restoration of the leather in the universities. Therefore, professional staff are trained by masters and internships abroad. New methods are being implemented with great difficulty on our soil, where restoration techniques have existed for decades. Communication between foreign colleagues and access to modern supplies for conservation is complicated.

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Semenov Vl.A, 1997. Mongun-Taiga. Saint-Petersburg, 48 p (In Russian).

Materials

- Japanese tissue paper: Japico GmbH & Co.KG., D-Dietzenbach
- Lascaux acrylic dispersion 303HV. Lascaux Colours & Restauro, Barbara Diethelm AG, Zürichstrasse 42, CH-8306 Brüttisellen, Switzerland. Tel. +41 44 807 41 41, Fax +41 44 807 41 40 www.lascaux.ch
- Polyethylene Glycol (PEG) 400
- Preventol Rl 80
- "Special dressing based on beeswax": Lanolin (anhydrous) 12g, Beeswax 1 g, Vaseline oil – 50 ml

Biography

Varvara Busova is a leather conservator and young archaeologist from Russia. She graduated in 2014 at the Saint-Petersburg State University as a Specialist in the Department of Archaeology. Since 2015 she has been working in the Grabar Art Conservation Centre (Moscow) in the Department of Leather and Archaeological Textiles Restoration. For the last 9 years, she has headed the field conservation laboratory at the Tuvinian Archaeological Expedition (IHMC RAS). She writes a PhD thesis about the leather production of the Scythians in the 1st millennium BC on the territory of Southern Siberia and she is interested in natural scientific methods in the study of the archaeological leather.

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Face Down in the Mud: The Conservation of the Tideway Boots. Press Expectations Versus Salvaging the Leather

Lucie Altenburg

Keywords
Boots, Leather, Archaeology, Waterlogged, London, Foreshore

Introduction

In July 2018, a skeleton was found prone at the Chamber's Wharf site during excavations for the new sewer running under London. Discovering complete human skeletons is not unusual in London excavations, but this differed from most cases as it was found still wearing a pair of knee-high leather boots.

Due to the unusual position of the objects and the instability of the wet leather, a MOLA conservator was called on site to block lift the boots out of the ground using medical fabric bandages. They were then micro-excavated back at the laboratory using medical fabric bandages and 3M Scotchcast casting bandages to support them.

In December of the same year, the story was released to the press and quickly went viral. Although the boots were described as 'perfectly preserved' or 'virtually intact', the actual condition of the objects and how they were retrieved and stabilised by conservators was not mentioned, even in the official press release. Conservation was briefly mentioned as undertaking some analysis work on the materials.

Discussion

The condition of all accessioned waterlogged leather at MOLA is visually examined using the Criterion Anchored Rating Scale (CARS) (Suenson -Taylor & Sully, 1996). It assesses the flexibility, cohesion friability and physical integrity of the material before and after treatment by attributing a score out of 12, with 4 points for each category, to reduce subjectivity and ensure consistency in assessing the condition of objects (**Table 1**). Flexibility being more difficult to assess without damaging the material, only has two possible defining criteria very much linked to the friability of the leather.

The leather was in an advanced state of decay, being brittle, friable and unable to support its own weight. The objects were fragmentary, the long bones and heels having protruded through the leather. Their CARS score was

Before Treatment

Physical integrity:2 / cohesivity: 2 / Friability: 2 / Flexibility: 2

After treatment

Physical integrity:3 / cohesivity: 3 / Friability: 3 / Flexibility: 3

The conservation treatment was led by a consultation with a MOLA leather specialist to prioritise the preservation of significant features such as the folded flaps and the construction of the heels and soles. Construction and decoration of footwear can provide invaluable information on social status, gender, age and any potential foot related ailments to the specialist.

All wet leather is conserved as per a set treatment established at the Museum of London:

- The leather is cleaned under running tap water
- It is immersed in a 20% solution of glycerol in water for 3 days
- The leather is frozen overnight and then placed in the freeze-dryer until its weight stabilises. The treatment was adapted in its implementation to the size and positioning of the objects. As the boots overrode each other, they could not be separated before freeze-drying (**Figure 1**).

Table 1: CARS evaluation sheet followed at MOLA and Museum of London for the visual assessment of archaeological wet leather before and after conservation treatment. © Museum of London.

Leather Treatment - Criterion Anchored Rating Scale

	1: 76% - 100%	2: 51% - 75%	3: 26% - 50%	4: 1% - 25%
Lack of physical integrity Assess amount of use wear and burial damage. Consider the physical integrity of the object as a whole and the degree to which object is complete eg tears.	Wear and burial damage extensive over whole area.	Wear and burial damage over greater part.	Isolated areas of wear and burial damage, not extensive.	Object intact, no wear and burial damage.
Lack of cohesivity Consider the leather fibre structure on a macro scale and the integrity of the surface as a whole. Look at vulnerable areas liable to loss. Bear in mind the nature and shape of the object.	A great many fragments readily detached during handling resulting in total loss of leather.	Several fragments readily detached during handling.	Minor areas of vulnerable fragments.	Leather intact, no vulnerable fragments.
Friability Diagnose primarily on the grain surface only. However some account should be taken of exposed edges. Where grain surface is no longer present, define condition of the remaining fibre surface.	Fibres easily detached during handling, resulting in total loss of surface.	Greater part of surface and exposed edges liable to loss.	A few areas of grain surface liable to loss of fibres.	Grain surface intact, no loss of fibres.
Flexibility Flexibility must be appropriate to the object. If flexible, not so weak as to be damaging to the object. If inflexible not so brittle as to allow damage to occur during handling.		Unacceptable - weak or stiff and brittle.		Flexible.

Figure 1: The four main phases of the conservation treatment: mechanical clean and removal from block; immersion in glycerol solution and freeze-dry © Lucie Altenburg

Although the treatment was carried out successfully, the state of advanced decay of the leather caused it to remain brittle and friable after freeze-drying. At field stage, conservators are required to stabilise objects. As the boots were dried and stable, further consolidation may be considered during post-excavation work. It was also noticed that the leather had not absorbed the glycerol as well as it normally does (**Figure 2**), and excess glycerol had to be cleaned from the surface. This has been noticed in other very decayed archaeological leather pieces.

This poster aimed to highlight the possible oversight of the conservation processes involved in the safeguarding of an object when it is perceived as a news sensation. For the months before the press release, the conservation was focused on salvaging as much as the leather as possible, prioritising the features of the utmost significance to the specialist. Once the story was released, reconstructing

Figure 2: Darkened surface of the leather from excess glycerol after freeze-drying © Lucie Altenburg

the shape of the boot became important to make it more understandable to the general public.

Conclusion

The conservation of the knee-high leather boots was considered successful. Given the condition the leather had been found in, the conservation treatment was able to record and salvage more material than was anticipated. The essential features identified with the specialist were preserved and have been safeguarded for future analysis. However the boots are still very fragmentary losing the complete shape advertised by the media. With no explanation as to the conservation processes which took place, some confusion remained amongst the general public as to the condition of the boots after drying was complete.

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Materials

Scotchcast, water activated resin casting tapes, 3M, Ratcliffe Rd, Atherstone CV9 1PJ UK service, 01827 713571

Vegetable glycerine, Harry Harvey Industries Ltd, 140 Bridgeman street Walsall WS2 9NW UK, 01922 641781

Biography

Lucie Altenburg is an archaeological conservator at Museum of London Archaeology (MOLA). She started working for MOLA in April of 2018 after graduating from the MSc in Conservation for Archaeology and Museums at University College of London (UCL).

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Découverte d'un Lot de Fragments de Cuir du Bas Moyen Âge à Billy (Allier, Auvergne-Rhône-Alpes)

Perrine Picq

Mots-clés
Cuir, Chaussure, Semelle, Bas Moyen Âge, Cordonnerie

Introduction

Dans le cadre d'un diagnostic archéologique mené sur la commune de Billy fin 2017 par le SAPDA (Département de l'Allier), en amont de travaux d'élargissement d'une route, portés par la DREAL (Direction Régionale de l'Environnement, de l'Aménagement et du Logement), un lot de fragments de cuir a été mis au jour. Découvert au sein d'un probable fossé défensif de la ville médiévale, l'étude du mobilier céramologique associé a permis d'en attribuer la datation aux XIV^{e}-XVI^{e} siècles. La commune de Billy est située dans la moitié sud du département de l'Allier. A 14 km de Vichy, le château de Billy est construit au sommet d'un éperon rocheux à 280 m d'altitude sur la rive droite de l'Allier, et le secteur concerné par le diagnostic se situe à proximité de la porte médiévale Chabotin **(Figure 1)**. De la structure du bourg médiéval de Billy et du tracé de son enceinte, ne sont connues que des hypothèses d'historiens ou des illustrations peu satisfaisantes dans leur fiabilité. Toutefois, si l'on en croit ces données iconographiques, le seul accès au bourg serait constitué par cette porte, à laquelle auraient été greffées les fortifications.

Figure 1 : La porte Chabotin et le diagnostic en cours de réalisation

Contexte de la découverte

La profondeur d'apparition importante couplée à l'impossibilité de procéder à des paliers de sécurité en raison de l'espace limité d'intervention, ont contraint les archéologues à observer les vestiges mis au jour majoritairement depuis le bord de la berme. Il en est de même pour la récolte du mobilier qui, effectuée dans les tas de terre, a pu induire quelques phénomènes de mélange, malgré l'attention de l'équipe. C'est dans ces conditions qu'a été recueilli un lot de fragments de cuir qui semblait s'inscrire dans un contexte lié au fossé défensif de la ville médiévale, aujourd'hui remblayé. Les unités stratigraphiques associées présentaient un profil tourbeux et organique vraisemblablement propice à leur conservation, dans lequel ont également été préservés des fragments de bois. Dans le cadre de la conservation préventive de ce mobilier, et en concertation avec le Service Régional de l'Archéologie (DRAC), un lavage doux à l'eau claire a été réalisé, afin d'éviter de désolidariser les éléments maintenus par le sédiment, les fils de couture, certainement d'origine végétale, ayant disparu. Avant leur conditionnement, des photographies ainsi qu'un inventaire ont été effectués. L'ensemble du mobilier a été ré-immergé dans des sachets sans oxygène, placés dans des boîtes hermétiques elles-mêmes regroupées dans des bacs opaques. Le tout est actuellement stocké dans une salle à atmosphère contrôlée, dont la température est maintenue à 18°C. Cet article repose uniquement sur les observations menées durant cette courte phase de post-fouille, l'attention ayant été portée sur la nécessité d'apporter un milieu de conservation le plus stable possible à ces objets dans l'attente d'un éventuel traitement chimique, sans lequel leur étude pourrait s'avérer destructive.

Description du corpus de cuirs

Ce corpus totalise 425 restes, et est composé de fragments de cuir aux caractéristiques diverses, qui semblent témoigner de la présence potentielle d'un ancien atelier de cordonnerie. Les éléments peuvent être déclinés en deux groupes, l'un se rattachant directement à des objets transformés, et l'autre se rapportant à la fabrication ou à la réparation de ces artefacts.

Deux chaussures quasiment complètes **(Figure 2)**, semblant provenir de deux paires différentes ont été découvertes. Il s'agit d'exemplaires de forme basse, constitués d'une empeigne semblant n'être constituée que d'une seule pièce de cuir, sur le dessus de laquelle sont insérés des lacets. Cette partie est cousue à une semelle par le moyen d'une trépointe, présentant des trous de piqûre. En revanche, aucun élément de garnissage (semelle d'usure) n'a été repéré durant les observations menées lors de la phase de post-fouille. Par ailleurs, 39 fragments de semelles ont été recueillis et permettent de distinguer des styles de fabrication différents, puisque l'on retrouve des formes arrondies, pointues ou incurvées **(Figure 3)**. Deux semelles d'enfants ont également été mises au jour. Certains de ces éléments présentent là encore les stigmates de coutures sur leur pourtour, et il est à noter qu'aucune d'entre elles n'est intacte, des traces d'usure, voire des perforations étant visibles sur tous les exemples. Huit modèles d'empeignes ou de tiges se rajoutent à ce lot, ainsi que trois lacets noués et cinq fragments de talons de chaussures, dont certains comprennent un bracelet sur leur partie supérieure. Ces quartiers présentent des indices d'affaissement, les cuirs étant repliés sur eux-mêmes. Le lot comprend de plus 21 trépointes, sur lesquelles les fantômes des fils de couture non conservés sont visibles grâce aux trous de passage du fil. Enfin, notons la présence particulière d'une lanière rectangulaire décorée de trois petites appliques tréflées en alliage cuivreux, et rivetées. L'éclat remarquable de ce métal lors de la découverte, lié aux conditions très favorables de sa conservation dans le sous-sol, s'est depuis altéré, et ce malgré les précautions mises en œuvre lors de son conditionnement.

L'aspect lié à la fabrication de ces objets est quant à lui illustré par la présence de nombreux éléments non transformés ou portant des marques de découpe **(Figure 4)**. Ainsi, 64 fragments de peau de dimensions variables ont été découverts. Les observations menées dans le cadre du diagnostic n'ont pas permis de déterminer l'espèce animale représentée. Par ailleurs, 167 rebuts de découpe ont été distingués et sont caractérisés par la présence en négatif de formes plus ou moins reconnaissables. A titre d'exemple, des formes triangulaires sont discernables sur certains fragments, indiquant certainement la découpe de pointes de semelles. Enfin, on dénombre un total de 115 lanières de cuir, qui paraissent également constituer des chutes de découpe traduisant cet artisanat.

Tous ces éléments, couplant la présence d'artefacts liés à la confection et à la réparation de chaussures semblent converger vers l'hypothèse d'un probable dépotoir se rapportant à l'exercice de la cordonnerie.

Figure 2 : Exemple de chaussure

Figure 3 : Fragments de chaussures

Figure 4 : Fragments comportant des marques de découpe

Conclusion

Ces premières observations, menées dans le cadre de la conservation purement préventive du mobilier dans ce contexte de diagnostic archéologique, demeurent encore à l'état de prémices. Une étude plus approfondie de ce corpus semble s'imposer, au regard de sa rareté, non seulement à l'échelle du département, où aucun élément de comparaison équivalent n'a été jusqu'ici repéré, mais également du territoire au moins régional. Ce travail complémentaire ne paraît en outre concevable que dans le cadre d'une stabilisation plus pérenne, considérant la fragilité actuelle du mobilier, difficilement manipulable. Il pourrait alors être envisagé de recueillir des informations complémentaires et précieuses, concernant la nature du cuir utilisé, les technique(s) de tannage mise(s) en œuvre, les modes de fabrication employés voire même la détermination d'une typologie comparative de ces éléments, afin de comprendre de manière plus précise les caractéristiques de ce mobilier.

Biographie

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Fur & skin
Fourrure & peau

L'organisation du Tri des Collections Naturalia : Raisons et Modalités de la Réévaluation et la Hiérarchisation des Collections d'Histoire Naturelle

Manon Legris

Résumé

La réorganisation des collections est l'un des enjeux non-négligeables dans l'actuelle réalité des muséums d'histoire naturelle français. Aujourd'hui, les accumulations du passé, en plus des nouvelles acquisitions, obligent certains muséums à repenser l'organisation de leurs collections afin de gagner de la place et de revaloriser leurs objets.

Actuellement, la pratique du tri dans les muséums dépend beaucoup du statut et de la provenance des objets. Il faut savoir que ces collections sont divisées en deux statuts principaux : les objets patrimoniaux, soumis à la législation relative au numéro d'inventaire, et le matériel d'étude, non contraint par cette législation.

Ces statuts sont donc plutôt définis par l'usage des objets qu'ont les chercheurs et professionnels des muséums.

Ces différentes destinations ont chacune un certain nombre de spécificités et problématiques propres comme les valeurs associées, la lisibilité, la législation selon le statut de l'objet et leurs limites d'application. Il conviendra alors de présenter les critères d'aide pour l'établissement d'une politique documentaire, et l'évaluation d'une collection. Enfin, un document sera proposé afin d'aider à évaluer les différentes issues pour un objet, à savoir : la conservation-restauration, la réorientation en matériel d'étude à valeur scientifique ou à valeur pédagogique et la destruction.

L'idée de cet article est de proposer un ensemble de solutions possibles, adaptable à chaque établissement. L'objectif n'est pas d'imposer une réponse unique à la question du tri, mais plutôt de présenter les différentes orientations envisageables.

Mots-clés

Evaluation des Collections, Histoire Naturelle, Taxidermie, Collection Patrimoniale, Matériel d'Étude, Matériel Pédagogique, Conservation-restauration, Conservation Préventive

Introduction

En premier lieu, il faut comprendre que le tri n'induit pas nécessairement l'élimination d'un objet. L'objectif du tri est de vérifier si les critères et valeurs attribués à un montage correspondent au statut attribué à l'objet, et ainsi, hiérarchiser les collections.

Sur le plan pratique, la réalisation du tri permet de gagner de la place dans les réserves, de proposer des collections en adéquation avec les besoins des chercheurs et du public, de faciliter la consultation des objets, d'optimiser la lisibilité et la compréhension des réserves, de simplifier le rangement et l'organisation.

Sur le plan de la conservation, l'organisation du tri est un temps pendant lequel on peut évaluer les collections et ainsi repenser les valeurs attribuées aux spécimens, évaluer leur état de conservation, leur potentiel d'utilisation, etc.

Il convient de préciser que l'ensemble des questions qui vont suivre ne peut être résolu par une seule compétence professionnelle ; la coordination et la communication entre les différents spécialistes sont primordiales afin d'adapter les réponses selon le type de collections et d'en assurer la bonne conservation.

Les valeurs

Tout d'abord, il est nécessaire de présenter les différentes valeurs que l'on peut associer aux naturalisations :

- la valeur patrimoniale et culturelle : les montages représentant une étape dans l'acquisition de notre culture.
- la valeur historique, toujours associée à la valeur patrimoniale et culturelle : les montages d'espèces disparues, les naturalisations anciennes, notamment

celles qui ont été documentées et/ou qui peuvent être recoupées avec les archives, révélatrices d'un moment, d'une époque, d'une technique, d'une vision.

- la valeur scientifique : incluant notamment les spécimens types[1], les montages d'espèces disparues, les spécimens dédiés à l'étude et la recherche.
- la valeur affective : certaines espèces nous fascinent naturellement plus que d'autres, ce qui est d'autant plus valable du point de vue du public. Cela inclut notamment les valeurs d'invitation au voyage et d'exotisme.

Les lois et réglementations

Dans un premier temps, il faut savoir qu'en France, les muséums d'histoire naturelle sont sous la double tutelle de l'Éducation nationale et du ministère de la Culture, ce dernier étant présent dans les régions grâce aux Directions Régionales des Affaires Culturelles (DRAC). Si cette première tutelle ne donne pas d'obligation particulière, la seconde a pour but de protéger les objets en les inscrivant à l'Inventaire National du Patrimoine (INP). De cette double tutelle résulte la division des collections d'histoire naturelle en deux statuts principaux : les objets patrimoniaux et le matériel d'étude.

Le statut de matériel patrimonial et culturel, à valeur historique et/ou scientifique

Les objets concernés par ce statut sont obligatoirement inscrits à l'INP, ce qui induit un certain nombre d'obligations, dont celle de procéder à un récolement décennal[2]. Ce statut est attribué aux montages ayant une valeur historique, les spécimens types, les espèces disparues ou en voie d'extinction. Les objets concernés par ce statut sont sous la responsabilité du muséum et sont considérés comme des biens publics au titre du livre VI, titre II, chapitre 2 du Code du patrimoine.

Pour ces collections patrimoniales, le tri est justifié si le montage n'est plus identifiable (en tant qu'espèce ou dans une collection) et si l'objet ne fournit plus assez d'informations : cela rend alors difficile la justification de sa conservation, il est donc détruit. Cependant, ces collections sont soumises à la législation relative au numéro d'inventaire et les objets sont protégés. Ainsi, dans le cadre d'une destruction, il faut recourir à une procédure de déclassement au préalable et documenter l'élimination.

Le statut de matériel d'étude, à valeur scientifique

La note-circulaire du 19 juillet 2012 définit le statut de matériel d'étude mais n'a cependant pas de valeur légale, il s'agit plutôt d'une orientation pour la gestion des collections concernées :

« La notion de matériel d'étude ne correspond pas à une catégorie des collections des musées de France au sens du Code du patrimoine (Livre IV, titre V). La présente circulaire […] fournit un cadre à l'étude scientifique, l'analyse patrimoniale, la gestion pratique et juridique des matériels qui nécessitent une étude pour en définir la destination (entrée en collection, utilisation comme matériel pédagogique ou scénographique, élimination…), ainsi que les conditions de suivi des études menées par le musée. »[3].

Finalement, ces règles et celles du matériel patrimonial et culturel sont assez similaires, mais les objets qui n'ont pas le statut patrimonial permettent d'avoir une plus grande marge de manœuvre pour leur gestion. Ce statut de matériel d'étude est généré par des équipes de recherche (les objets concernés sont sous leur responsabilité) et permet ainsi aux chercheurs d'effectuer des prélèvements sur les naturalisations en vue d'analyser l'ADN, d'étudier l'évolution, l'anatomie… C'est pourquoi, quand les chercheurs estiment qu'un spécimen ne présente plus d'intérêt particulier, ils demandent au muséum si l'objet peut être intéressant pour la muséographie ou la pédagogie, faute de quoi ils engagent la destruction.

Le statut de matériel d'étude, à valeur pédagogique

Il existe aussi une autre catégorie de statut de matériel d'étude, celle du matériel pédagogique. Il n'a pas de valeur légale mais est couramment mis en pratique dans les MHN. Ce matériel concerne les objets à vocation pédagogique (galeries des enfants, objets présentés dans les ateliers tactiles pour malvoyants, etc.) qui ont une durée de vie très courte due à la différence d'usage. Ce

[1] Spécimens de référence portant tous les critères permettant de décrire une espèce.

[2] Selon l'article L451-2 du Code du patrimoine.

[3] Note-circulaire du 19 juillet 2012 relative à la problématique des matériels d'étude et à la méthodologie préalable à l'affectation de certains de ces biens aux collections des musées de France.

type de matériel n'a donc pas de valeur patrimoniale ou scientifique et leur gestion n'inclut pas de restauration. Il peut éventuellement y avoir une réparation de l'objet, mais il serait trop coûteux d'engager une campagne de restauration par un restaurateur agréé, la réparation se fait alors plutôt en interne par les taxidermistes.

La Convention de Washington

Aussi, les MHN voient leurs collections soumises aux dispositions de la Convention de Washington sur le commerce international des espèces de faune et de flore sauvages menacées d'extinction, dite CITES.

Cette convention s'applique aux animaux et plantes protégés, qu'ils soient vivants ou morts mais aussi aux parties de ces spécimens (peaux, plumes, dents...) et aux produits qui en sont issus.

Ces lois et réglementations ont bien évidement pour but de protéger les objets, mais dans le cadre des muséums d'histoire naturelle, cela peut s'avérer contraignant si l'on veut réorienter un objet patrimonial par exemple.

Les statuts des objets sont donc plutôt définis par l'usage que l'on en fait. Considérer l'objet comme matériel d'étude permet de le consulter facilement, alors que les réglementations du Code du patrimoine et de la CITES visent la protection des objets de manière générale.

Cependant, nous allons voir que la réalité d'application de ces réglementations dans les MHN est à relativiser.

Lisibilité

Lorsqu'un objet patrimonial a perdu sa lisibilité (**Figure 1**) et qu'une restauration ne peut être envisagée, dans le cas par exemple d'une naturalisation tombée en poussière suite à une hydrolyse acide de la peau, on aperçoit alors les limites des réglementations du Code du patrimoine par rapport à la réalité des collections de sciences naturelles : l'objet est certes inaliénable, mais il n'a plus d'image, donc ne dispense plus d'information visuelle. Or, si un spécimen ou son phénotype[4] n'est plus identifiable, il convient de se questionner sur les raisons de son existence au sein d'une collection patrimoniale et d'envisager sa réorientation ou sa destruction.

Les phénomènes, comme la perte importante de lisibilité, obligent les muséums à réviser leurs collections et à envisager une nouvelle destination pour ces objets, ce qui est la définition même du tri.

Figure 1 : Cas d'une perruche à collier *(Psittacula krameri)* avant et après une infestation. On constate ici que l'absence de plumes rend le montage inexploitable. Fond blanc : © Bernard FAYE. Fond noir : © Manon LEGRIS.

Les différentes orientations

Nous allons maintenant étudier en détail les différentes orientations possibles pour un objet (**Figure 2**).

- La conservation-restauration : intervention de surface ou de structure. Effectivement, dans le cas d'un bien patrimonial, on tentera de stabiliser les altérations évolutives, de reconstituer les parties manquantes. En revanche, s'il s'agit de reconstituer la moitié du spécimen, cela n'a souvent pas d'intérêt réel et il faut estimer si le coût de la restauration vaut la peine d'être engagé. Selon les cas, les ressources matérielles, financières et humaines disponibles, il convient parfois mieux de réorienter le spécimen vers une destination d'étude ou pédagogique.
- La réorientation : La réorientation correspond à un changement dans l'usage des objets.
  - Réorientation en « matériel d'étude » à valeur scientifique : Elle permet la réalisation d'un certain nombre d'analyses scientifiques, contribuant ainsi à l'évolution des connaissances des sciences naturelles. Aussi, il convient de se demander si l'on conserve tout ou partie d'un même objet selon l'intérêt des éléments en présence, et si l'on conserve une partie, laquelle ? Quels sont les tissus optimum pour l'étude et l'analyse, sachant que les technologies évoluent vite, ce qui implique des changements de protocoles de prélèvement (quantité, localisation, technique de prélèvement…) ? Il faut aussi s'interroger sur la manière de les conserver et sur les ressources disponibles pour cette conservation. Ces questions doivent être étudiées de manière collégiale avec les scientifiques selon leur spéciali-

[4] La silhouette extérieure d'un spécimen.

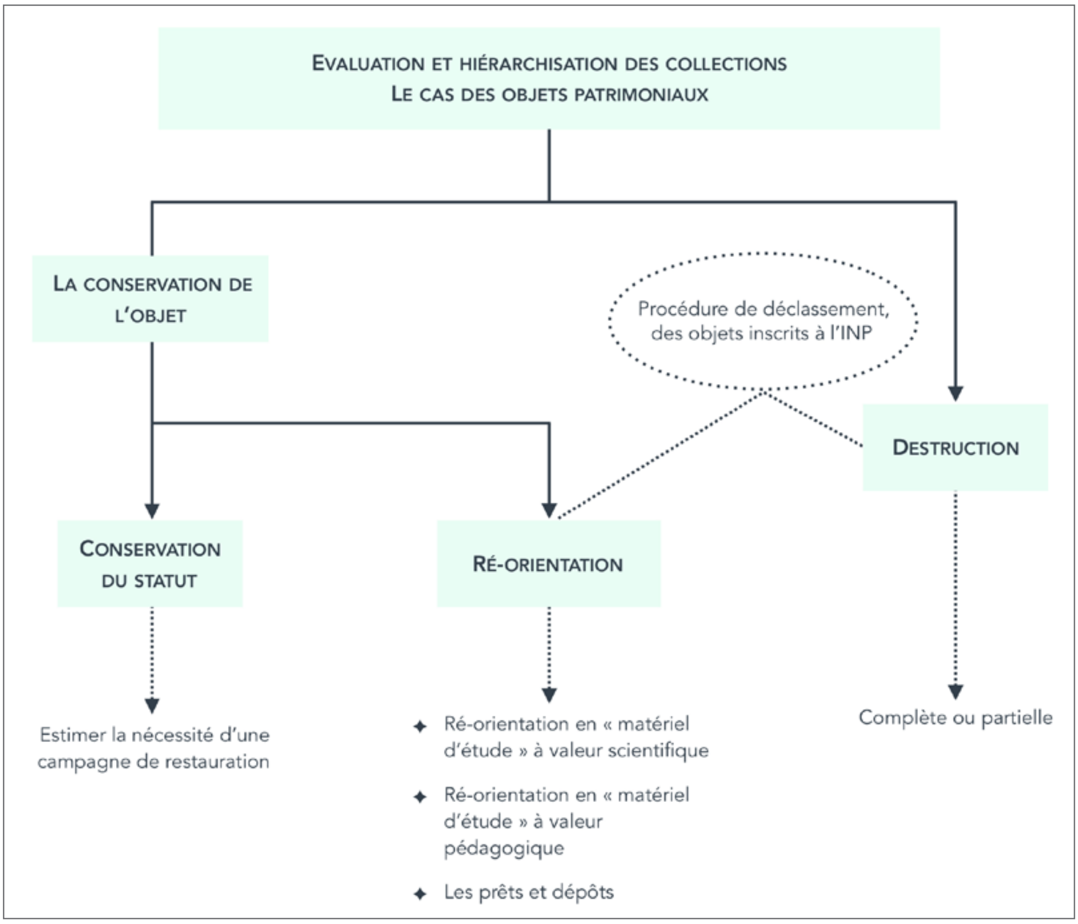

Figure 2 : Schéma des réorientations possibles pour les collections d'histoire naturelle. © Manon LEGRIS.

sation, et en fonction de la politique documentaire du muséum.

– Réorientation en « matériel d'étude » à valeur pédagogique : Les objets qui ne sont pas inscrits à l'INP et qui ne sont pas considérés comme matériel d'étude à valeur scientifique peuvent être envisagés comme matériel pédagogique. Bien que cette notion n'ait pas de valeur légale, beaucoup d'institutions la mettent tout de même en pratique. Cependant, pour le choix des spécimens à but pédagogique, il faut se documenter sur les réglementations environnementales (pour les espèces protégées par la CITES) et impérativement évaluer la toxicité (intrinsèque ou des produits résiduels de préparation et de conservation) selon les réglementations d'hygiène et sécurité en vigueur afin d'éviter tout risque d'empoisonnement.

- L'élimination ou la destruction de l'objet : Il convient de faire, en amont, un travail d'archives pour avoir toutes les informations relatives à l'objet. Ces informations permettent de justifier la destruction, l'élimination ou la conservation d'un objet et ces données associées sont absolument à conserver quelle que soit la destination de celui-ci. Cette documentation relative est d'autant plus importante si l'on veut déclasser un bien patrimonial. Si l'évacuation de l'objet est avalisée par la commission scientifique, l'objet pourra alors être éliminé, ou détruit. L'élimination d'un objet hors de la collection d'un musée implique son déclassement, ainsi que la vente ou le don de cet objet. Quant à la destruction d'un bien, qu'elle soit complète ou partielle, ce n'est pas un acte anodin. Souvent, les muséums prévoient un reliquat à conserver, or si l'établissement est confronté à un manque de place, détruire une partie des objets peut contribuer à régler ce problème. La destruction ou l'élimination peuvent donc être envisagées dans le cas d'un objet qui ne fournit pas ou plus assez d'informations, dont la perte de lisibilité empêche l'identification visuelle de l'espèce ou dont la manipulation est impossible, auxquels s'ajoutent des critères d'encombrement et de risques d'infestation. Si l'objet n'a plus de valeur pédagogique, scientifique, historique, muséographique, alors son évacuation est justifiée.

Limites

Cependant, la réalité d'application de ce protocole de destruction est limitée par la nature même des collections d'histoire naturelle. En effet, le ministère n'a pas pris en compte le problème des espèces couvertes par la CITES : si un montage de tigre du Bengale (*Panthera tigris tigris*) est inexploitable (effondré, fortement lacunaire, etc.), il n'a certes plus d'utilité mais le spécimen est couvert par l'annexe I de la CITES, qui est le plus haut degré de protection d'un spécimen. Pour l'instant, ce problème reste irrésolu.

L'autre problème est l'hétérogénéité des collections par les différents formats, matériaux intrinsèques et de mise en œuvre, usages, statuts, etc. Dans le cadre de la Conférence Permanente des Muséums de France sur le « Matériel d'étude et circulaire du 19 juillet 2012 dans les muséums », Nathalie MÉMOIRE[5] questionne vingt-et-un muséums de France sur le pourcentage de matériel d'étude dans leurs collections : les réponses vont de moins de 1% à 98% (Mémoire, 2014).

Aussi, le sens donné au terme « matériel d'étude » peut varier d'un muséum à l'autre. En effet, certains y comprennent « des accumulations non encore inventoriées mais composées d'éléments documentés (par étiquettes associées) » (Mémoire, 2014). Elles ne sont donc pas inscrites à l'INP, sont décrites succinctement et devront « sous deux ans faire l'objet d'un plan prévisionnel d'étude et d'analyse patrimoniale permettant d'effectuer le tri en vue de son affectation ». D'autres estiment ces accumulations comme des « «ensembles complexes» de matériel patrimonial » (Mémoire, 2014). Ces ensembles sont inscrits à l'inventaire national du patrimoine et doivent en suivre les réglementations. Cependant, certains ensembles sont dits « mixtes » car ils sont composés d'objets documentés et d'autres qui ne sont ni identifiés ni documentés.

Enfin, la parution tardive de la note-circulaire du 19 juillet 2012 fait que certains muséums ont déjà intégré à l'INP des ensembles qui auraient pu être dans la catégorie « matériel d'étude ».

Etablir une politique documentaire

Avant d'évaluer et hiérarchiser les collections, il convient d'établir une politique documentaire de conservation évolutive.

Cette politique documentaire peut s'établir dans un premier temps, selon ces différents critères, qui seront hiérarchisés en fonction de l'axe de communication choisi par le muséum et/ou le département concerné, en concertation avec les responsables de collection :

- Les missions du muséum : proposer une culture scientifique au public, faire rêver, inviter au voyage, faire découvrir des vocations (ateliers pour enfants), donner à comprendre l'importance de la nature et de ses lois qui régissent notre existence, aider à l'avancée des sciences naturelles, à la compréhension de l'histoire naturelle et de son évolution…
- Le public concerné : enfants, familles, naturalistes, chercheurs, passionnés, curieux
- La spécificité de ses fonds : plutôt historique ou scientifique
- Les ressources disponibles : budget, espace disponible, matériel, personnel formé…

Evaluer une collection : Objectiver et hiérarchiser les valeurs

Dans un deuxième temps, il convient d'évaluer les collections et de vérifier que leur statut et leurs valeurs soient toujours actuels, afin de hiérarchiser les collections. En effet, ne pas établir cette hiérarchie revient à ignorer le statut des objets. Or, il convient de se demander ce qu'il faudra évacuer en priorité en cas d'incendie ou d'inondation. Effectivement, il faut mettre la priorité sur les objets à statut patrimonial car leur existence se conçoit sur un temps le plus long possible.

Quant aux valeurs associées aux spécimens, il faut réussir à se dégager des valeurs affectives car ce sont celles qui changent le plus vite, étant relatives à la vision qu'ont les êtres humains selon les différentes époques et à la façon dont ils se positionnent par rapport à la nature. Aussi, toutes les parties d'un montage n'ont pas les mêmes valeurs : dans le cadre de l'étude, les phanères n'ont pas un intérêt capital mais il y a des éléments de référence comme le crâne, les pattes, un morceau de la peau, les dents, etc., qui peuvent être analysés et qui ont donc une valeur scientifique.

Voici des exemples de critères d'évaluation des collections d'histoire naturelle. Ces critères ne sont pas présentés dans un ordre hiérarchique, c'est la politique documentaire propre à chaque muséum qui définira ceux qui doivent être mis en avant.

[5] Conservateur en chef du patrimoine, directrice du MHN de Bordeaux.

- **la raret**é : des représentants de l'espèce vivante ou en conservation.
- **la fr**équence **d'utilisation** : étude, expo, prêts. Ce critère ne concerne pas les objets à statut patrimonial ni les spécimens types, mais plutôt le matériel d'étude et pédagogique, voir sans fonction.
- **l'incompl**étude ou l'**inad**équation : spécimen en connexion et complet ou lacunaire voire effondré.
- **l'état physique** : incluant la qualité de la naturalisation, l'état de conservation.
- **le statut officiel** : patrimonial, matériel d'étude, sans statut, spécimen couvert par la CITES ou non.
- **les valeurs passées, actuelles et le potentiel d'exploitation** : patrimoniale et culturelle, historique, scientifique, rareté.
- **l'intérêt du spécimen** : valeurs associées, spécimen type, espèce disparue ou en voie d'extinction, représentation des caractères phénotypiques et du taxon[6] de l'espèce, pertinence, technique de taxidermie.
- **la réputation** de l'auteur, de la collection.
- comment le spécimen **s'intègre à une collection** ou non.
- le niveau de **difficulté d'adaptation** du spécimen pour une exposition : selon l'attitude du spécimen ou la forme du socle, les possibilités de désoclage du spécimen, etc.
- **nombre de représentants** de la même espèce (incluant les mêmes critères), pouvant se substituer à ce montage.
- **la cohérence avec la politique documentaire** du muséum.
- **les conditions et les moyens** (financiers, matériels, personnels formés) de conservation, de stockage et éventuellement de restauration.
- **la corrélation avec de la documentation**, des archives photographiques, des journaux de voyage, etc.

Ainsi, pour justifier la ré-évaluation des statuts des objets, il faut déjà prouver qu'il y a un manque de place et pas seulement un besoin de faire un tri au sens organisationnel (par taille/format, famille, collectionneur, collecteur…) qui peut déjà libérer de la place selon l'organisation des réserves de l'institution.

La solution libérant un maximum de place est d'avoir toute la collection séparée et d'organiser les réserves par format (optimisation des espaces de réserve, choix des individus les plus représentatifs pour les expositions). Cependant, la conservation est plus importante que la consultation et l'histoire des objets. Si une collection représente un risque particulier, ce sera plus simple à gérer du point de vue de la conservation si l'ensemble n'est pas disséminé un peu partout dans les réserves. On peut donc imaginer une organisation des réserves selon le degré d'attention à porter aux objets. Les objets avec un statut patrimonial peuvent donc être regroupés dans des réserves où les conditions de conservation seront plus strictes que les réserves dédiées aux spécimens pédagogiques.

L'orientation plus ou moins muséale ou universitaire des muséums d'histoire naturelle, ajoutée à la diversité des matériaux présents dans leurs collections, ont permis de cerner l'objectif de cet article. S'il ne convient pas d'imposer une réponse unique à la question du tri, il est en revanche possible de présenter les différentes orientations envisageables, idéalement pour aider les différents établissements à organiser leur propre tri. Un document (**Tableau 1**) a donc pu être établi pour aider les muséums à hiérarchiser l'urgence des opérations et à organiser le tri, notamment lors du récolement décennal. Cette proposition d'évaluation ne tient pas lieu de document officiel, elle pourra cependant aider à compléter un dossier de demande de déclassement ou de destruction, et pourra être ajoutée à la documentation relative de l'objet ou ensemble.

Ce document permet de conclure en proposant, non pas une solution unique, mais des possibilités de réponses qui doivent être adaptées à la politique documentaire de chaque muséum.

Conclusion

En effet, dans ce sujet, tout est affaire de choix, à décider en consultation avec les différents spécialistes : l'organisation des réserves, la hiérarchie des valeurs associées aux objets, l'orientation du message du muséum, etc. Si certaines questions subsistent, nous espérons néanmoins que cet article pourra contribuer à l'organisation du tri dans les différents muséums, les modalités étant propres à l'orientation de chacun.

Cependant, si pour aujourd'hui les décisions se prennent à l'échelle des institutions et de leurs collections, il pourrait être intéressant d'envisager, à l'échelle nationale, une réunion des muséums afin de définir ceux à vocation universitaire et ceux à vocation muséale. Il serait

[6] Groupe d'organismes vivants possédant un certain nombre de caractères communs.

Tableau 1 : Grille d'aide à l'évaluation des collections d'histoire naturelle. © Manon LEGRIS.

DATE D'ÉVALUATION :
NOM DU RÉDACTEUR :
LIEU :

PHOTO DU SPÉCIMEN

Informations relatives à l'objet				
Identification	☐ Mâle	☐ Femelle	☐ Adulte	☐ Juvénile
	N° d'inventaire :		N° transpondeur :	
	Auteur :		Provenance :	
	Datation :		Localisation :	
Sujet/type de préparation	☐ montage naturalisé ☐ montage ostéologique ☐ mise en peau ☐ reliquat ☐ autre :			
Description	Dimensions, volume et empiétement :			
	Matériaux :			
	Attitude :			
	☐ Spécimen en connexion		☐ lacunaire	☐ effondré
	Socle : (type, matériaux, inscriptions)			
	Conditionnement :			
Réglementations et valeurs associées	Statut : ☐ patrimonial	☐ matériel d'étude à valeur scientifique		☐ pédagogique
	Spécimen couvert par la CITES :		☐ oui	☐ non
	Valeurs passées, actuelles et potentiel d'exploitation (justifier) : ☐ historique, ☐ patrimoniale et culturelle, ☐ scientifique, ☐ rareté, ☐ autre :			
Données relatives	Documentation, archives photographiques, anciens CE et rapports d'intervention, conditions de conservations passées, etc.			
Etat de conservation	*Joindre le CE, surtout en cas de déclassement et de destruction.*			
Pour les montages naturalisés				
Qualité de la naturalisation	Vraisemblance du montage, respect des volumes, phénotype, exactitude de la position des articulations, le niveau de précision des détails : détails musculaires et veineux, attitude.			
Utilisation du spécimen	Intérêt du spécimen : valeurs, spécimen type, espèce disparue ou en voie d'extinction, représentation des caractères phénotypiques et du taxon de l'espèce.			
	Fréquence d'utilisation : étude, expositions, prêts ou nombre d'années écoulées sans utilisation			
	Adaptabilité de l'objet : pour la consultation ou l'exposition			
Autres critères d'évaluation	Réputation de l'auteur, réputation de la collection, l'objet fait partie d'un ensemble ou d'une collection ou non, nombre de représentants de la même espèce pouvant se substituer à ce montage (incluant les mêmes critères), etc.			
Appréciation du rédacteur				
Conservation	☐ Oui	☐ Non		
	☐ Nécessité d'une intervention de restauration, si oui joindre le CE et les préconisations d'intervention. *Référencer les informations dans la base de données (avec un degré d'urgence de l'intervention).*			
Réorientation	☐ Oui	☐ Non		
	☐ Etude : *Référencer la nouvelle localisation dans la base de données* Déclassement : ☐ oui ☐ non Restauration : ☐ oui ☐ non			
	☐ Muséographie Déclassement : ☐ oui ☐ non Restauration : ☐ oui ☐ non			
	☐ Pédagogique Déclassement : ☐ oui ☐ non Restauration : ☐ oui ☐ non			
	☐ Prêts & dépôts : *nouvelle localisation, délais et les référencer dans la base de données* Déclassement : ☐ oui ☐ non Restauration : ☐ oui ☐ non			
Destruction	☐ Oui	☐ Non		
	Destruction de ☐ tout ou ☐ partie : quels sont les reliquats, nouvelle localisation, conditionnement et nouveau n° d'inventaire. *Renseigner dans la base de données toutes les informations relatives au spécimen, les critères de destruction, des photos avant destruction.*			
Elimination	☐ Oui	☐ Non		
	Si oui, coordonnées du nouveau propriétaire :			

alors possible d'aboutir à la séparation des collections patrimoniales et du matériel d'étude. Le fait de ne pas conserver ces différents types de collection au même endroit permettrait de faciliter la gestion de la conservation préventive et curative, l'organisation des roulements muséographiques ainsi que la gestion de l'accès et de la consultation des objets.

Une autre raison à cette scission est le problème de l'évolution rapide des technologies, qui a un impact direct sur les techniques de prélèvement (où, comment et en quelle quantité), combiné à l'évolution des connaissances scientifiques. Le résultat est qu'il y a sans cesse besoin de faire de nouveaux types d'analyses et échantillonnages.

Enfin, à force de vouloir tout préserver, nous nous confrontons à un certain nombre de problématiques, qui nous poussent à faire des choix si l'on veut assurer la conservation des objets : les collections d'histoire naturelle vont finir par disparaître si l'on veut tout garder sans s'assurer des bonnes conditions de conservation de chaque objet. La conservation de la matière est la raison même de l'existence de la taxidermie. Alors, afin de mieux conserver le patrimoine naturel, il est impératif d'effectuer un tri pour hiérarchiser les collections et pouvoir au mieux en préserver la matière.

Remerciements

Jamais je n'aurais pu imaginer pouvoir réaliser cet article sans la richesse des rencontres et des échanges tout au long de mon parcours universitaire. Je souhaite donc adresser mes remerciements les plus sincères à toutes les personnes qui ont pu contribuer à l'aboutissement de ce projet.

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Biographie

Diplômée du Master CRBC de l'université Paris 1 Panthéon-Sorbonne en 2018, **Manon Legris** se spécialise en conservation-restauration des Naturalia dès 2011 en réalisant un apprentissage de plus de deux ans sous la responsabilité de Christophe Gottini, Responsable de la plateforme taxidermie-restauration du Muséum National d'Histoire Naturelle. Elle apprend alors la naturalisation et les techniques anciennes et modernes de taxidermie. De 2014 à 2016, dans le cadre de la licence, elle réalise les travaux pratiques universitaires sous la tutelle de Jacques Cuisin, Délégué à la conservation du MNHN. Il lui enseigne la gestion des collections, l'étude des matériaux présents en muséums et leurs altérations, l'évaluation des collections, etc. Des stages pratiques réalisés au Musée du Quai Branly - Jacques Chirac ainsi qu'au Muséum d'Histoire Naturelle de Toulouse compléteront ces enseignements. Restauratrice indépendante, elle a notamment travaillé pour le Musée Calvet à Avignon et le Quai des Savoirs à Toulouse.

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Fur and Skin Processing in Prehistory: An Experimental Approach to Prehistoric Tanning Technologies

Theresa Emmerich Kamper, Linda Hurcombe

Abstract

The importance of skin processing technologies, in the history and dispersal of humankind around the planet cannot be overstated. Tanning technologies can be hard to identify and yet the knowledge is both archaeologically useful and can be used to inform the conservation and ongoing curation of the artefacts. This presentation outlines a systematic analysis methodology targeted at this specific material type, with the goal of determining the tanning technologies in use during prehistory, from extant archaeologically recovered processed skin objects. The methodology is a product of macroscopic and microscopic observations of a sample reference collection containing over 200 samples. These were used to produce a database of defining characteristics and tendencies for each of six tannage types; wet and dry scrape brain tan, bark tan, alum taw, urine tan and rawhide. The sample collection is made up of twenty-two economically important species from both Europe and North America, as well as a collection of well used clothing and utilitarian items, made from traditionally processed skins. This research has demonstrated that archaeologically preserved objects made from processed skin can provide information about the tannage technologies in use prehistorically, as well as more detailed information such as manufacturing sequences and the conditions of use to which the object was subjected. A case study of material from the Bronze Age site of Whitehorse Hill, Devon, UK will be presented. The organic finds recovered include at least four items that incorporate animal products. One is a complex artefact of nettle fibres (Urtica dioica) and processed skin sewn together into a linear textile. The tanning technologies determined using the methodology were able to inform reconstructions of some of the items from the site for the flag ship museum exhibit of this exciting set of artefacts.

Keywords

Prehistoric Leather, Fur, Skin Processing, Hides, Tanning Technology, Experimental Archaeology

Introduction

Prehistoric artefacts of processed skin are amongst the rarest of finds but in the USA where one of the authors was raised, the process of tanning is still part of traditional knowledge. Dr Theresa Emmerich Kamper's background as a traditional tanner led her into academia to research the time depth of this ancient skill. Her study showed that though archaeological leather was being researched, a standardized method for identifying early period tannage technologies was not available. What was needed was a systematic way to distinguish prehistoric tannage technologies so that their time-depth and distribution could be better understood. The approach she developed combines extensive archaeological research and over 25 years of the author's personal tanning experience (Kamper, in press). Prof Linda Hurcombe researches prehistoric artefacts and experimental archaeology and takes a special interest in perishable material culture which she terms 'the missing majority' (Hurcombe 2007, 2014). The present paper is a combination of their complementary interests in establishing methodologies for better understanding those rare remains that do survive and presenting this information to curators and conservators. The authors are actively researching collections where this approach might prove useful and a brief overview of the methodology and of a case study are given here to raise awareness of the possibilities for this kind of research.

The processing of animal skins into wearable or utilitarian material is an overlooked and underappreciated technology, which was of the utmost importance in the day-to-day lives of ancient peoples. Whilst much has been written on skins, fur and leathers, most of the available literature has either focused on topics other than how the skin was processed, or on the more recent tanning technologies which better adhere to the parameters for modern definitions of leather (Cameron, 1991; Popa and Kern, 2009; Reed, 1972; Schaffer, 1974; International Council of Tanners, 1968; van Driel-Murray, 2000; Bazzanella, 2005; Calnan, 1991; Calnan and Haines, 1991; Chahine, 1991; Goubitz, 1984; Hollemeyer et al., 2008; Strzelczyk et al., 1997). This article, in contrast, emphasises the older, more consolidated skin processing technologies. Thus, this research defines skin processing as 'the preservation and manipulation of animal skins to prevent decay and produce a material which is suited to its required task'.

While this technology played a central role in the livelihood of prehistoric peoples, early evidence of tanning can be difficult to discern. In many areas, variations of fat and smoke tanning technologies were used – a method that leaves little physical evidence behind other than the rare instance where we find the processed skin itself. Though the preservation of processed skin in an archaeological context is rare, it is found often enough to provide a reasonable array of examples from which to theorise about how, when and where various tanning technologies arose and were disseminated around the world. These existing examples of processed skin items provide a unique opportunity to investigate this set of complex and diverse technologies. At present, the analysis of these finds is often descriptive, giving good information on dimensions, appearance, stitching and patterning, as well as thoughts on what the item may have been when in use. In many cases, analysis is hampered by the fragmentary state of the finds, and, while important, archaeological skin products often have an appearance which can discourage interest and research in the subject in favour of more visually appealing artefacts.

This research aims to fill this gap in information by providing a systematic and standardized method of analysing and discussing these technologies using commonly available technology, alongside extensive and systematic reference collections, as a method for differentiating between past tanning technologies (van Driel-Murray, 2002a; Groenman-van Waateringe, 1999). It provides a simple, accessible and inexpensive way to add to the collective knowledge of skin processing technologies and informs curators about archaeological and ethnographic tannage technologies, allowing them to make more informed decisions on best practice.

Overview of the methodology

This methodology could only be developed and then supported using a large comparative data set. It employs observations of an extensive sample reference collection, both macroscopic and microscopic, to produce a database of defining characteristics for six tannage types;

- Rawhide
- Fat/Oil Tan (Wet Scrape)
- Fat/Oil Tan (Dry Scrape)
- Urine Tan/Treatment
- Vegetable Tan
- Alum Taw

The primary collection contains 22 key species identified as economically important from both Europe and North America.

1. **Bighorn Sheep** (*Ovis canadensis*)
2. **Bison** (*Bison bison)*
3. **Black Bear** (*Ursus americanus*)
4. **Coyote** (*Canis latrans*)
5. **Elk** (*Cervus canadensis)*
6. **Mule Deer** (*Odocoileus hemionus*)
7. **Pronghorn Antelope** (*Antilocapra americana*)
8. **Exmoor Pony** (*Equus ferus caballus*)
9. **Fallow Deer** (*Dama dama*)
10. **Galloway Cow** (*Bos primigenius)*
11. **Roe Deer** (*Capreolus capreolus*)
12. **Red Deer** (*Cervus elaphus*)
13. **Soay Sheep** (*Ovis aries)*
14. **Toggenburg Goat** (*Capra aegagrus hircus*)
15. **Wild Boar** (*Sus scrofa*)
16. **Badger** (*Taxidea taxus)*
17. **Beaver** (*Castor Canadensis*)
18. **Dog** (*Canis lupus familiaris*)
19. **Red Fox** (*Vulpes vulpes*)
20. **Moose** (*Alces alces*)
21. **Rabbit** (Sylvilagus sp.)
22. **Reindeer** (*Rangifer tarandus*)

A secondary collection of clothing and utilitarian items, made from traditionally processed skins, was included to add 'in-life use' traces to the database. These behavioural characteristics are included as part of the methodology because they were found to be specific to tannage type. They are set in place during the object's use life, therefore, post depositional changes such as over-tannage from bog interment affect this set of characteristics very little.

The skin processing was done using (61 × 61 cm) squares from each species split up into six, (20 × 30 cm) pieces. One piece per species was tanned using each of the six tanning methods. The samples were tanned with the hair on or off, or both depending on what was commonly done traditionally with each species. A total of 22 samples formed the reference collection. The species and tannage technologies were chosen within a set of geographical and chronological parameters. The geographic parameters encompassing North America, the United Kingdom and Europe were used to narrow the species targeted for the sample collection to a large but manageable number. The time frame bracketing these areas is based in part on the existence of well-dated hide artefacts, some of which fall outside the geographic boundaries for the research but prove that hide artefacts can survive from very early periods. As such, the chronological boundaries include the Mesolithic (with some species being pertinent to the Palaeolithic, as there is indirect evidence for clothing from images and tools from the Upper-Palaeolithic (Cook, 2013: 22-23, 61-62, Hayden, 2002) in the hope that the sample collection will stay relevant to any future items found which date significantly earlier. Due to the Roman's heavy use of the vegetable tanning process and their well-documented methods for producing it (Reed, 1972: 90-91; Thompson, 1982: 143; van Driel-Murray, 2002b: 261), the upper end of the time frame for the research ended with the Roman Expansion and the assumption that large scale vegetable tanning followed in their wake (van Driel-Murray, 2000: 299; 2001: 185; 2002b: 252). As this occurrence varies across the region, so too did the upper time limit placed on the research.

The method was tested against both archaeological items from a variety of preservation contexts, and ethnographic items from museum collections across North America and Europe. This analysis confirmed that defining characteristics do exist between the primary tannage technologies, and that at least some defining characteristics survived in all preservation contexts. These can be recorded at multiple levels of observation, and often provide insight into small sections of the artefact's production sequence and life history.

This research is detailed in Kamper, 2020 (in press with Sidestone Press) and shows definitively that processed skin items from vastly different preservation contexts can provide a wealth of information about prehistoric tannage technologies, as well as information on manufacturing sequences and the conditions of use an item experienced. The method is a valuable analytical tool for those involved in conservation, curation or analysis of archaeological or ethnographic skin products. It provides a consolidated source of information for artisans working with traditional tanning, or re-enactors interested in the history or science of skin products. Finally, it serves as an example of the targeted use of experimental archaeology in a large-scale research project.

Whitehorse Hill as an archaeological case study

The overview of the site is based on the excavation publication (Jones 2016). The excavation of the Whitehorse Hill cist burial took place in 2011 as the site was threatened by erosion. The cist was located on Dartmoor, a high moorland region in the southwest of Britain. Radiocarbon dating of the grave goods places the burial in the Early Bronze Age, 1730-1600 cal BC (Jones 2016:ix). The excellent preservation of a surprising amount of organic material was due to the burial's location in a peat rich area. Once the significance of the remains was appreciated a block of material was lifted and micro-excavated in a lab revealing some unique objects (Williams 2016). Dr Theresa Kamper saw the material prior to full conservation but after initial cleaning by Helen Williams at the Wiltshire and Swindon History Centre, at which time she was given permission to study the material as a case study within her PhD. Prof Hurcombe later studied this material closely in conjunction with Fiona Pitt, curator, Plymouth City Museum and Art Gallery in order to make a replica of the composite textile panel as part of an exhibition of the material in 2014 and as part of her research on *Touching the Past* funded by the AHRC (Pitt and Hurcombe 2017). Further replicas are currently being prepared as part of a more permanent exhibition. The exceptional finds include a tin, shale, ceramic and amber necklace, a copper alloy pin and a layer of purple moor grass, a bear pelt, a plant and hidework composite textile panel (**Figure 1**) a braided cattle hair and tin stud bracelet or armband and wooden ear studs, and a lime bast coil basket with decorative cattle hair over stitching (Jones 2016). Several of the finds are totally unique such as the hair armband or bracelet and the composite plant and hidework textile panel (Sheridan et al. 2016; Cameron et al 2016) and the set as a whole is an exceptionally rich assemblage of objects precious at the time of their deposition and even more so to archaeological research today.

Figure 1. The composite textile containing nettle fabric, decorative hide work elements and a section of unknown material. © T. E Kamper

Both plant and animal materials are preserved but there are still some elements missing. The focus here is on the prehistoric hidework finds which offer the chance to think through the tanning technologies of the extant skin items using the methodology outlined above and interweave information suggested by the differential preservation resulting in some elements, such as the thread of the textile panel not surviving. The following overview of the analysis of the material using the tanning technology identification method shows a range of information can be drawn out here in addition to the published reports (Cameron and Mould 2016, Cameron et al 2016).

The analysis presented here focussed on the extant hidework among the finds and recorded detailed data as well as microscopic and macroscopic pictures of the decorative processed skin elements. The pieces of processed skin incorporated into the construction consisted of two lines of folded welts (decorative strips of hidework which can also be described as beading), and a row of small triangles (**Figure 2**). The pieces of skin were dark brown in colour, with a fuzzy flesh side, which showed defined fibres and a tight structure. The pieces were still pliable, but too small and fragile to adequately test stretch. The skin pieces were very thin with a range of 0.5mm to 1mm in thickness. The grain comprised from 10% to 15% of the dermal thickness. Both calf skin and deer have a similar grain to mid-dermis ratio (Haines, 2006). The grain layer was intact and, based on the absence of all but a few hair roots, most likely intentionally dehaired. The grain side was smooth, with a fine pattern still showing moderate topography, but with almost no visible hair follicles. Of the few hairs found, all had solid shafts, ruling out the Cervid family from the species which could have been used to produce the processed skin. The few hairs observed were oriented in different directions on adjoining triangles and welts: a further indication that the skin was intentionally dehaired, as opposed to losing the hair post-depositionally. Had it originally been constructed from hair-on skin, it would have made for an odd-looking piece with the different triangles having hair pointing in a variety of directions.

Figure 2. Folded welts and decorative triangles of calf skin. © T. E Kamper

The orientation of the textile as a whole in relation to the points of the triangles is unknown.

They each have two tiny holes for tacking the tips down to the layer of unknown material. This could have been to keep them flat if they pointed up, or just to keep them neatly in place during the item's use, if they pointed sideways or down. The material to which the triangle's tips are attached is now largely gone. It has no discernible fibre structure. As the plant element of the composite textile survives, the missing element is unlikely to be plant-based. Furthermore, the stitching material is no longer visible in the textile panel though the holes from the stitching still remain. The dermal tissue of the bear skin is also missing. One explanation for this differential preservation would be the different treatments of the skins. The decorative calfskin is the best preserved. Cow skin has a tight dermal structure and in adults the skin is thick. For calfskin, the dermal structure is still tight but the skin is easier to process and the thinner skin would be easier to sew and work into a composite panel. The detailed microscopic analysis of distinguishing characteristics, alongside behavioural characteristics such as edge and hole morphologies indicate that the skin from which the decorative elements were made was originally vegetable tanned. This designation also helps to explain why these processed skin elements survived while other animal product items did not. The implication is that the base layer could be from a less well tanned hidework element.

Exceptional preservation conditions for both plant and animal remains, micro-excavation in the laboratory, and exceptional conservation skills, have all allowed the authors to apply the technique for investigating these pre-industrial tannage technologies to offer interpretation and insight into these rare hidework finds. The greater awareness of this characterisation approach, drawing on broad sets of experimental data, will provide better information to archaeologists, curators and conservators responsible for further investigations and ongoing curation and preservation of artefacts which give a deep time perspective on traditional tannage technologies.

Conclusions

This research aimed to devise a method of analysing simple tannage technologies so that their usage could be better documented. The extensive experimental reference collection presents a platform for this method which provides a simple, accessible and inexpensive way to add to the collective knowledge of skin processing technologies. The archaeological case study shows how it can be applied to an archaeological example. The method can be used to inform curators and conservators about archaeological and ethnographic tannage technologies, allowing them to make more informed decisions on best practice and adds to the existing tools available to those studying hide artefacts. Even in exceptional preservation conditions the relative deterioration of organic substances may vary according to their processing in life and precise condition on burial. Photographs of different details may be essential to specialists trying to understand the artefacts later. Detail shots of all the surfaces (different materials and top and bottom surfaces), close-up side views of the edges or sections of the different parts of the artefacts will be important and details of stitching may be of great significance for a detailed identification. Early consultation with a specialist could provide information that would aid the conservation process as was the case with the White Horse Hill burial goods. The authors welcome contact from curators and conservators with collections that may benefit from this approach.

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Biographies

Dr. **Theresa Emmerich-Kamper** is an avid practitioner of traditional living skills. She has tanned skins using traditional technologies for over twenty-five years. She holds a MA in Experimental Archaeology from the University of Exeter, and a PhD on the microscopic analysis of prehistoric processed skin artefacts. She interned with the Smithsonian National Museum of Natural History, co-authoring the article 'Modelling scale and variability in human-environmental interaction in Inner Asia' in *Ecological Modelling*. During the Openarch project, she was heavily involved in experimental work and public demonstrations at archaeological open-air museums, helped deliver an international workshop, and co-authored a chapter in *Lifecycle of Structures in Experimental Archaeology: an object biography approach* with Sidestone Press. Dr. Emmerich-Kamper is currently an honorary research fellow with the University of Exeter, teaching tannage technology courses across Europe, North America and the Near East, and engaging in research projects with many museums and academic institutions.

Professor **Linda Hurcombe** specialises in prehistoric material culture, functional analysis and experimental approaches. During her PhD on microwear analysis of obsidian tools she learned to knap and conducted experiments with stone tools on a range of materials, leading to her wide interests in artefacts. On joining Exeter University, she set up the MA in Experimental Archaeology in 2000, the first course of its kind in the world. A former Head of Department, she has published many articles and books on topics such as *Archaeological Artefacts as Material Culture* and *Perishable Material Culture in Prehistory: Investigating the Missing Majority*, both with Routledge. She often works with museums in the UK and abroad and her research spans the use of animals and plants as the raw materials for crafts all the way through to their performance qualities in life and the best means to present these issues to the public.

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Leather Dressing: The Conservation of Leather and Fur in Fashion

Marina Kastan Hays

Abstract

This paper defines the conservation challenges particular to fashionable garments made from leather (and related materials) and offers concrete suggestions for their treatment. The degradation of the kinds of leather used for fashion objects—in particular, chrome-tanned leather—is discussed, and the need for further research in this area is emphasized.

Keywords

Fashion, Chrome-tanned Leather, Coated Leather, Nanocollagen, Hair-on Cowhide, Reptile Skin, Loss Compensation, Textured Fills

Introduction

There is a considerable body of literature on leather conservation techniques, but very little has been published on the conservation of Western-style garments made from leather and related materials. This paper aims to address this deficiency by focusing on the challenges of and solutions for conserving fashionable dress objects made from various types of leather. These differ in key ways from other artifacts constructed using these same materials. For example, most skins used for garments are tanned with chrome, and they may be coated or otherwise treated in ways not commonly seen in leather used for other purposes. Furthermore, current curatorial approaches to exhibiting fashion require that conservation treatment of these objects consider their stability and appearance in equal measure.

Treatment methodologies used in the conservation of books, upholstery, archaeological or ethnographic artifacts, and other objects made from leather and related materials can and should be employed by conservators of fashionable dress. Case studies describing the conservation of two garments from the collection of the Metropolitan Museum of Art's Costume Institute—a hair-on cowhide coat and a jacket made from a patchwork of reptile skins—serve as examples of how methods developed and used by conservators in various specialty areas may be adapted and used in the treatment of fashionable garments made from leather and fur.

Leather and related materials in fashion

Though the words costume, dress, and fashion are sometimes used interchangeably, there are significant differences between them. As fashion conservator Sarah Scaturro has written, "while all three [words] refer to objects worn on the body, 'costume' is an older and outdated term conjuring historic, ethnographic, and theatrical garments, while 'dress' is a safe, generalized designation for bodily adornment and its associated material practices. 'Fashion' is more loaded; implying adornment made and consumed in a system that privileges irrational change" (Scaturro, 2016).

Because novelty is an essential element of fashion, the range of materials from which fashion objects are made is virtually infinite. With regard to leather, this means endless variation in the way that skins are processed, as well as the materials that leather is combined with, and the ways that they are joined. The Costume Institute's collection contains many garments that illustrate the kind of experimentation with materials that the fashion system encourages. One such example is a dress designed by John Galliano for Dior in 2006 **(Figure 1)**, made from small squares of crocodile leather adhered to silk tulle (Metropolitan Museum of Art, 2003.438). In formulating a treatment plan for this garment, a conservator would have to take into account the requirements of the leather, the silk, and the adhesive used to bond the two; as well as other factors, such as the need to preserve the drape of the material.

Figure 1: Dress, John Galliano for Dior, 2006. Crocodile skin adhered to silk tulle. Metropolitan Museum of Art, 2003.438.

Even the leathers used for more basic designs are fundamentally different than those used for other kinds of museum artifacts. For example, most leathers used to make garments have been sprayed with clear or pigmented plastic coatings to hide imperfections and give their surfaces a more uniform appearance (Sterlacci, 2010). Conservators must investigate the nature of these coatings, which have varied chemical makeups, and consider how they might be affected by elements of treatment such as heat, moisture, or solvents.

Even more significant, though, is the question of tannage. Conservation literature suggests that most of the leather museum conservators encounter is vegetable tanned (see, for example, Larsen, 2008). Fashion conservators, however, work primarily with chrome-tanned leather, which is used for garments for several reasons. Because the amount of chromium needed to tan a hide is small relative to the amount of vegetable material that tanning requires, chrome-tanned leather is less full at the interfibrillar level (Haines, 1977). As a result, it is softer, more flexible, and stretchier, which are generally desirable qualities for a garment material. However, chrome-tanned leather can be too soft even for some garments, so a wide range of substances may be introduced to fill the leather, making it firmer. Paraffin, greases, cellulose, glucose, and barium sulphate were used for this purpose in the early twentieth century (Bowker and Geib, 1925). Now, synthetic tanning agents, called syntans, are used (Covington, 2000). Again, the presence of these added elements complicates the work of the conservator.

Another reason that chrome-tanned leather is commonly used for fashion objects is its exceptional hydrothermal stability. With a shrinkage temperature around 100º Celsius, chrome-tanned leather can withstand dyeing and other post-tanning processes that leather of other tannages cannot, allowing for a nearly infinite range of aesthetic effects. The high hydrothermal stability of chrome-tanned leather may be one reason for a widespread but erroneous belief that chrome-tanned leather is more or less impervious to degradation.

Deterioration of chrome-tanned leather

Objects in the Costume Institute's collection provide evidence that leather tanned with chrome can and does deteriorate. One such example is a one-of-a-kind coat from 1963, made from hair-on cowhide with mink fur appliqué (**Figure 2**; Metropolitan Museum of Art, 1979.570.1). The coat was a collaboration between the New York-based furrier and art collector Jacques Kaplan (1924-2008) and the artist Maria Sol "Marisol" Escobar (1930-2016), who used oil paints to render a life-sized female nude on the front and back of the garment. When worn, the wearer's head and legs would appear to be those of the body in the painted image, an effect that is simultaneously witty and unsettling. This wholly unique object is an important document of the experimental fashions of the 1960s and the crossovers between the fashion and art worlds at that time.

Figure 2: Coat, Jacques Kaplan (designer) and Marisol (painter), 1963. Hair-on cowhide, mink fur, and oil paint; rayon viscose lining. Metropolitan Museum of Art, 1979.570.1.

Unfortunately, the condition of the coat had prevented it from being exhibited for decades. The hair-on cowhide is severely degraded, with little structural integrity. The overall weakening had led to extensive tearing, and the grain and hair layer was flaking off. The leather was analyzed using an x-ray fluorescence (XRF) spectrometer and proved to be chrome tanned. This result was surprising, as conservation literature tends to emphasize the exceptional durability of chrome-tanned leather (see, for example, Fogle, 1984). In fact, the degradation of chrome leather is simply less studied and less well-understood than that of vegetable-tanned leather, especially within the field of conservation.

The chemical degradation of leather is not a single, linear process. Deterioration may be caused by oxidation, hydrolysis, or a combination of the two, depending on the type of leather and conditions under which it is stored (Thomson, 2006). Furthermore, there may be a number of different kinds of hydrolytic or oxidative action that impact different parts of the leather's chemical structure. Some factors affect crosslinks between molecular units, reducing hydrothermal stability, while others affect fiber cohesion, resulting in a loss of mechanical strength (Seligsberger and Mann, 1978).

Chrome-tanned leather, like all leather, may undergo both oxidation and hydrolysis. However, the precise nature of these degradation reactions may differ depending on tannage. The results of GCMS analysis before and after accelerated aging show that the changes in amino acid distribution in chrome-tanned leather differ from those of vegetable-tanned leather (Larsen, 1994). Similarly, chrome- and vegetable-tanned leathers show different correlations between age-related losses in tensile strength and quantity of nitrogen degradation products, suggesting variation in the mechanisms of deterioration (Hannigan, Naghski, and Windus, 1965).

Furthermore, environmental factors impact chrome-tanned leather differently than they do leather of other tannages. Vegetable-tanned leather degrades rapidly in moist heat, while chrome-tanned leather withstands warm, humid conditions relatively well. The reverse is true of dry heat. In experimental conditions meant to approximate a desert environment, chrome-tanned leather lost 45% of its bursting strength within 3 years, while vegetable-tanned leather lost only 10% (Seligsberger and Mann, 1978). This has significant implications for conservation treatments where dry heat is used, for example to reactivate adhesives.

Vegetable- and chrome-tanned leathers, though, are similarly affected by acidity. Most conservators are familiar with the acid hydrolysis of vegetable-tanned leather that leads to the condition commonly known as red rot. One major cause of red rot is sulphur dioxide, which is readily absorbed from polluted air by condensed vegetable tannins and subsequently converted into sulphuric acid (Haines, 1977). Chromium does not have the same affinity for sulphur dioxide that tannins do, but chrome-tanned leather that is exposed to polluted air does show an increase in sulphuric acid content, suggesting that some reaction with sulphur dioxide has taken place. Increased acidity, whether it results from the formation of sulphuric acid or other factors, causes chrome-tanned leather to undergo hydrolysis, leading to breakdown of the collagen and a significant loss of mechanical stability. One real-time aging experiment found that chrome-tanned leathers stored for 36 years in an urban library lost an average of 70% of their tensile strength during that time (Hannigan, Naghski, and Windus, 1965).

The viscose rayon lining of the painted coat and the acid-free tissue that had been used to pad it for storage had both been dramatically discolored, suggesting that acidity was the primary cause of the coat's deterioration **(Figure 3)**. Indeed, the pH of the leather—measured by extraction—was just under 3, which is the point at which leather begins to catastrophically break down (Calnan, 1989). The chrome-tanned hair-on hide, then, was suffering from something very like red rot.

Figure 3: Viscose rayon lining of the painted coat (Metropolitan Museum of Art, 1979.570.1), discolored from contact with acidic leather.

Holistic treatment of deteriorated chrome-tanned leather

A number of holistic treatments for acid-deteriorated leather exist, including application of resin or cellulose ether consolidants, exposure to ammonia vapor or use of buffer salts to raise pH, and re-tanning with aluminum alkoxide. However, each of these have documented downsides or limitations (Lama et al., 2015; Bicchieri et al., 2018). Recently, conservators at the Leather Conservation Centre in Northampton have had good outcomes from treatment of vegetable leather with a mixture of aluminum alkoxide and oxazolidine II, but the latter component acts by reacting chemically with tannins and is therefore unlikely to be an effective treatment for chrome-tanned skins (Lama et al., 2015).

A recently-developed treatment consisting of application of electrochemically-synthesized nanocollagen seemed to the author to be the most viable possibility for treating degraded chrome-tanned leather. Bicchieri et al. (2018) found that 0.7 mg/ml nanocollagen in a 70:30 solution of isopropyl alcohol and deionized water effectively penetrated degraded leather well and bonded with the existing protein, resulting in increases of both tensile strength and shrinkage temperature and some restoration of flexibility. Furthermore, they observed no adverse visual effects, such as darkening of the leather. To determine whether this treatment might be used on the painted coat, an effort was made to reproduce the results of the published experiment using small pieces of leather that had flaked off the surface of the garment. Because of a lack of access to the equipment needed to synthesize nanocollagen, a commercially available 100% pure nanocollagen powder was used instead. Unfortunately, application of the solution made using this powder resulted in an immediate, dramatic, and permanent color change in the leather **(Figure 4)**. The reason for the disparity between this result and the positive outcomes of the previous experiment is unclear. Possible causes include differences between the purchased and synthesized forms of the nanocollagen and differences between the tannage or condition of the leathers used in the tests. Continued efforts to replicate the positive results of the published experiment are needed.

Figure 4: Small pieces of the grain layer of the painted coat (Metropolitan Museum of Art, 1979.570.1). Left: untreated. Right: Treated with nanocollagen (0.7 mg/ml) in a 70:30 solution of isopropyl alcohol and deionized water.

Treatment case studies

Until a viable holistic treatment for deteriorated chrome-tanned leather is found, fashion conservators will have to focus their efforts on addressing the results of deterioration rather than attempting to reverse or slow the deterioration itself. In the treatment of fashion objects, aesthetics are a matter of great importance. At the Costume Institute, conservators are of course concerned with the long-term preservation of the objects in their care, but are equally dedicated to ensuring that those objects "appear … as close to the fashionable ideal as possible" (Scaturro and Fung, 2017). If a garment's condition is such that its appearance does not match the intentions of its designer or maker, it can no longer be understood as an authentic document of fashion history. Attempts to mitigate the visual effects of deterioration, for example, by loss compensation, are a very important element of treatment.

Accordingly, the treatment plan for a jacket designed in 1970 by Norma Kamali (**Figure 5**; Metropolitan Museum of Art, 1987.265) was developed with equal consideration for the object's stability and the designer's aesthetic intentions. The jacket is made from a patchwork of reptile skins and suede, joined with a bright orange zig-zag stitch. The visible stitching draws attention to the piecing, giving the jacket a DIY ("do-it-yourself") appearance that reflects the anti-establishment spirit that defined society, politics, and fashion at the end of the 1960s.

That zig-zag stitching, then, is an essential element of the garment's design. In many areas, the leather had torn along the seam line, having been weakened by the perforations made by stitching **(Figure 6a)**. Because the stitches go through both the leather and an interlining material (which remained intact), it wasn't possible to insert support patches beneath the tears. An overlay was

Figure 5: Jacket, Norma Kamali, 1970-71. Reptile skins and suede; synthetic lining. Metropolitan Museum of Art, 1987.265.

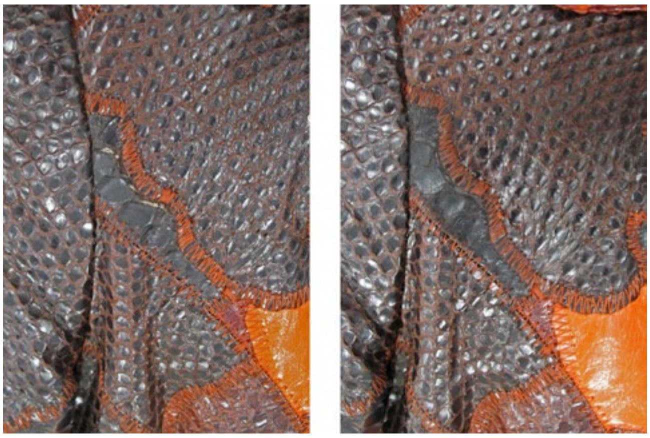

Figure 6a, b: Proper right front chest of Kamali jacket (Metropolitan Museum of Art, 1987.265), before (left) and after (right) treatment.

required, but it was important that the material used not obscure the stitching below.

An initial attempt was made to consolidate the tears using lightweight Japanese paper that had been "optically cleared" by applying Plextol B-500, an acrylic polymer adhesive (Williams, 2018). Though nearly transparent, the cleared paper still appeared too light against the black leather. The results achieved with tinted papers were also unsatisfactory, as sufficiently saturated color rendered the paper too opaque. A far more satisfactory result was achieved using silk crepeline, which is commonly used as a supportive or protective material for textiles. Crepeline is a very lightweight and sheer but dimensionally stable fabric that retains its transparency even when dyed to match bright or darkly colored objects. A 15% concentration of Lascaux 360 and 498 (1:1) was painted onto the crepeline, which was then allowed to dry on a piece of silicone-release Mylar. Overlays were cut to shape and put in place with the side that had dried against the Mylar in contact with the leather. The adhesive was reactivated using a heated spatula. This effectively consolidated the tears without impacting the legibility of the stitching or the texture of the skin **(Figure 6b)**.

The jacket also had a small area of loss on one shoulder where the scales of a piece of python skin had delaminated, and the deteriorated leather beneath had torn away **(Figure 7a)**. The leather in the surrounding area was weak and required consolidation. In developing a treatment plan, the importance of the varied textures of the different leathers to the jacket's design was a consideration. It was decided that an infill should be made to match the python skin as closely as possible. This was accomplished using a technique for fabricating textured fills developed by book conservators Sarah Reidell and Grace Owen-Weiss. Their method consists of making a mold from a surrogate material with a similar texture to that of the object—in this case, faux snakeskin fabric made from PVC—then casting a thin fill from acrylic media backed with Japanese paper (Reidell, 2018). Before applying the fill, a piece of rayon lens tissue toned with acrylic paint was inserted underneath the python skin and adhered with Beva 371 film (25.4 microns thick) to support the weak leather around the tear. The lens tissue extended to cover the area of loss so that it served as a base to which the textured fill could be adhered. A heated spatula was used to soften the edge of fill so that it lay flush with the adjacent leather. The results **(Figure 7b)** were very satisfactory; this technique has many possible applications in fashion conservation, not just for leather objects.

The Kaplan/Marisol painted coat also required infills in areas where the leather had crumbled, leaving holes

Figure 7a, b: Proper right front shoulder of Kamali jacket (Metropolitan Museum of Art, 1987.265), before (left) and after (right) treatment.

Figure 8: Infill for painted coat (Metropolitan Museum of Art, 1979.570.1) made from layers of water-cut Uso Mino paper, tinted with acrylic paint.

Figure 9a, b: Proper left back shoulder of the painted coat (Metropolitan Museum of Art, 1979.570.1), before (left) and after (right) treatment.

(Figure 9a). These areas were first backed with Cerex and Beva 371 film. The initial treatment proposal suggested that losses could be filled with new hair-on cowhide, pared extremely thin. However, all commercially available modern hair-on hides were chrome-tanned and had the characteristic blue tint that this tanning method imparts. This made them a poor visual match for the coat leather—which was also chrome tanned, but had yellowed with age. Instead, infills were made by layering water-cut Japanese paper and brushing out the long fibers so that they resemble hair **(Figure 8)**—an idea that must be credited to Yvette Fletcher at the Leather Conservation Centre. For each fill, a piece of Uso Mino paper (12 gsm) was tinted with acrylic paint, cut to the precise shape of the loss, and adhered with 6% Klucel G in ethanol. This served to further consolidate the crumbling leather and formed a base layer on top of which additional pieces of toned paper were layered. The result **(Figure 9b)** was a good visual match for the coat material, which will allow museum visitors to see past the deterioration of the object and focus instead on its artistic merit.

Conclusion

In recent years, the idea that fashion objects indeed do have artistic merit has become much more widely accepted, and as a result fashion is becoming increasingly present in museums. Conservators will face new challenges in caring for these objects, which are made from enormously varied and often unfamiliar materials, and which have unique and particularly demanding requirements for display. As a profession, we will need to dedicate time and resources to developing a better understanding of how materials such as chrome-tanned leather degrade. At the same time, we must continue to look for innovative solutions to ensure that our treatments not only extend the life of fashionable garments, but also allow them to be seen as their designers intended them to be. My own treatment approaches have been heavily inspired and informed by the work of conservators in many different specialties, and I believe that this is the key to success going forward—indeed, not just for fashion, but for artifacts of all kinds.

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Materials

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Lens tissue (100% rayon): Legion Paper, 38 E. 32nd St., New York, NY, 10016, legionpaper.com

Nanocollagen 100: Magnus, 22301 S. Western Ave. Suite 104, Torrance, CA, 90501, magnususmaerica.com

Silk crepeline, Uso Mino paper (12gsm), Usuyo gampi paper, Lascaux 360 and 498, Plextol B-500, and Beva 371 film (1 mil/25.4 microns): Talas, 330 Morgan Avenue, Brooklyn, NY, 11211, talasonline.com

Biography

Marina Hays is a textile conservator with a particular interest in the history and conservation of fashionable dress. She is currently the Mellon Fellow in Textile Conservation at the Denver Art Museum in Denver, Colorado. From 2017 to 2019 she was the Polaire Weissman Fund Fellow in Conservation at the Metropolitan Museum of Art's Costume Institute. She holds a Master of Arts in Fashion and Textile Studies with a concentration in Conservation from the Fashion Institute of Technology and a Master of Library and Information Science from Pratt Institute.

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La Conservation-Restauration des Collections de Peaux, Cuirs et Matériaux Associés au Musée du Quai Branly - Jacques Chirac

Stéphanie Elarbi, Clothilde Castelli, Elsa Debiesse, Astrid Gonnon

Résumé

Le musée du quai Branly - Jacques Chirac conserve une collection de près de 340 000 objets provenant de quatre continents, constituée majoritairement de matériaux organiques. Les peaux, cuirs et matériaux associés représentent plus de 18 000 items identifiés à ce jour. Cet article présente les pratiques retenues par le musée du quai Branly - Jacques Chirac pour la préservation de ces collections spécifiques, par le biais de trois études de cas. La présentation du traitement curatif d'une rare armure de Patagonie en peau de guanaco soulignera la nécessité de différencier les traces d'usage des dommages postérieurs que présentent un tel objet et les choix de conservation qui en résultent. Un projet de présentation de la collection sibérienne de robes et accessoires en peau de salmonidé montrera comment les caractéristiques de ce matériau, révélées par une étude approfondie et une identification des espèces, ont permis de guider les traitements de conservation-restauration. Enfin l'étude technologique et les interventions menées sur quatre anoraks inuits en intestins de phoques détailleront comment l'accès retrouvé à ces objets s'accompagne d'une connaissance matérielle améliorée.

Mots-clés

Cuir, Peau, Conservation-restauration, Armure, Robe, Anorak, Salmonidés, Intestin

Introduction

Depuis son ouverture en 2006, le musée du quai Branly - Jacques Chirac conserve une collection de plus de 340 000 objets ainsi que de 700 000 documents graphiques et photographies, provenant d'Afrique, d'Asie, d'Océanie et des Amériques. Ces objets, constitués majoritairement de matériaux organiques, présentent une exceptionnelle variété de peaux, cuirs et phanères. Composés en partie ou en intégralité de ces matériaux, plus de 18 000 items ont été identifiés à ce jour. De typologies très diverses, leurs mises en œuvre comme leurs fonctionnalités interrogent les modalités de préservation.

Comment adapter un traitement de conservation-restauration à la spécificité d'un objet ou à la cohérence d'un corpus ? Quelles options retenir pour la gestion de cette collection hétérogène en réserves ? Quels dispositifs de présentation imaginer pour assurer la lisibilité et la conservation optimale de ces objets lors d'une exposition ?

Cet article présente, au travers d'études de cas, les pratiques retenues par le musée du quai Branly-Jacques Chirac pour assurer la préservation de ces collections. L'ensemble des traitements évoqués a été mené par des conservateurs-restaurateurs prestataires[1], en collaboration avec le pôle de conservation-restauration et les responsables de collections du musée.

Une collection plurielle

La diversité des objets étudiés se traduit de multiples façons, en premier lieu par les espèces représentées. Afin de garantir la conservation et la circulation des collections, dans le cadre de la C.I.T.E.S. (Convention sur le commerce international des espèces de faune et de flore sauvages menacées d'extinction du 3 mars 1973)[2], le musée du quai Branly - Jacques Chirac a mis en place un travail d'identification des matières animales impliquant différentes collaborations entre institutions

[1] Groupement Etnologia : Alexandra Bouckellyoen (Mandataire), Camille Alembik, Alice Flot, Stéphanie Legrand-Longin, Claire Musso, Julie Nives Nivou, Mélanie Pichaud, collaboration de Leslie Veyrat pour le mannequinage.

[2] https://www.cites.org/fra/disc/text.php

patrimoniales ainsi que des techniques d'exploration innovantes : microscopie numérique en 3D Hirox, Microscope Electronique à Balayage et scanner. Si la majorité des espèces exploitées sont des mammifères d'élevage, la particularité de la collection se révèle au travers des innombrables espèces sauvages identifiées : mammifères de toutes tailles, terrestres ou marins, poissons, oiseaux, reptiles et batraciens.

Les parties anatomiques exploitées sont principalement externes (peaux, fourrures et phanères), mais aussi internes : tendons et parois du système digestif (intestin, estomac et péritoine). Les mises en œuvre, étroitement liées aux ressources et aux traditions locales, vont de préparations sommaires à des processus de tannage complexes, impliquant des propriétés très disparates pour les cuirs et les peaux. Séchage, tannage ou parchemin, les techniques de préparation sont multiples et bien souvent hybrides. Rarement analysés jusqu'ici, elles sont connues principalement par le biais de sources documentaires ethnographiques, récits de voyages et photographies.

Les peaux brutes, peu ou pas transformées, sont utilisées comme vêtements ou parures, comme contenants, comme éléments d'ameublement ou comme attaches et courroies. A l'inverse, les peaux façonnées, découpées et assemblées, sont employées pour des costumes et accessoires complexes et souvent associées à d'autres matériaux tels que le bois ou les métaux pour des figures de théâtre d'ombre, des marionnettes ou des jouets par exemple. Enfin, ces peaux peuvent aussi être tendues sur cadres ou structures pleines pour des instruments de musique, des embarcations ou comme revêtements luxueux pour des objets divers : armes, harnachements, boîtes ou éléments mobiliers.

Les objets peuvent recevoir des finitions et des décors plus ou moins élaborés : coloration par teinture, peinture ou laque, mise en forme par tressage, découpe, ajours ou encore décors gravés, appliqués ou brodés. Mises en œuvre et finitions sont intrinsèquement liées aux fonctionnalités et aux usages, quotidiens ou rituels.

Cette extraordinaire diversité fait écho aux états de conservation très variables de ces objets, dépendant également de leurs contextes de collecte ou d'acquisition et de leurs vies muséales.

L'établissement d'un bilan précis de l'état de conservation des cuirs et peaux est limité par le caractère composite et hétérogène de ces objets. Cependant, l'évaluation des collections tend à confirmer une plus grande stabilité des peaux tannées face aux attaques biologiques, contrairement aux peaux séchées qui semblent y être particulièrement sensibles. De même, certaines typologies telles que les peaux en tension ou les fourrures, présentant des altérations récurrentes liées à leur grande sensibilité aux variations thermo-hygrométriques, font l'objet d'une vigilance accrue et sont très régulièrement inspectés lors de campagnes de veille sanitaire en réserves comme en exposition.

La diversité de la collection interroge également les principes de conservation-restauration retenus pour assurer la préservation d'objets issus de quatre continents et relevant de fonds archéologiques, d'objets rituels ou de productions contemporaines. Les degrés d'intervention établis émanent d'une démarche qui s'attache à définir les objectifs de la conservation-restauration en considérant les fonctionnalités des objets traités. Ces fonctionnalités sont relatives aux contextes de production et d'usages, comme à la biographie des objets dans les collections patrimoniales.

Les trois exemples présentés illustrent ces choix : l'intervention minimale sur un unique objet, le traitement curatif d'un corpus complet en vue de sa présentation, puis la restauration de la lisibilité d'un ensemble en péril.

Conservation curative d'une armure Tehuelche de Patagonie : intervention minimale

Cette armure[3] unique dans les collections, est entrée au musée de la marine du Louvre par le biais d'un don de M. Grandidier en 1863. On trouve sa trace dans l'inventaire du musée de Saint-Germain-en- Laye, elle aurait été rapportée en France par Dumont d'Urville. Les autres exemples connus sont aujourd'hui conservés au National Museum of the American Indians, Washington DC, au Musée d'Histoire Naturelle de Santiago du Chili et au musée de la Plata en Argentine.

Réalisée en peaux de guanaco[4], l'armure est constituée de deux pans assemblés par couture et de manches rappor-

[3] Numéro d'inventaire : 71.1909.22.1 D

[4] Les premiers inventaires mentionnent du cuir de bœuf tandis que l'armure conservée au National Museum of the American Indians est faite de peau de cheval

tées. Chacun des pans est composé de huit couches de peau superposées (**Figure 2**) et de trois couches pour les manches, l'ensemble pesant 13,9 Kg. L'armure est ornée de pigments ocre rouge et d'une bande centrale en réserve cernée de deux lignes noires. L'encolure est bordée de trois rangées de clous métalliques et de lanières de peau (**Figure 1**).

Figure 1 : Cuirasse Tehuelche de Patagonie après restauration – 71.1909.22.1 D. ©Musée du quai Branly - Jacques Chirac. Photo Claude Germain.

Figure 2 : Détail des couches de cuir de la cuirasse Tehuelche – 71.1909.22.1 D. ©Musée du quai Branly - Jacques Chirac. Photo Alexandra Bouckellyoen.

Etat de conservation

Une altération spectaculaire affecte le pan avant de l'armure : une importante lacune traversant les huit couches de peau, combinée à des déchirures multiples, fragilise considérablement la structure de la cuirasse. Les contraintes mécaniques imposées par le poids de l'objet en interdisaient toute présentation. Cette éventration est-elle une altération relative à l'usage de l'armure, portée pour la guerre équestre (Gonzalez, 1972), ou doit-elle être qualifiée de dommage postérieur survenu durant les vies institutionnelles de l'objet ?

Pour tenter d'y répondre, une enquête a été menée dans la documentation des collections, augmentée d'examens de l'armure. Une documentation photographique de 1966 montre l'objet avec cette même altération[5], mais ni la documentation des collections ni la littérature ne font mention de cette altération ou de son origine (Gonzalez, 1972).

L'examen rapproché de l'altération révèle une dégradation de la peau en périphérie de la lacune, la présence d'auréoles, la trace de plis présente sur la zone ou encore l'aspect étagé de la lacune affectant les différentes couches. Ces observations étayent l'hypothèse d'un contact prolongé avec un liquide stagnant dans l'armure pliée, occasionné par un dégât des eaux en contexte muséal. Par ailleurs, des résidus de microorganismes ont été identifiés sur la partie dégradée. Cependant, cette hypothèse n'étant basée que sur l'observation matérielle, sans confirmation possible par d'autres sources, le choix d'une intervention minimale a été retenue. Celle-ci visera à stabiliser les couches de peaux fragilisées en périphérie de la lacune, à consolider les déchirures sans restitution des parties lacunaires.

Traitement de conservation-restauration

A l'occasion d'une modification muséographique sur le plateau des collections permanentes, le projet de présentation de l'armure a motivé une réflexion sur son traitement, alliant intervention de conservation-restauration et soclage. L'armure a dans un premier temps été nettoyée mécaniquement par gommage (gomme en latex vulcanisé, Smoke sponge®), le résultat obtenu est resté visuellement modéré. Les tests de réactivité des couches de peaux à l'eau ont permis une remise en forme suivi d'une consolidation. Les bords des déchirures déformés ont été remis en forme par humidification localisée avec un nébuliseur ultrasonique puis séchage lent sous poids. Ces dernières ont été consolidées par doublage au papier japonais 100% Kozo (17 g/m^2), privilégié pour sa résistance mécanique et sa stabilité physico-chimique à long terme, et d'un copolymère d'acétate de vinyle et de maléate de dibutyle (Mowilith DMC2), choisi pour sa

[5] Collection Iconothèque – Musée du quai Branly-Jacques Chirac, tirage argentique n°PP0118733, anonyme

transparence, son pouvoir d'adhésion élevé et sa haute flexibilité. Afin d'améliorer la cohésion de la partie altérée et de permettre une exposition verticale sur support, les différentes couches de peau ont été liées par des ponts à l'aide de charnières de papier japonais et d'adhésif de même nature.

Une forme interne ajustée à l'armure apporte également un soutien mécanique à la partie altérée, elle permet le soclage du vêtement sur une structure métallique tubulaire. Ce traitement qualifié de minimal dans son degré d'intervention peut ne pas être considéré comme tel car il pose le parti pris d'une empreinte visuelle forte dans la perception de l'objet. Il a par ailleurs nécessité un temps de traitement important dévolu à la stabilisation et à la consolidation de la peau, mais autorise une retraitabilité facilitée lorsque des informations complémentaires sur l'origine de cette altération pourront être apportées.

Traitement curatif d'un corpus en peaux de salmonidés : étude et présentation

Présentée à l'automne 2015, l'exposition *Esthétiques de l'Amour* (Cevoli et al., 2015) a impulsé une campagne de conservation-restauration d'un corpus de seize vêtements et accessoires en peaux de poisson (robes, bottes et sacs), caractéristiques des populations Nivkh et Aïnou vivant dans le bassin de l'Amour et dans l'île de Sakhaline, en Sibérie Extrême-Orientale **(Figure 3)**. Traditionnellement réalisés en peau de salmonidés, souples et imperméables, ces objets sont utilisés à des fins cérémonielles ou comme protection contre les intempéries.

Figure 3 : Robe Nivkh de Sibérie après restauration – 71.1934.15.105 D. ©Musée du quai Branly - Jacques Chirac. Photo Patrick Gries/Valérie Torre.

Afin d'établir un degré de mise en état de conservation et de présentation homogène et concerté, une étude préalable a été menée afin de détecter la présence de résidus de pesticide et de s'en protéger, d'identifier les espèces de salmonidés employés et de comprendre leur mode de préparation produisant des peaux plus ou moins claires, souples, lisses, pour enfin établir les patrons des vêtements, leurs modes d'assemblage et la stratigraphie des décors en appliqués.

Etude technologique

Les poissons sont au cœur de l'économie et de l'artisanat des populations vivant sur les rives de l'Amour. Deux espèces de salmonidés, le saumon du Pacifique (*Oncorhynchus keta*) et le saumon bossu (*Oncorhynchus gorbuscha*), la carpe de l'Amour (*Cyprinus rubrofuscus*), deux espèces d'huchos, trois de redfins, le kalouga, les esturgeons de l'Amour et de Sakhaline et le brochet de l'Amour ont pu être identifiés lors de l'étude technologique des objets considérés. Les critères définis pour procéder à ces identifications des espèces ont été la taille et la forme des pièces de peau, le grain de la peau après écaillage (s'il est particulier et facilement reconnaissable, comme le galuchat), et le motif des écailles lorsqu'il a été préservé à l'issue de l'étape de préparation[6].

Une fois débarrassées de leur chair, ces peaux sont obtenues par corroyage (macérées dans l'eau et l'urine, puis battues, lissées) et séchées. Leur blancheur dépend aussi des conditions climatiques au moment du séchage (Rajagopalan, 2014). Leurs décors sont constitués de bandes de peaux teintes avec des colorants d'origine végétale et minérale ou peintes à l'aide de pochoirs en écorces de bouleaux, ciselées ou découpées, puis cousues ou partiellement collées (probablement à la colle de poisson) (Musso, 2015).

Etat de conservation

Les objets[7] traités durant ce projet datent de la seconde moitié du XIXe siècle et début du XXème siècle. Leur coupe est proche de celle des robes mongoles et mandchoues du XIXe siècle, s'ouvrant devant sur le côté dextre et de forme évasée. Cette typologie de vêtements est celle des manteaux de fête et de noces (Naseka, 2015).

6 L'identification des espèces a été menée par l'ichtyologue Pascal Deynat, rapport interne musée du quai Branly-Jacques Chirac

7 Numéros d'inventaire : 71.1899.76.95, 71.1899.76.127, 71.1934.15.105 D, 71.1962.11.1, 71.1966.46.3, 71.1966.46.4, 71.1966.46.5, 71.1966.46.6

Ce corpus présentait des altérations majoritairement mécaniques : plis et déformations liées à d'anciennes présentations **(Figure 4)** et modes de stockage inadaptés, d'anciennes infestations, massive pour le manteau aïnou **(Figure 5)**, ainsi que des affaiblissements structurels (coutures rompues ou défaites). Les lacunes et les déchirures observées, évolutives, étaient susceptibles de s'aggraver lors des manipulations. Par ailleurs un empoussièrement et un encrassement assez hétérogènes ont été constatés sur certains vêtements.

Figure 4 : Vitrine « Ghiliak, vêtements » du Musée d'Homme en 1947. ©Musée du quai Branly - Jacques Chirac. Laboratoire photographique du Musée de l'Homme. Photo Roger Chuzeville.

Figure 5 : Manteau Aïnou de l'île de Sakhaline avant restauration – 71.1899.76.95. ©Musée du quai Branly - Jacques Chirac. Photo Claude Germain.

La peau des poissons, contrairement à celle des vertébrés terrestres, ne présente pas d'épiderme, mais une couche de glandes muqueuses contenant peu de cellules kératineuses, leur conférant une forte sensibilité aux rayonnements lumineux (Florian, 2007). De plus, la température de dénaturation de ces peaux est inférieure à celle des mammifères, variant de 38 à 45°C pour les poissons d'eaux froides à 50-56°C pour ceux des eaux chaudes, une différence liée au différent taux d'hydroxyproline contenu dans le collagène (Florian, 2007). Ce phénomène est accru par leur mode de préparation, exempt de tannage à proprement parler. Or, suite à leur vieillissement, les chaînes peptidiques subissent des dégradations physico-chimiques qui induisent notamment un abaissement de leur température de dénaturation. Ces peaux peuvent donc être particulièrement sensibles à l'eau et ce, même à température ambiante. Celle-ci peut provoquer une forte rétraction et une coloration jaune irréversible (processus de gélatinisation du collagène).

Traitements de conservation-restauration

En amont de la remise en forme, les peaux ont été dépoussiérées puis nettoyées mécaniquement par gommage (gomme en latex vulcanisé, Smoke sponge®), les faibles frottements directionnels s'adaptant au sens des reliefs des écailles, sans laisser de résidus.

Puis la remise en forme a été réalisé progressivement par humidification localisée, à l'aide de membrane Sympatex® et de tissu Sontara® imprégnés d'une solution eau déminéralisée/éthanol (en proportion 70 : 30, v/v.). Considérant la forte sensibilité à l'eau des peaux, l'apport d'humidité a été contrôlé afin de prévenir la formation de taches jaunes et une rétraction irréversibles. Des tests de sensibilité des teintures et peintures à l'eau et à l'éthanol ont été préalablement menés avant afin d'éviter leurs dégorgements.

Une fois suffisamment assouplies, le séchage progressif des peaux a été réalisé sous poids et par mise en tension contrôlée, à l'aide d'aimants, de pinces, de formes internes, avec interface de papiers buvard **(Figure 6)**. Les déchirures ont été consolidées par doublage à l'aide de papier japonais Kozo préalablement teinté à la peinture acrylique (Liquitex®) et encollé avec un adhésif vinylique PVAc en base aqueuse (Jade 403®). Ce système a été choisi pour sa faible épaisseur, sa flexibilité et sa résistance aux contraintes mécaniques. Afin d'éviter que la part aqueuse de l'adhésif ne tache la peau, il a été laissé sécher quelques instants avant d'être appliqué sur la peau. L'avantage de cet adhésif est de combiner un bon pouvoir adhésif à un séchage assez rapide (Cevoli, 2006).

Enfin, des supports de conservation et de présentation pérennes ont été conçus en concertation avec le responsable de collection et une spécialiste de la présentation des collections de mode, valorisant la dimension esthétique de ces pièces. Ces formes internes réalisées sur mesure en mousse de polyéthylène (Plastazote®) couverte de ouate de polyester et gainée de toile décatie écrue **(Figure 7)**, permettent de présenter les vêtements sur mannequin tubulaire comme de les conserver en forme en réserves dans des boites de conservation, limitant les manipulations directes des objets.

Figure 6 : Botte Nivkh de Sibérie en cours de remise en forme – 71.1966.46.10.1-2. ©Musée du quai Branly - Jacques Chirac. Photo Etnologia.

Figure 7 : Manteau Aïnou de l'île de Sakhaline et son dispositif interne de présentation et de stockage – 71.1899.76.95. ©Musée du quai Branly - Jacques Chirac. Photo Etnologia.

Sauvegarde et accès à un ensemble d'anoraks en intestins de phoque

Parmi les nombreux objets en matériaux insolites des collections figure un ensemble de vingt-deux anoraks en membranes intestinales de mammifères marins datant du XIXe siècle, provenant d'Alaska et du Groenland. Quatre anoraks présentaient un état de dégradation extrême allant jusqu'à une perte totale de lisibilité et d'identification. Certains, pliés en quatre et extrêmement rigides, ne présentait plus la physionomie d'un anorak et à ce titre, la conformité à l'inventaire ne pouvait être validée. Les quatre pièces ont bénéficié d'une intervention de restauration accompagnée d'une étude technologique complète[8].

Etude technologique

Cette étude (Alembik, 2010) a permis d'identifier en amont les matériaux constitutifs du corpus (couche de sous-muqueuse d'intestins), de documenter leur technologie de fabrication (spécificité des intestins « blanchis » ou « intestins d'hiver ») et leur assemblage (identification de six points d'étanchéité en fils d'aponévrose de muscles). Les espèces les plus utilisées pour la production d'anoraks se comptent parmi les cétacés, les phocidés et les pinnipèdes (Alembik, 2010).

De forme fermée, l'anorak s'enfile par la tête et est réalisé selon un patron en T s'évasant vers le bas. Il se porte par-dessus d'autres vêtements de fourrure. Sa fonction pratique est de protéger des conditions météorologiques extrêmement rigoureuses de l'Arctique. Lorsqu'il est humide, l'organisation spécifique des fibres de collagène apporte à ce matériau à la fois élasticité et résistance à la traction. A l'instar des tissus « respirants » contemporains, tels que le Gore-Tex®, il est imperméable à l'eau liquide mais favorise l'évacuation de la sudation et de la vapeur d'eau. La paroi du système digestif donne ces propriétés d'étanchéité et de respirabilité du matériau grâce à ses capillaires qui, se rétractant à la mort de l'animal, permettent un échange unidirectionnel entre le bol alimentaire et le sang (Sáiz Gómez, 2014). Selon les croyances des Inuits, cette protection serait aussi d'ordre spirituel, à l'encontre des mauvais esprits (Hickman, 1987)[9].

Etat de conservation

Ces anoraks présentaient des altérations mécaniques importantes : de nombreux plis, des déchirures, de fortes déformations liées à un processus de raidissement et des lacunes issues d'anciennes infestations d'insectes kératophages, **(Figure 8)**. Les objets étaient également fortement empoussiérés, encrassés et tachés pour certains. Ces dégradations sont dues pour partie à un ancien mode

[8] Les anoraks traités portent les n° d'inventaire : 71.1905.33.33, 71.1905.33.123, 71.1943.0.229, 71.1943.0.7 X Am

[9] Hickman, 1987, p.9

de stockage inadapté, notamment un pliage des anoraks et une absence de soutien mécanique. L'ensemble de ces dégradations menaçait non seulement la préservation à long terme de ces objets mais empêchait aussi la compréhension, l'étude et la présentation du corpus.

Figure 8 : Anorak inuit d'Alaska avant restauration – 71.1905.31.123. ©Musée du quai Branly - Jacques Chirac. Photo Etnologia.

Traitement de conservation-restauration

La restitution de la morphologie et du volume des anoraks a été possible grâce à un traitement de remise en forme progressif par humidification contrôlée en enceinte. Un traitement localisé par compresses n'était pas adapté au matériau car il risquait de créer des contraintes hétérogènes sur la membrane. Afin d'éviter les variations hygrométriques répétées, l'intervention a été réalisée dans une grande enceinte imperméable, permettant à la fois de laisser les objets en atmosphère humide constante (maintenue autour de 90% d'humidité relative) et aux restauratrices de travailler à l'intérieur de l'enceinte. Le taux d'hygrométrie a été contrôlé grâce à un nébuliseur ultrasonique placé à l'intérieur de la tente et de capteurs d'humidité relative. Le volume des anoraks a été progressivement restitué par l'utilisation de contre-formes temporaires en film PVC thermo-soudées placées à l'intérieur du vêtement puis gonflées à l'aide d'un aspirateur souffleur réversible (Elarbi, 2015).

Un nettoyage de la surface et des zones jusqu'alors masquées par les déformations a pu être mené parallèlement à la remise en forme et révéler l'aspect translucide des membranes. En premier lieu, un gommage a été réalisé à l'aide d'éponges cosmétiques sèches, puis un nettoyage physico-chimique a été mené à l'aide de Conservators Sponge® imprégnées d'une solution d'eau/éthanol (en proportion 70 : 30, v/v). Les critères de sélection du solvant étaient : la meilleure solubilisation possible du dépôt et la moindre interaction avec la membrane intestinale.

Les déchirures et trous d'envol de la membrane ont été stabilisés par doublage afin de restituer une cohésion du matériau et de permettre la manipulation sans risque des anoraks. Les doublages ont été réalisés à l'aide de papier japonais Gampi préalablement mis en teinte à l'acrylique (peinture acrylique Liquitex®) et d'un adhésif vinylique PVAc en base aqueuse (Jade 403®). Le papier a été choisi pour son lustre semblable à celui des membranes, sa finesse et sa translucidité tandis que l'adhésif a été sélectionné pour sa stabilité physico-chimique et sa compatibilité avec les propriétés optiques et le degré de rigidité des membranes.

Les traitements ont permis une restitution totale de la forme des anoraks et une nouvelle perception du matériau constitutif, autorisant à présent sa présentation **(Figure 9).** Enfin, des formes internes ont été confectionnées afin de conserver le volume des vêtements. Elles répondent à la fois à des besoins de stockage, de manipulation et d'exposition. Chaque support se compose de trois parties principales (le volume du corps, bras gauche et bras droit) et d'un cerclage interne pour la tête. Ces éléments, façonnés en mousse de polyéthylène (Plastazote®) et gainés d'ouate de polyester puis de non-tissé de polyéthylène haute densité (Tyvek®), sont facilement emboitables les uns aux autres et amovibles. Les anoraks ont été calés dans des boîtes en carton de conservation permettant un stockage à plat ou à la verticale **(Figure 10)**.

Figure 9 : Anorak inuit d'Alaska après restauration – 71.1905.31.123. ©Musée du quai Branly - Jacques Chirac. Photo Claude Germain.

Figure 10 : Conditionnement pour stockage en réserves de l'anorak inuit – 71.1905.31.123. ©Musée du quai Branly - Jacques Chirac. Photo Cyril Zannettacci

Ce projet a permis non seulement de redonner une lisibilité et apporter une meilleure compréhension de ce corpus d'anoraks, jusqu'alors mal connu, mais aussi de stabiliser leur état de conservation de manière pérenne – ce dernier autorisant dorénavant leur présentation.

Conclusion

Les projets de conservation-restauration présentés sont le reflet d'une réflexion sur une politique de préservation concertée, appliquée à une vaste collection, constituée d'une grande diversité de matériaux et de provenances. Chacun a permis la compréhension matérielle et contextuelle des corpus considérés. Les traitements ont pris en considérations des niveaux de conservation hétérogènes, en adaptant au cas par cas un protocole de conservation-restauration établi à l'échelle de la collection.

De nouvelles perspectives d'études et de recherches appliquées se dessinent, telles que l'évaluation de matériaux de doublage et de comblement, notamment pour une restitution visuelle des peaux ou fourrures. Enfin, un futur projet interdisciplinaire, croisant étude historique, approche anthropologique et ethnographique, analyse matérielle et intervention de conservation-restauration, en lien avec des populations autochtones, sera nous l'espérons porteur d'un développement renouvelé de la discipline.

Remerciements

Le pôle conservation-restauration du musée du Quai Branly – Jacques Chirac remercie le groupement de conservateurs-restaurateurs Etnologia, Jacques Cuisin, Ingénieur de recherches responsable de la plateforme de préparation/restauration au Museum national d'Histoire Naturelle de Paris et Pascal Deynat, Ichtyologue spécialiste des requins pour leur collaboration.

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Matériaux

Adhésif PVAc en base aqueuse Jade 403® : Talas, 330 Morgan Ave. Brooklyn, New York, Etats-Unis, www.talasonline.com

Adhésif copolymère d'acétate de vinyle et de maléate de dibutyle Mowilith DMC2® : C.T.S. France S.A.R.L., 26 passage Thiere, 75011 Paris, www.ctseurope.com

Carton de conservation : Klug-Conservation, Zollstrasse 2, 87509 Immenstadt, Allemagne, www.klug-conservation.fr

Conservators Sponge®: Preservation Equipment Ltd, Vinces Road, Diss, Norkolk IP22 4HQ, Etats-Unis, www.preservationequipment.com

Couleurs acryliques Liquitex® : Liquitex, www.liquitex.com

Gomme Smoke Sponge® : CXD France, 1 avenue Louison Bobet, 94120 Fontenay-sous-Bois, France, www.cxd-france.com

Intissé de polyéthylène Tyvek® : CXD France, 1 avenue Louison Bobet, 94120 Fontenay-sous-Bois, France, www.cxd-france.com

Membrane Sympatex® et Gore-tex® : CXD France, 1 avenue Louison Bobet, 94120 Fontenay-sous-Bois, France, www.cxd-france.com

Mousse de polyéthylène Plastazote®: CXD France, 1 avenue Louison Bobet, 94120 Fontenay-sous-Bois, France, www.cxd-france.com

Papier japonais Kozo et Gampi : CXD France, 1 avenue Louison Bobet, 94120 Fontenay-sous-Bois, France, www.cxd-france.com

Tissu d'essuyage Sontara® : CXD France, 1 avenue Louison Bobet, 94120 Fontenay-sous-Bois, France, www.cxd-france.com

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Le Conditionnement Anoxique : Premier Bilan d'une Campagne de Préservation sur les Collections de Fourrures au Musée du Quai Branly - Jacques Chirac

Éléonore Kissel, Fabrice Sauvagnargues

Résumé

Le musée du quai Branly - Jacques Chirac (mqB-JC) conserve une collection d'environ 340 000 objets, constituée majoritairement de matériaux organiques. Une partie de cette collection, principalement d'origine arctique ou sibérienne, était conservée dans des réserves froides. Celles-ci présentaient des dysfonctionnements chroniques quant à la gestion du climat, d'où la décision de les démanteler en 2019.

Dans cette perspective, eu égard au fait de la sensibilité élevée à la biodétérioration des objets contenant de la fourrure, il a été proposé d'initier un projet de conditionnement anoxique qui permette à la fois d'exclure le risque d'infestation par des insectes et de diminuer la cinétique de dégradation des peaux.

L'idée remontait à plusieurs années. Suivant l'exemple d'un projet de conditionnement anoxique de grande ampleur sur des matériaux météoritiques réalisé au National Museum of Natural History de Londres, nous avons en 2016 acquis l'équipement requis pour cette opération : oxymètre sans contact, films imperméables au passage de l'oxygène, absorbeurs puis, en 2017, confié une mission à une consultante pour assister le chargé de la conservation préventive à formuler les propositions de base du projet, en particulier la définition lorsque possible de formats standards associés à une certaine quantité d'absorbeurs d'oxygène. En 2018, les conditionnements anoxiques ont été réalisés sur 291 objets.

Après descriptions des processus mis en œuvre pour réaliser les conditionnements, nous concluons sur un premier bilan de l'opération et les perspectives que nous envisageons pour la suite du projet.

Mots-clés

Anoxie, Hypoxie, Préservation, Conservation Préventive, Conditionnement, Fourrures, Métaux Archéologiques, Matériaux Artificiels, Anoxique, Conditionnement, Infestation, Biodétérioration, Prévention, Ensachement, Musée du Quai Branly - Jacques Chirac

Introduction et présentation contextuelle

Les collections du musée du quai Branly - Jacques Chirac (mqB-JC) ont été constituées par la réunion des œuvres et objets initialement conservés au Musée de l'Homme (MH) et du Musée national des Arts d'Afrique et d'Océanie (MNAAO), puis complétées par des acquisitions propres au nouvel établissement inauguré en 2006. Les collections totalisent aujourd'hui plus de 340 000 items, provenant des Amériques, d'Afrique, d'Océanie et d'Asie issus de tous les écosystèmes de la planète. Parmi eux, on trouve environ 18 000 pièces constituées en tout ou en partie de cuirs ou de peaux de natures diverses. Le projet présenté ici porte plus spécifiquement sur une campagne de conditionnement anoxique centrée sur des fourrures, principalement issues des zones arctiques.

Environ 550 de ces objets avaient été placés, au Musée de l'Homme, dans des réfrigérateurs : il est difficile aujourd'hui de déterminer si ce choix avait été effectué pour maintenir les objets dans un climat proche de leur écosystème d'origine, ou pour diminuer les risques d'infestations biologiques (Burbank, 1996 ; Dejean, 2002 et 2004 ; mqB, 2005 ; Pool, 1997). Quoi qu'il en soit, sur le site du mqB-JC cet héritage avait donné lieu au transfert des collections du Grand Nord-américaines et sibériennes dans des réserves froides, conditionnées à 6°C. En 2011, un audit des pratiques de conservation matérielle a démontré d'une part, la difficulté induite par le choix de cette température, un sas étant nécessaire pour éviter les risques de condensation lors de la sortie des réserves de ces objets, et d'autre part, le dysfonctionnement des dispositifs de traitement d'air contrôlant le climat dans ces réserves. En 2012 les points de consigne de la température ont été relevés à 12°C afin d'éliminer le besoin d'un sas tout en maintenant les insectes à l'écart des collections. Le climat restait cependant instable : or, la littérature professionnelle mettait en garde contre les dégradations induites par des cycles de variations de temps et d'hygrométrie répétés sur les fourrures. En 2015, la tolérance de variation des taux d'hygrométrie a été augmentée afin que les équipements climatiques répondent plus efficacement mais en 2017, après plusieurs tentatives d'amélioration du fonctionnement des appareils de régulation, il a été décidé de les mettre à l'arrêt. Les courbes enregistrées à cette période démontrent l'impact instantané de cette décision : le taux d'hygrométrie s'est stabilisé à un taux moyen, pour le bien des collections (**Figure 1**). On mentionnera également la diminution immédiate des coûts énergétiques associés à ces équipements.

Durant la période 2011-2017, en parallèle, sont apparues diverses publications relatives au conditionnement anoxique des collections. Les premières publications sur le sujet datent de la fin des années 1980 (Burke, 1996 ; Grattan, 1988) mais une décennie plus tard, elles se multiplient en proposant un micro-environnement sans oxygène pour des typologies d'objets diverses : textiles naturels ou synthétiques, métaux archéologiques, caoutchouc naturel, etc. Un colloque fondateur sur l'anoxie et la microdécolorimétrie s'est tenu à Londres en 2011 (INCCA, 2011), dont l'intégralité du contenu était disponible en podcast – alors une relative nouveauté dans le mode de diffusion des informations, qui a maximisé l'impact de ce colloque autrement destiné à un auditoire relativement restreint. À partir de 2013, le Muséum national d'Histoire naturelle de Londres (NHM) a communiqué sur ses campagnes de conditionnement destinées aux collections géologiques, notamment d'origine météoritique. En 2014, il était proposé dans un mémoire de l'Institut national du Patrimoine (INP) le conditionnement anoxique d'un objet archéologique en fer instable. L'équipe du mqB-JC travaillait par ailleurs, depuis 2012, à la révision générale de sa politique de lutte intégrée contre les insectes (*Integrated Pest Management*, ou IPM). Cette réflexion a conduit à s'interroger sur l'intérêt qu'il pourrait y avoir à remplacer le froid par une technique de préservation moins énergivore pour des objets hautement sensibles à la biodétérioration, tout en limitant la cinétique de dégradation des peaux et fourrures. En 2015, l'équipe décida de convier Chris Collins du NHM afin de bénéficier d'une formation à la mise en œuvre de micro-conditionnements anoxiques.

Campagne de conditionnement anoxique

Fin 2016, une possibilité d'investissement nous a permis d'acquérir un oxymètre OxySense® 5250I et des pastilles O2xyDot®, première commande d'une liste de matériaux que nous avions identifiés dans la littérature, d'une part et lors des formations d'autre part. Par ailleurs, cet appareil était indispensable à la réalisation des tests de perméabilité à l'oxygène de films servant à produire des conditionnements. Ces tests se sont révélés non concluants, les films considérés ne permettant de maintenir une anoxie que sur une courte

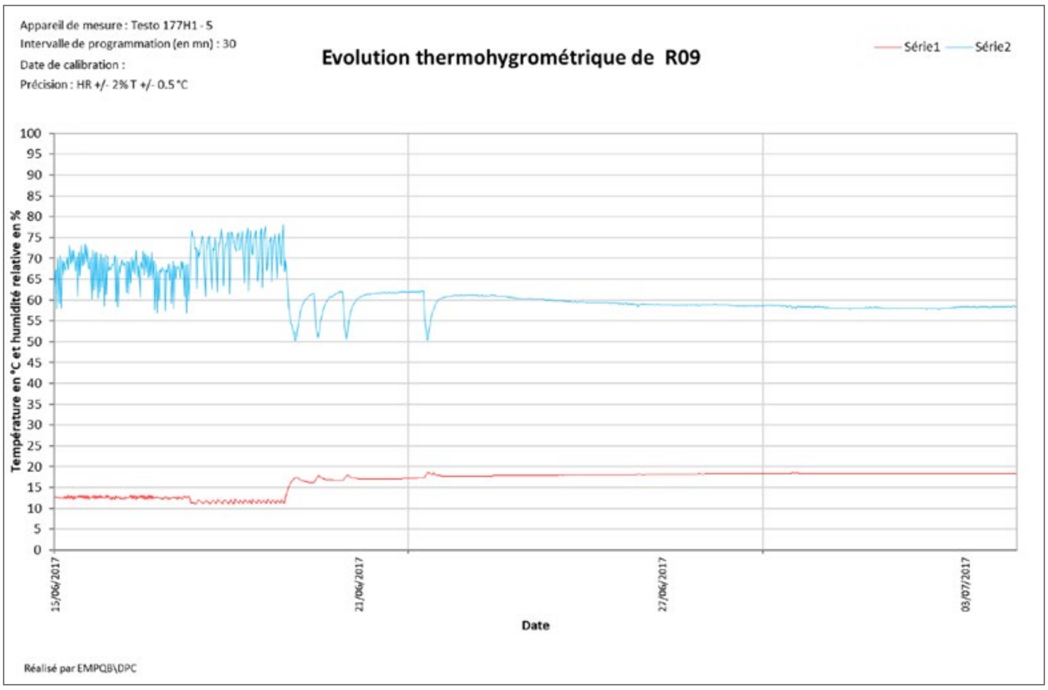

Figure 1. Fréquence et importante amplitude des variations hygrométriques dans la réserve froide, stabilisation immédiate du taux d'hygrométrie après la mise à l'arrêt du système de régulation couplée à une montée de la température à environ 18 °C. ©Musée du quai Branly - Jacques Chirac

durée. Les commandes suivantes ont consisté en l'achat d'absorbeurs d'oxygène RP20K®, qui n'affectent pas le taux d'hygrométrie interne des conditionnements et de film Escal®, ce dernier présentant les meilleures spécifications en matière de perméabilité pour un matériau transparent. La mesure du taux d'oxygène se fait de manière non-invasive et fonctionne de la façon suivante : la pastille, collée sur la face interne du contenant en Escal®, est illuminée par une lumière bleue ; celle-ci est absorbée par la pastille qui émet en retour une fluorescence dans le rouge ; en fonction des caractéristiques de cette fluorescence, l'appareil infère un taux d'oxygène contenu dans le conditionnement. L'adhésif fourni avec les pastilles ayant échoué à passer les tests d'Oddy réalisés en interne, nous avons fait le choix de recourir à un adhésif de conservation pour fixer la pastille.

Forts de ces éléments, en 2017 nous avons missionné Dolors Sala Fenès, conservatrice-restauratrice, afin de nous accompagner dans la définition des gabarits et la réalisation des conditionnements micro-régulés. Bien que les premières pistes nous faisaient considérer les pièces en peaux et fourrures comme prioritaires, il nous a semblé intéressant de prendre en compte les collections de restes alimentaires par pragmatisme : sensibles aux biodétériorations mais déjà conservées en fond de boîtes en carton de conservation, ces pièces permettaient de travailler facilement à l'élaboration de formats standards. De plus, la présence de ces fonds de boîtes pré-existants limitaient le risque d'écrasement car les sachets RP20K® réduisent le volume de 21 % environ après avoir absorbé l'oxygène.

Trois formats gigognes ont ainsi été réalisés, T1, 2 et 3 : T2 (5 litres), peut contenir deux T1 (2,5 litres), tandis que dans un contenant T3 (10 litres) on peut placer deux T2 ou quatre T1. Ayant à l'esprit la volonté que ces conditionnements puissent être réutilisables, les patrons ont été dessinés de façon à avoir une grande hauteur afin de permettre plusieurs ouvertures puis soudures successives. En raison du coût des matériaux, les chutes ont été conservées et ont servi à réaliser un format miniature dit T0.

Parallèlement à ces formats standards, des prototypes de plus grande taille ont été réalisés pour des objets de moyen et grand format. Dessinés selon les mêmes patrons, ces conditionnements ont nécessité de contenir des fonds de boîtes en polypropylène alvéolaire cannelé garnis ou non de mousses de polyéthylène réticulé. Les angles ont été habillés de Filmoplast T® afin de protéger le film Escal® contre les percements. Ces formats « sur mesure » se sont révélés être les plus délicats à mettre en œuvre et sont ceux qui, à l'usage, connaissent le plus grands nombres d'échecs en termes de maintien d'une atmosphère anoxique. En effet, plus les boîtes sont de grand format, plus elles sont difficiles à sceller parfaitement sur de grandes longueurs. Un même patron a été utilisé pour les petites et les grandes boîtes, mais la forme de la partie supérieure, là où le film est plié, fait que la soudure est délicate à rendre parfaitement hermétique. Une solution envisagée serait de changer de pince à thermosouder, en utilisant un appareil de plus grande largeur produisant une soudure gaufrée ayant plusieurs lignes parallèles.

Suite à ces préparatifs, nous avons, en 2018, renouvelé la mission de la conservatrice-restauratrice qui a alors réalisé les conditionnements en film Escal® dans les tailles standards et sur mesure. Les objets y ont été placés, puis entre un et cinq absorbeurs y ont été déposés. Le fait de ne pas mettre plus de cinq absorbeurs dans les conditionnements tenait à une volonté prosaïque : baisser le taux d'oxygène sans saturer les grands conditionnements d'un trop grand nombre d'absorbeurs et limiter les coûts. Cette pratique a cependant montré ses limites concrètes : pour les contenants de grand format, nous avons créé un environnement hypoxique dont nous ignorons s'il est suffisamment pauvre en oxygène pour produire les résultats escomptés. Cette technique sera désormais abandonnée.

Au total, 291 objets ont été conditionnés dans 113 conditionnements. Plus de 70 % des objets appartiennent à la typologie des restes alimentaires, seuls 11 % sont en fourrures et 12 % en cuir seul. Certains objets ont donc été conditionnés seuls, d'autres l'ont été en groupe. Dans tous les cas, les regroupements ont été faits sur la base des collections, puis par formats ou typologies. La majorité des pièces provient des Amériques puis viennent les objets d'Asie, d'Afrique, d'ANPO et d'Océanie.

Le taux d'oxygène résiduel a été contrôlé et inscrit dans un fichier entre un et sept jours après le scellement des conditionnements ; six mois plus tard, une campagne de contrôle qualité a été entreprise, qui a consisté à vérifier le taux d'oxygène ainsi que l'état des conditionnements : soudures, état de surface du film, maintien de la pastille O2xyDot®. À ces données s'ajoutent la date de réalisation, les dimensions, le volume et le nombre d'absorbeurs.

À terme figureront la température de dénaturation du collagène par DSC et le pH. L'objet de ce fichier de suivi est de permettre un contrôle des conditionnements sur cinq années.

Discussion et bilan

La première campagne de conditionnement anoxique du mqB-JC s'est révélée très instructive. En premier lieu, elle nous a interrogés sur la typologie d'objets à mettre préférentiellement dans un environnement sans oxygène (Thomas, 2012) : faut-il privilégier les denrées alimentaires, qui en cas d'infestations biologiques se trouvent en miettes et ne pourront qu'être déclassés ? Faut-il y inclure les denrées susceptibles d'être dégradées par oxydation, par exemple les crânes miniatures en sucre de la Fête des morts mexicains (**Figures 2 et 3**) ? Est-il pertinent de le faire pour ce type d'objets s'ils sont déjà oxydés ?

Figure 2. Crâne en sucre, Mexique, 71.1959.92.8 : entré dans les collections du mqB-JC en 1959. On notera l'oxydation du sucre, irréversible : pourrait-on l'éviter sur de nouvelles acquisitions par le biais d'un conditionnement anoxique ? ©Musée du quai Branly - Jacques Chirac

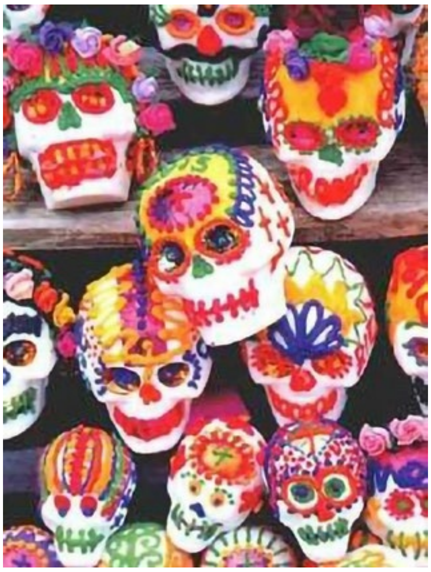

Figure 3. Crânes en sucre mis en vente après leur confection pour la Fête des morts en 2013. ©http://pernelle.canalblog.com

Concernant les cuirs, peaux et fourrures, un contenant hermétiquement scellé permettant une mise en quarantaine permanente serait-il suffisant pour limiter les risques de biodétérioration après que les objets soient transférés hors des réserves froides (**Figures 4a et 4b**) ? Ici, une pochette faite d'un simple film de polyéthylène de 350 µm suffira à un moindre coût, comme l'indique la littérature professionnelle issue de l'agro-alimentaire (Kelley, 2010). La valeur ajoutée d'un conditionnement anoxique résiderait-elle dans la possibilité de limiter la cinétique d'oxydation des peaux, vecteur important de leur dégradation ? Rappelons que le dysfonctionnement climatique récurrent des congélateurs du Musée de l'Homme puis des réserves froides du mqB-JC ont sans doute accru la fragilité des peaux et fourrures…

Figure 4a. Sac en peau de raton laveur en provenance du Honduras (71.1960.51.7). On observe que la majeure partie de la fourrure a disparu ou s'est détachée du fait d'une infestation biologique. Figure 4b. Amas de poils détaché présentant des résidus d'infestations (cocons, exuvies, déjections, etc.) : il est impératif d'éviter toute nouvelle attaque par des insectes sur cet objet. ©Musée du quai Branly - Jacques Chirac Photo Éléonore Kissel

Concernant le caoutchouc naturel ou les matériaux artificiels dont la cinétique de dégradation est très rapide, par exemple les objets en nitrate ou en diacétate de cellulose, un conditionnement anoxique constituerait-il la solution idéale ? La réponse doit être fondée sur une identification adéquate du matériau considéré, car de celui-ci découlera un processus chimique préférentiel d'altération : ainsi, le caoutchouc naturel, la mousse de polyuréthane de type polyéther, le polychlorure de vinyle et quelques autres résines se dégradent principalement par oxydation, tandis que le nitrate de cellulose, l'acétate de cellulose, l'urée-formaldéhyde et d'autres matériaux sont plus sensibles à l'hydrolyse acide (Lovett et Eastop, 2004 ; Ward, 2011 ; Hacke et al., 2014 ; Fenn et Williams, 2018). Le conditionnement anoxique est bien adapté aux matériaux qui se dégradent par oxydation, tandis que pour ceux se dégradant par hydrolyse acide il faudra privilégier un micro-environnement combinant une faible hygrométrie et des adsorbeurs de polluants gazeux. L'expérience effectuée sur un objet du mqB-JC en acétate de cellulose confirme le danger potentiel d'un conditionnement anoxique seul pour cette typologie de matériaux (**Figure 5**).

Figure 5. Ensemble de perles en acétate de cellulose provenant du Sud marocain, mis en conditionnement anoxique en 2018 et présentant depuis, un dégagement d'acide acétique confirmé par un test avec les bandelettes indicatrices AD Strip® (71.1938.151.31.1-8). Le conditionnement de cet objet a été refait selon des modalités mieux adaptées à la nature du matériau. ©Musée du quai Branly - Jacques Chirac photo Fabrice Sauvagnargues

Enfin, nous n'avons pas à ce jour investigué l'intérêt du conditionnement anoxique pour les matériaux d'origine météoritique (**Figure 6**), les pyriteux ou les métaux archéologiques instables à l'oxygène (Allington-Jones, 2017). À l'instar du NHM de Londres, devrions-nous orienter nos efforts sur cette typologie de matériaux ?

Figure 6. Couteau-scie d'homme, Nunavut (71.1949.39.25). L'origine météoritique d'une partie de la lame a été confirmée par des tests menés par Christophe Moulherat, chargé des analyses au mqB-JC, à la demande de Matthieu Gounelle, professeur au Muséum national d'Histoire naturelle et commissaire de l'exposition *Météorites* : une moitié de la lame est en fer terrestre et l'autre en fer météoritique. ©Musée du quai Branly - Jacques Chirac

Au-delà de la sélection des objets, nous avons pu mesurer les difficultés techniques induites par la mise en œuvre du conditionnement anoxique sur des collections ethnographiques : par comparaison avec les campagnes de grande échelle du NHM de Londres, la diversité des matériaux et des formats constitue un écueil important. Sur des matériaux autres que les collections géologiques, les références de la littérature professionnelles portent en majorité sur des petits corpus contenant au maximum quelques dizaines de pièces : une centaine de textiles au Bhoutan (Brennan, 2008), huit textiles mexicains enduits de caoutchouc naturel (Hacke, 2014), un objet en métal archéologique (Logan, 2005 ; Chalvidal, 2014), une dizaine de parkas (Scott, 2018).

La principale difficulté réside dans la fabrication et l'assemblage des grands conditionnements sur mesure. Plus le conditionnement est grand, plus le risque de créer des défauts de soudure est important. Ainsi, sur les trente conditionnements dont le volume est compris entre 10 et 130 litres, deux seulement présentent des taux d'oxygène compris entre 3 et 6 % ; les contenants restants se répartissent comme suit : cinq sont compris entre 10 et 14 %, quatorze entre 14 et 17 % et neuf comprennent 21 % d'oxygène, comme l'atmosphère que l'on respire. La question qui se pose est donc de savoir quel est le volume maximal traitable et ce qu'il est raisonnable de faire, au vu de l'investissement en matériaux et en temps considérés ? Un micro-conditionnement sous atmosphère hypoxique peut-il être une réponse suffisante, tant en termes de lutte contre les infestations biologiques que pour réduire la cinétique de dégradation des objets ? Il conviendra de le valider. À l'inverse pour les volumes inférieurs à 10 litres, la méthode est éprouvée, les résultats le montrent : nous avons identifié près de 100 % de réussite. Notons enfin qu'au-delà de l'assemblage, c'est bien la précaution avec laquelle sont manipulés et rangés les conditionnements qui comptent : le film Escal® reste, sinon fragile, à tout le moins délicat et il importe d'éviter les pincements, percements et altérations.

La deuxième difficulté que met en lumière cette campagne de conditionnement est le coût, l'investissement même, qu'elle nécessite. En temps, tout d'abord, puisque cela représente quarante jours de prestation et la moitié, vingt jours, de travail en interne. Financièrement, ensuite, puisque nous avons investi 13,5 k€ pour l'oxymètre et que les consommables sont onéreux (film Escal® : 14,3 €/m, absorbeurs d'oxygène RP20K® : 6,76 €/pce, pastilles O2xyDot® : 0,66 €/pce). À titre d'exemple, le coût de revient d'un conditionnement T3 (15 × 30 × 22 cm soit 10 litres, le plus grand des conditionnements de format standard que nous ayons trouvés fonctionnels) est de 15 €.

Conclusion et perspectives

La recherche diffusée dans la littérature scientifique souligne combien les environnements anoxiques (conditionnements, cadres, vitrines) et hypoxiques (zones de stockage) constituent des solutions hautement efficaces pour prévenir et/ou diminuer la cinétique des altérations des biens culturels. Le mqB-JC s'impose cependant trois conditions pour la poursuite de ce projet :

1. Notre équipe doit poursuivre sa réflexion sur le choix des typologies d'objets, en priorisant sans doute les objets considérés comme les plus instables à l'oxygène et les plus difficiles à traiter en cas de dégradation. Concrètement cela représenterait au total environ 250 objets comportant majoritairement de la fourrure, 150 objets métalliques et une quantité à définir d'objets en matériaux artificiels – lesquels sont en cours d'identification, car au préalable ils doivent être distingués des matières naturelles qu'ils ont vocation à imiter (ex. : différenciation de l'ambre véritable de ses avatars, nitrate de cellulose, acétate de cellulose ou résine phénolique). En termes de mise en œuvre, pour les objets en fourrure la question de la stabilité anoxique des contenants de format supérieur à 10 litres sera également critique, et devra être résolue.
2. Nous souhaitons améliorer le contrôle-qualité des conditionnements anoxiques. Deux aspects au moins seront étudiés : le risque de pollution interne au conditionnement pouvant donner un taux d'oxygène faussé lors de la lecture avec le système O2xyDot®, et l'intérêt sur le long terme de ce micro-environnement par rapport à l'altération des peaux. Pour ce faire, nous initierons des mesures de pH complétées par la détermination de la température de dénaturation du collagène pour des binômes d'objets « jumeaux », qui seront mis ou non en conditionnement anoxique pendant plusieurs années avant de bénéficier de nouvelles mesures.
3. L'intérêt d'un environnement hypoxique sera également investigué dans les années à venir. Deux questions principales se posent : à partir de quel seuil d'oxygène la contamination par des insectes ne peut se produire et de même, la cinétique de dégradations chimiques diminuer de manière significative voire être palliée (oxydation, rupture des chaînes moléculaires des polymères artificiels) ?

Moyennant la poursuite de ces investigations, nous pensons que le conditionnement anoxique est une technique qui peut et doit être disséminée, y compris paradoxalement dans des établissements patrimoniaux aux moyens modestes. En effet, l'oxymètre peut être partagé, de même que les fournitures – tout particulièrement en raison du fait qu'elles sont onéreuses. Des musées, monuments historiques, sites archéologiques, services d'archives et bibliothèques pourraient s'associer pour que chacun d'entre eux puisse protéger par un micro-environnement anoxique ses trésors les plus absolus. Pour ce faire, le pôle Conservation-Restauration du mqB-JC pourrait contribuer à disséminer l'information scientifique, technique et pratique aux équipes qui le souhaiteraient. Des campagnes à plus grande échelle pourraient par ailleurs être envisagées pour des collections instables ou excessivement fragiles à la lumière, à l'oxydation et à la biodétérioration, à l'instar de ce qui a été initié au musée du quai Branly - Jacques Chirac.

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Matériaux

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Escal® et RP20K® : m.art preserving GmbH, Burstenstrße 37a, D-51702 Bergneustadt, Allemagne, www.m-art-preserving.com

Filmoplast T® : C.T.S. France S.A.R.L., 26 passage Thiéré, 75011 Paris, France, www.ctseurope.com

AD Strip® : CXD France, 1 avenue Louison Bobet, 94120 Fontenay-sous-Bois, France, www.cxd-france.com

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Analyzing Deterioration Processes in Mammal Skins: The Role of Interdisciplinary Cooperation

Steffen Bock, Christiane Quaisser

Keywords
Natural History Collections, Degradation, Study Skins, Acidic Hydrolysis, Profiling of Large Collections, Interdisciplinarity

Following the natural life cycle, all organisms will decay after their death. Preserving these organisms, their integrity and characteristics beyond their original lifetime is the actual core task of natural history collections, thus serving as an archive of life. Accompanying an intensive growth of these collections over the last two centuries, an enormous knowledge around preservation and conservation of natural history objects have been built up. However, whereas the purpose for collecting and use of the objects has always been research driven, the maintenance was considered as a technical problem and was lacking a systematic and scientific approach for a long time. Professional collection management and conservation science are rather young fields in natural history collections. The Museum für Naturkunde (MfN) Berlin, founded in 1810, is no exception. Although there is an awareness of deterioration processes in different parts and materials of the collection, there are not yet many effective solutions to stop them. A good example is the collection of about 30,000 mammal skins.

The study skin of a snow leopard (*Panthera uncia*) acquired by Alexander von Humboldt in 1829 or skins of extinct species like the Tasmanian wolf (*Thylacinus cynocephalus*) are two examples for valuable study skin material which is threatened by steady decay. Many skins are brittle and can be easily torn. In some cases, handling and use of the objects had to be stopped in order to prevent them from further damage. However, since the objects were meant to be used, making them unavailable for access and use virtually means that they do not serve their museum purpose anymore. Not much was known about the causes for the decay. Hardly any documentation could be found about preparation methods and follow-up treatments. A situation that is not unique for this specific museum collection.

Figure 1. Flat study skin of a springbok (*Antidorcas marsupialis*). The Museum für Naturkunde in Berlin houses over 30,000 study skins in the mammal collection. Many of the skins are threatened by a steady decay. © Hwa Ja Götz, Museum für Naturkunde Berlin.

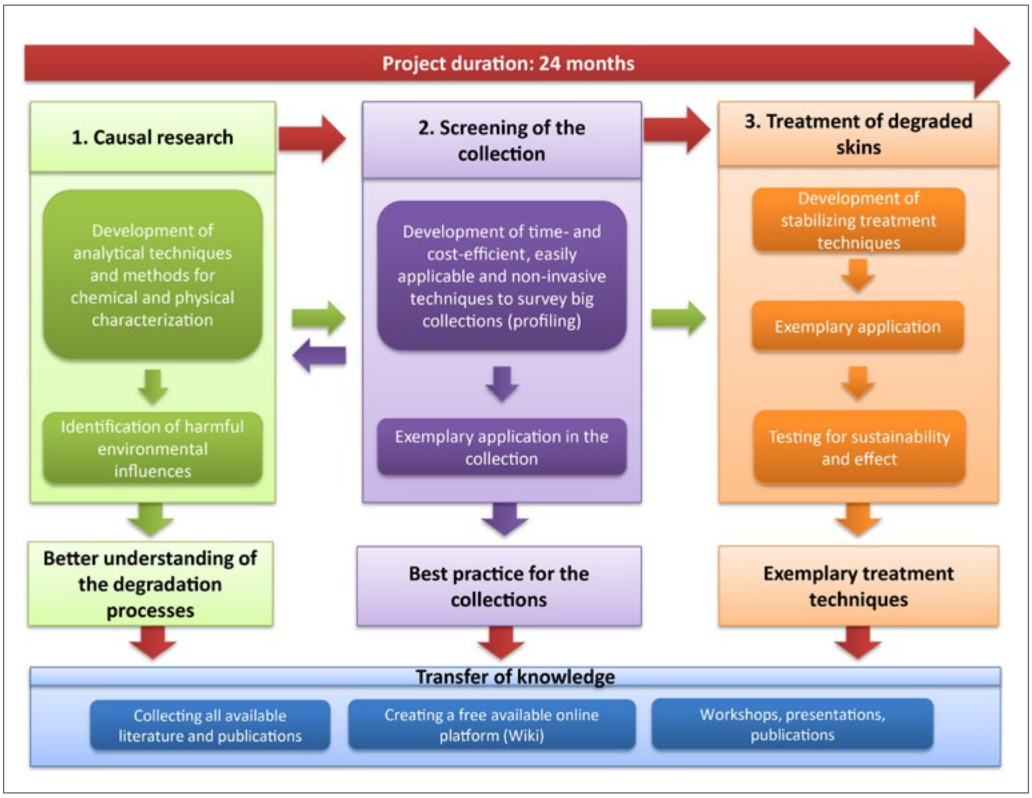

Figure 2. Outline for the research project at the Museum für Naturkunde in Berlin, Germany, funded by the DBU (AZ33841/01).

A two-year research project funded by the German Federal Environmental Foundation (DBU, AZ33841/01, 2018-2020) is aiming at 1) identification of key factors for the deterioration, 2) simple, non-destructive survey methods to assess the status of bigger collections, 3) methods to stabilize fragile skins to enable ongoing use, and 4) practical information on sustainable preparation for future collections. The project is conducted within an interdisciplinary partnership with the German Center for Book Conservation (ZFB) and the German Research Institute for Leather and Plastic Sheeting (FILK) and includes taxidermists, tanning companies and experts from leather research.

In-depth chemical analyses developed from analytical methods used in leather research (ashing test, shrinkage temperature, pH value, amino acid analysis, etc.) identified acidic hydrolysis as one of the main causes for the decay and thus confirmed the assumptions by taxidermists that the preservation methods themselves are initially responsible for the degradation.

Surplus acids in the skin catalyze the degradation of collagen fibers, one of the main structures that make skin flexible and tear resistant. Degraded collagen and reduced tear strength are at times not detectable by visual examination alone, and at the moment can generally be detected mainly by expensive and invasive testing in the lab. Based on the results of this project, cheap, non-invasive and easily applicable methods to survey and assess the condition of big collections were developed and tested. The range of methods included objective parameters such as puncture resistance, thickness and surface pH level as well as subjective parameters such as tear strength, flexibility, feeding scars left by pests and hair loss. These parameters cannot replace extended chemical analysis. However, as confirmed by the tests carried out on the MfN skin collection, they can provide a first and quick overview of the status of a comprehensive collection.

In the project, more than 370 study skins from 18 different mammal species were tested. Results showed that 75% of them were very weak with only little tear strength remaining, and could easily be torn. Applied on the whole skin collection, this means that the collection is highly threatened - a dramatic result that was not obvious before and which stresses the urgency of effective rescue measures.

Apart from the research results that will help to safeguard and improve our collection, it is a lesson learned that projects like this only succeed in a strong partnership bringing together in-depth knowledge, experiences and skills across disciplines and including technical as well as scientific expertise. A lot of knowledge has not yet been published and projects could combine the traditional experiences and skills from zoological preparation with the scientific and modern techniques of conservation in cultural history collections. Our skin conservation project is just one example of how the interdisciplinary cooperation between experts from zoological collections, taxidermy, restoration, leather science, preventive conservation and material research can pool their knowledge and combine methods to find solutions.

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Biographies

Steffen Bock's professional background combines the experience as a collection manager, conservation scientist and biologist. During his master studies in ecology, biodiversity and evolution at the Free University in Berlin, Germany, he focused on collection management and curation of systematic collections. Since 2012, he worked in various Vertebrate and Invertebrate collections at the Museum für Naturkunde in Berlin, Germany, and most recently as a collection manager of the Mammal collection between 2016 and 2018. Since 2018, he has been coordinating a research project funded by the German Federal Environmental Foundation (DBU) that investigates the decay in scientifically used Mammal Collections.

Christiane Quaisser is a biologist by profession and has a background in ornithology and nature conservation. After her PhD on the impact of agricultural land-use on the breeding success of birds, she started her museum career as a trainee in a natural history museum in 1999. Scientific projects brought her to work on major bird collections in Europe. In 2007 she moved on to management of natural history collections. In 2013, she became Head of Collections at the Museum für Naturkunde in Berlin, Germany, and in 2014, Head of the Science Programme Collections Development and Biodiversity Discovery. Her work has always focused on the strategic development of collections with interdisciplinary collaboration as a key success factor. Current research interests are focusing on conservation science, e.g. biocides and deteriorations processes in mammal skins.

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Gilt Leathers
Cuirs dorés

La Collection Páramo : Muséographie et Provenance des Cuirs Dorés dans les Collections Espagnoles

Félix de la Fuente Andrés

Résumé

Une des difficultés de l'étude des cuirs dorés, et notamment des cuirs dorés espagnols les plus anciens, est le manque d'informations sur leur origine, bien que nous disposions de nombreuses références documentées. Le but de cette étude est d'essayer d'établir des corrélations entre certains cuirs dorés et leur lieu de provenance en prenant comme exemple la collection d'Anastasio Páramo (1879–1945), aujourd'hui conservée au Palais de Viana à Cordoue. D'après Páramo, ces cuirs proviendraient d'églises et de couvents de Cordoue et de sa région. Cette collection a ultérieurement été considérée comme représentative des «*Guadamecíes*» espagnols anciens. La question est de savoir si l'observation de caractéristiques identiques dans une série d'œuvres voisines permet de conclure à une provenance commune. La méthode d'étude a consisté à confronter les caractéristiques des œuvres avec les sources documentées et bibliographiques. En conclusion cette étude apporte des données intéressantes pour aider à caractériser les cuirs dorés conservés en Espagne, leur histoire et leur muséographie ; elle a notamment permis de préciser l'origine de quelques ensembles aujourd'hui dispersés dans plusieurs collections.

Mots-clés[1]

Guadamecí, Anastasio Páramo, Palais de Viana (Cordoue), *Museo Nacional de Artes Industriales, Museo Nacional de Artes Decorativas, Museo de Santa Cruz* (Tolède), *Convento de Carmelitas Descalzas* (Tolède)

Introduction

Cette étude porte sur l'origine des *guadamecíes* de la collection du Palais de Viana à Cordoue et a pour but de préciser leur provenance; elle a bénéficié de la collaboration des responsables du Palais de Viana. Elle a été menée à l'occasion d'une campagne sur les encadrements des cuirs qui a été menée en 2018 et qui a permis d'examiner les œuvres en détail et de recueillir des informations de première main.

La collection a été achetée en 1926 par le Marquis de Viana à Anastasio Páramo, qui l'avait lui-même constituée à Tolède au début du XX^{e} siècle; c'était une des collections les plus anciennement connues[2], constituée à une époque où il était encore possible d'accéder aux cuirs sur leur emplacement d'origine. La perte du contexte d'origine des cuirs dorés, notamment la perte du complément que peut apporter l'architecture du lieu et son ameublement, constitue un obstacle pour élucider plusieurs questionnements importants comme l'origine et la diversité des productions, les techniques de fabrication, la chronologie, les cheminements des œuvres et leur utilisation. Les conséquences de cet obstacle sont particulièrement fâcheuses quand il s'agit d'œuvres anciennes, donc rares et mal connues. La connaissance de la provenance permet de constituer et de définir un corpus d'œuvres bien documentées; ce qui est un complément essentiel aux connaissances techniques concernant le support, la préparation des feuilles d'argent, la composition des autres matériaux utilisés, etc.

La collection Páramo-Viana, bien qu'elle ait été peu étudiée, comporte assez d'informations documentées

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1 *Guadamecí*:cuir doré; MNAI: Musée National des Arts Industriels; MNAD: Musée National des Arts Décoratifs; MSCT: Musée de *Santa Cruz* à Tolède; MEV: Musée Episcopal de Vic.

2 La constitution de la collection du MEV date de cette époque ; elle est formée de quinze cuirs, dont huit furent acquis avant 1893 (Museo Artístico Arqueológico, Vich, 1893) et sept avant 1913 (MEV, Inventaire manuscrit, f. I-41) ; FUENTE, 2014, note 5.

pour conforter la présente étude; elle constitue un ensemble riche et diversifié qui permet de formuler des hypothèses sur son origine.

Les connaissances préalables

Anastasio Páramo Barranco (1879-ca.1945) était un personnage très cultivé (érudit, polyglotte, voyageur, avocat, généalogiste, collectionneur et antiquaire) qui a partagé son activité entre Madrid et Tolède (Fuente, 2006). Il était membre de diverses institutions académiques[3], avec de nombreuses implications sociales et politiques. Avec le titre de comte-consort de Benacazón il constitua un véritable musée d'antiquités dans son palais (appelé palais de Pantoja puis de Benacazón); c'était un arrêt obligatoire pour tous les amateurs d'art et collectionneurs qui visitaient Tolède; c'était aussi un sujet fréquent de publication pour les revues de tourisme et d'antiquités (Byne 1925, Paramo 1926 et 1928)[4]. Cela lui permit de développer une fructueuse activité de marchand et d'antiquaire, grâce à un vaste réseau de clients (musées, collectionneurs, antiquaires) répartis dans toute l'Europe et aux Etats Unis. A l'époque, ses activités d'érudit, de collectionneur et de marchand n'étaient pas clairement différenciées; de surcroît en Espagne la législation sur la protection du Patrimoine Culturel n'était pas encore très développée et laissait le champ libre à la spéculation et à la spoliation (Martinez Ruiz 2005, Pérez et Socias 2011).

La Collection Páramo était très composite et comportait des objets très variés (pièces archéologiques, céramiques, tissus, verrerie, ferronnerie, sculptures, numismatique, livres, documents, meubles et cuirs); elle était déjà constituée en 1915, moment où fut déposée une série d'objets au Musée National des Arts Industriels (MNAI) **(Figures 1 à 3)**[5], musée qui venait d'être créé à Madrid[6] et dont Páramo devint le conseiller.

La collection, constituée de 23 panneaux de cuir doré, est restée au MNAI jusqu'en 1924, date à laquelle elle a fait partie de l'*Exposición de Guadameciles*[7] de Cordoue. C'est là qu'elle a attiré l'attention de Don José de Saavedra y Salamanca, marquis de Viana, qui aménageait alors son palais dans cette ville[8]. C'était l'époque où on remettait en valeur les «industries et arts nationaux» et les cuirs dorés étaient considérés comme étant une des composantes de l'identité locale:

> "[…] industrie artistique, héritée des arabes, qui atteignit son apogée aux XVIe et XVIIe siècles dans cette ville, recevant d'elle le nom de ses fameuses productions […],- l'art des cuirs imprimés et dorés ou «*guadameciles cordobeses*» [c'est-à-dire, les *Cuirs de Cordoue*]. […] Il aurait été souhaitable [qu'ils] restent à Cordoue pour constituer la partie principale du Musée Municipal qui est en cours d'organisation"[9].

En définitive cette collection cordouane était considérée par le marquis comme un symbole qui renforçait le prestige de sa maison dans la ville. Il créa une salle des cuirs au Palais de Viana, où elle existe toujours aujourd'hui, avec les mêmes montages et les mêmes encadrements que du temps où ils étaient au MNAI **(Figures 1-3)**[10]. Quelques étiquettes originales de marchands et la plupart de celles de l'exposition de 1924 et de l'acquisition sont toujours conservées **(Figures 2-3)**. Le document d'envoi

[3] Académie Royale de l'Histoire de l'Espagne, Académie des Beaux-Arts et Sciences Historiques de Tolède, Conseil de surveillance de l'*Hispanic Society* de New York, et du MNAI, etc.

[4] Autres références: https://toledoolvidado.blogspot.com/2018/07/el-palacio-de-benacazon.html.

[5] S.d. (ca. 1915) Lettre d'offre d'A. Páramo au directeur du MNAI (MNAD, Archives, C0004, D.42); elle mentionne une annexe, non conservée, comportant l'inventaire. Il existe des photographies des salons du MNAI avec le dépôt installé comportant des cuirs (*Museo Nacional de Artes Industriales, 1916, Boletín*).

[6] *Gaceta de Madrid*, 31/12/1912. Le MNAI devient *Museo Nacional de Artes Decorativas* en 1928.

[7] *Exposición de Guadamaciles,* Córdoba, 1924; 1924/05/08, Document de réception des cuirs pour l'exposition (Archivo Histórico Nacional, Sección Nobleza, Fondo *Torrelaguna*, Caja 8, doc. 16/5).

[8] 1926, janvier [illisible], "Anastasio de Páramo […] cédait à M. le Marquis de Viana […] toute sa collection de *Guadamaciles* ou cuirs de Cordoue travaillés [qu'il] a dans une salle du Musée National d'Arts Industriels [et qui] sont reproduits au Catalogue Illustré de l'*Exposición de Guadameciles* qui s'est tenue [á] Cordoue [en] 1924". Deux annexes sont jointes, l'une avec 23 "Exemplaires du catalogue" [de l'exposition de 1924] et l'autre avec trois "Exemplaires qui ne figurent pas au catalogue". *Archivo del Palacio de Viana*.

[9] REY, J. Mª.1924, «Preámbulo», *Exposición de Guadamaciles*, op.cit.

[10] Entre 1916 et 1924 les cuirs étaient encadrés sans verre, cloués au panneau arrière et quelques fois renforcés avec des baguettes (fig. 1-3).

Figure 1 : Musée National des Arts Industriels, Salle 1. Installation de la collection Páramo en 1916.

Figure 2 : Musée National des Arts Industriels, Salle 2 (détail). Installation de la collection Páramo en 1916.

à Cordoue mentionne les pièces du MNAI[11], et en ajoute quatorze autres[12], ce qui laisse supposer que les cuirs disponibles de Páramo étaient encore plus nombreux, ce qui expliquerait que le MNAD conserve encore aujourd'hui quelques exemplaires semblables avec leur numération d'origine. Ce personnage, si «diplomate», et de surcroît conseiller du MNAI, aurait ainsi accordé une compensation au Musée pour la perte du dépôt, en lui faisant don de quelques autres cuirs, mais cette hypothèse n'est pas actuellement documentée.

En 1970 a été réalisé un réaménagement de l'ensemble (changement des panneaux de fond des encadrements,

Figure 3 : Palais de Viana, Cordoue. Collection de cuirs. étiquettes au revers d'un panneau.

adjonction de feuilles de polyuréthane, installation de verres de protection; **Figure 3**)[13].

L'origine des panneaux de cuir

Páramo soutenait que les cuirs provenaient de Cordoue mais sans apporter de données vérifiables[14]. Néanmoins, d'après certains indices, et du fait de l'existence de panneaux comparables conservés au MNAD et au MSCT, cette affirmation devait être vérifiée. Dans ce but, nous avons utilisé une méthodologie qui a consisté à confronter les sources documentaires, les données historiques et stylistiques, et les informations recueillis lors de l'examen détaillé de trois exemples précis suspectés d'avoir appartenu à une même tenture:

- Viana, Nº 10 (**Figures 4-6**)[15]: Panneau formé de quatre éléments de bordure horizontale juxtaposés. Chacun représente une paire de *putti* ailés soutenant une guirlande de fleurs et de fruits; ils sont reproduits

[11] 1926, 23 avril, Madrid. Lettre du Marquis à Francisco Aguilar. Archives du Palais de Viana, *Casa y Estados del Marqués de Viana, Administración Central,* Nº. 206.

[12] 37 exemplaires, parmi lesquels 25 sont des cuirs dorés. Jusqu'au Nº. 23, il y a concordance entre l'annexe de l'offre de vente, le catalogue de l'exposition, et le dépôt au MNAI: dix-huit *guadameciles* (nº 1-17 y 21), trois couvertures de coffre (Nº 18-20), et deux coffrets (24-25); à ceux-ci ont été ajoutées quatorze pièces en plus: sept *guadameciles* (Nº annexe/Nº. actuel: 24/21, 25/23, 26/02, 27/04, 35/22, 36/09, y 37/19), et sept reliures (annexe Nº. 28-34). Les Nº 36-37 sont mentionnés avec une typographie différente.

[13] On ignore si les cuirs pâtirent de ces interventions.

[14] Annexe à l'offre de vente (voir note 8). Les provenances mentionnées sont imprécises (Cordoue, Lucena, Andújar, Jaén, Puente Genil, Séville, Cabra, un village, une église), ou approximatives ("[Acquis à] un antiquaire qui l'a acheté dans un village […], M. le médecin militaire qui habitait à la caserne et possédait des antiquités […] qui les a achetés dans un village de la province, […] M. Salcedo de Madrid qui les a achetés à Cordoue, […] un antiquaire de Cordoue").

[15] Viana Nº 10 : Dimensions: 24×178 cm (chaque section, 24×58,5 cm). Inventaire Páramo, Nº 8; *Exposición de Guadamaciles*, 1924, op. cit. Nº 8; *Cordobanes y Guadamecíes*, 1955, op. cit. Nº 183, Lám. LXVIII; NIETO, Nº 17; MORENO, Nº. 18.

Figure 4 : Palais de Viana, Cordoue. Collection de cuirs, Nº. 10 (note 17).

Figure 5 : Palais de Viana, Cordoue. Collection de cuirs, Nº. 10 (détail).

Figure 6 : Palais de Viana, Cordoue. Collection de cuirs, Nº. 10. Inscription figurant au revers. Lumière ultraviolette.

de façon répétitive entre deux bandes décorées; la polychromie est éclaircie par l'usure. Au revers on peut voir les assemblages, qui ne sont pas d'origine, et qui ont été renforcés avec des morceaux de papier et de parchemin collés. L'élément le plus informatif est la mise en évidence d'une inscription à l'encre noire, avec une calligraphie cursive castillane des XVIe-XVIIe siècles, répétée sur trois morceaux, et dont le texte est "Cto. Mes. Carmelitas", qu'on peut interpréter comme "Couvent des Mères Carmélites".

Ce panneau était déjà au MNAI en 1916 (**Figure 2**); le MNAD conserve quelques fragments comparables et c'est le cas aussi d'autres musées[16].

– Viana, Nº 16 (**Figure 7**)[17]: Partie d'une tenture murale, formée de trois carreaux assemblés par collage. Le décor représente des arabesques et des rinceaux fleuris agrémentés de feuillages; la composition occupe presque toute la surface du décor. La polychromie et les feuilles d'argent sont très altérées. Ce panneau n'est pas retrouvé dans les archives photographiques du MNAI, mais le MNAD conserve quatre fragments comparables, en dépôt du MSCT, et provenant du Couvent des Carmélites de Tolède (Nº DE-16.728 a, b, c y d; **Figure 8**).

– Viana, Nº 28 (**Figure 9**)[18]: Le panneau est composé de trois morceaux de bordure horizontale, avec une bande rajoutée le long du bord inferieur. Le décor représente une succession de motifs incurvés en forme d'arc adossés solidarisés entre eux par un élément en forme de bague; le décor est complété par la représentation de lions couronnés affrontés, d'oiseaux, d'œillets et de tulipes. La polychromie est bien conservée. On ne retrouve pas cet exemplaire sur les photographies du MNAI, mais le MNAD conserve quelques panneaux dont le décor est identique (fig. 10; CE00277, CE00419, CE00423, CE00429, CE00484, CE01468 et CE27528), et un exemplaire est un dépôt du MSCT (DE 16760); quelques autres décors aujourd'hui perdus ont aussi été référencés[19].

Caractérisation de l'ensemble

Cet ensemble partage quelques caractéristiques communes. Dans tous les cas on retrouve l'existence d'une couche d'argent, quelque fois très abimée, mais on ne peut pas individualiser les feuilles. La polychromie est très voisine; elle a été réalisée avec des vernis colorés, vert pour les feuillages, rouge pour les fleurs et les animaux, avec différentes tonalités de «doré» et d'»argenté» pour les fonds, sauf pour le N° 28 qui est vert foncé.

16 MNAD (CE-00465 et DE-16.759, ce dernier dépôt du MSCT) ; *Museu de l'Art de la Pell*, Vic (Nº. 395, 712 et 938).

17 Viana Nº 16. Dimensions: 88×78 cm. Inventaire Páramo, Nº 4; *Exposición de Guadamaciles*, 1924, op. cit. Nº 4; *Cordobanes y Guadamecíes*, 1955, op. cit. Nº 56, Lám. XXVII; NIETO, op. cit. Nº 8.

18 Viana Nº 28. Dimensions: 29 ×175,5 cm. Inventaire Páramo Nº 9; *Cordobanes y Guadamecíes*, 1955, op. cit. Nº 186, Lám. LXIX; NIETO, op. cit. Nº 18; MORENO, op. cit., N° 13?

19 Par exemple, dans la collection du peintre Julio Romero de Torres (SARAZÁ, 1915, pp. 38-39).

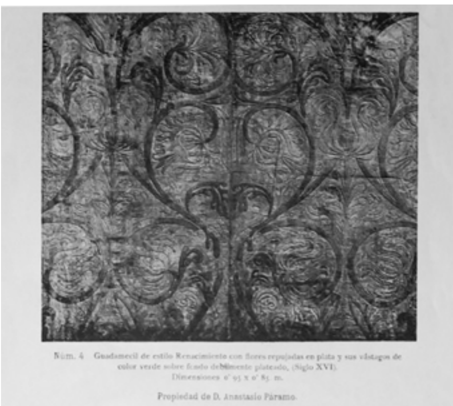

Figure 7 : Palais de Viana, Cordoue. Collection de cuirs, N°. 16 (note 19).

Figure 8 : Musée National des Arts Décoratifs, N°. DE-16.728.

Figure 9 : Palais de Viana, Cordoue. Collection de cuirs, N°. 28 (détail), (note 20).

Figure 10 : Musée National des Arts Décoratifs, N°. CE00277.

Le décor est en très léger relief avec des motifs bien individualisés et nettement définis mais leur surface est rigoureusement plane; ainsi le relief s'exprime entre deux plans dont l'un correspond au fond du décor et l'autre à la surface des différents motifs. Cet aspect n'est pas le plus habituellement observé et on peut s'interroger sur la façon dont il a été réalisé. A-t-il été réalisé selon la technique du repoussé, où la pression est exercée sur la face chair du cuir, ou au contraire selon la technique de l'estampage, la planche gravée étant alors appliquée et pressée sur la face fleur du cuir?

Par ailleurs, les motifs et la composition des différents décors sont en harmonie. Sur les carreaux du panneau de champ (Viana, N° 16, **Figure 7**), le motif principal est représenté par une branche incurvée de grande amplitude de laquelle naissent des fleurs et des feuillages, l'ensemble du décor étant symétriquement organisé. Sur une des bordures (peut-être bordure inférieure, Viana N° 28, **Figure 9**) sont représentés des motifs arciformes bagués adossés, entourés de représentations végétales et d'animaux symétriquement disposés. Sur l'autre bordure (peut-être bordure supérieure, Viana N° 10, **Figures 4-6**), figurent des *putti* ailés; cette représentation est un thème classique de la Renaissance; on le retrouve par exemple dans des sculptures de Donatello (chaire de la Cathédrale de Prato), sur des peintures (salle des Anges du palais ducal d'Urbino), ou encore sur des dessins (Raphael) ou des gravures (Marcantonio Raimondi, 1480-1532). On le retrouve encore sur la bordure supérieure de quelques tentures de cuir doré, comme celles qui sont conservées au Musée Bardini de Florence (N°. 858) (Fournet 2004, Rossignoli 2009), au MNAD de Madrid (CE-00526, CE-00542), et au MSCT de Tolède (CE-1815) (Fuente et Ocaña 2017). Toutefois on ne connaît pas de parallèle iconographique identique à ce modèle.

Par déduction, on arrive à l'hypothèse que ces trois éléments proviennent d'une même tenture, qui a été démembrée secondairement.

Nous avons enfin retrouvé des indications sur la provenance commune de l'ensemble des cuirs étudiés. Les inscriptions prouvent que la bordure des *putti* (Viana 10) provient du Couvent des Carmélites de Tolède. Pour les autres (Viana 16 et 28), il existe des cuirs identiques qui ont été achetés par l'Etat au même Couvent en 1968, et qui ont été répartis entre le MSCT et le MNAD[20].

[20] Résolution de la Direction Générale des Beaux-Arts du 22/09/1970.

Il convient de faire un bref commentaire sur le Couvent des Carmélites Déchaussées de Tolède (Martinez Caviró 1990)[21]. Cette communauté de femmes a été fondée par Sainte Thérèse d'Avila en 1570; mais elle ne disposa d'un siège définitif qu'en 1607, après l'acquisition de l'actuel couvent auprès du comte de Montalban; il s'agissait d'un palais de la Renaissance inachevé. Il fut nécessaire d'adapter l'édifice et les cours aux nouvelles fonctions, et d'ajouter d'autres structures, comme l'église, qui fut bâtie de 1626 à 1640. L'acquisition du mobilier et du trousseau s'est échelonnée entre1570 et 1626.

Concernant l'origine des cuirs de la collection et leur provenance de Cordoue, il n'existe aucune preuve autre que le témoignage de Páramo. Or on sait que vers 1902-1906 il y avait peu de *guadameciles* conservés en place dans la région de Cordoue[22]. De plus, il était difficile de rassembler une telle collection à cette époque. En conséquence, on ne peut que remettre en question la région de Cordoue comme provenance de la collection Páramo-Viana et considérer l'allégation de Páramo que comme une opération commerciale dans le contexte de l'Exposition de *Guadameciles de Cordoue* de 1924, avec ses connotations de promotion et de prestige, pour la ville et pour le marquis[23]. En revanche il est beaucoup plus logique de considérer la ville de Tolède comme le lieu de provenance des cuirs de la collection. C'était le lieu d'activité de collectionneur et de marchand de Páramo et c'était un site privilégié pour les affaires[24].

Pour ce qui est de la technique, on peut la juger atypique pour des cuirs dorés méridionaux, qu'ils soient espagnols ou italiens:

- Les cuirs ne sont pas assemblés par couture, mais par collage.
- Il y a une couche d'argent, mais on ne peut pas distinguer les feuilles.
- La polychromie est faite avec des vernis colorés ou des laques.
- Le décor est réalisé à l'aide des moules gravés, soit par la technique du repoussé, soit par l'impression.
- Il n'y a pas de ciselure aux petits fers.

Par ailleurs, le relief des motifs n'a pas la facture que l'on observe habituellement sur les cuirs dorés repoussés des Pays Bas; il est en effet peu important et aplati. De plus l'importation de productions de ce pays, à cette époque, était assez compliquée, alors que les ateliers espagnols étaient à proximité immédiate.

Comme il est fréquent, la recherche permet de résoudre certaines questions, mais elle en suscite de nouvelles qu'il faut résoudre à leur tour, comme par exemple celles-ci :

- La technique du relief aplati signifie-t-il qu'il s'agit d'une nouvelle technique ? ou bien de la mise au point du moulage ?
- Des cuirs dorés en relief ont-ils été fabriqués en Espagne ? et dans l'affirmative, avec quelle procédure, et à quel moment ?
- S'il y a eu des importations, quelles en étaient les origines ? et selon quels canaux de distribution ?

Conclusion

La collection Páramo est devenue la collection de Viana à partir de 1926. Le plus souvent il s'agit des compositions hétéroclites, réalisées à partir de différentes tentures[25]; ces compositions nouvelles, conçues par Páramo vers 1915[26], ont été conservées; elles comportaient d'importantes modifications après des manipulations diverses (voir note 13).

- Les panneaux Nº 10, 16 et 28 de la collection Viana ont des correspondants au MNAD et le MSCT. Le panneau Nº 10 de la collection Viana, porte une inscription relative au Couvent des Carmélites de Tolède, ce qui

[21] ; voir aussi, *Expédient pour la déclaration de Biens d'Intérêt Culturel* […] *du Couvent des Carmélites* […] *de Tolède, BOE Nº 305, de 19/12/1996.*

[22] RAMÍREZ de ARELLANO, 1902-06, pp. 777-778 y 1112 nº 1064 y 1616. En dehors des devants d'autel de la Cathédrale, il localise seulement quatre exemplaires (Couvent du *Corpus Christi* de Cordoue, et Couvent de Trinitaires *de La Columna* de Belalcazar); voir ÍDEM, 1901.

[23] Avant l'exposition de Cordoue de 1924, on ne connait pas de relation entre Páramo et Viana. Parmi les documents de Páramo il n'y a qu'une brève note du Marquis, qui remercie son interlocuteur des félicitations qu'il lui a adressées à l'occasion de son anniversaire en 1926.(*Archivo Histórico Nacional, Sección Nobleza, Toledo, Fondo Torrelaguna, Caja* 8, *doc*. 116).

[24] Vente d'un panneau de faïence du Couvent de la *Concepción Francisca*, de Tolède, au Musée Archéologique National de Madrid (Nº 60064).

[25] Viana Nº 15, 17, 18, 20, 22, 24, 26 y 28.

[26] Excepte le Nº 3, une imitation moderne.

permet de répondre au questionnement principal de cette étude.

- En 1968 le MSCT a acheté au Couvent de Tolède quelques autres morceaux de cuir de ce même ensemble. Nous récusons l'idée selon laquelle la collection Páramo-Viana proviendrait de Cordoue; elle a été constituée à Tolède à partir de démembrements de couvents et d'églises de cette région.

  Pour ce qui est des trois exemples étudiés, l'hypothèse la plus vraisemblable, est qu'ils sont issus d'une même tenture de cuir doré, provenant du couvent des Carmélites Déchaussées de Tolède dont l'aménagement a été réalisé entre 1570 et 1626. Des parties de cette tenture sont actuellement réparties entre la Collection de Viana à Cordoue, le Musée des Arts Décoratifs de Madrid, le Musée de Santa Cruz de Tolède et le Musée de l'Art du Cuir de Vic. Il est nécessaire d'approfondir les recherches sur la technique d'élaboration du décor, dans le but de déterminer l'atelier de fabrication de cette tenture et son histoire.

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Floor Coverings: Leather Carpets in the Papal Residences 1600 - 1730

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Abstract

The leather carpet, this perfect stranger. Brief report on 347 artefacts – either new, or repaired, or reused – described in the bills of sixteen gilt-leather trusted workers who worked for fifteen Pontiffs from 1600 to 1730 decorating halls, apartments and chapels in the papal residences. The summary of their features includes the structure, the materials and the tools employed, as well as how the decorations varied over the time. The report will also recap both the ordinary maintenance operations and the outright remakes, as well as the more drastic dismantling for the purpose of different usages.

Keywords

Damask Leather, Floor Coverings, Gilt-leather, Gilt-leather Worker, Historic Maintenance, Re-use, Leather Furnishings

Introduction

The extensive research initiated in the nineties on the occasion of the study of the leather artefacts from Palazzo Chigi in Ariccia aimed at more accurately outlining the figure of the gilt-leather worker. This also evidenced data on a specific type of furnishing that falls in the category of the floor coverings, namely the leather carpet. These sets of data are valuable because they illustrate artefacts of which no samples are apparently available and of which we had up to now only the generic descriptions present in the inventories, artefacts that thus deserve full standing in the history of the gilt and painted leather.

With reference to the topic and the period being reported here, the research carried out at the Rome's State Archives (ASR) concerned the accounts of the *Camera Apostolica*[1]. These related to fifteen Pontiffs and their Roman residences and countryside villas and more specifically concerned the documents pertaining to sixteen Palace gilt-leather workers **(Table1)**. These documents are quite detailed and thus provide a wealth of information about the materials and the structure of the gilt and the damask (also known as scorched) leather furnishings and have allowed us to trace the description of up to 347 leather carpets either new, repaired or undone[2].

Discussion

The gilt-leather workers and the papal residences

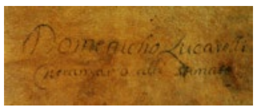
In the period under examination the gilt-leather worker is always referred to as the *coramaro*[3], the denomination derives from the word *corame*, a term that at the time assumed multiple meanings: leather, skins aggregate, leather wall-hangings[4].

The Palace *coramaro* belonged to the group of artisans included in the Pope's Family List that were in charge of the supply and maintenance of the furnishings and structures of the Papal buildings.

Two reference figures coordinated his activity, the *Maggiordomo* (Butler) issued the work orders according to the Pope's guidelines, as well as the authorizations to pay the bills. The *Florieri,* in charge of the Wardrobe (*Floreria*), received the commissioned furnishings and certified the regular fulfillment of the order[5].

During the 17th century the bills presented by the *coramaro* were subject to controls and the review was often entrusted for their evaluation to art experts, whereas at the turn of the century and during the early 18th century it more simply referred to prices agreed upon by the *Camera* itself.

Table 1: 1600-1730 List of the Popes and of the Palace *coramari*

Popes		*Coramari*	Workshops	Stamp impressions / writings
	Clemente VIII Aldobrandini 1592-1605	Pierantonio Costanzo	not found	not found
	Leone XI Medici aprile 1600	Flaminio Costanzo	not found	not found
	Paolo V Borghese 1605-1621	Flaminio Costanzo Leone di Monti	not found	not found
	Gregorio XV Ludovisi 1621-1623	Virgilio Costanzo	not found	not found
	Urbano VIII Barberini 1623-44	Rinaldo d'Alfonsi Rinaldo Barbino	RA - not found RB - *coramaro a Monte Giordano*	
	Innocenzo X Pamphilj 1644-55	Andrea Tauler Pietro Turchi	AT - *coramaro a San Pantaleo* PT - not found	
	Alessandro VII Chigi 1655-1667	Antonio Mugnaione	not found	
	Clemente IX Rospigliosi 1667-1669	Agostino Nespola	*coramaro alla chiavica di S.Lucia*	
	Clemente X Altieri 1670-1676	Andrea Tauler Paolo Ridolfi	AT - *coramaro a San Pantaleo* PR - not found	
	Innocenzo XI Odescalchi 1676-1689	Giuseppe Montori	*coramaro alli Cesarini*	
	Alessandro VIII Ottoboni 1689-1691	Giuseppe Montori	*coramaro al Gesù*	
	Innocenzo XII Pignatelli 1691-1700	Giuseppe Montori	*coramaro al Gesù*	
	Clemente XI Albani 1700-1721	Francesco Marcone Vincenzo Marcone	FM - *coramaro alla chiavica di S.Lucia incontro l'oratorio di S.Rosa e Rosalia* VM - *coramaro alla chiavica di S.Lucia*	not found
	Innocenzo XIII Conti 1721-1724	Giulio Cesare Lucarelli Domenico Lucarelli	GCL - *coramaro alle Stimmate* DL - *coramaro alle Stimmate*	GCL - not found
	Benedetto XIII Orsini 1724-1730	Domenico Lucarelli	*coramaro alle Stimmate*	

Coats of arms: from Wikipedia, "List of Popes"; stamp impressions/writings: photos by the authors, apart from the A. Tauler one published by A. Rodolfo, C.Volpi, "Vestire i palazzi", Città del Vaticano 2014, p.55.

It is finally worth noting that the artefacts were marked on the reverse side with acronyms and symbols and Table 1 reports a few stamp impressions easily attributed to the Palace *coramari* active in the period under study.

The leather furnishings, commissioned by the Pontifical Court, mainly included wall-hangings, portieres, covers and frontals and were allocated to both the Roman and the suburban residences, whereas the carpets were almost solely intended for the Vatican and Quirinale Palaces.

It is during the 17th century that the Pontiffs established in Rome a permanent double residency. Paul V Borghese was the Pope that, once the works for St. Peter and the new apostolic palace were completed, in 1606 decided to renovate and expand the Quirinale Palace changing it from summer residence, as it was customary in the 16th century, to collateral residence to account for the different tasks being performed. Those pertaining to the pastoral guidance and the liturgical celebrations would take place in the apostolic Vatican Palaces and those regarding political and organisational activities in the new Quirinale venue, whereas Paul V endorsed as summer residence the prestigious Mondragone complex. In 1623 newly elected Urban VIII initiated the construction of a new summer palace in the area of Castelgandolfo immediately identified as a Papal residence, so that the two Roman residences coupled with the summer one in Castelgandolfo became a coordinated and long-lasting complex.

The leather carpets

In the sector of the gilt-leather artefacts the modern entry "carpet" - hereby used for the sake of simplicity - was rarely adopted, and only to indicate a large cover laid flat to protect furniture tops[6]. More than one are instead the qualifying terms encountered in the bills that were examined: up to the first half of the 17th century we find either *panno da terra* (ground cloth), where *panno* was improperly used as it meant a wool or linen fabric[7], or *corame da terra* (ground *corame*), or *corame da sotto* (underneath *corame*), followed by the name of the type of furniture: table, etc. Often in the period under scrutiny the word *sotto* (underneath) was more simply adopted completed by the name of the furniture that it

Table 2: Terminology: entries recorded in the bills of the *coramari*

panno da terra	***panno da sotto (…)***	***corame***	***corame da/di terra***	***corame da/per sotto (…)***	***sotto (…)***	***strato da terra***	***strato sotto (…)***	***strato di corame***
ground cloth	cloth underneath (…)	corame	ground corame	corame underneath (…)	underneath (…)	ground «layer»	«layer» underneath (…)	«layer» of corame
L.De Monti 1607-10	L.De Monti 1610, 1613		P.Costanzo 1600	L.de Monti 1605-07				
			L.de Monti 1605-13		L.de Monti 1607, 1611			
F.Costanzo 1616-19			F. Costanzo 1616-19	F.Costanzo 1605				
D'Alfonsi 1623					F.Costanzo 1615			
R.Barbino 1623-32, 1646		R.Barbino 1634	R.Barbino 1635-39	R.Barbino 1635-39				
A.Tauler 1646								
A.Mugnaione 1655-60					P.Turchi 1651	P.Turchi 1651		
			A.Nespola 1668-69	A.Nespola 1668-69	A.Mugnaione 1655-62		A.Mugnaione 1655	
						A.Nespola 1668-69		
					A.Tauler, P.Ridolfi 1671-75	A.Tauler, P.Ridolfi 1670-75		
					G. Montori 1679-1700	G. Montori 1684-1700		
					V. Marcone 1700-14	V. Marcone 1700-14		
						G.C.Lucarelli 1721-25		
						D.Lucarelli 1724-30		D. Lucarelli 1728-29

referred to, e.g. underneath the chair. Starting from the second half of the 17th century we begin to find the term *strato*[8] ('layer') used by itself or also by adding "ground" or "underneath", flanked in the early 18th century by "*corame* 'layer'" **(Table 2)**.

The carpets were required to cover the floor of the baldachins, to be placed on the ground along one or more sides of the beds, under tables, chairs, kneeling-stools, on the stairs of the altars and on the floors of either the rooms being used daily or the large salons where the cardinalitial Committees would reconvene or the public hearings would take place. They were made up by damask or silvered or gilt leathers, were frequently finished off all around by ample friezes and almost always completed by hems or borders **(Table 3)**.

Table 3: Amount and approximate size of the leather carpets

Carpets	New	Repaired	Re-used	Approximate size
for the beds	59	18	2	from 6 to 18 sq.m
for the baldachins	73	28	8	from 8 to 16 sq.m
for the tables	10	1	0	from 6 to 13 sq.m
for the chairs	34	0	0	from 2 to 12 sq.m
generic	55	41	14	from 6 to 115 sq.m

The carpets meant for the beds are among the more numerous: 59 new ones and many those that were repaired, especially from the end of the 17th Century. Two locutions were used: "underneath the bed" that rather meant "at the foot of the bed"[9] and it referred to rectangular or square carpets and "around the bed"; in the second case there are either the "ground" ones dubbed as "seven shaped" and hence laid out along two sides of the bed or the "three-faced" ones and thus placed on three sides; among the latter ones there is one allocated in 1628 at the Quirinale palace for the bed of Urban VIII to which in the following year a fourth "face" was added, "placed at the wall band"[10].

The carpets allocated to the baldachins are equally numerous, 73 the new ones and - starting from the last quarter of the 17th century - several those repaired or undone to be differently used. The glued skins were nailed onto the footboard or reinforced on the back along the perimeter. These carpets, always finished with hems mostly of the same material, were often outfitted with fringes and cascades to conceal the thickness of the footboard.

The ten carpets to be placed under the tables requested between 1605 and the third decade of the 18th century were all destined for the Pope's dining tables, except for one that in 1723 goes "under the table where Our Lord writes"[11]. The number of those to be placed under the chairs is limited; 34 have been traced, mainly reserved for the chairs destined for the Pope.

In 1605 Lion XI Medici, in his only month of reign, commissioned a great number of leather artefacts, among which as many as 14 carpets, six of which were simply intended for covering the floors. Since then and up to 1730, 55 carpets of the same type have surfaced whose sizes vary from 500 to 12 skins, 41 – plus a large unspecified number – had been repaired and 14 were undone and intended for reuse. While the bigger ones were allocated to the rooms reserved to the Consistory that periodically hosted the Cardinals' Assembly, the remaining ones were distributed among the rooms assigned to the Audience and the S.Offizio, as well as the rooms of various apartments in the pontifical residences **(Table 4)**.

Table 4: Location and approximate size of the leather carpets not related to furnishings

Location	Approximate size
Concistoro halls	from 85 to 115 sq.m
Concistoro winter halls	11 sq.m
Congregation of the *S.Uffizio* halls	from 10 to 30 sq.m
Audience and Congregations halls	from 9 to 25 sq.m
Apartments	from 6 to 50 sq.m

In the 18th century Pope Albani commissioned many gilt-leather artefacts. In particular he ordered 37 carpets and had another 25 repaired. He even had one made for his private chapel, a so-called "*stratino*" (small carpet) "where the Pope would kneel" [12].

This concise list ends with three isolated artefacts: a turquoise sumac carpet that in 1617 covered the staircase of the altar of one of the Quirinale chapels; in 1663 one was placed under the kneeling-stool in the private chapel of Alexander VII[13]; lastly, in January 1722 the *coramaro* Lucarelli delivered a "three faced" carpet to be positioned around three sides of a canapé placed in the apartment of Benedict XIII at the Quirinale, carpet that nine months later had to be repaired because it was already worn out[14].

Characteristics of the skins

The bills of the *coramari* include a series of references, albeit concise and partial, to materials, tools and procedures aimed at qualifying the product and justifying the expense.

The square and decorated skin represented the unit price which defined the cost of the furnishings and thus the number of the skins, including the smaller formats of the various decorative parts (the half skin, the one-third skin, the two thirds-skin) was accurately calculated. More than the labor and the materials used for the decoration, the cost of the finished skin was affected by the skin itself: namely by its integrity, its quality and its dimensions. Intact skins, without joints and inserts, were the most precious and expensive. Origin and tanning procedure denoted their quality. Fabriano appears to be the main procurement centre in the first half of the 17th century at least, while we learn that the sumac was the more valued for manufacturing the damask white carpets.

As for the dimensions of the skins the *coramari* alternatively complied with two measurement systems: a 'local' and thus Roman one that discerned between "ordinary size" and "large size"[15], and one that referred to the measures adopted by main production centres in the Iberian peninsula - namely those adopted in Cordoba, in Barcelona and more generically in Spain - thus attesting the adhesion to the model of excellence represented by the "Spain's *corami*" particularly appreciated by the Pontiffs and still in use in the first part of the 17th century[16]. The *pellone*, a skin double the size of the "ordinary" one[17], is by all means part of the "large sizes". Also a "large" one would be considered a skin with Spanish measures[18], among which in particular, as reported by Pierantonio Costanzo in one of his bills[19], the one from Cordoba. Once the 17th century is over the Spanish measures were abandoned, while the local ones tended to even out towards ordinary formats: "skins of the usual size".

The decoration of the carpets

The manufacture and decoration of the carpets did not substantially diverge from those of the other leather furnishings except for the very moderate use of the coats of colour due to the rapid, inevitable wear caused by the footsteps and the presence of the furniture. The skins were worked according to the traditional techniques: damask, silvered, gilt and then variously decorated. The predominant tonality of this type of artefacts is subject to variation in time in a rather uniform manner, except for the large carpets destined to the salons of the Consistory always rigorously white, enlivened by gilt hems starting only from the seventies.

The damask skins were continuously used to make carpets even of great dimensions, by themselves or in combination with gilt or silvered skins arranged all around as friezes and borders or simple hems. Despite the wide array of colours allowed by this technique, the skins selected for the carpets of the pontifical residences were uniquely red or white. It must be specified that the term "white" used in the bills is not to be intended as a veritable and proper colour, but rather as the actual tonality of the natural, not dyed leather and its frequent usage testified by the bills can be easily ascribed to the faint hue of the sumac tanned skins. The ornamental repertoire was vast and included both the decor typical of the damask cloths, such as checked, flowers, brocade patterns, etc., and the inevitable Pope's insignia or his heraldic emblems. Columns motifs run all along the perimeter only in the large carpets realised for the salons of the Consistory under Paul V.

It must be noted that the expression normally used by the *coramari* is "skins worked in damask mode", but also "*traboccate*" skins occasionally turns up[20]. The term is probably related to that of a specific tool used for the stamping of the skins[21], an unnamed tool, but accurately described and illustrated by Peder Månssons **(Figure1)**, that reveals an extraordinary similarity with the siege engine called trèbuchet (*trabocco*[22]). This connection seems to be validated by a notary deed from the second half of the 16th century related to a controversy about harassing noises caused by the work in progress in the shop of a *coramaro*, where among the implicated tools a *trabucco* is also mentioned[23].

(b)

(a)

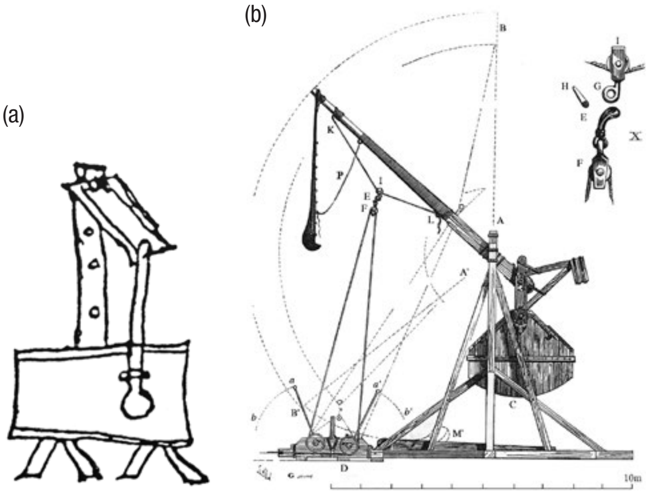


Figure 1: Trebuchet (*trabucco/trabocco*): a) instrument used to stamp damask skins, b) siege engine.
(a) drawing by Peder Månssons, beginning of the XVI century (see note 21), b) from Wikipedia, "Trebuchet")

The silvered skins were in use for a relatively short period that goes from 1605 to 1621, under the pontificates of Lion XI and Paul V. We are talking of a limited number of samples (13 altogether that include carpets for beds, chairs and baldachins), but it is striking how many different decoration techniques were adopted: some skins were punched with ornamental and at times elaborate motifs, e.g. brocade patterns, others were embossed or stamped and outlined with different colours, chiefly red or incarnadine and finally also damask, obtaining through this peculiar stamping procedure (skins *traboccate*) the burnishing of the metal leaf according to the selected decorative motif [24].

Carpets realised entirely with gilt skins were annotated in the bills beginning from the pontificate of Urban VIII (1623-1644) and their use lasts through time. There were few variations in the decoration techniques. The skins were simply gilt (*oro liscio*) and thus lacking whatever ornament or rather stamped in more or less extended mode by means of punching tools (*ferri*). The Pope's coat of arms or the heraldic motifs that marked it were usually an integral part of the decoration and were normally placed in the point of greater visibility, i.e. in the corners (*cantonate*) of the carpet. As said, the use of the colour was sporadic, chiefly reserved to perimetral parts as fringes and friezes or, at times, to hems of coloured ribbon, generally crimson. To realise the elaborate composite structure of the coat of arms using gilt skins only the *coramaro* had special pattern tools (*ferri a disegno*), presently not included in the decorative repertoire of the tools in his workshop **(Figure 2)**.

Figure 2: Example of a Pope's coat of arms carried out using pattern tools (*ferri a disegno*): parchment binding of a bill by the *coramaro* Rinaldo D'Alfonsi for Urban VIII Barberini, GT 52, 1623. (by permission of Ministero per i Beni e le Attività Culturali)

Among the up to now known treatments of the leather, traditionally performed by the *coramari*, an innovation was represented by the suede skins, mentioned in one single bill of 1690 relative to the manufacturing of a large carpet composed in fact by "yellow dyed suede skins"[25].

Once decorated, the skins were united by stitching or gluing. The bills indicate that the perimeter of the larger carpets was reinforced with canvas bands placed on the back, and that on the footboards of the baldachins the carpets were secured with tacks. However, the informations on the assembly and installation modes are sporadic and they can rather be deduced by the periodic maintenance operations.

Maintenance and re-use

Due to the use they were subjected to, the carpets would rapidly deteriorate and the maintenance operations were performed at relatively short intervals. If we for instance focus on the vicissitudes of the large carpets of the salons of the Consistory, we learn that the repair works were executed with an almost yearly frequency.

Multiple operations were performed regarding both the structure and the decorative layers. The carpets were unstitched, or cut out if glued, to eliminate or consolidate the deteriorated joints of the skins, while the broken and worn out parts were patched. In specific cases the damaged skins were removed, thus reducing the size of the carpet[26], or they were switched to a less visible position[27]. The carpets made with glued skins once repaired were often stretched out (*stirati*) tacking them temporarily to a wall[28].

The skins were destained and washed with sponges soaked mostly in wine. They were further treated re-gilting them where needed, re-stamping them where the colour had flaked off, punching where necessary the surface[29]. The damask skins were instead again dyed and re-stamped[30].

When the excessive wear prevented their maintenance the carpets were dismantled and reassembled changing their destination and use. Once undone, the better skins were selected and then patched up if necessary and at times redecorated[31]. From the documents that were traced it turns out that solutions of this kind were adopted starting from the thirties of the 17th century and that they almost exclusively concerned the carpets that covered the base of the baldachins and those assigned to the floors of rooms and salons designated for official ceremonies. It will suffice the example of the two Consistory's large white carpets of *traboccate* skins which - during the reign of

Urban VIII - were converted into wall hangings for two rooms of the Quirinale, once they had been silvered, gilt, stamped, enameled[32]. Generally, if the carpets were too shabby they were used only to obtain covers for tables, small tables, box-beds or at times portieres or cushions.

The cost of the interventions was always calculated in man/days while a separate count was kept for the materials such as glue, thread, leather patches, sponges, wine, gold varnish, new skins used for hems and replacements, etc.

Conclusions

In conclusion, it is open to debate whether the accurate descriptions provided by the documents will not only contribute to the history of the gilt and painted leather, but also aid in locating samples of these valuable but forgotten artefacts among the innumerable but fragmented specimens available.

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1 The Roman Catholic Church financial and administrative body.

2 The documents are contained in ASR, Camerale I, Giustificazioni di Tesoreria. The text will refer to: GT followed by the n° of the binder, by the name of the gilt-leather worker and by the date.

3 *“.. quegli che faceva i cuoi d’oro, detto così dal mettere a oro le pelli”*, in Vocabulary of the Academics of the Crusca (hereafter referred to as: Crusca), IV ed., 1729, vol. 3, p. 432.

4 *“Aggregato di cuoi. Paramento di cuoi”*, in Crusca, Giunte alla III ed.,1691, vol. 1, p. 342.

5 For data on the Pope’s Family List see: A. Menniti Ippolito 2004, pp.175-209.

6 In the documents analysed the term *tappeto* (carpet) appears only once and it refers to a cover, in GT 60, R.Barbino, 1627.

7 *“Tela di lana, o di lino”*, in Crusca, I ed., 1612, p. 590.

8 The word *strato* meant *pavimento* (floor), see: Crusca,II ed., 1623, p. 846. The term *pavimento* indicates a carpet in an inventory of 1588, in Bonnot-Diconne C. 2016, p. 299.

9 *“ .. si è fatto un panno da sotto letto .. quale serve attorno al letto* (around the bed).. *a Monte Cavallo ..”*, in GT 39, L. di Monti,1613.

10 GT 63, R.Barbino, 1628 and GT 63, R. Barbino, 1629.

11 GT 470, G.C.Lucarelli, 1723.

12 GT 359, F.Marcone, 1711.

13 GT 159, A.Mugnaione ,1663.

14 GT 470, G.C.Lucarelli, 1722. A canapé is an elegant kind of sofa created in France during the Louis XV period.

15 There are no documentary data apt to provide indisputable numerical values, but based on a validation carried out on a significant sample of 17th century furnishings of Roman production it seems plausible to attribute to the “ordinary size” the skins with a surface ranging from 0,19 and 0,29 sqm and to the “large size” those in the interval between 0,40 and 0,50 sqm.

16 As an example see GT 35, L. di Monti 1610-12. In 1612 the Palace *coramaro* Leone di Monti was engaged in the assembling of 7.242 skins coming from Spain to be allocated in various locations within the Quirinale Palace, in ASR, Registro dei mandati camerali, Busta 991.

17 GT 86, R.Barbino, 1639.

18 Complying with the dimensions established in the ordinances of the corporations of the *guadamacileros* of Cordoba, Madrid and Barcelona, the surface of the “Spanish” skins ranges from 0,32 to 0,34 sqm. See Ferrandis Torres J. 1955, pp.29-33; Madurell Marimon J.M. 1973, pp. 21-23.

19 P.Costanzo, *“N.ro 4 pezzi di Corami (…) sonno pelle da Fabriano lavorate alla misura di Spagna la più grande che ci sia, alla Cordovesa”*, in GT 26, 1598.

20 See, for instance, GT 63, R.Barbino, 1629.

[21] Johannsen O. 1941, pp. 169-170, chapt. 27. See Calnan C., Paris M. 2007, pp. 6-11.

[22] "*trabocco: strumento bellico da gittare*", in Crusca, I ed., 1612, p. 895.

[23] ASR, Notai Auditor Camerae, busta 6029, c. 933r, notary Pirolus, 1566.

[24] GT 43, F.Costanzo, 1617.

[25] "*pelle gialle scamosiate e tinte n° 208*" , in GT 239, G.Montori, 1690.

[26] GT 379, V.Marcone, 1713.

[27] GT 359, F.Marcone, 1711.

[28] GT 270, F.Marcone, 1701.

[29] GT, 219, G.Montori, 1684; GT 258, G. Montori,1699; GT 47, F. Costanzo, 1620; GT 379, V. Marcone, 1713.

[30] GT 270, F.Marcone, 1701.

[31] See for instance: GT 270, G.Montori, 1700.

[32] GT 63 - R.Barbino, 1629.

Biographies

Mara Nimmo: degree in Art conservation in the sector of paintings, with four years of post-graduate courses in paintings conservation and in training of conservators at the Istituto Centrale del Restauro in Rome (ICR). Degree in Humanities with a three year post-graduate diploma in Medieval and Modern Art History, Università degli studi di Roma "La Sapienza". From 1975 to 1998 she was first a conservator and then an art historian at the ICR, where in 1987 she established the section for the conservation and restoration of leather artefacts and its conservation studio, which has the responsibility of carrying out studies, research and experiments in the sector. Amongst other duties, she taught the history of artistic techniques at the Arezzo campus of the Università degli studi di Siena up to 2005. She has published extensively on technical subjects.

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Conserving Gilt Leather in the Netherlands

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Abstract

Conserving gilt leather has a long history. Only rarely gilt leather wall hangings or other objects made of gilt leather show up that have never been treated in the past. In the Netherlands the most important and influential gilt leather conservators were Jan C.M. Mensing (1869-1952) and Henk A.B. van Soest († 2005). These two craftsmen have been working on circa 60% of the surviving gilt leather wall hangings within the Netherlands. Aside conserving old gilt leather wall hangings, Jan Mensing did make several new ensembles. Henk van Soest on the other hand specialized in conservation.

An on-going documentation-project in the Cultural Heritage Agency of the Netherlands has identified altogether 19 different craftsmen and/or workshops who have been conserving gilt leather wall hangings since the mid-19th century. By collecting the data from all different conservation treatments, much can be learned about the condition of the existing wall hangings, about the effect of specific treatments, and above all this this overview provides valuable information about future conservation needs.

Keywords

Gilt Leather, Wall Hangings, The Netherlands, Cultural Heritage Agency, Conservation, Restoration, Tarnishing, Silver Foil

Monday, April 11, 1746, the new 'Leydse Courant' was distributed. In 1746 this newspaper was published three times a week: on Monday, Wednesday and Friday. This issue started with news from Spain: the arrival of a shipload from Cuba with gold coins, silver, sugar and a variety of various products amongst which, interesting in the context of this conference, 1200 unprepared skins for commercial purposes. The War of the Austrian Succession was on that moment in full swing. There was news about many other ships and their cargo's, news from Sweden and France, most of it war related. In the margin of the newspaper were, as usual, various advertisements: Amsterdam merchants offering music-books and fashionable floor-carpets; A Leyden bookprinter offering a newly published book; The offer of a world famous English cream against Arthritis; The announcement of an auction of sculptures on a country estate; And more relevant for us, the advertisement of a Leyden wall-hanging manufacturer: "*In Leyden on the Breestraat near the Choorlammer-alley, Wall-Hangings are being made, painted with oil paints on wax cloth, of about 1,5 ell wide, which are resistant –much better than other hangings– to the dampness of the walls, and will not crack nor fall down by the frost; Also prepared painting cloth is being produced from 1-10 ells wide; Gilt leather and paintings can be cleaned 'as being 'new', no matter how dirty these are*".[1] With slight variations, this advertisement was published several times from 1742 up to 1769 in both the 'Leydse Courant' and the 'Amsterdamsche Courant'.[2] Fascinating is the version from May 21, 1749, in which both the name of the owner of this workshop is mentioned, J. Egmond, and a slightly extended description of his services: "*gilt leather can be cleaned 'as being 'new', provided that the gold colour has not eroded*".

Obviously there was a demand for the cleaning and conserving of gilt leather wall hangings in those days. It is known that there was a substantial number of gilt leather hangings in the Netherlands. For instance, on the most important part of the Rapenburg, one of the big canals of Leyden, at least 26, of the 65 houses in total, had during the 17th and 18th centuries gilt leather hangings, counting in total 60 gilt leather rooms. Some of these we know by their deliveries, others are mentioned in probate inventories. Of all these gilt leather hangings, not a single snippet has survived today.[3] In the city of Leyden alone, there will have been altogether a couple of hundred gilt leather rooms during the 17th and 18th centuries.

Egmond was definitely not the only person offering his services to clean and conserve gilt leather hangings. Another one was Bruyn Jansz Bruyning from Amsterdam. On March 20, 1668 he advertised in one of the other Dutch newspapers, the '*Oprechte Haerlemse Dinsdaegse Courant*', that he had started up his business: "*to renew gilt leather, take it off, to renovate it either in situ on the walls, or in his own workshop, at ones wishes, all for a very neat price, as he is very experienced in this work*".[4] At that very moment, there were in Amsterdam ten different gilt leather factories active, which did produce all together quite a substantial quantity of gilt leather panels and hangings. There is no doubt at all, that they must have been familiar with the problematic aspects of the maintenance and restoration of their products.

From archival researches many references for repairs, conservation and re-use are known. Various documents have been traced, talking about re-varnishing, re-painting, re-stitching, re-hanging, and/or re-nailing of gilt leather hangings, and sometimes of replacing individual gilt leather panels. For instance in 1636 the gilt leather company in The Hague was paid for the delivery of seven gilt leather panels, three lower borders and three upper borders.[5] Given this curious combinations of panels and borders, these must have been used for repairs. Much more evident is the payment in December 1707 of the Amsterdam gilt leather maker Martinus van den Heuvel: He was being paid for the replacement of 44 panels that were in bad shape in the audience room of one of the guesthouses in the city.[6] Quite likely he replaced those panels in bad shape with new gilt leather panels from his own factory. In several other cases, however, old, second-hand gilt leather panels are being referred to. Illustrative is a note to one of the gilt leather hangings that is listed in the probate inventory of the Dutch palace Honselaarsdijk in 1755. In the margin of this inventory is written: "*This hanging has been taken down to be used for repair work on other hangings*".[7] Several invoices for repair work do explicitly mention the costs of old leather panels that were used for the repairs and probably the replacement of damaged panels.

The repair by the Middelburg paper hanger Willem van Heulen was carried out in a very different way. In 1765 he was asked to work on a gilt leather hanging in one of the rooms of the guesthouse of the provincial government. He decided to fix the leather hangings securely to the walls, altogether with not less than 3.991 brass nails.[8] The good thing is that he had chosen for brass nails, instead of iron ones. But nonetheless, these nails will have prohibited any movement of the leather. Today, we have quite different thoughts about the best way to hang leather wall hangings. Willem van Heulen however, was definitely not the only one who did choose for this approach. Nails are often mentioned in archival documents for fixing the leather wall hangings. Most of these will have been iron nails, some brass, and occasionally there is a reference of 'tinned nails'.[9]

Without any doubt all craftsmen, whatever their background, will have done the best they could: gilt leather makers, paper-hangers, painters, and sometimes even saddlers. As the invoice of a saddler for repair work in 1745 on one of the leather wall hangings in the town hall in 's Hertogenbosch was extremely low –only about 4 Dutch guilders–, we can presume that his work was restricted to do some re-stitching and nothing else.[10]

The tarnishing of the silver leaf of gilt leathers is a much observed degradation phenomenon. This is, as we all can presume, a very old problem. In the probate inventory from 1759 of the castle of Buren, one of the castles of the Dutch stadtholders, a wall hanging is listed of: "*silvered leather, however through time and atmosphere very worn down*".[11] In 1709 the silvered leather wall hanging of Louis Victor in Amsterdam will have been in a similar condition. The first quote he received for overpainting it, he considered as too expensive, for which reason he did ask another painter to do the job.[12]

All together quite a few invoices are known which are talking about restoring gilt leather hangings by applying varnish- and wax-layers. The Leyden paper hanger and decorator Paul Marron (active in the years 1720-1740) always applied wax coatings, both at the installation of new gilt leather wall hangings, and when he was restoring old ones. While his fellow townsman Cornelis van Hoogeveen usually applied a varnish coating.[13] Others, as the paper hangers Willem van Heulen from Middelburg and Hendrick Schoonhuysen from Gouda, applied a '*gilt leather varnish*' to restore the old shine and clarity.[14] The Frenchman Fougeroux de Bondaroy advised in his booklet '*Art de Travailler les Cuir Dorés ou Argentées*' from 1762, to use for this purpose a layer of glue, turpentine, gum Arabic or egg white.[15] This recipe was used in the '*Encyclopedia*' of Diderot and Le Rond d'Alembert from

1776.[16] Both these two sources pointed out one of the other major threats for gilt leather wall hangings: due to solar heat the varnish would contract, causing irreparable damage. Both of them were therefore of the opinion that gilt leather was much better off in damp rooms, than in dry and sunny rooms. Hardly anyone of us will doubt this. However, we have to take into account where this was written up. As the French climate is not identical to for instance the English climate. The values of both solar heat and dampness were, and are, in these countries quite different, as we all know. So, we shouldn't have any doubts about the words of the London gilt leather maker John Conway. In an advertisement from 1738 he stated that his leather hangings were '*not being liable to be spoiled or damaged by the damps in* [the] *winter*'.[17] Too much damp is indeed, not a good thing either.

Of all maintenance and restoration problems, the removing of surface dirt, often dust, insect dirt or soot, will have been one of the easiest issues to solve. In 1732 the London gilt leather maker John Hutton advised the Leyden merchant Daniël van Eys about the cleaning of the gilt leather hanging he had recently acquired from him: "*To keep your gilt leather hanging clean and neat, to prevent that smoke or coal dust will spoil it, it must be maintained well, once every six or two months with a clean, dry, and very soft cloth, and if it needs to be cleaned of the dejecta of flies or some other insects, this should be washed off with cold, clean rainwater, without fear of spoiling the painting or the gilding*".[18] Soot-deposit was a big culprit, as we can learn also from the words of Jan Wijnkoop, caretaker of the Amsterdam town hall in 1692. He was asked for his opinion on a sample for a new gilt leather wall hanging for one of the rooms in the town hall. The chosen ground colour of the hanging didn't appeal to him. He advised: '*to make the pearl-colour slightly more blue, as this would help to make the hanging more durable, as they were used, within the room this hanging would come, to light the fireplace up strongly*'.[19]

In what frequency gilt leather hangings have been repaired and conserved is hard to say. In most cases it is impossible to link any surviving archival documents to a specific hanging. An exception to this rule is the gilt leather wall hanging in the room of the councilmen in the town hall of 's Hertogenbosch. This hanging was hung in 1763 by the local paper hanger Caspar Reijts who was paid for this hanging and his work altogether 422 Dutch guilders.[20] This gilt leather wall hanging is still in existence (**Figure 1**). Obviously, the councilmen had chosen at that time for a very fashionable pattern: long vertical panels of about 79 centimeters wide with a pattern that can be linked to contemporary silk designs. Just over a century later, in 1882 this hanging was repaired by J. Krijbolder, a local paper hanger from's Hertogenbosch.[21] Only 30 years later, the Dutch gilt leather maker and conservator Jan C.M. Mensing (1869-1952) had to do the work again (**Figure 2**).[22] Mensing's invoice is surviving, but of much more interest are the reports in the local newspaper in which Mensing's restoration is described in detail.[23] According to Mensing, the gilt leather was repaired by

Figure 1: The room of the councilmen in the town hall of 's Hertogenbosch (the Netherlands) with the gilt leather wall hanging supplied and hung by the local paper hanger Caspar Reijts in 1763. Photo Cultural Heritage Agency, 2004

Figure 2: The Dutch gilt leather maker and conservator Jan C.M. Mensing (on the left) in his Amsterdam workshop together with three assistants. Photo from: J.Ph. Wormser, 'Het Goudleder', Bouwkunst, 5 (1913) pl. 52.

Krijbolder in an improper way. The wooden panels on which he had glued the leather, needed to be taken of; subsequently Mensing transported the leather to his workshop in Amsterdam to be conserved. The way Jan Mensing attached the leather back on the walls – with brass nails, retouched in gold-colour – is described in detail, even as his finishing touch: the application of a mastic-varnish, and subsequently a special produced wax, made of lavender- and poppy-oil, this to give the leather a soft gloss. Mensing even replaced two panels by new copies that were –according to the newspaper- at that time hardly distinguishable from the others, and actually they still are.

In 1994 this gilt leather wall hanging had to be conserved again, for the third time, in 112 years. This time the work was carried out by the late Henk A.B. van Soest († 2005), gilt leather conservator in The Hague **(Figure 3)** Aside his own workshop, Van Soest had a part-time appointment at the '*Central Research Laboratory for Objects of Art and Science*' in Amsterdam. Henk van Soest, a well-known leather conservator, did spend most of working life on the conservation and restoration of gilt leather wall hangings.

Figure 3: The Dutch gilt leather conservator Henk A.B. van Soest at work in the town hall of 's Hertogenbosch, 1969. Photo Cultural Heritage Agency/ Central Laboratory, 1969.

Together, Jan Mensing and Henk van Soest did conserve and/or restore a substantial percentage of all Dutch gilt leather wall hangings. Jan Mensing was in the first half of the 20th century the person to go to. Altogether, he has conserved, together with his assistants, on at least 19 different gilt leather ensembles in the Netherlands. Aside this, he has produced several new gilt leather hangings. At this moment 5 new gilt leather wall hangings made by him are known, but probably there will be more. More recently, in the years 1966-2000 the late Henk van Soest has been working and/or advising on at least 60 gilt leather hangings within the Netherlands, either within the '*Central Research Laboratory*' in Amsterdam, either in his private workshop, the '*Maatschap ten Behoeve van het Restaureren en Conserveren van Goudleer*' [= '*Partnership for the Restoration and Preservation of Gilt Leather*'] in The Hague. Together, Van Soest and Mensing have been working on circa 60% of the surviving gilt leather wall hangings within the Netherlands. This is a very substantial number. The impact of their treatments is large, as are of course the effects of the treatments of all other craftsmen who have been working on these gilt leather hangings.

As it will be very welcome for future conservation projects to know as much as possible about previous conservations, a documentation project has started to collect as much information as possible about the treatments in the past. In this on-going project, information is collected from all sorts of sources. Primary, with the help of a trainee, the archives of the former 'Central Research Laboratory' and the '*Netherlands Department for Conservation*' [='*Rijksdienst voor de Monumentenzorg*'] have been researched.[24] These two institutes have merged into one organization: the present Cultural Heritage Agency of the Netherlands. The archives however are, as can be expected, not all in the same place. Files have been collected from the former Central Laboratory and its successors, and from three different sub-archives from the '*Netherlands Department for Conservation*'. Another archive, that of the State Art Collections –another department within our offices–, is waiting to be researched: there will be some documentation-files about the conservation of a few gilt leather screens. Aside these archives there is another important source for information, the historic newspapers. Thanks to the digitization, newspapers turn out to be a rich and almost never-ending source. All kinds of information pops up from this valuable source, as cited above. In The Netherlands we have the website 'Delpher.nl', initiated by the Dutch Royal Library, where a substantial part of the historic Dutch newspapers are available in digital form.

Aside the archives of the Cultural Heritage Agency and the Dutch newspapers, data will also be collected from other places: local archives, museums, etc.: reports and other relevant documents. Extracting relevant information from published material and articles (as for instance the ICOM-CC post- & preprints) will deliver further information from which we can learn about the treatments of individual hangings during the years. The driving questions for this project are: *When was done what, by who*? By doing so, we will get a much better understanding of the restoration history of the Dutch gilt leather rooms in recent times, which will be of huge help for future projects. Even though this documentation project just started about in January 2019, and several figures need to be verified, the first outcomes are very worthwhile.

Altogether, we do know at this moment about 113 different gilt leather projects in the Netherlands: counting all gilt leather hangings in situ, various panels in museums (dating from the 17th up to the 20th centuries), and one or two gilt leather screens. Up till now not less than 19 different craftsmen and/or workshops have been identified who have been working on this material since the mid-19th century. The chart in Excel we are using is simple and effective, though it is growing large. It holds the basic information on the locations and addresses, the names and years the craftsmen and/or restorers have been working on the specific items, and subsequently the references to the documentation files and literature. The documents themselves are stored digitalized, integrated and easily accessible, in the just updated central registration system of our offices. As the Excel–chart is set up in chronological order it can be seen at a glance when conservation-work was carried out on a specific hanging. But also the opposite: it can easily be discerned where –without a sudden catastrophe of course– it is expected that conservation work might or needs to be done in the (near) future. This was an unexpected outcome. This is an aspect that some of my colleagues who are dealing with planning and heritage grants, are very much interested in, and –as can be expected– all Dutch gilt leather conservators!

As mentioned above, Henk van Soest has been working on about 60 gilt leather wall hangings. 31 of these hangings have been conserved during the last 15 years by other conservators. All of them had to replace the elastic textile Lycra that Van Soest always applied to keep the leather stretched. In all of these cases the Lycra was disintegrated and had lost its elasticity. Without one single exception, the Lycra was replaced by other hanging systems. Due to its decay, all other Lycra attachments are waiting to be replaced in the near future. Studying the Excel-chart in detail with this issue in mind, we do know rather precisely what conservation challenges we are facing. This documentation project will be continued the coming years. The files will be completed and supplemented from other sources. Not only will the collected material be analyzed and researched, but also completed with condition reports of the various gilt leather hangings. Realizing this, the conservation-challenges and -needs of all Dutch gilt leather hangings will become visible.

A few decades ago an overview of gilt leather hangings in the Netherlands was completely lacking. Up till the mid 1980's we didn't have any clue how many gilt leather hangings there were in the Netherlands, in what locations, how they looked like, of what age, we had no idea about their history and provenance, let alone their condition. Since then, the situation changed radically: from all aspects the level of knowledge is increasing. It is a process in progress.

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Biography

dr. **Eloy Koldeweij** (1959) studied History of Art at the Leiden University, The Netherlands, and specialized in historic interiors and gilt leather. In 1998 he got his Ph.D. on Dutch gilt leather at the Leiden University. Since September 1997 he is working as a specialist on Dutch historic interiors at the Cultural Heritage Agency of the Netherlands. He is co-founder and former board member of the Dutch Wallpaper Society, the Dutch Interior Society and the Gilt Leather Society. He has published and lectured extensively on various aspects of the historic Dutch interior, and gilt leather.

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[1] 'Te Leyden op de Breedestraat, by de Corlammersteeg, maakt men KAMER-BEHANGZELS, met Olyverw geschilderd op Wasdoek van een en een half El breed ," die beeter als andere Behangzels tegen het Vogt der Muuren bestaan kunnen en niet bersten of afvallen zullen; Men maakt daar ook gepIumuurt SCHILDERDOEK van 1 tot 10 Ellen breed, zonder naaden; Ook word daar *GOUD-LEER* en SCHILDERYEN, hoe vervuild dezelve ook zyn, als nieuwe schoongemaakt; Men verkoopt daar ook GAAS voor Chassinetten.' In: *Leydse courant*, 11/04/1746 no. 43 p. 1.

[2] *Leydse courant*, 23/04/1742 no. 49 p. 2; 25/04/1742 no. 50 p. 2; 29/07/1743 no. 90 p. 2; 09/12/1743, no. 147 p. 2; 03/09/1745 no. 106 p. 1; 09/05/1746 no. 56 p.2; 24/08/1746 no. 101 p. 2; 15/04/1748 no. 46 p.2; 10/03/1749 no. 43 p. 2; 21/05/1749 no. 61 p. 2; 08/03/1751 no. 29 p. 2; 10/05/1751 no. 56 p. 2; 10/04/1752 no. 43 p. 2; 23/04/1756 no. 49 p. 2; 13/02/1758 no. 19 p. 2; 13/03/1758 no. 31 p. 2; 26/02/1759 no. 25 p. 2; 31/03/1760 no. 39 p. 2; 05/04/1762 no. 41 p. 2; 12/05/1762 no. 57 p. 2; 10/02/1764 no. 18 p. 2; 09/03/1764, no. 30 7.2; 10/04/1764 no. 44 p. 2; 01/04/1765 no. 39 p. 2; 20/05/1765 no. 60 p. 2; 09/03/1768 no. 30 p. 2; 14/03/1768 no. 31 p. 2; 27/03/1769 no. 37 p. 2; *Amsterdamsche Courant* 12/08/1760 no. 97.

[3] E.F. Koldeweij, *Goudleer in de Republiek der Zeven Verenigde Provinciën: nationale ontwikkelingen en de Europese context*, Amsterdam/Leiden 1998 (Ph.D. Leiden University), Vol. I, p. 227-228, 303.

[4] 'hy ter handt genomen heeft, om oude Goude-Leeren te vernieuwen, uyt te halen, en een nieuwen luyster te geven, 't sy aen de Muer soo het hanght, of in sijn Huys, na eysch desselfs, voor een civiele prijs, alsoo hy extreme kennisse daer van heeft'. *Oprechte Haerlemse Dinsdaegse Courant*, 20/03/1668; Koldeweij 1998, Vol. I, p. 244.

[5] Leiden, Hoogheemraadschap van Rijnland, Archieven van Rijnland no. 10044, Attachment Invoices 1637; Koldeweij 1998, Vol. I, p. 245.

[6] Stadsarchief Amsterdam, 5039, Thes.Ord., Resolutiën 1704-1711 no. 10, fol. 100-100v; idem, Memoriaal 1707-1708, no. 541, fol. 268 (16/12/1707); Koldeweij 1998, Vol. I, p. 245.

[7] 'N.B. dit behangsel is afgenomen om andere mede te repareren'. D.F. Slothouwer, *De paleizen van Frederik Hendrik*, Leiden 1945, p. 86; S.W.A. Drossaers & Th.H. Lunsingh Scheurleer, *Inventarissen van de inboedels en de verblijven van de Oranjes ... 1567-1795*, 's-Gravenhage 1974-1976, Vol. II, p. 483 no. 19; Koldeweij 1998, Vol. I, p. 246.

[8] Zeeuws Archief, Rekenkamer C, inv.no. 3505, Acquitten 1780, 4e grossa, 5e summa; Koldeweij 1998, Vol. I, p. 245.

[9] Koldeweij 1998, p. 236.

[10] Koldeweij 1998, p. 246.

[11] 'kamer behangen met versilverde leer, dog door de tijd en lugt seer versleten'. Drossaers & Lunsingh Scheurleer (1974-1976) Vol. II, 545, no. 33; Koldeweij 1998, Vol. I, p. 246.

[12] Stadsarchief Amsterdam, NA 7218, nots. P. van Aken, p. 113-117 (10/07/1709). Koldeweij 1998, Vol. I, p. 246.

[13] Paul Marron: City Archives Leiden, SA 8846, Bijl. Thes. Extr. 1734 (04/03/1734); idem, SA 8847, Bijl. Thes. Extr. 1735 (18/11/1735); idem, SA 8848, Bijl. Thes. Extr. 1736 (15/01/1736). Cornelis van Hoogeveen: City Archives Leiden, Family-archive De la Court, no. 106, Invoices of Allard de la Court (27/03/1750); City Archives Leiden, SA 8867, Bijl. Thes. Extr. 1753, invoice Cornelis van Hoogeveen (17/02/1752); Leiden, Hoogheemraadschap van Rijnland, Archieven van Rijnland no. 142, Notulen van de vergadering van dijkgraaf en hoogheemraden (1769-1778), z.fol. (14/10/1775); Koldeweij 1998, Vol. I, p. 246.

[14] Zeeuws Archief, Rekenkamer C, inv.no. 3023, Acquitten 1756, 2e grossa, 11e summa; H. van Dolder-de Wit, *De St. Janskerk te Gouda: mensen en monumenten in een oude stadskerk*, Gouda 1993, p. 159; Koldeweij 1998, Vol. I, p. 246.

[15] A.D. Fougeroux de Bondaroy, *Art de travailler les cuirs dorés ou argentés*, Paris 1762 (Description des Arts et Métiers), p. 34.

[16] D. Diderot & J. le Rond d'Alembert, *L'Encyclopédie*, Paris 1751-1772, Suppl. Vol. II (1776), p. 736-737.

[17] *London Daily Post and General Advertiser*, Monday 13/03/1738; Koldeweij 1998, Vol. I, p. 245.

[18] 'pour le tenir nette et propre, pour prevenir que la pousier ne les gate c'est de les faires bien proter un fois tout les six semesne ou deux mois avec un linge net, secque, et bien doux, et s'il s'y faisoit destacher par la salté des mouches ou quelques autre insectes, il faut les laver avec une esponche tempé dans l'eau de pluye froide et bien nette, sans craindre de gater la painture ou l'orrure'. City Archives Leiden, Kleine Archieven no. 16, Archive Van Eys, no. 1-J: Letters from London, letter dd. 04/04/1732; Koldeweij 1998, Vol. I, p. 245. Koldeweij, E.F. 'Gilt leather hangings in chinoiserie and other styles: an English speciality', Furniture History, Vol. 36, 2000, p. 65.

[19] 'een weijnich blaeuwer te maecken als het in't voorsz. monsterkleet was, om des te meer bestendigh te konnen wesen, vermits men in dat kamer gewoon was sterck te vueren'. Stadsarchief Amsterdam, NA 4903, nots. W. Sylvius, fol. 106v-108 (05/06/1692); Koldeweij 1998, Vol. I, p. 244-245.

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[21] Koldeweij 1998, p. 247.

[22] Koldeweij 1998, p. 296.

[23] *Provinciale Noordbrabantsche en 's Hertogenbossche courant*, 13-12-1911, no. 286, p. 2; idem 20-12-1911, no. 292, p. 5-6.

[24] Trainee Meike Wiedemann, master student Art History, Leyden University, January – June 2019.

The Development of a Conservation and Restoration Methodology for Embossed Leather Wall Coverings and Their Installation in Three Exhibition Rooms at Moritzburg Castle

Introducing the Temporary Exhibition "Changing Rooms – Gilded Leather at Moritzburg Castle"

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Abstract

Between 2012 and 2016 a team of six freelance restorers and one restorer employed by Moritzburg Castle completed the comprehensive restoration of a set of embossed leather wall coverings for three rooms at the castle, as well as fifteen accompanying chairs upholstered with gilded leather. Over three years we worked with the Saxon State Office for the Preservation of Historical Monuments and the Research Institute for Leather and Synthetic Materials in Freiberg to develop a certified leather for restoration works. For the first time an exhibition about the making of gilded leather wall hangings and their restoration is shown at Moritzburg Castle.

Keywords

Moritzburg, Gilded, Gold, Leather, Wall Hangings, Restoration

Introduction

Moritzburg Castle is home to the largest collection of Baroque gilded leather wall coverings still in existence in the world and is an outstanding cultural heritage site of national and international importance.

Previously in the Baroque period 60 of the castle's rooms were decorated with stamped or embossed and painted leather wall coverings. Today a total of 13 of the castle's rooms still contain these wall coverings, some of which have been altered and moved from their original locations. In addition, there are several thousand surviving leather pieces of various sizes in the castle's stores.

This is the very first exhibition about the gilded leather wall hangings to be organised at Moritzburg. The challenge was to incorporate the temporary exhibition into the permanent exhibition rooms of the castle with minimum disturbance to the Baroque interiors. The exhibition tells about the historical production of the Italian and Flemish/Dutch gilded leathers, which patterns the Saxon King Augustus the Strong purchased and explains why and when later Saxon rulers changed the decoration of the castle rooms. We also talk about the finds which we made during the creation of an inventory of all the leather pieces in recent years and the number of leather panels which could be restored and reinstalled in future times. **(Figure1)**

Even today visitors can still see evidence of war damage to some of the leather wall hangings as well as damage caused by lightning in the 18th century.

During the summer of 2019 visitors were able to see restorers at work on the gilded leather in one of the exhibition rooms.

Figure 1: Stone Hall at Moritzburg as part of the exhibition "Changing Rooms - Gilded Leather at Moritzburg Castle", © Schloss Moritzburg, photo: Carlo Böttger

This text will describe the efforts to conserve and restore the embossed leather wall coverings in the three-roomed apartment of the Crown Prince of Saxony, later Elector of Saxony/ King Augustus III of Poland. It will also deal with the outcomes of the project.

Up to the year 2003 it had been possible to restore the stamped and painted leather wall coverings in two rooms of the castle. Thereafter plans were made for the renovation and restoration of the three rooms mentioned above with their embossed leather wall coverings. It was now a question of whether the tried and tested techniques for the restoration of stamped leather could also be applied to embossed leather.

Starting point

In the course of alterations carried out at the end of the 19th century two of the rooms in this apartment on the first floor of the south west wing were fitted with blue and gold embossed leather wall coverings, which during the Baroque period had decorated three floors of one of the castle's four towers. The whole design of the room is characterised by the neo-Baroque transformation which took place in the late 19th century. Because these alterations had been carried out to very high specifications, it was important that this standard should be maintained in the course of the 2015 restoration. The leather wall coverings were originally stitched together, but since the 19th century they had been cut and glued, which meant that they should now be restored according to the status quo.

The leather wall coverings in the third room of the apartment were already missing by the end of the 19th century, and a cloth wall covering from the 1980s was fitted here. In the interests of protecting the cultural heritage of the site it was decided to install original embossed gilded leather wall coverings in the third room also. Given that there was insufficient leather of the type used to decorate the two neighbouring rooms, conservators from the Saxon State Office for the Preservation of Historic Monuments (Landesamt für Denkmalpflege Sachsen – LfDS) chose a red, light blue and gold leather, sections of which were already on the walls in a number of rooms around the castle. Leather fragments suitable for restoration purposes could also be found in the stores. This leather was available in sufficiently large quantities, but was also in urgent need of restoration. **(Figure 2)**

The fact that there was no 18th century wood panelling in the third room meant that it was possible to return the cut leather panels to their original, larger Baroque dimensions. The enlarged panels were then sewn together, in the same way as all the other 18th century embossed leather wall coverings at Moritzburg used to be made.

Figure 2: Embossed three coloured motif for the third room in the apartment, © Schloss Moritzburg, photo: Gabriele Hilsky

The building and restoration work was planned to allow sufficient time beforehand for in depth research to be carried out on the leather wall coverings. For a number of years from 2004 onwards the permanent leather restorer at Moritzburg Castle was able to carry out comprehensive research on the two types of leather mentioned above, together with the Saxon State Office for the Preservation of Historical Monuments (LfDS) represented by certified restorer Dr Andreas Schulze. Following analysis of the materials to be restored and their condition, conservation and restoration procedures were carried out on test samples.

Discoveries and challenges

- An earlier application, possibly in the 1930s, of a mixture of fats and oils as a conservation measure resulted in the leather from both groups becoming extremely brittle. The layers of paint and varnish were changed and partially dissolved. The oils and fats combined with the gold varnish, which led to partial encrustation of the surface (Trommer, 2005).
- As a result the layers of paint flaked away from the leather base material. **(Figure 3)**
- A further consequence was the heavy overpainting, sometimes partial sometimes complete, of the blue background area, which led to a dark, dirty looking effect.
- Due to the differing conditions which pertained in the locations from which the three-coloured leather panels were taken, the appearance of the reassembled wall coverings was not at all homogeneous.
- Almost all of the sewn edges as well as many whole sections of the leather panels were missing. **(Figure 4)**
- In order to replace the missing leather pieces it was necessary to find solutions which would be acceptable

both from an aesthetic and from a restoration point of view.

- The techniques needed for embossing and sewing the leather had to be learned.
- The blue and gold leather wall coverings had to be restored in large sheets. Special logistical measures had to be used for the taking down and the reinstallation of the wall coverings, as well as for the handling and moving of the leather sheets during the restoration process.
- By 2003 the supply of leather which had been available for restoration work was almost exhausted, and a suitable new supply had to be developed and produced (Hilsky et al, 2008).
- Because most of the operational steps used for the restoration of the two types of leather were very similar, this presentation will only describe the work carried out on the red, blue and gold leather wall coverings, which was more demanding and time consuming.

Figure 3: The surface of the blue grey background is cracked and flaking, and in danger of falling off, © Schloss Moritzburg, photo: Gabriele Hilsky

Figure 4: Leather fragment before restoration, © Schloss Moritzburg, photo: Gabriele Hilsky

Objectives of the conservation and restoration measures

- Making good the damage done to the leather which had come about as a result of climatic fluctuations and of modifications following earlier restoration work.
- Stabilisation and retention of the substance of the original paint layers.
- To repair and patch damaged leather panels in order to create complete and homogeneous wall sections for aesthetic reasons.
- The improvement of the aesthetic appearance of the leather wall coverings by means of surface cleaning and removal of the overpainted layers.
- The visual integration of the replacement leather pieces which were used in order to repair the original panels.
- The development of a new method of installation in order to avoid damage caused by the old practice of fixing the wall coverings rigidly onto wooden frames.
- It was necessary for all the handling methods employed to conform to the nationally and internationally recognised ethical restoration standards. Among other things these standards stress the importance of the concept of reversibility in relation to all procedures carried out and all materials used in the restoration.

Implementation of the conservation and restoration measures

Selection and documentation

First of all the restorers selected and recorded the condition of suitable three-coloured leather panels and fragments from among the more than 500 that were available. In order to fill the wall space we would need 92 complete panels and 32 border pieces as well as 8 newly made strips of leather to be used for edging purposes.

Stabilisation of flaking paint layers followed by cleaning and exposing overpainted areas

Because the coloured background, in particular the light blue areas, was cracked in some places, very brittle and also no longer firmly bonded to the base, it was necessary to combine the cleaning with a partial stabilisation of the painted layer. With the help of thin Melinex sheets, careful warming, the application of gentle pressure using a Teflon spatula, and with thin parchment glue (5% glue to 95% water) it was possible to stabilise the blue areas. The dampness of the parchment glue also helped with the cleaning process.

The stabilisation process was followed by fine cleaning using small sponges, microfibre cloths and water, and by the removal of the blue overpainting with the help of electric erasers or eraser pencils. **(Figure 5)**

Figure 5: Cleaning the original blue background, © Schloss Moritzburg, photo: Gabriele Hilsky

Removal of unwanted substances from the front and rear surfaces of the leather

It was necessary to remove all the old protective materials from previous conservation attempts. These included fabric glued to the leather with starch-based paste, often with unknown additives, different kinds of paper and pieces of original leather with different patterns inappropriately glued to the back of the panels. The layer of paste between the original leather and the attached strips of fabric was often infested with insects, which would eat the paste and also cause significant damage to the leather itself.

Gold-bronze and other overpainted colours applied to the front side of the leather in the course of earlier restoration attempts all had to be removed. This was achieved through the use of solvents combined with removal by hand. The reaction of individual leather pieces to the removal process varied enormously, and restorers continually had to adapt their technique according to how the material was behaving. **(Figure 6)**

Figure 6: Overpainted border, © Schloss Moritzburg, photo: Gabriele Hilsky

Replacing damaged and missing leather pieces

Restoration work was carried out using a type of calfskin leather which had been developed in the course of a three year project by the Research Institute for Leather and Synthetic Materials (Forschungsinstitut Leder und Kunststoffbahnen – FILK) in Freiberg, Saxony. Depending on the size of the missing areas, each of the leather pieces came in one of three different forms: flat sheets treated with parchment glue; silvered leather, or embossed and silvered leather. Missing edges up to about two centimetres wide were not embossed. The parchment glue served both as an adhesive for the silver leaf and also as a protective layer on top of the silver.

The custom made new leather pieces were patched into the empty areas with parchment glue. At the beginning this process was made easier and quicker by the use of a special new low pressure table.

Techniques for the embossing of leather had to be learned, and the description set out in the historic text written by Fougeroux de Bondaroy was used as a guide (Fougeroux de Bondaroy, 1762). A detailed description can also be found in the dissertation of Professor Andreas Schulze (Schulze, 2011). A pear wood mould, made by a wood carver and restorer, was used to emboss the leather panels.

A card template is used in order to emboss the irregular shaped leather pieces which are required for patching the original, incomplete panels. The card is the same size as the carved wooden mould and the same thickness as the leather. A hole the same shape as the missing piece is cut into the card. A new piece of silvered leather is cut to the same shape with an additional 1 cm bevelled edge so that it can be fitted into the hole in the card and attached from behind with masking tape. The sheet of card and leather is then placed face downwards onto the carved wooden mould and pressed. The card template ensures that pressure is applied equally across the whole surface.

Retouching the painted areas

A variety of techniques were used. In the original painted areas, retouching work was carried out using only water colours, gouache, and white egg tempera paint. The use of a small amount of egg tempera paint will reduce the vulnerability of the paint to humidity and to the effects of later damp cleaning. **(Figure 7)** For leather which would be used to replace missing gilded pieces, pearl gloss watercolour paint was used. New embossed and flat leather edges were mostly retouched with several glazed layers, and sometimes the pattern was simply painted on. If required, Maimeri restoration paint was used.

Figure 7: Detail of red background – the area on the right hand side has been retouched, © Schloss Moritzburg, photo: Gabriele Hilsky

Sorting the leather panels

As expected, once all the leather panels had been restored there were obvious visual differences between them in terms of both colour and condition.

A great jigsaw puzzle exercise began, with restorers trying to match each panel with suitable 'neighbours'. Laid out on a large floor area and grouped according to their visual appearance, the individual leather panels were gradually assembled to create whole wall sections.

Putting the wall sections together

Once the needle holes had been made around their edges the leather panels could be sewn together, initially in vertical lines of four. This took place on two large sewing tables, using dark brown linen thread in the so called 'running' stitch. Gradually the sheets of leather grew longer and wider, to the point where they were eventually large enough to cover a whole wall.

Installing the leather wall sections

Each individual wall section was clamped to a wooden batten and hung from a mobile scaffold so that it could be wheeled into position in front of the wall destined to become its new home. It proved extremely difficult to determine the exact dimensions required in order to be able to install each large sheet of leather on its designated wall. Despite a considerable amount of preparation, none of the walls were completely straight or even. A second puzzle therefore had to be solved before everything could hang properly.

The leather wall coverings are almost free-hanging. This means that the leather wall sections are firmly attached only along the top edge of the supporting frames with the newly added leather border strips being screwed to wooden battens set into the wall plaster. Down the sides and along the lower edges, the wall coverings are generally held in place by newly made wooden beading. However, small leather spacer washers have been used in a number of places, where there is a danger that the

Figure 8: For comparison; how a corner of the third room looked without leather wall covering, © Andreas Schulze

Figure 9: The same corner with leather wall covering following completion of the refurbishment in 2016 © Ledergruppe Moritzburg, photo: Arne Mai

leather wall coverings could come loose from the beading as a result of drying or shrinking. In this way the great sheets of leather can expand and contract over the course of the year without the risk of cracking around inflexibly fixed edges. This can also prevent sagging at the seams, the weakest area, and stretching of the wall sections. However, a small amount of distortion of individual wall panels is acceptable. **(Figures 8, 9, 10)**

Figure 10: One of the restored blue and gold embossed leather wall hangings in the apartment of the Crown Prince © Schloss Moritzburg, photo: Carlo Böttger

Conclusion

From 2012 to 2016, a team consisting of six freelance restorers and one restorer on the permanent staff of Moritzburg Castle worked together on the project described above. During this time the team comprehensively restored the blue and gold embossed leather wall coverings in two rooms of the Crown Prince's apartment. Fifteen accompanying chairs upholstered with gilded leather were also restored.

The four year restoration period was preceded by several years of research and development including the preparation of a comprehensive restoration plan in partnership with the Saxon State Office for the Preservation of Historic Monuments (LfDS). At the same time a new type of certified restoration leather was developed by the Research Institute for Leather and Synthetic Materials (FILK) in Freiberg.

During the Baroque period the apartments in the four towers of Moritzburg Castle were fitted with embossed leather wall coverings made up of individual panels which were sewn together in large sheets. In later years, it is not exactly clear when, sections of the wall coverings were taken down and separated. Individual panels were cut into smaller pieces, glued together inappropriately, and the altered leather wall sections were reinstalled in different rooms. Finally, as a result of this project, Moritzburg Castle again has a room decorated in the 18th century style with embossed and sewn gilded leather wall coverings.

Members of the Moritzburg Leather restoration team:

- Diplomrestauratorin Jana Bösenberg
- Diplomrestauratorin Elvira Kless
- Diplomrestauratorin Franziska Wosnitza
- Diplomrestauratorin Ulrike Sommer
- Diplomrestauratorin Katrin Kutzera
- Diplomrestauratorin Arne Mai
- Diplomrestauratorin Gabriele Hilsky

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Trommer B. 2005. «Fettimprägnierung von Moritzburger Ledertapeten» , FILK Freiberg 12.12.2005

Materials

Parchment glue: Altenburger Pergament- und Trommelfell GmbH, Mozartstr. 8, 04600 Altenburg, Deutschland. info@pergament-trommelfell.de Tel.: +49 3447 314010

Restoration leather: Forschungsinstitut für Leder und Kunststoffbahnen, gGmbH FILK, Meißner Ring 1-5, 09599 Freiberg, Deutschland Tel.: +49 3731 3660

Gouache Colour: HORADAM Schmincke

Watercolour: Schmincke

Egg Tempera: Rowney

Oxgall: Schmincke

Watercolour box: KREMER Pigmente GmbH & Co.KG, for retouch of gold, Hauptstr. 41-47, 88317 Aichstetten, Deutschland, info@kremer-pigmente.de +49 7565 914 480

Biographies

Gabriele Hilsky

- Born in Dresden 1956.
- Work experience at Town Museum, Freital.
- 1976 to 1981 studied painting restoration at the Academy of Fine Arts, Dresden. Diploma in Painting Restoration.
- Since January 1982 has held a permanent post as restorer at Moritzburg Castle, with special responsibility for the restoration of gilded leather wall coverings. Team leader of the Moritzburg leather restorers' group.

Margitta Hensel

- Born 1964 in Dahme/ Brandenburg.
- 1984 to 1988 studied Museology (distance learning course) at the Vocational College of Museum Studies, Leipzig. Diploma in Museum Studies.
- 1989 to 1995 studied Art History (distance learning course) at the Martin Luther University, Halle. Diploma in Art History.
- Employed at Moritzburg Castle since 1982. Worked as Curator since 1992. Responsible for the refurbishment of the Fasanenschlösschen (Little Pheasant Castle), Moritzburg.

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L'histoire Mouvementée de Cinq Tentures Historiées en Cuir Doré Peint et Ciselé du 17ème Siècle Représentant des Scènes de l'Ancien Testament

Céline Bonnot-Diconne, Jean-Pierre Fournet, Muriel Barbier, Laurianne Robinet, Marie Radepont, Lucile Beck, Marie Heran, Sylvie Heu-Thao

Résumé

Essentiellement produites dans les Pays-Bas du Sud, dans la première moitié du 17ème siècle, les tentures historiées en cuir doré polychrome sont des œuvres aujourd'hui exceptionnelles. Trois de ces tentures étaient conservées au musée du château de Lunéville. Elles formaient un ensemble homogène par leurs thèmes, par leur origine et par leur style mais tiraient aussi leur intérêt de leurs qualités artistiques et de leur très grande rareté. Malheureusement un incendie causa leur disparition en janvier 2003. Des recherches effectuées dans les années précédant leur destruction, à l'occasion de leur restauration respective, avaient révélé qu'elles faisaient en réalité partie d'une série d'au moins cinq décors. Toutes représentaient des thèmes de l'Ancien Testament : *David victorieux*, *David jouant de la harpe devant Saül, La rencontre de Salomon et la Reine de Saba*, *La bataille de Gelboé* et *David composant des psaumes*. Or récemment cette série dont la majeure partie avait donc disparu, s'est trouvée partiellement complétée par la découverte inattendue de ***La bataille de Gelboé*** puis de fragments de bordures. Acquis en 2015 par le musée national de la Renaissance à Écouen, la restauration de ce grand décor et sa mise en exposition ont suscité beaucoup de questions sur l'histoire de ces tentures et la façon de les présenter. Des analyses nouvelles ont été effectuées à cette occasion parmi lesquelles la datation au carbone 14 du cuir et du fil de couture. En parallèle, des recherches dans des archives locales mais également familiales ont permis d'en apprendre plus sur l'étonnant parcours de ces cinq tentures au 19ème puis au 20ème siècle.

Mots-clés

Cuir Doré, Tenture, Lunéville, Gelboé, Château d'Écouen, Carbone 14, Ancien Testament, Analyses Physico-chimiques

Introduction

Les tentures historiées en cuir peint ont connu leur apogée aux 16ème et 17ème siècles. Destinées à orner les riches demeures de toute l'Europe, elles côtoyaient et parfois concurrençaient les tapisseries en textile. Comme elles, elles mettaient en scène des personnages et constituaient de véritables tableaux peints. Leurs sources d'inspiration étaient communes : la mythologie, l'histoire ancienne, l'Ancien Testament, le Nouveau Testament. Elles comportaient une bordure décorée et étaient habituellement présentées flottantes, uniquement fixées par leur bord supérieur.

Ces tentures ont d'abord été fabriquées en Espagne à partir du 15ème siècle. Au 16ème, et surtout au 17ème siècle, d'autres pays européens en fabriquèrent ; les Pays-Bas du Sud notamment - à Malines et à Bruxelles surtout – en produisirent une grande quantité et en exportèrent beaucoup. Ces œuvres originales étaient habituellement peintes sur cuir doré, c'est-à-dire sur des peaux tannées, cousues entre elles, recouvertes de feuilles d'argent, elles-mêmes enduites - pour leur donner la coloration dorée - d'un « vernis jaune », sur lequel était ensuite posée la couche picturale[1]. L'ornementation était souvent complétée par de la ciselure[2] aux petits fers.

La plupart des tentures historiées en cuir peint du 16ème siècle ont disparu. Quelques rares exemplaires du 17ème siècle – originaires des Flandres le plus souvent – existent

[1] Fougeroux de Bondaroy, 1762.

[2] Empreintes réalisées par le poinçonnage.

encore de nos jours[3]. Le château de Lunéville conservait, jusqu'à l'incendie qui l'a ravagé en 2003, trois tentures historiées en cuir peint du 17ème siècle qui appartenaient à un même groupe stylistique : la tenture de *David victorieux*, la tenture de *David jouant de la harpe devant Saül* et la tenture de *La rencontre de Salomon et de la reine de Saba*.

Figure 1 : David victorieux. Tenture de cuir doré ciselé, 3,30 × 4,40 m ; carreau : 1,15 × 0,85 m ; éléments de bordure : vertical 1,15 × 0,50 m, horizontal 0,50 × 0,85 m. Second quart du 17ème siècle, Pays-Bas du Sud. Château de Lunéville, Meurthe-et-Moselle. (Détruite dans l'incendie du 3 janvier 2003). © J-P.Fournet

La série de Lunéville

La tenture de *David* victorieux, aujourd'hui perdue **(Figure 1)**, mesurait 3,30 sur 4,40 m[4]. Les huit carreaux centraux, mesurant chacun 1,15 sur 0,85 m, portaient le décor principal ; les 16 carreaux périphériques, larges de 0,50 m, constituaient la bordure. Les carreaux, jadis solidarisés entre eux par des coutures, ont ultérieurement été collés sur des panneaux de bois. Chacun des huit carreaux de la partie centrale était constitué de deux peaux de veau collées ensemble. La scène principale représentait le cortège triomphal de David, victorieux de Goliath, entrant à Jérusalem (*La Bible*, 1 Samuel, **17**, 48-58 et **18**, 6). Au premier plan les personnages étaient répartis en deux groupes ; à droite David, la tête ceinte d'une couronne de laurier, montait un cheval blanc ; il était accompagné, à sa droite, du roi Saül revêtu d'une cape et d'une toque en hermine. A gauche une jeune femme blonde, élégamment habillée, s'avançait. Derrière elle des femmes jouaient de la musique. A l'arrière-plan étaient disposés des hommes en armes ; au centre, piquée sur une lance, la volumineuse tête ensanglantée de Goliath, dominait l'ensemble. La bordure périphérique était ornée de fleurs dans ses parties horizontales **(Figure 2)**, de *putti* ailés portant des vases à godrons fleuris surmontés de fruits dans ses parties verticales et de perroquets aux angles supérieurs **(Figure 3)**. L'ensemble était agrémenté par une abondante ciselure **(Figure 4)**.

Figure 2 : Elément de bordure horizontale appartenant à la tenture de La rencontre du roi Salomon et de la reine de Saba. © C.Bonnot-Diconne

La tenture de La rencontre du roi Salomon et de la reine de Saba mesurait 2,82 sur 3,57 m et se composait de quinze morceaux distincts solidarisés entre eux par des coutures[5] **(Figure 5)**. Elle était présentée flottante. Les six carreaux centraux, constitués chacun de deux peaux de veau collées ensemble, portaient le décor principal ; ils

Figure 3 : Détail de la figure 1. Angle supérieur gauche de la bordure. © J-P.Fournet

[3] Lieux de conservation. Grande-Bretagne: *Knowsley Hall*, Prescot, Merseyside. Autriche : *Osterreichisches Museum für Angewandte Kunst* (MAK), Vienne, (détruits en 1945). Danemark : *Gammel Estrup Manor*, Auning. Espagne : *Palacio de Viana* et *Museo de Bellas Artes*, Cordoue. France : château d'Écouen ; Caen, musée de Normandie ; Blois, musée des Beaux-arts ; Paris, collection privée. Italie : *Fondazione Roma*, Rome. Pays-Bas : château *Het Loo*, Apeldoorn. Suède : Palais royal et *Nordinska Museet*, Stockholm ; Palais royal, Drottningholm ; château d'Ulriksdal, Solna ; château de *Stora Sunby*, Ekilstuna ; château de Torrups, Malmö.

[4] Fournet, 2004, t. 4, pp.632-637 et 642-646.

[5] Bonnot-Diconne, 2002 ; Fournet, 2004, t. 4, pp.625-631 et 642-646.

étaient entourés, en haut et latéralement, par des bordures identiques à celles de la tenture précédente. Le décor central représentait la reine de Saba, venue du fond de l'Arabie, se présentant devant Salomon (*La Bible*, 1 Rois, **10**, 1-13) ; un genou à terre elle saluait le roi debout devant elle. La scène comportait deux parties ; à droite étaient figurés les personnages de la suite de la reine avec leurs chameaux à l'arrière-plan ; à gauche était représentée la suite du roi ; entre le roi Salomon et la reine de Saba, le décor s'ouvrait sur un vaste paysage. Une abondante ciselure agrémentait le décor.

La tenture de David jouant de la harpe devant Saül, elle aussi perdue, mesurait 3,18 sur 3,28 m et se composait de vingt morceaux[6] **(Figure 6)** qui étaient à l'origine cousus entre eux ; ultérieurement les coutures ont été remplacées par des collages. La scène centrale était représentée sur six carreaux constitués chacun de deux peaux de veau collées ensemble ; elle était entourée de bordures identiques aux précédentes. L'ensemble comportait une abondante ciselure. Avant sa destruction, la tenture, comme la précédente, était présentée flottante. Elle était en très mauvais état de conservation avec une couche picturale très altérée, ce qui nuisait considérablement à la lecture du décor. La scène centrale représentait Saül en proie aux « terreurs » que lui infligeait « Yahvé » et que David calmait en jouant de la harpe (*La Bible*, 1 Samuel, **16**, 14-23).

Les trois tentures de Lunéville, en raison de leurs similitudes, appartenaient à l'évidence à un même groupe stylistique. Des documents conservés au château de Lunéville laissaient depuis longtemps penser que deux autres tentures, l'une représentant la *Bataille de Gelboé* et l'autre *David écrivant des psaumes*, appartenaient à ce même groupe, mais leur lieu de conservation était alors inconnu.

La bataille de Gelboé : découverte

En juillet 2015, douze ans après la destruction complète de la série de Lunéville, le musée national de la Renaissance à Écouen (95) eut l'opportunité inattendue d'acquérir sur le marché de l'art parisien, une tenture qui représente une scène de bataille. Les collections du musée s'enrichirent ainsi d'une pièce figurative en cuir doré polychrome : *La bataille de Gelboé*, encore appelée *La mort* (ou *Le suicide*) *de Saül*. L'œuvre qui a aujourd'hui perdu sa bordure mesure 2,25 sur 3,26 m, et est constituée de carreaux mesurant chacun environ 1,12 sur 0,82 m. La

Figure 4 : Exemples de ciselure de la tenture de la Bataille de Gelboé. © C.Bonnot-Diconne

Figure 5 : La Rencontre du roi Salomon et de la reine de Saba. Tenture de cuir doré ciselé, 2,82 × 3,57 m ; carreau : 1,15 × 0,85 m ; éléments de bordure : vertical 1,15 × 0,51 m, horizontal, 0,52 × 0,85 m. Pays-Bas du Sud, second quart du 17ème siècle. Château de Lunéville (détruite dans l'incendie du 3 janvier 2003). © Art technique

Figure 6 : David jouant de la harpe devant Saül. Tenture de cuir doré ciselé, 3,18 × 3,28 m ; carreau : 1,13 × 0,80 m ; élément de bordure : vertical 1,13 × 0,44 m, horizontal 0,46 × 0,80 m. Second quart du 17ème siècle, Pays-Bas du Sud. Château de Lunéville (détruite dans l'incendie du 3 janvier 2003). © J-P.Fournet

[6] Fournet, 2004, t. 4, pp.638-641 et 642-646.

scène représentée a immédiatement été identifiée comme la bataille au cours de laquelle les Juifs furent défaits par les Philistins vers 1010 av. J.-C. (**Figure 7**). Gelboé est une montagne de Palestine située au nord-est des monts de Samarie sur laquelle s'est déroulé un combat entre les Philistins et les Hébreux. Ces derniers étaient menés par Saül qui – après l'oracle de la sorcière d'En-Dor – pressent la défaite à venir (Ancien Testament, 1 Samuel 28,1-21). L'affrontement fut un désastre pour les Hébreux qui fuirent devant les Philistins. Saül blessé, ne pouvant supporter la défaite et la mort de ses trois fils, se suicida en se précipitant sur son épée après avoir mis le pommeau en appui sur le sol et dirigé la pointe vers sa poitrine. Premier roi d'Israël, sacré par Samuel, son souvenir a ensuite été estompé par ses prestigieux successeurs, David puis Salomon. Son histoire est très liée à celle de Samuel et à la jeunesse de David. Contrairement à David, Saül, dont le suicide va à l'encontre des préceptes chrétiens, a été peu représenté dans l'art occidental.

La facture du décor réalisé témoigne d'une parenté étroite avec celles des trois tentures du château de Lunéville. Et en effet, son acquisition par le musée national de la Renaissance a permis de venir accréditer cette thèse.

La bataille de Gelboé : analyses

Les phases de constat détaillé puis de restauration ont été l'occasion de procéder à une étude approfondie de ce décor et à des analyses. En 2015, l'œuvre était en réalité dans un état très délabré, ayant déjà fait l'objet de plusieurs campagnes de réparations, avec notamment la pose d'innombrables doublages au revers (**Figure 8**). C'est une pièce murale monumentale d'une surface de plus de 7 m², constituée aujourd'hui de seulement huit carreaux (**Figure 7**). Toutes ses bordures, c'est-à-dire 24 carreaux, ont disparu et des indices montraient qu'elle avait été anciennement accrochée de manière fixe sur un châssis, à la façon des tableaux (ses bords étaient repliés sur plusieurs centimètres et portaient des traces de clouage). C'est peut-être à cette occasion que le bord inférieur du décor fut découpé sur toute sa longueur. On a pu estimer que les quatre carreaux inférieurs avaient perdu jusqu'à 5 cm de hauteur. De très nombreuses incrustations réalisées avec divers matériaux étaient repérables sur toute sa surface. Par exemple du cuir ancien, c'est-à-dire des morceaux argentés, peints et ciselés avaient été réemployés pour combler des manques. Ces morceaux avaient d'ailleurs été tirés du même type de décor (cuir doré, peint et ciselé). L'exemple le plus démonstratif est celui visible sur le carreau inférieur droit (**Figure 9**) où un morceau de cuir de 38 cm de longueur a été retrouvé. Il était cousu grossièrement pour combler une lacune. Ce fragment était en réalité tiré d'un carreau de bordure tel que l'on pouvait en observer sur la tenture de *Salomon et la Reine de Saba*.

La restauration de cette tenture[7] et sa présentation au musée d'Écouen ont suscité beaucoup de questions,

Figure 7 : La bataille de Gelboé (après restauration). Panneau de cuir doré ciselé, 2,25 × 3,26 m. Pays-Bas du Sud, second quart du 17ème siècle. Musée national de la Renaissance, château d'Écouen (95). inv. Ec. 2037. © C.Bonnot-Diconne

[7] Voir C.Bonnot-Diconne, 2016, *Constat d'état d'une tenture murale en cuir doré polychrome*, Rapport 2CRC réf.2016-02 et C.Bonnot-Diconne, 2017, *Restauration d'une tenture murale en cuir doré polychrome*, Rapport 2CRC réf.2017-51.

Figure 8 : Revers de la Bataille de Gelboé avant restauration. © C.Bonnot-Diconne

Figure 9 : Exemple de réemploi d'un élément de bordure pour combler une lacune (Bataille de Gelboé, avant restauration). © C.Bonnot-Diconne

notamment quant à la façon de l'exposer. Plusieurs options étaient en effet envisageables. Par exemple, pourquoi ne pas lui restituer des bordures perdues ? Néanmoins si la surface initiale de l'œuvre eut ainsi été retrouvée, cela augmentait de façon considérable la taille du décor (que les bordures soient peintes ou au contraire laissées d'une couleur neutre). Pour mémoire, à Lunéville, les trois tentures avaient été restaurées à des périodes différentes et ne présentaient pas du tout le même aspect. L'une était collée sur des planches de bois, les deux autres étaient flottantes. Or comme le prouvaient des anneaux de cuir retrouvés sur la tenture de *Salomon et la Reine de Saba*, ces décors étaient bien flottants dès leur origine. Le musée de la Renaissance a fait le choix du compromis : montrer au visiteur l'aspect flottant des tentures dans les demeures du 17ème siècle mais ne pas restituer les bordures, facilitant ainsi le déplacement éventuel de l'œuvre dans les espaces du musée (ou en cas d'évacuation d'urgence) ; cela répondait aussi aux contraintes budgétaires du musée **(Figure 10)**.

Figure 10 : Vue de la Bataille de Gelboé (après restauration) dans la grande salle du Roi. © M.Barbier

La Bataille de Gelboé est aujourd'hui exposée dans la grande salle du Roi au premier étage du château d'Écouen, derrière une mise à distance. Elle avoisine les deux tapisseries de la tenture des *Fructus Belli*, au sujet également belliqueux. Elle fait désormais l'objet d'un suivi régulier (comme pour toutes les autres tentures en cuir de ce musée) et le climat et l'éclairement sont contrôlés.

Ces décors originaux étaient tous peints sur « cuir doré ». L'ornementation était complétée par de la ciselure aux petits fers. Les fers relevés sur *la Bataille de Gelboé* sont au nombre de dix et sont parfaitement identiques à ceux recensés sur *La rencontre du Roi Salomon avec la Reine de Saba* **(Figure 4)**. Cette dernière tenture avait été restaurée en 2002 et avait fait l'objet d'analyses dont nous avons pu comparer les résultats à celles effectuées en 2016 par le CRC[8] sur *la Bataille de Gelboé*. Ainsi la peau qui a été employée est bien du bovin dans les deux cas. Bien que n'ayant pas été conservées dans les mêmes lieux et donc dans des conditions identiques, la température de dénaturation du cuir était sensiblement la même : 45° C. Sur *La Bataille de Gelboé* comme sur *Salomon avec la Reine de Saba*, on ne relevait pas la présence d'acides forts, avec un pH d'environ 4. Les analyses ont aussi montré que les pigments employés étaient les mêmes : la couleur rouge est une laque de garance recouverte par une mince couche de vermillon, le vert est un résinate de cuivre et le blanc est du blanc de plomb[9]. Sur *Gelboé,* l'analyse de la feuille

[8] Voir Robinet L., Heu-Thao S., Radepont M., Analyses de la tenture de la bataille de Gelboe du musée national de la Renaissance à Écouen, Rapport d'analyse CRC No 2016-02, septembre 2016.

[9] Le pigment bleu n'a pu être identifié car en trop faible quantité dans du blanc de plomb.

métallique a révélé une composition pratiquement pure en argent avec seulement des traces d'autres composés métalliques tels que l'or et le mercure. Cette feuille d'argent est très épaisse, avec une épaisseur environ 10 fois supérieure à l'épaisseur mesurée en moyenne sur un cuir doré (Radepont 2019). Il est intéressant de noter que l'épaisseur de la feuille d'argent est bien moindre dans les zones argentées et ternies, avec 453 nm contre 1190 nm dans les zones préservées, probablement en raison de l'altération de celle-ci, du fait de l'interaction avec l'environnement et possiblement de nettoyages répétés. Sur *La Bataille de Gelboé*, la présence d'une couche protéinique employée comme protection de cette feuille d'argent a été détectée pour la première fois[10].

La datation et l'origine de ces tentures

Les tentures disparues du château de Lunéville et la tenture de *La Bataille de Gelboé* font donc bien partie d'un même groupe stylistique ; elles peuvent être rapprochées des tentures historiées de *Dunster Castle*[11] et de *Walsingham Abbey*[12], en Angleterre. Les six tentures de *Dunster Castle* relatent des épisodes de l'*Histoire de Cléopâtre et Marc-Antoine*. Les tentures de *Walsingham Abbey* – actuellement perdues de vue et qui ne sont connues que par un catalogue de vente de 1916 – représentent l'*Histoire* d'*Esther et d'Ahasuerus*. Toutes ces tentures de cuir peint, d'inspiration biblique ou historique, ont un même style avec des personnages vêtus en costumes contemporains. Ces raisons ont conduit à considérer que toutes ces œuvres provenaient du même atelier[13]. Elles correspondent à ce qui se faisait à cette époque dans les Pays-Bas du Sud et tout particulièrement à Bruxelles. Le peintre Godefroid Allart (actif 1647-1671) a notamment dessiné et peint des décors comparables sur des tentures de cuir doré pour des fabricants bruxellois, en particulier pour Martin Sotteau (actif 1638-1647) et pour François Ysenbaudt (actif en 1671)[14]. Les auteurs ont vraisemblablement trouvé leurs sources dans des gravures ; les décors de *Walsingham Abbey* (*Histoire d'Esther et d'Ahasuerus*) ont notamment été inspirés par des gravures de Philips Galle (1537-1612) faites d'après des dessins de Maarten van Heemskerk (1498-1574)[15].

La plupart des auteurs[16] s'accordent pour dire que ces tentures datent vraisemblablement du second quart du 17ème siècle. Sur *la Bataille de Gelboé*, des échantillons ont donc été prélevés pour une datation par la méthode du carbone 14. Par chance, il a été possible de combiner deux datations : celle du cuir et celle d'un fil de couture qui avait servi à assembler un élément de bordure à un carreau principal. Par radiocarbone, le résultat obtenu permet de connaître la date de la mort de l'animal pour le cuir et celle de la récolte des fibres végétales pour le fil de couture. Si l'on considère que le décor a été fabriqué dans les années qui ont suivi ces deux évènements, les résultats permettent d'affirmer que sa datation est comprise dans l'intervalle 1500-1645. La date de 1645 peut être retenue comme datation maximum, ce qui vient conforter l'hypothèse que ces décors datent bien de la première moitié du 17ème siècle.

Cinq tentures ont eu une histoire commune. Les trois tentures disparues de Lunéville, la *Bataille de Gelboé* et une autre tenture vraisemblablement de même facture, aujourd'hui perdue de vue, – *David écrivant des psaumes* –, avaient toutes été conservées dans une même famille. Simultanément mises sur le marché de l'art en Bourgogne, au début du 20ème siècle, leur histoire peut être partiellement reconstituée grâce aux archives conservées au château de Lunéville[17], aux comptes-rendus des réunions de l'Association des Amis du Château de Lunéville (CRAACL)[18], aux informations données par les intervenants qui se sont intéressés à ces œuvres au 20ème siècle et aussi grâce aux archives familiales des anciens propriétaires[19].

[10] Cette couche de protection décrite par Fougeroux de Bondaroy en 1762 n'avait jamais pu être identifiée formellement jusqu'à présent.

[11] Lyte, 1909, pp.371-375 ; Waterer 1967, pp. 142-147 ; Dodd, 1999, pp.21-24.

[12] Cubbit, 1916, p.32 ; Jervis, 1989, pp.8-9 ; Wells-Cole, 1997, pp.97-98.

[13] Jervis, 1989, pp.8-9.

[14] Duverger E., 1981.

[15] Wells-Cole, 1997, pp.96-97 ; Bonnot-Diconne et Koldeweij, 2002, p.767.

[16] Waterer, 1967, p.94 ; Wells-Cole, 1997, pp.96-97 ; Dodd, 1999, p.21; Bonnot-Diconne et Koldeweij, 2002, p.767.

[17] Lettres de l'abbé Choux, conservateur du musée de Nancy, du 20 juillet 1973 et du 16 mai 1977.

[18] CRAACL. Séances des 1er février, 27 juin, et 12 septembre 1956, 5 mai 1963, 9 juillet 1974.

[19] Un des propriétaires de ces tentures, Jean de Malartic (1868-1947), est devenu moine, après son veuvage en 1930, au monastère de Hautecombe (Savoie). Après sa mort, ses archives familiales ont été déposées au monastère de Ganagobie où elles sont consultables : IX B50 et B51.

Nous ne savons rien des tentures jusqu'à la fin du 18ème siècle, ni par qui elles furent commandées, ni leur site initial d'exposition. Au début du 19ème siècle elles se trouvaient dans la propriété des Aubriot de Rozières – aïeux des Malartic – au château de Rozières à Rozière-sur-Crise (02). En 1815 elles auraient été détériorées par les troupes cosaques qui occupaient le château. La famille dût se séparer du château de Rozières au milieu du 19ème siècle ; elle alla s'installer près de Mâcon (71). La maison de Sancé fut achetée en 1851 par Olympe de Rosières (1803-1879). Le château des Poccards à Hurigny entra dans la famille quelques années plus tard. Le château des Poccards sera la propriété de Jean de Malartic (1868-1947), petit neveu d'Olympe ; la propriété de Sancé deviendra celle de la sœur de Jean de Malartic, Edith de Morès de Malartic (1869-1933). À une date inconnue les tentures de cuir peint ont été partagées entre les deux branches de la famille, une partie d'entre elles allant dans la propriété de Sancé, l'autre partie allant au château des Poccards.

Les cinq tentures apparurent simultanément dans le domaine public en 1909 quand un antiquaire de Dijon, nommé Privet, agissant probablement au nom du (ou des) propriétaire(s), les a proposées, pour 25 000 francs, au musée Lorrain de Nancy. Le vendeur soutenait que cet ensemble avait appartenu, avant la Révolution, aux collections du château de Lunéville. Des cuirs dorés avaient effectivement orné la *Salle de la Livrée* du château de Lunéville au 18ème siècle[20] ; mais en réalité ces cuirs dorés, tous aujourd'hui disparus, ne correspondaient en rien à ceux proposés. Les cinq tentures avaient donc une autre origine. La proposition de l'antiquaire resta sans suite.

En 1955, les mêmes tentures furent de nouveau proposées au musée de Nancy par un antiquaire de Mâcon, Georges Renoud-Grappin, mais sans résultat également. En mars 1956, le président des Amis du Château de Lunéville, sollicité à son tour, fit l'acquisition, auprès de M. Renoud-Grappin, pour le musée de Lunéville, de la tenture représentant *David Victorieux*. D'après les archives familiales, celle-ci avait été achetée en 1954 par M. Renoud-Grappin à Sancé[21]. Elle fut restaurée dès son acquisition.

En juin 1956 il existait encore deux tentures de cuir peint au château des Poccards à Hurigny, vraisemblablement *La rencontre du roi Salomon et de la reine de Saba* et *David jouant de la harpe devant Saül*, et une autre dans l'autre branche de la famille à Sancé, vraisemblablement *David écrivant des psaumes*. Quant à la cinquième tenture, qui représentait la *Bataille de Gelboé*, elle avait été vendue quelque mois auparavant par M. Renoud-Grappin à un acquéreur inconnu.

Le 9 juin 1973, les deux tentures de *David jouant de la harpe devant Saül* et la *Rencontre de Salomon et de la reine de Saba* furent achetées par le château de Lunéville à la salle des ventes de Mâcon, lors d'enchères publiques organisées par maître Platet, pour la somme totale de 27 427,50 francs[22]. Après restauration les deux tentures furent exposées au château de Lunéville en 1977. Les deux autres tentures mentionnées en 1909 – la *Bataille de Gelboé* et *David écrivant des psaumes* – resteront perdues de vue pendant plusieurs décennies. C'est en mars 2015 que la *Bataille de Gelboé* va réapparaître inopinément sur le marché de l'art et être acquise par l'Etat, sur les crédits du Ministère de la Culture, au profit du musée national de la Renaissance. Après restauration elle a été installée au château d'Écouen en décembre 2017.

Conclusion

Le groupe des cinq tentures historiées en cuir peint de cette étude, représentant des scènes mémorables de la Bible et de l'histoire des rois d'Israël, constituait donc un ensemble exceptionnel qui ne pouvait être comparé qu'avec celles de *Dunster Castle* et de *Walsingham Abbey* en Angleterre.

Elles représentaient des exemples caractéristiques de cuirs dorés historiés, peints et ciselés, dont les ateliers bruxellois s'étaient fait une spécialité au 17ème siècle. Il est heureux que la tenture de la *Bataille de Gelboé*, naguère considérée comme perdue, ait pu être récemment redécouverte et qu'elle ait trouvé sa place dans un des plus beaux musées français. Aujourd'hui quatre des cinq tentures proposées à la vente en 1909 ont été identifiés, seule la tenture de *David écrivant des psaumes* reste encore malheureusement inconnue. Souhaitons qu'un jour cette tenture sorte de l'ombre à son tour.

[20] Archives Nationales (A. N.) : KK1130, f° 64. Inventaire du 16 mai 1764.

[21] Bonnot-Diconne et al., 2002, p.765.

[22] Note conservée au château de Lunéville.

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Gilt Leather Punch Marks: Preliminary Evaluation of 3D Technologies for Documentation and Punching Tool Reconstruction

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Keywords
Punch Marks, 3d Scanning, 3d Printing, Images' Geometrization, Cad, Tool Reconstruction, Documentation, Punching Tools Prototypes

Introduction

The impression with metal punches had a significant role in the decoration of gilt and painted leather furnishings, from the first known specimens of the 16th century well through to the beginning of the 18th century. Data collection of punch marks' shapes and sizes is of great interest both for art historians and conservators as it supports a more rigorous geographical and chronological classification of the artefacts and workshops. It is also relevant for conservation purposes.

To date, the documentation of punch marks has been carried out with graphic techniques, including rubbing, or photographic methods, mostly macrophotography with metric scale. Steel reproductions of the original tools can be manufactured manually and are used for reintegrating an artefact's missing parts or for creating replicas.

Objectives

This study presents a preliminary evaluation of the adoption of 3D technologies (3D scanning and printing) for the documentation and reconstruction of punches, as a potential alternative to traditional methods. In addition to the evaluation of the quality of the results, it also assesses this process's ease of accessibility and cost effectiveness.

Using as reference model a 16th century fragment of gilt painted and punched leather[1], the process has entailed the following steps:

- acquisition of the punch marks, using 3D scanning and digital images in orthoplane with microscope and 2D scan;
- elaboration of a 3D graphic model with dedicated programs evaluating both geometric reconstruction and the elaboration of the 3D scans;
- construction of punching tool prototypes with 3D printing technique;
- evaluation of the prototypes efficiency in reproducing the original marks.

Methods

Three punch marks, characterized by different geometric elements, have been selected for the study:

- the bird's eye with double ring of dots (9 mm),
- the mat (9,1 x 13,5 mm),
- the wavy parallel line (11,6 x 10,35 mm).

3D scans of the whole gilt-leather fragment were executed using a structured light scanner Einscan SE from Shining corporation[2], and elaborated with MeshLab and Meshmixer[3] **(Figure 1)**.

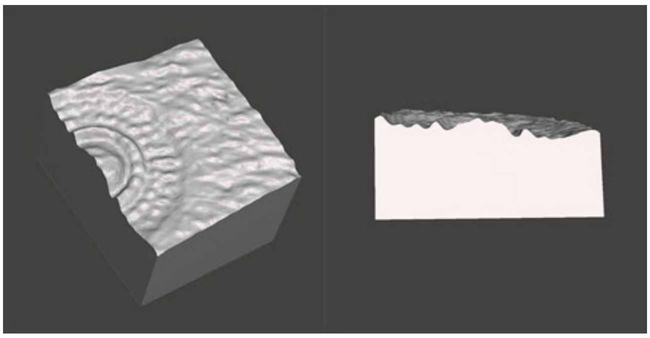

Figure 1: 3D scan: section of a punch mark.

The images of the three punch marks were collected both with digital microscopy DinoLite (AM4815ZTL)[4] at 20x and a 2D scan using an Epson table scanner (Epson 1640 XL)[5]. Each image was accompanied by reference measurements (segments and grids graded to the tenth of millimetre) and loaded within a CAD software (Autocad 2017 from Autodesk), which evaluated the sizes of each single decorative element, proceeding then to geometric restitution of the shapes first in a 2D and then in a 3D field (**Figure 2**). In order to assess the depth and profile of the decorative elements, micro-moulds of the marks were obtained using coloured flour paste[6] and were subsequently sectioned, photographed and measured with digital microscopy. The use of a profilometer was excluded due to the difficulty in accessing this instrument and its high cost.

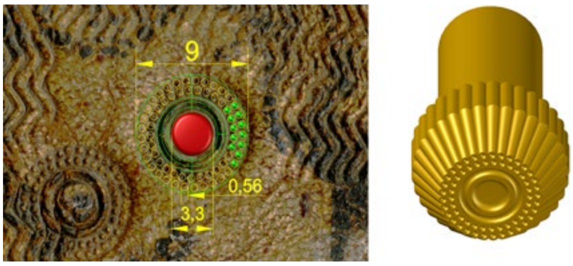

Figure 2: Geometrization and 3D modeling.

We based the shape of the tools' handles and tip on images from reference textbooks and an engineer's[7] technical considerations on the effectiveness of blow transmission.

With regard to the physical restitution of the punches, we adopted two kinds of the more common and less expensive 3D printers:

- those adopting FDM (Fused Deposition Modelling) technology, utilizing thermoplastic elements;
- those using photopolymeric resins with Vat Polymerisation technology, including SL (Stereolithography) and LCD (Liquid Cristal Display)[8].

Following different trials, the three punch prototypes were developed using two different materials to allow for a first comparison. These were, respectively, standard resin 'Basic Red' [9] using a Vat Polymerization LCD printer [10] and high mechanical strength resin 'Durable'[11] with a Vat Polymerization SL printer[12].

The prototypes' efficiency, in terms of hammer blow resistance and likeness to the original mark was evaluated by punching a silvered leather up to 1000 times[13]. In order to record any possible structural changes (splintering, cracking and wear), the punch marks were photographed with a digital microscope at the beginning of and throughout the trials.

Results and discussion

The punch marks are small in size, with some of their geometrical elements being smaller than one millimetre. In each punch mark, the elements' shape and size can vary due to the artefact's deformation and changes in the energy and angulation of the punching tool blow. The extent of the documented variations does not generally influence the appearance of the decorative motif as a whole, but it is worth mentioning as a median value of the measures.

For the aims of this study, the 3D scans proved unfit, as the extremely small size of the details, and the artefact's materials, particularly metallic layers and glossy and translucent varnishes, have strongly affected the scan quality, producing 3D models[14] not sufficiently precise and detailed (**Figure 1**).

On the contrary, images' geometrization, using a CAD software, produced a rather accurate three-dimensional graphic model, allowing the regularization of the punch elements shape and levelling of dimensional tolerances (**Figure 2**). Design software allows for the limitless implementation of this procedure, and many on-line downloadable programs are adequate for this purpose[15].

As for 3D printing of punches, initial tests have shown that FDM technology is unable to render the prototype's minute details with adequate precision. Conversely, printers using Vat Polymerization technology (SL and LCD) can achieve extremely accurate micrometric definition, both in the cavities and in the reliefs, together with smooth surfaces (**Figures 3 and 4**).

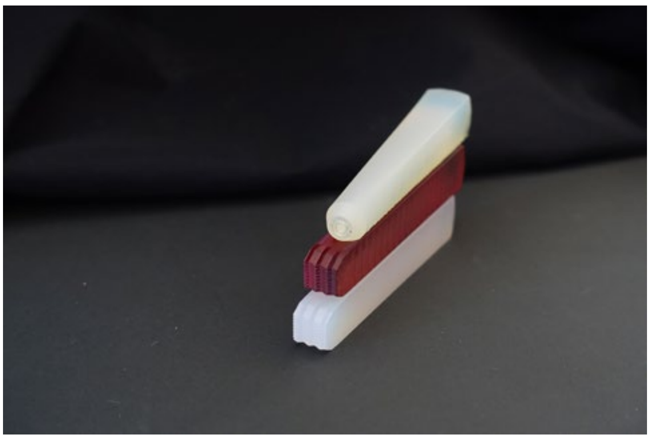

Figure 3: Punching tools prototypes.

Figure 4: Prototype tip, prototype punch mark and original punch mark.

The costs of the prototype printing tool vary according to the resins used, but are generally contained[16]. In order to further reduce the printing expenses, the production of a prototype with the handle printed with the FDM technique[17] and the tip in resin printed with Vat Polymerization technique is underway.

For its conformity to the originals, the quality of the marks obtained with the prototypes was judged to be satisfactory. Both resins utilized in the punching process failed to show any wear relating to the decorated surfaces in contact with the leather, or on the top of the tool handle receiving hammer blows. On the contrary slight differences were evident on the surface characteristics of the mark in the silvered leather surface. While the prototype made of 'Durable' resin produced a glossy mark, the standard resin left a more matted one, probably due to a rougher surface caused by the stepped arrangement of the printed micro-layers.

Conclusions

This study demonstrates that punching tools can be satisfactorily documented and reproduced with 3D technologies. Starting from images of punch marks acquired with digital microscopy or 2D scan, and precisely measured, it was possible to obtain an accurate three-dimensional graphic model which could be printed. The adoption of 3D printers with Vat polymerization technology has allowed the production of punching tool prototypes which have been tested on silvered leather, demonstrating good strength characteristics and producing marks similar to the originals. The process is presently in its early stage and it will be developed further. It offers the advantages of requiring low-cost investments and relying on easily accessible technologies.

Acknowledgements

Francesco Petrucci, curator of the Chigi palace in Ariccia, Verio Prodi, Cesare Selli and doctor Mecox for their help in translating this text.

Biographies

Federica Moretti is a freelance conservator trained at the Istituto Centrale per il Restauro in Rome. In 2006 she created her own company (A.R.CON. Federica Moretti), which has since been active in the field of conservation of works of art in Italy and abroad. She has an ongoing collaboration with both, the ISCR high school in Rome and the CCR of Venaria Reale, executing direct conservation treatments, conducting research, teaching and leading missions abroad for both institutions. Over the years, she has developed considerable expertise and experience in the conservation of leather artefacts, carrying out significant and complex works for the Vatican Museums, the Egyptian Museum of Turin and the German Research Institute Max-Planck-Gesellschaft.

Davide Fodaro conservator and lecturer in the ICR (Istituto Centrale per il Restauro, Rome, Italy), he specializes in conservation sculpture (terracotta, plaster). He has worked in Italy and abroad participating in excavation campaigns in Greece, Libya and Jordan. He experimented with laser cleaning applied to sculptures made in a range of different materials (terracotta, plaster, wood, wax), presenting the results at national and international conferences.

In recent years he has been involved in the application of 3D technologies in the field of conservation of cultural heritage and replication of works of art.

His publications mainly focus on sculpture conservation, study of sculpture techniques, laser cleaning and the application of 3D technologies in the conservation of cultural heritage.

Marina Marchese has a diploma in graphic design at the IED (Istituto Europeo di Design, Rome). At ICR since 1986 she is part of the Graphic and Photographic Documentation Office where she is involved in relief and graphic documentation of conservation treatments carried out in the institute on different types of work of arts. Among the most relevant works: the cycle of frescoes by Raffaello in the "Loggia di Amore e Psiche" at Villa Farnesina in Rome, the Wooden Choir of the Cathedral of Orvieto, the Mosaics of the apse of the Basilica of St. Clement in Rome. She has been also teaching (Drawing ICAR /17) for the ICR High School. She has collaborated in Italy with the Università degli Studi della Tuscia and abroad for documentation campaigns in Turkey and Egypt. In the last few years she has been interested in 3d technologies.

Mariabianca Paris holds a degree in Art Conservation in the sector of paintings at the Istituto Centrale per il Restauro in Rome (ICR) and in Medieval and Modern Art History at Università degli Studi di Roma "La Sapienza". Conservator at ICR since 1986 included in her duties, is the ongoing responsibility for research, training, treatments and consultancy in the Leather Conservation Studio that she helped to establish in 1989. She is a member of the ICOM-CC working group 'Leather and Related Materials' since 1990, and she acted as its co-ordinator in the period 2008-2011. She is the author of several technical publications on gilt leather.

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1 Fragment of the "Amorini" freize from Chigi Palace in Ariccia.

2 Point Distance: 0.17 mm ~ 0.2 mm; Single Shot Accuracy: ≤0.1 mm.

3 MeshLab: open source software developed by the ISTI-CNR research center Meshmixer: free software by Autodesk

4 Optical magnification power 5x - 140x; resolution up to 1280 x 1024 pixels.

5 Tests with different resolution demonstrated that the mark volumes and the depth are adequately represented starting from 1200 dpi. On the use of this technique see E. Borrelli, *Un inusuale uso di uno scanner 2D per l'ottenimento di immagini ad alta risoluzione ed elevata profondità di campo di artefatti e oggetti tridimensionali*, in Archeomatica, 1, 2017, pp. 14-20.

6 Didò by F.I.L.A. (Fabbrica Italiana Lapis ed Affini S.p.A), soft and malleable paste made of water, flour and salt particularly suitable for the reproduction of minute details. The contact time for the relief of the shape is about four seconds, and under the microscope no residues are visible after the application.

7 We thank F. Viscusi for his valuable contribution.

8 See: B. Redwood, F. Schöffer, B.Garret, 3D HUBS, *The 3D Printing Handbook. Technologies, design and applications*, Amsterdam, 2017, The Netherland.

9 'Basic Red' resin produced by Harzlabs (Tensile strength: 20 N/mm^2, Elongation at break: 6-7%, Hardness Shore D: 80-85, Shrinkage: 2.5%).

10 Printer Anycubic Photon: layer height, 40 micron; print angle, 45°.

11 'Durable' resin produced by Formlabs (https://formlabs.com/materials/engineering/#durable-resin): wear resistant, ductile, with a low module and high impact force, for prototypes of parts requiring deformation and a soft, glossy finish.

12 Formlabs Form 2 printer, layer height: 50 micron; print angle: 45° (for bird's eye) and vertical (for mat and wavy parallel line). We would like to thank 3DiTALY (Rome) and FabFactory (Rome) for their contribution and service.

13 The trials were performed on vegetable tanned leather silvered with the traditional technique and slightly wetted, using hard rubber hammers.

14 The 3D scan sections have been performed with Meshmixer software from Autodesk.

15 Such as : FreeCAD; Sketchup; QCAD; TinkerCAD; Fusion 360 (free for the first 3 years).

16 For the three punches printed with the high mechanical strength 'Durable' resin, the cost was 15 euros each plus a fixed quota of 25 euros for the machine start-up.

17 Printer: CraftBot plus; slicing software: Simplify 3D; material: PLA PLUS di ESUN.

Datation par la Méthode du Radiocarbone de Peintures au Blanc de Plomb Apposées sur des Cuirs Dorés

Cyrielle Messager, Lucile Beck, Ingrid Caffy, Emmanuelle Delqué-Količ, Jean-Pascal Dumoulin, Solène Mussard, Marion Perron, Christophe Moreau, Céline Bonnot-Diconne

Mots-clés
Datation Radiocarbone, Blanc de Plomb, Cuir Doré, Cérusite, Peinture

Introduction

Les cuirs dorés sont, depuis la fin du Moyen-Âge, particulièrement appréciés en Europe pour décorer les murs des riches demeures nobles et bourgeoises (Fongeroux de Bondaroy, 1762). Ces décors peuvent être peints, notamment avec du blanc de plomb. Ce pigment est le pigment blanc le plus utilisé dans l'histoire de la peinture européenne jusqu'au début du XXème siècle. Il est principalement constitué de deux carbonates de plomb, la cérusite ($PbCO_3$) et l'hydrocérusite ($Pb_3(CO_3)_2(OH)_2$), synthétisés depuis l'Antiquité à partir de lamelles de plomb métallique, de vinaigre et de fumier de cheval (Stols-Witlox, 2011). Les récentes recherches qui ont été menées sur ce pigment ont permis de démontrer l'incorporation de dioxyde de carbone (CO_2) d'origine organique au cours de son processus de synthèse (Beck et alii. 2018, Gonzalez et alii., 2019). A partir de ce résultat, nous avons développé un protocole innovant en vue de dater la fabrication du blanc de plomb par la méthode du radiocarbone (Beck et alii.2019). Pour tester sa validité et sa robustesse, on se propose de dater sur les mêmes cuirs dorés la peinture et le support en cuir par la méthode du carbone 14 puis de comparer les résultats avec les données historiques.

Matériaux et méthode

Les deux échantillons de cuirs dorés peints que nous avons étudiés proviennent de tentures murales de deux sites différents et sont ornés d'un décor végétal sur fond blanc. D'après les informations historiques et stylistiques dont nous disposons, le cuir doré 1 (CD1) date de la seconde moitié du XVII^{ème} siècle et le cuir doré 2 (CD2) date d'avant 1736 **(Figure 1)**. Les analyses par spectrométrie de fluorescence par rayons X sur la peinture blanche ont attesté la présence majoritaire de plomb et les analyses par diffraction des rayons X ont confirmé sa composition à base d'un mélange de cérusite et d'hydrocérusite pour CD1 et d'un mélange d'hydrocérusite et de plumbonacrite ($Pb_5O(CO_3)_3(OH)_2$ pour CD2.

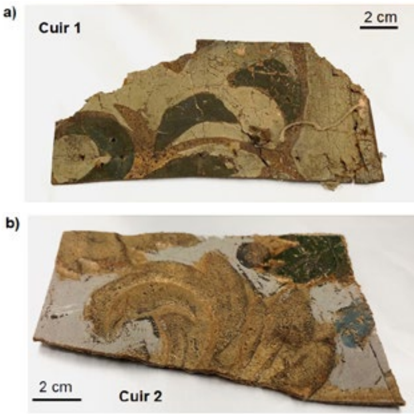

Figure 1 : Échantillons des deux cuirs dorés étudiés représentant un décor végétal : les fonds blancs-gris sont peints au blanc de plomb © LMC14

En vue de la datation radiocarbone du blanc de plomb, nous avons développé un protocole expérimental reposant sur l'extraction du carbone des carbonates de plomb par décomposition thermique (Beck et alii. 2019). Ainsi, environ 20 mg de peinture ont été prélevés et chauffés à 400°C pendant 1h sur une ligne de collecte de CO_2. Le gaz recueilli est alors graphité et pastillé en cible (Delqué-Količ et alii. 2013). Entre 2 et 3 mg des supports en cuir ont été traités et préparés pour la datation radiocarbone suivant le protocole appliqué aux matières organiques (Dumoulin et alii., 2017). Le blanc de plomb et le cuir ont été datés par carbone 14 en utilisant le spectromètre de masse par accélérateur ARTEMIS, LMC14/LSCE, CEA Saclay, France (Moreau et alii., 2013). Les dates ont été calibrées grâce au logiciel Oxcal 4.3 (Reimer et alii., 2013) et les résultats sont présentés en **Figure 2**.

Résultats

Pour chaque cuir doré, les trois datations sont en accord. La combinaison statistique des données permet de valider la cohérence des résultats (test du χ^2 avec T = 2,7 < 6,0 pour CD1 et T = 1,5 < 6,0 pour CD2 (**Figures 2b et 2d**)). D'après les représentations des dates radiocarbones calibrées, il semble certain que le pigment et le support en cuir de l'échantillon CD2 soient contemporains (**Figure 2c**). En revanche, pour l'échantillon CD1 (**Figure 2a**), malgré la cohérence statistique des données, on ne peut pas exclure que le pigment ait été synthétisé bien avant l'abattage de l'animal qui a servi à fabriquer le cuir.

Globalement, les datations radiocarbones sont en accord avec les informations historiques fournies pour les deux cuirs dorés (**Figure 2**). L'intervalle de temps le plus probable pour CD1 [1634-1667 (à 85,0%)] (**Figure 2b**) est très proche de l'époque attendue, à savoir la seconde

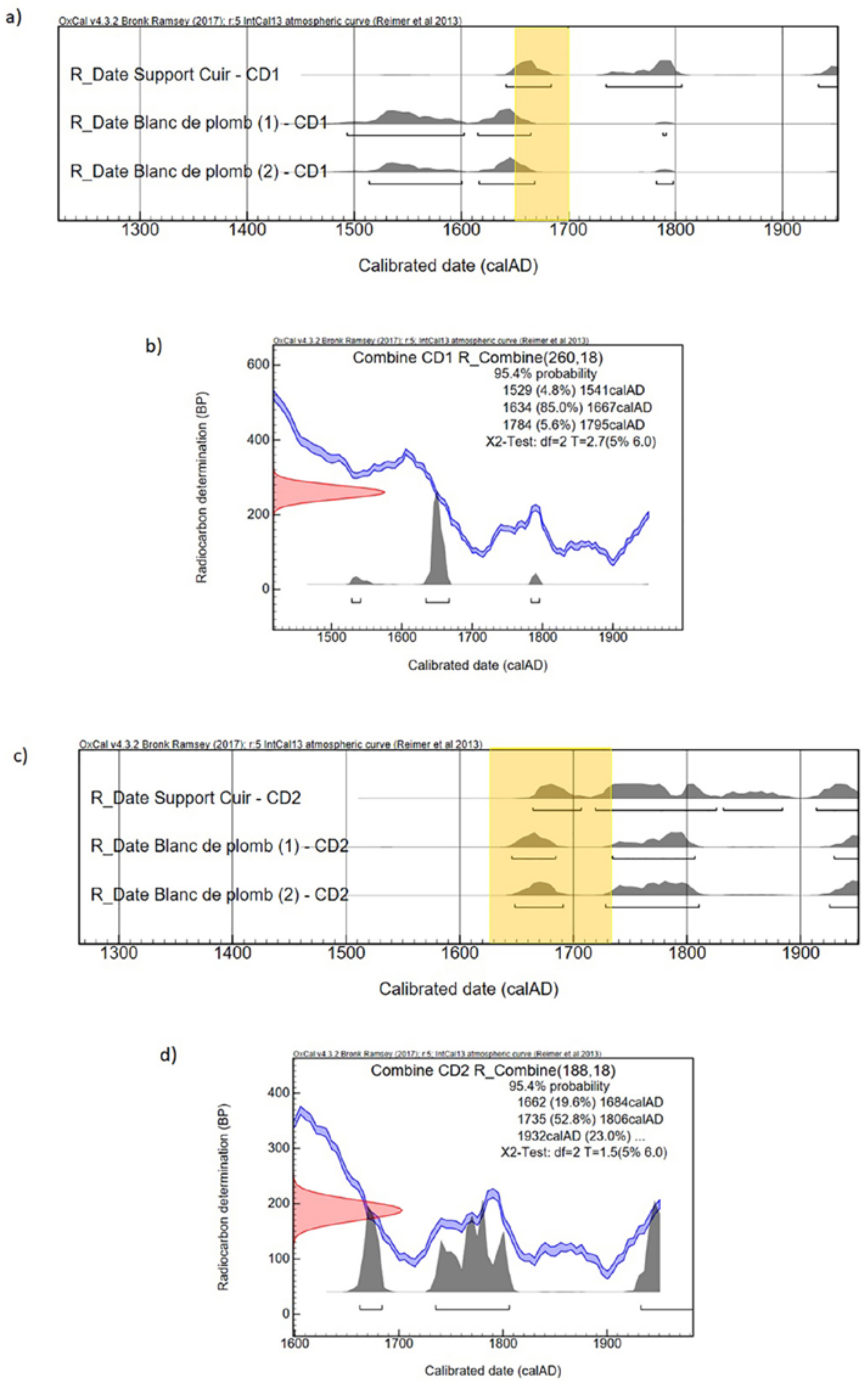

Figure 2 : Résultats des datations du support cuir et de la peinture au blanc de plomb pour les deux échantillons de cuirs dorés : a) et c) Représentation et comparaison des datations radiocarbones obtenues pour le cuir et le blanc de plomb (x2) des cuirs dorés CD1 et CD2. La marque jaune représente la date attendue b) et d) Combinaison statistique des trois dates pour les cuirs dorés CD1 et CD2.

moitié du XVIIème siècle. Concernant l'échantillon CD2, on observe une large distribution de probabilité due aux fluctuations de la courbe de calibration. Parmi les trois intervalles de temps probables **(Figure 2d)**, l'intervalle [1662 - 1684 (à 19,6%)] et le début de l'intervalle [1735 - 1806 (à 52,8%)] sont partiellement en accord avec les sources historiques puisqu'il est attesté que ce décor était déjà en place en 1736.

Conclusion

Etudier des cuirs dorés peints par la méthode du radiocarbone offre la possibilité de dater un matériau organique, le cuir, et un matériau inorganique, le blanc de plomb. Ainsi, ce sont deux informations qui peuvent être collectées et corrélées à partir d'un même échantillon. Nous avons pu éprouver notre protocole expérimental d'extraction du carbone des carbonates de plomb et ainsi démontrer la possibilité de dater le blanc de plomb par la méthode du radiocarbone. Cette étude permet l'avènement d'un nouvel outil pour l'authentification des peintures.

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Matériaux

Les échantillons de cuirs dorés nous ont été fournis par Mme Céline Bonnot-Diconne.

Biographies

Lucile Beck est docteur en physique, de formation physico-chimiste et archéomètre. Elle responsable du Laboratoire de Mesure du Carbone 14 (LSCE, CEA-Saclay), Instrument National pour la datation radiocarbone par spectrométrie de masse par accélérateur.

Céline Bonnot-Diconne est restauratrice du patrimoine, spécialisée sur le cuir. Elle dirige le Centre de Conservation et de Restauration du Cuir (2CRC, Grenoble, France) où sont restaurés de nombreux décors en cuir doré polychrome.

Ingrid Caffy est technicienne chimiste IRD spécialiste en préparation des échantillons au LMC14.

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The Use of Macro X-ray Fluorescence Scanning (MA-XRF) to Study the Decorative Layers on a Gilt Leather Altar Frontal

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Keywords
Gilt Leather, Altar Frontal, MA-XRF, Pigment, Metal Leaf

Introduction

The Art & History Museum in Brussels has a collection of gilt leather wall hangings and decorations which are poorly documented. Similarly, very little is known about the museum's only example of gilt leather altar frontal **(Figure 1)**. The altar frontal's central area depicts the Virgin of the Rosary with the Christ Child. Its style indicates that it was probably produced in Italy during the 18th century or after. The piece will be displayed in the new permanent exhibition scheduled to open in 2020. Within a Master's degree project work, macro X-ray fluorescence scanning (MA-XRF) was used to study the materials and the execution technique and to propose suitable conservation-restoration treatments. The results of these analyses are described below.

Methods

MA-XRF is a non-invasive technique which was used to identify and map the distribution of the different chemical elements present on the decorative surfaces of the altar frontal. It can provide information about the nature of the altar frontal's materials such as inorganic pigments, metallic leaves or overpaint.

MA-XRF maps were registered using the M6 Jetstream large area scanner (Bruker AXS, Germany), with a Rh-target microfocus X-ray tube operated at 50 kV and 600 µA current, and a 30 mm^2 X-Flash silicon drift detector (energy resolution <145 eV at Mn-Kα). The altar frontal was scanned using an X-ray beam size of 500 µm, in steps of 500 µm, and a dwell time per step of 10 ms. The spectra were collected, deconvoluted and examined with the Bruker M6 Jetstream software. Chemical elements were identified in the scan by examining the sum spectrum and maximum pixel spectra. Results of MA-XRF analyses are presented as elemental distribution plots for the main chemical elements detected in grey-scale images.

The pigments present can then generally be derived based on the identified chemical elements, the knowledge of

Figure 1: Gilt leather altar frontal, dimensions 199.9 cm × 96.1 cm. © Art & History Museum, 2018

their chemical composition and the colour of the paint layer. A complementary **micro-Raman** spectroscopy analysis was necessary to identify the blue pigment. A small sample was taken in the floral frieze and analysed with a Renishaw inVia Raman microscope with a diode laser with a wavelength of 785 nm, operated below 10 mW to prevent pigment degradation. The analyses have been carried out in the laboratory department of the Royal Institute for Cultural Heritage in Brussels.

Results and discussion

Because of the large dimensions of the altar frontal, only distinct areas of its surface were scanned. In **Figure 2**, an assembled overview of the different silver distribution images, corresponding to the seven analysed areas of the altar frontal is shown.

Silver leaves cover the overall surface of the leather. These leaves measure approximately 16 cm per side (blue arrow in **Figure 2**), based on the rectangular shape visible in the MA-XRF map. The darker areas in **Figure 2** correspond to areas rich in lead and/or tin, probably masking the weaker response of the lighter silver.

MA-XRF maps also facilitate the detection of two or more chemical elements in the same area. As shown in **Figure 3**, copper and zinc are present in areas with a golden aspect, suggesting a brass based overpaint. Further results are summarized in the **Table 1** below.

Table 1: Summary of the results and interpretations of the instrumental analyses performed on the altar frontal

Area on the altar frontal	Elements detected with MA-XRF	Interpretation
Red background	-	Organic pigment such as madder or carmine
Red of the flowers' petals and the Virgin's dress	Hg	Vermilion (HgS)
Green leaves	Cu	No precise interpretation possible: Malachite or Verdigris or copper resinate?
Dark outlines around the painted motifs	Fe	Earth pigment containing ironoxide
Blue of the floral frieze, the flowers' petals and the sky	Pb	Lead white + Prussian Blue (identified by micro-Raman)
Some areas of the gold varnish	Cu, Zn	*Bronzine* overpaint (brass flakes mixed with a binder)
Silver areas	Sn	Tin overpaint (tin flakes mixed with binder)

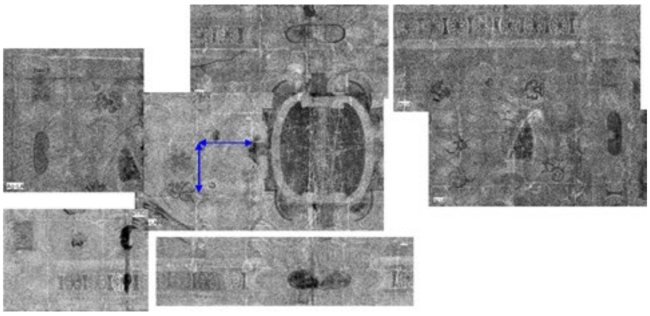

Figure 2: Elemental distribution map of silver. © IRPA, 2018

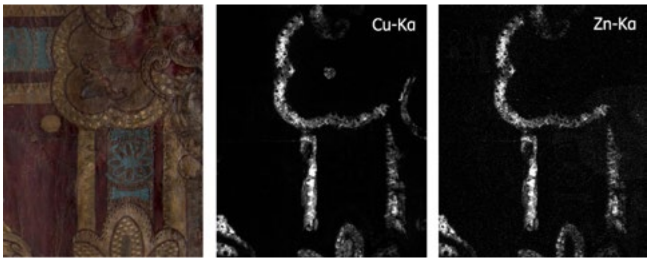

Figure 3: Visible image of the right top part of the altar frontal (left) and corresponding elemental distribution maps of copper (center) and zinc (right). © IRPA, 2018

In some cases, the MA-XRF mappings required the use of complementary techniques, since organic pigments (the red background) or green copper-based pigments cannot be unambiguously characterized with this technique. Analysis of the blue paint used on the altar frontal only revealed the presence of lead, suggesting lead white. Micro-Raman spectroscopy of a tiny withdrawn paint fragment clearly showed the presence of Prussian blue $(Fe_4(Fe(CN)_6)_3$ and confirmed the use of lead white. Because of the high tinting strength of Prussian blue, its relative concentration is expected to be low and its MA-XRF response masked by the heavier lead element.

Conclusion

MA-XRF gives information about the nature of the inorganic materials in the altar frontal's decorative layers. The analyses did not show the presence of modern paints produced after the 18^{th} century. Materials' observations of the altar frontal suggested that the brass based and tin overpaints were made during the 19^{th} century when the antependium was still exposed in a place of worship. The results of the analyses coupled with the stylistic study of the altar frontal corroborate the 18^{th} century's dating.

MA-XRF is an efficient method to study the chemical elements present in the different decorative layers of gilt leather and to visualize their distribution without having to take any sample. Even the largest hangings and altar frontals can be analysed. Therefore, this technique brings significant added value compared to other techniques for pigments and metal analyses. To refine the results' interpretation, MA-XRF can be complemented with other instrumental analyses.

Acknowledgments

We would like to thank the Art & History Museum, especially Emile van Binnebeke, curator of European Sculpture and Furniture for allowing technical analysis of the gilt leather altar frontal.

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Biographies

Anne-Catherine Goetz holds a Master in Conservation-restoration of archaeological and ethnographical objects from the Haute Ecole Arc in Neuchâtel, Switzerland (2018). Her Master's thesis focused on the study and the conservation-restoration treatments of an altar frontal and a piece of wall hanging, both made of gilt leather and stored in the Art & History Museum in Brussels. Since 2019, she works at the International Carnival and Mask Museum in Binche, Belgium.

Marina Van Bos is a senior scientist, specialized in the study of painting techniques and materials. She studied Chemistry at the University of Ghent (Belgium), where she obtained her MA and PhD (1990). She is working in the Laboratory Department of KIK/IRPA since 1991.Her main research activities relate to two domains. Within the cell "Monuments and Monumental Decoration", analyses of the painted finishing layers of murals, monumental decoration (interior and exterior) and wall paper are carried out.Within the cell "Leather/paper/parchment" of the laboratory, she is responsible for the identification of the various components in pictorial layers and/or inks of manuscripts or paint on paper and leather, mostly by using a non-invasive approach.

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New conservation approaches
Nouvelles approches de conservation-restauration

A “Rehabilitation Protocol” for a Medieval Codex in Risk of Disappearance

Diana Avelar Pires

Abstract

The protocol we are presenting was developed during the conservation treatment of a Diurnal according to the Braga rite, a medieval manuscript from the Braga District Archive. The conservation treatment of this codex was part of a larger project that occurred in 2016 at the National Archives Torre do Tombo (ANTT) in Lisbon. The main goal was to preserve and conserve four medieval codices: a Book of Hours, a Missal of Mathew, the Diurnal and the Liber Fidei. The Diurnal may have been the one that imposed greater technical challenges to the team of Conservators.

Regarding the Diurnal, its advanced deterioration state had made the manuscript inaccessible to the public for several years. The text-block is made of very thin vellum, and the text was written with metallogallic ink. Several problems were identified that could lead to the complete loss of the document: the ink corrosion caused the loss of a significant amount of material and the ink also presented signs of being powdery.

After the team conducted several tests and analyses, the 3 phases of the “Rehabilitation Protocol” were developed and put in practice. This protocol is an experimental model that stands on already confirmed techniques and materials validated by specialized Conservators. But, by establishing a procedure based on controlled and monitored stages, we defined a series of steps that ensured the homogeneity of the treatment throughout the total of 336 folios, making it an innovative way of recovering badly degraded volumes.

Keywords

Manuscript, Vellum, Metallogallic Ink, Isinglass, Rehabilitation Protocol, Suction Table

Introduction

Due to a collaborative project between the National Archives Torre do Tombo (ANTT) and the District Archive of Braga (ADB), it was possible to gather an interdisciplinary team that allowed the study and research of 4 medieval codices, at the care of ADB. Namely, art historians Ana Lemos and Catarina Barreira developed part of the research, representing the Medieval Studies Institute (IEM) of the Faculty of Social and Human Sciences (FCSH) of the Nova University.

On the one hand, the codicology studies that resulted from this collaboration allowed the development of more knowledgeable interventions, and on the other, the dis-binding of some of these codices enabled a privileged observation and interpretation of the manuscript’s materials and production. The interdisciplinary approach enabled a greater depth of knowledge about these codices and the development of substantiated interventions.

The 4 manuscripts were the Diurnal according to the Braga rite (which we will address in this paper), a Book of Hours of Rouen, a Missal of Mathew with a Calendar of Braga and the emblematic Liber Fidei **(Figure 1)**. This group of manuscripts has great heritage value, both for the history of the city of Braga, but also for the history of the medieval codex in Portugal. Naturally, this became a unique opportunity to make an extensive study of these codices.

The Diurnal, according to the Braga rite

The conservation and restoration intervention of the Diurnal revealed to be a great challenge to the team of four knowledgeable and experienced Conservators involved: two Senior Conservators from the ANTT – Inês Correia and Sónia Domingos - and two external Conservators that developed the practical work - Diana Avelar Pires and Liliana Amadeu Silva.

Figure 1: The 4 codices: a) Diurnal; b) Book of Hours; c) Missal of Mathew; d) Liber Fidei.

The Diurnal (ms. 1 of the ADB) is a small sized codex – 110 × 85 × 70 mm –, and its date has been proposed between 1451 and 1457 by Prof. Joaquim Félix de Carvalho (Carvalho, 2007). It was not possible to confirm this information when the new codicology study was done by historian Catarina Barreira due to the extensive damage of the calendar in the beginning of the manuscript. The text-block is made of very thin parchment - vellum - with a total of 320 folios and 8 other folios made of paper that comprise the guards of the codex, which may have been added later during re-binding. The boards are made of wood covered by silk brocade. The fastenings are quite heavy and prominent, and are likely made of silver **(Figure 2)**.

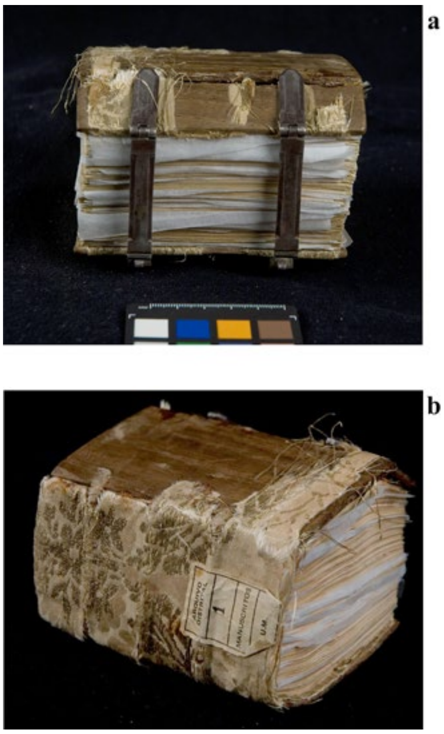


Figure 2: Diurnal according to the Braga rite: a) foredge before intervention; b) spine before intervention.

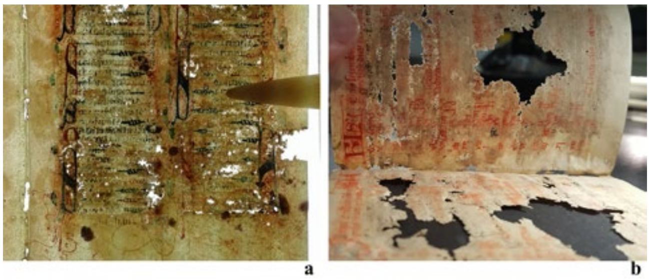
The codex also counts with the presence of 3 full page miniatures: the Crucifixion, the Resurrection and the Pentecost - and a smaller miniature representing the Veil of Veronica. The dark color we see on Christ's face may be linked to the use of silver, but further analysis would be needed to confirm this assumption.

From the beginning, when developing the first approach for a proposal, the senior conservators encountered more questions than answers. Before them there was a manuscript presenting advanced signs of degradation, with several serious structural problems, and seemed to be almost impossible to safely handle. The text-block was very frail with severe material loss both at the substrate and the medium. The boards were broken along the sewing supports and along the fastenings, and from the cover remained only a small fragment that was weak and unstable.

The methodology used during the conservation survey and identification of the Diurnal was based on a stratigraphic analysis of the several layers that compose the medieval codex. This method is based on a tool developed by Dra. Inês Correia (Correia, 2017), one of the project managers, in her PhD thesis (Correia, 2015). This analysis deconstructs the document in Stratigraphic Unities (SU) that can be divided in 4 main groups: the text-block, the structure, the protection and the covering. We chose to look at the object from the point of view of the binder, following the different stages of production. Each of the stratigraphic layers is subdivided and analyzed independently regarding materials and techniques used to build each one of them. From this study we are able to establish chronological marks that allow us to identify changes that may have occurred in the past, for example, re-bindings, additions or subtractions of text, etc. We also evaluated the conservation state of each one of the layers mentioned, giving us a good idea of the overall damage and fragilities of the codex.

Rehabilitation protocol

The conservation state of the Diurnal according to the Braga rite was the main reason for the development of a protocol for the treatment of parchments presenting advanced deterioration and fragility. The text-block represented the most unstable stratigraphic unity of the set. The degradation in the vellum folios was directly related with the ink used to write the text, a metallogallic ink. The degradation of the ink developed into the corrosion of the vellum (Reissland, 2011) in place of the letters **(Figure 3)**. The ink was also powdery and there was high risk of it disappearing by handling and abrasion, which may have been due to the poor quality of the binder/ carrier used to produce it **(Figure 4)**. To further increase the damage of the vellum folios, there was the presence of pink/ purple stains that may indicate that there has been some microbiology activity. This factor may have contributed to the fragmentation of the parchment structure.



a b

Figure 3: Conservation survey of the vellum: a) ink corrosion; b) loss of material.

a b

Figure 4: The ink was powdery, in some cases practically disappeared from the surface of the vellum (a), leaving only the indentations of the ink corrosion (b). Last image obtained using a stereoscopic binocular microscope ×40.

The goal of the intervention was the restitution of the mechanical and structural properties of the vellum and to stabilize the powdery pigment on the surface of the substrate.

The protocol is based on the application of 3 controlled phases each involving several processes: humidification and flattening of the parchment, sizing through fogging of the adhesive, and consolidation or in-filling of the material loss. Each one of the phases was previously tested in old parchment fragments to prove its efficacy and to make any adaptations or modifications the team found necessary. Based on the team's experience, extensive reference research and thoughtful preliminary study, it was possible to manage and develop the different stages of the intervention.

Regarding the techniques and materials employed throughout the protocol, there were no innovations, since all of them are well known and already established in the community of manuscript conservation eg. the use of an adhesive in a dispersion solution - fogging -, the use of Japanese paper for tear consolidation and in-fillings in parchment, and the use of an adhesive like Isinglass in parchment conservation (Jonynaite, 2001), (Hassel, 1999). However, the protocol ended up being innovative in recovering badly damaged parchment, by the establishment of three distinct and controlled phases. This way we are able to perform a homogeneous treatment throughout the codex, which was particularly important, considering the Diurnal has a total of 320 folios, and the protocol was applied to them all.

Although the protocol was developed with a very specific purpose, we believe that it may be applied to any parchment or manuscript presenting the same kind of degradation or that is in a non-reactive state. There is no record, as far as we know, of a similar protocol applied to document in the same stage of deterioration.

Phase I - Humidification and flattening

Phase I comprises the humidification and flattening of the vellum folios. The main goal was to make the parchment more suitable to accept the sizing in the next phase and permit temporary flattening of the folios. The humidification is made through a Gore-tex membrane with a blotter dampened with a solution of 70:30 (ethanol: distilled water). The Gore-tex allows the humidification of the parchment in a homogeneous way without putting it in direct contact with the solution (Purinton, 1992). The vellum folios are protected on both sides with Holitex sheets; the Gore-tex membrane is placed on top, the damp blotter and a sheet of polyester covers the set to prevent the solution from evaporating. During the first 30 minutes of humidification, the set is placed directly on top of the suction table to improve the humidification. At the end of that period, the solution is reinforced in the blotter and it stays for another hour and a half without using the suction table. This way we obtained a total humidification time of 2 hours. By the end of that time, the folios were flattened for 30 minutes under dry blotters and light weight, going directly to phase II of the Protocol.

Phase II - Sizing by fogging

In phase II, the vellum folios were sized by fogging the adhesive in order to consolidate the powdery pigment present. At the same time, the sizing worked as an attempt to reinforce the parchment's internal structure where it was frailer. The fogging is made inside a chamber that was created for this purpose with the capacity to house 10 folios, standing above the suction table. On each side of the chamber 2 nebulizers were placed, each one with the capacity to fog 6 ml of adhesive. So, for every 10 bifolios there would be an amount of 12 ml of adhesive fogged in the chamber. After testing different adhesives and different proportions of the adhesive, the one that provided the best results was Isinglass at 1% (wt/v) in distilled water **(Figure 5)**.

The process of fogging occurred for a period of 30 minutes in two stages: 15 minutes of fogging for each side of the bifolios. For the first 5 minutes, the suction table was turned off allowing the creation of an adhesive cloud inside the chamber and, the next 10 minutes, the suction table was turned on and forced the adhesive particles to go through the structure of the folios.

As a result, we verified that the pigment on the surface of the vellum was no longer in a powdery form allowing for the safe handling of the folios. The vellum, as a substrate, had improved in its flexibility and mechanical strength, visible at the naked eye.

After this procedure the bifolios were again flattened between Holitex sheets and blotter under light weight. This phase also made the parchment more resilient in preparation for the next phase of consolidation and in-filling material loss.

Phase III - Consolidation and in-filling

Phase III aims to consolidate the folios, either punctually or as lining for the ones that lost a significant part of their volume. Again, the adhesive selected was Isinglass, but this time in a 4% solution in distilled water, and two Japanese papers were selected: 9 gsm Manila was applied only at the spine area to reinforce the holes for re-sewing; the 3,5 gsm Tengujo with Kozo fibers was used to line areas of extensive material loss and also as consolidation of tears or fragile areas in the folios. The standard procedure at ANTT, was to perform a lining when the lacuna reaches over 50% of the folio area.

After this procedure the folios were dried between Holitex sheets and blotter under light weight, being then cased together in quires and put under light weight again until the re-sewing stage of the text-block **(Figure 6)**.

The total amount of time to apply the protocol to the 320 folios of vellum was 4 weeks, working full time. The work was equally divided and interleaved by the two external conservators as to create a functional workflow, and avoid fatigue due to repetition of movements.

In the collation scheme presented **(Table 1)** it is possible to visualize the structure in which the quires of the Diurnal are organized, as well as treatments in red and blue. In red we identified the folios that suffered lining

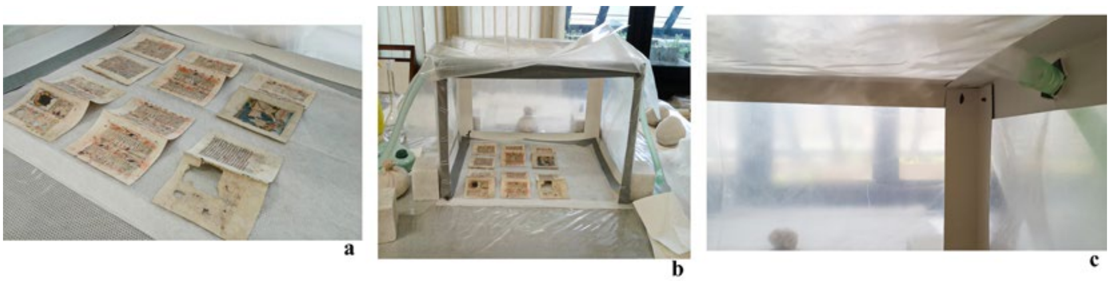


Figure 5: Phase II of the rehabilitation Protocol: a) and b) placing the folios inside the chamber; c) fogging the adhesive.

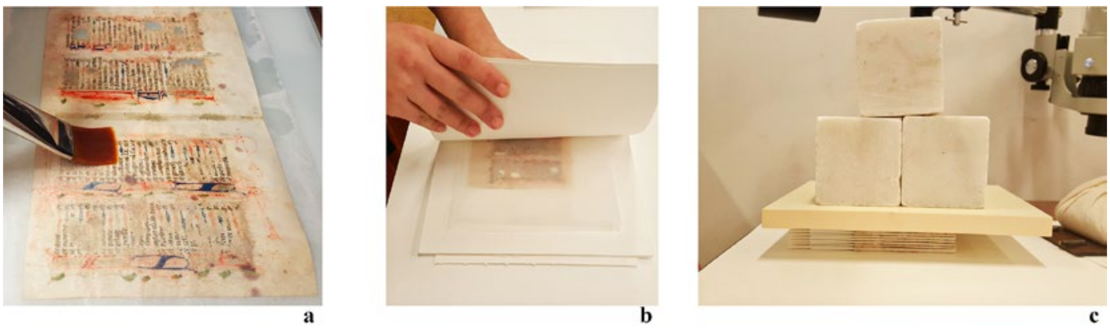


Figure 6: Phase III of the rehabilitation Protocol: a) consolidation with 3,5 gsm Tengujo Japanese paper; b) and c) careful drying with blotters and light weight.

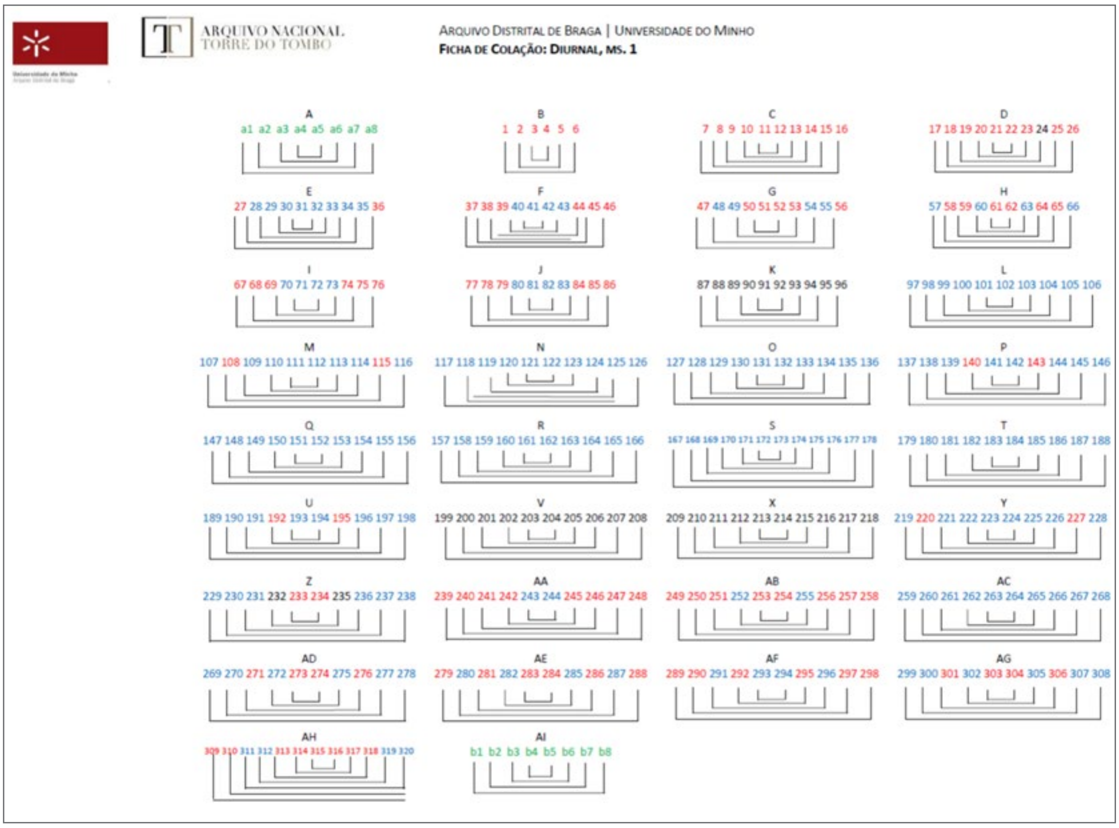


Table 1: Collation scheme with indication of the treatments performed in each folio: in red the folios that were lined; in blue the folios that were partially consolidated.

and in blue the ones that were partially consolidated or have been reinforced in the spine area. This way, it becomes easy to have a general view of the level of intervention within the manuscript, which is linked to the conservation state it was in. It is interesting to note that the degradation is worse in the first 3 quires – B, C and D –, becoming again worst at quire AA, which is exactly where there is an alteration of the liturgical content, changing from Temporal to Santoral, and which might have been subject to more reading in the past.

After this phase and before re-sewing, the manuscript was digitized following the policy defined by the ANTT.

Conservation and restoration treatments performed

To mention the following treatments performed on the codex in a brief way, here is a list divided by Stratigraphic Unity:

Text-block: freezing using the protocol at use at ANTT, dis-binding, dry cleaning, rehabilitation protocol; cleaning, washing, sizing and in-filling of the paper guards; digitization.

Structure: re-sewing and construction of endbands following the original techniques and similar materials; pasting new parchment spine reinforcements.

Protection: cleaning and consolidation of the wood boards, re-bonding of the broken pieces of the boards, in-filling the material loss on the boards; re-attachment of the boards to the text-block by pasting in the sewing supports.

Covering: separation of the silk brocade from the boards; humidification, washing and flattening of the silk brocade fragment; reinforcement of the fragment with japanese paper; pasting a support in new silk to allow for re-covering of the codex; adding a protection in organza only by stitching; re-covering the re-sewn text-block; and lastly, pasting down the new spine reinforcements and pasting the paper guards.

The treatment of the Diurnal was concluded in three months.

Housing

After the conservation and restoration treatment a box was created to include not only the codex but also an archive of the samples as well as the collation scheme. The archive of samples includes the original materials that were not reintroduced in the codex throughout the treatment like the linen threads and original sewing supports, as well as endbands and spine reinforcements, and fibers from the brocade. All these materials no longer performed as they should. We also included a tiny fragment of the wood covers in a coverslip identifying the wood as being oak. Samples of dust and particles found inside the codex, as well as fragments of adhesive from the spine, were also kept inside the box and can be analyzed in the future **(Figure 7)**.

The fastenings of the codex represent some volume on top of the codex, therefore an individual case was created to safely accommodate them, protecting them from erosion and, at the same time, keeping the codex in a safe position **(Figure 8)**.

The box was created in a standard A4 format and was built with a grey-white 0.5mm acid free board, blue cotton tape and polyethylene sheets were used to create the pockets for the sample archive.

Figure 7: Housing of the Diurnal in a box with sample archive.

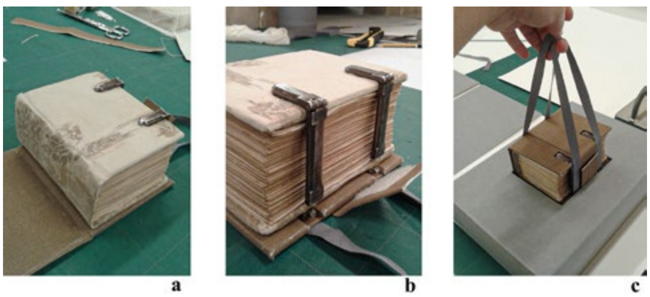


Figure 8: Construction of a protective case allowing safe handling of the codex.

Conclusion

The rehabilitation protocol provided favorable results as the treatment developed. Each phase was carefully planned not only to suppress the eminent problems, but also to permit access to the next phases of the treatment. Without the first stages it would not have been possible to reach the next ones. We took apart the binding because, a. the structure was not stable and could not withstand anymore handling, b. inaccessible information could be read again, and c. enabled the treatment of each layer of the codex in separate: text-block, structure, protection and covering.

The object obtained after the conservation intervention is a manuscript that can be handled safely, with little or no risk of information loss. Its content, the written text, is also available to the community through digitization. This way, we hope to reduce the solicitation from physical consultation. If the environmental conditions of humidity and temperature are respected, both the chemical and mechanical stability of this codex will be assured. The next generations will now be able to enjoy a unique object and have the opportunity to further study and research this invaluable manuscript **(Figure 9)**.

Regarding the binding of the manuscript, it was decided to re-use the original materials as much as possible, in order to make sure the manuscript regained stability and to give it a protective cover. Being a document from the 15th century, there are several technical issues that are expected from its binding: wood boards, a straight spine with no shoulders, raised sewing supports and endbands sewn to each quire (Szirmai, 1999). The round that the spine presents today, after this intervention, is the natural one that the vellum permitted, without the use of a press or excessive weights. The new spine reinforcements that were introduced were pasted - using WS 3978 - from the hair side, which will not interfere now or in the future with the natural opening of the document. The spine of the cover was not directly pasted to the text-block spine to further improve the movement and not to create tension in the silk brocade.

This way, and assuming the transformative value of the intervention, it is believed that the dignity of the codex was restored after being weakened by years of deterioration. Before the community of researchers and users of the ADB, inaccessible information could be read again and there is a codex that works from a mechanical point of view. It was the ideal specimen for this kind of conservation treatment because of its state of degradation, but also because it enabled the investigation and showcasing of new techniques.

Acknowledgements

I would like to thank all my work colleagues, Inês Correia, Sónia Domingos and Liliana Amadeu Silva for the exceptional demonstration of teamwork and spirit of cooperation throughout this project. Also thank the historians Ana Lemos and Catarina Barreira for all the support and enthusiasm shown with the codices and the final results of the interventions.

My regards to both institutions that enabled this project and that trusted us with invaluable documents, and the exciting opportunity for learning it represented.

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Materials

Gore-tex: Futurdidact, Portugal, http://www.futurdidact.pt/, geral@futurdidact.pt

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Distilled water: Futurdidact, Portugal, http://www.futurdidact.pt/ , geral@futurdidact.pt

Blotter: Arte Y Memoria, Indústria 26, 08551 Tona, Barcelona (Spain), +34 938 125 378, http://www.arteymemoria.com

Holitex: Arte Y Memoria, Indústria 26, 08551 Tona, Barcelona (Spain), +34 938 125 378, http://www.arteymemoria.com

Polyester sheet: Futurdidact, Portugal, http://www.futurdidact.pt/ , geral@futurdidact.pt

Russian Sturgeon glue (Isinglass): Talas, 330 Morgan Avenue, Brooklyn, New York 11211, +1 212 219 0770, http://www.talasonline.com

Japanese paper, 9 gsm Manila: Futurdidact, Portugal, http://www.futurdidact.pt/ , geral@futurdidact.pt

Japanese paper 3,5 gsm Tengujo Kozo: Arte Y Memoria, Indústria 26, 08551 Tona, Barcelona (Spain), +34 938 125 378, http://www.arteymemoria.com

Grey-white board, 0,5 mm: Arte Y Memoria, Indústria 26, 08551 Tona, Barcelona (Spain), +34 938 125 378, http://www.arteymemoria.com

WS 3978, reversible PVA: Williams Adhesive. Available from Conservation Resources International, 8000 H Forbes Place, Springfield, VA 22102 (703/321-7730).

Biography

Diana Avelar Pires is a Book Conservator from Portugal residing in France for nearly two years. Diana has a bachelor's and master's degree in Conservation and Restoration and developed two international internships: 6 month Erasmus training in the University of Pardubice in the Czech Republic (2012) and a 6 month internship at the Conservation and Preservation Department of Johns Hopkins University (2013). In 2014 Diana was a project Conservator at The National Archives in Kew, London. From 2015 to 2017 she worked as a freelance Conservator in Lisbon, Portugal, where she had the opportunity to collaborate in several projects in institutions such as the National Archives Torre do Tombo, the Carmo Convent, the company Monte da Lua - Parques de Sintra, the EDP Foundation and many private clients. Diana has been developing her expertise in bookbinding and manuscript conservation, having taken part in a course given by Jeff Peachey (2015) and another at the Ligatus Summer School (2016).

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Textured Fills: Replicating Leather Surfaces with Acrylic Media and Reusable Silicone Rubber Molds

Sarah Reidell

Abstract

Conservators have long struggled to replicate original surface textures on leather objects without the use of noxious solvents, expensive materials, or fastidious techniques. A treatment technique, now common in the United States, creates textured compensation fills by drying colored acrylic media and a repair substrate on a reverse mold. The silicone rubber mold is formed on a surrogate texture that approximates the original surface of the leather object. Using a surrogate prevents possible delamination, staining, or other types of damage. With care, these flat and highly-detailed molds can be reused indefinitely. Acrylic media are carefully selected and mixed to provide high pigment load, match color saturation and sheen, hold peaks, and maintain flexibility. Substrates of fabric, paper, or non-woven polyester are easy to incorporate into the wet acrylic blend and dry on the mold at the same time, creating a thin but flexible repair material. The dried material can be shaped to size and applied to the object using easily reversible adhesives. The technique is particularly effective for bound volumes where there is partial or no access to the reverse of the original leather. Though created for and predominantly used in book conservation treatments, this technique has been adopted for other kinds of compensation repairs requiring a detailed surface on objects like cased photographs, modern art, textiles, costume, and natural history collections. Overall, the technique is highly controllable, customizable, and cost-effective without sacrificing durability or strength. It is, however, not suited to leather objects with sueded nap or hair.

Keywords

Leather, Fills, Compensation, Acrylic, Surrogate, Mold, Book Conservation, Texture, Mold Making, Silicone Rubber Mold

Discussion

Conservators have long struggled with quick and easy ways to replicate original surface textures on leather objects without the use of noxious solvents, expensive materials, or fastidious techniques. A treatment technique, now common to book conservators in the United States, creates textured compensation fills by drying colored acrylic media and a repair substrate on a flat reverse mold. Once prepared, the silicone rubber mold bears the negative of the surrogate texture. A mixture of acrylic media, customized to match the original color and sheen of the book, is smoothed in a thin layer, or layers of complimenting tones, onto the mold. A support substrate of paper, nonwoven polyester, or textile is laid on the acrylic while wet. They dry as one. Once removed, the recto of the textured fill bears a match to the surrogate surface. Textured fills are most successful when incorporated as aesthetic compensations to more robust internal stabilization repairs (Brock, 2001; Primanis, 2000).

First developed and shared with the North American conservation community in 2010 (Haun and Beenk, 2010; Owen and Reidell, 2011), this texturing technique was a product of necessity and exploration. In 2009, Owen and Reidell were part of a team joining labs at a new, centralized facility at the New York Public Library. A stock of older leathers in storage had poor working characteristics. New leathers for compensation fills presented a formidable expense and required significant time investment when used infrequently. The co-authors felt that single-use surface casting techniques for compensation fills and bridging losses common to other conservation specialties (Kronthal et al 2003, O'Donnell, 1997; Nieuwenhuizen, 1998; Craft and Holz, 1998; AIC, 2000; Kite and Thompson, 2006; Bernstein and Evans, 2008), though desirable, were not feasible for books that must remain flexible and bridge three-dimensional spines, board edges, and caps.

Molding kits as well as acrylic gels and highly pigmented paints already used in conservation, and all easily sourced from artist supply stores, produced flexible and aesthetically compatible repairs. At first these were referred to as «cast composites» but now more simply as «textured fills» for loss compensations (Reidell, 2018). Sections of sheeted cast textures were easy and fast to produce from flat, reusable molds. Textured fills used as aesthetic complements to more robust internal repairs could be more easily reversed than dyed leather. Though market prices may fluctuate, all of the supplies mentioned in this presentation can be affordably purchased from art suppliers in the EU at prices comparable to the US. For a full description of the process and complete bibliography, please refer to the 2011 article (Owen and Reidell, 2011) but note a change in the acrylic media selection as described below.

Book conservators in institutional collections may repeatedly come across the same colors or grains of leather when doing small fills to stabilize caps, fix broken boards, or reattach joints. Traditional book repairs like leather rebacks (Reid-Cunningham, 2018) to repair broken or missing spines require high levels of expertise, are time-consuming, and are not always reversible. Modern leather production, tanning chemistry, and market conditions can introduce a lot of unknown variables to fills made with dyed new leather. Toned paper repairs (Etherington, 1999; Puglia & Anderson, 2003) can be quick and easy with good aesthetic matches for calfskin bindings that have plated surfaces. Unfortunately, they can also be poor matches to original leather with high relief, may show paper fibers, and may be easily abraded.

Treatment context is key. Some, but not all, institutions have homogeneous collections of objects with similar binding materials and stylistic attributes. Conservators in institutional settings may have a higher demand for quick but aesthetic repairs as part of exhibition workflows. Conservators in private practice may be able to refine their specialization and, through repetition, execution of a particular treatment skill. Compelling reasons for any repair selection should be ease, compatibility, and reversibility, but most importantly control. Textured repairs introduce a high degree of customization.

Textured fills are made away from the object utilizing surface casting concepts common in other areas of conservation and two-part commercially-available mold kits. Instead of taking a unique mold from an individual object with a commercial filler (Craft and Solz, 1998; Bernstein and Evans, 2008), a flat mold is created from a piece of surrogate material with similar texture. Surrogate surfaces stand in for the original because of concerns that the silicone rubber mold leaves permanent residues on an original object.

A surrogate texture can be prepared to approximate the original decorated surface of the leather object, or can be selected from sandpaper, textiles, new leather, or a host of other creatively sourced materials. Using a surrogate prevents possible delamination, staining, or other types of damage that can occur when taking a mold directly from a powdery, degraded leather surface. New leathers can be plated, stamped and finished with heated brass tools using a variety of methods to approximate historical decorative patterns and grains common to a collection. Experiments by workshop participants indicate that highly textured surrogates with deep relief can be «sized» with a water-thinned acrylic adhesive to aid detail capture and prevent fibers from embedding in the mold. It is still an evolving process but objects that are not suitable for this technique include soft original surfaces with nap like velvet or suede; objects with hair or fur; and objects without much discernible texture like parchment or highly polished, plated calfskin bindings. Those must be repaired with other materials.

The preferred platinum-cure silicone rubber mold, Smooth-On Rebound 25, is available as a two-part kit from art supply stores and is commonly used by brushing directly onto three-dimensional surfaces. By instead pouring the silicone rubber onto a surrogate affixed into the bottom of a customized shallow tray, the completed mold can be used to create flat sheets of material, mimicking the working practice and qualities of infills and other repairs made from leather, textile, or other sheeted materials.

To prevent bulges and distortions in the finished mold, adhere the surrogate to board and then adhere that board to the bottom of a disposable paper tray. The Rebound 25 mold does not shrink so you can easily follow the instructions on the container or the manufacturer's website for determining the volume of silicone rubber required and mixing instructions. Finished molds are flexible and easier to work with and clean when 3-5mm thick. The two parts, A and B, are mixed in equal proportions in a clear container **(Figure 1)**. It is important to wear nitrile gloves, not sulfur-containing latex gloves which chemically prevent the curing process.

The mixed silicone rubber is slowly poured into a tilted tray so it flows over the leather surrogate completely and evenly **(Figure 2)**. The bottom of the tray is knocked onto a flat surface several times to force out any additional trapped air. The tray should dry undisturbed on a level surface for at least six hours or overnight. Bubbles will settle on their own. Minus drying time, the mold-making process takes about 10 to 15 minutes. With care, these flexible and highly detailed molds can be reused indefinitely for the repeated creation of complex textures or follicular patterns that may be common within a given collection. Maintain molds by rinsing them under warm water and stretching to release dried acrylic remnants. Do not scrub or abrade the surface.

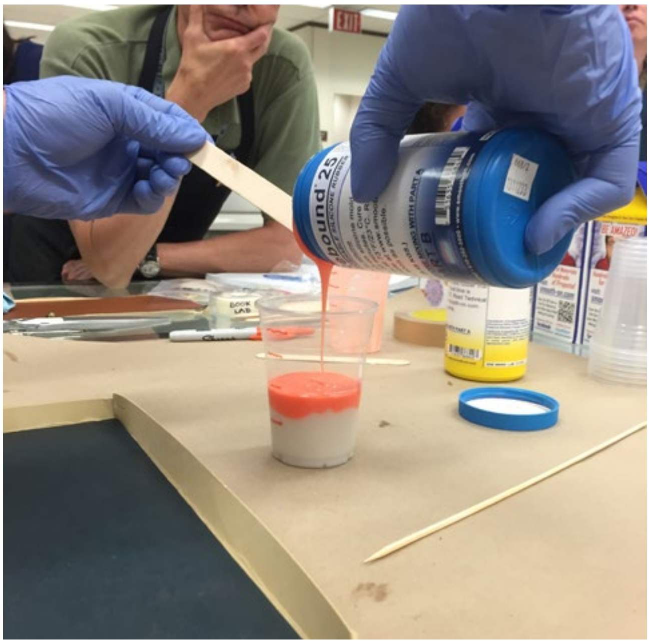

Figure 1: Book conservators mix mold components in a clear plastic container during textured fills workshop held at Library of Congress in 2015. @Reidell

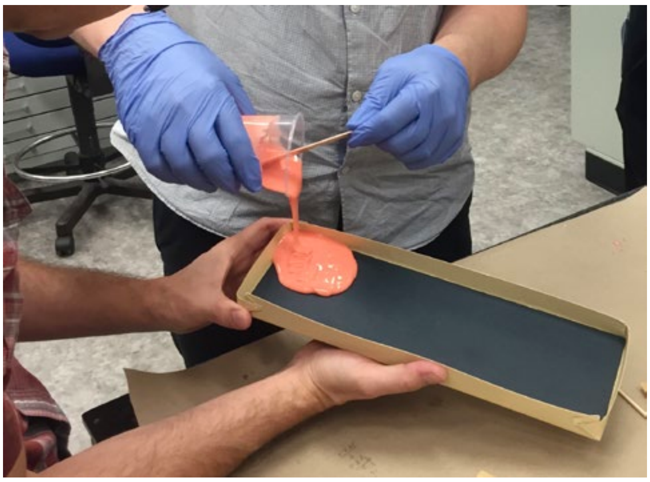

Figure 2: Silicone rubber mixture is slowly poured into a tilted tray to flow completely and evenly over the surrogate surface. @Reidell

Acrylic media are carefully selected and mixed to provide high pigment load, match color saturation and sheen, hold peaks, and maintain flexibility. The source for the acrylic components is Golden Artist Colors, a North American company, with a history of collaboration and open dialogue with artists and the conservation community about working properties and technical information (Rice, 2004). Other brands lack publicly available technical details like opacity/transparency rating that are crucial to this technique. Still, vendors do change formulas and keep ingredients confidential so always check for the latest information on each product.

Three different categories of Golden products are used to replicate a surface texture. Golden acrylic paints and gel media are mixed by volume in this basic ratio: 2 parts Heavy Body color(s), 1 part Heavy Gel media in preferred sheen, 1 part GAC 100 Acrylic Polymer Medium, and 1 part GAC 500 Acrylic Polymer Medium. This is a slight modification to the original 2011 article which used GAC 200 in place of the GAC 100, but proved too inflexible after implementation. Adjust the ratios as needed to match requirements for flexibility and peak capture. Volume required will depend on the dimensions of the mold.

To match color, select the appropriate hue(s) from the highly pigmented Golden Heavy Body paints to match the colors within the peaks and valleys of the original object. The opacity/transparency rating is printed on the back of each container, and in even more detail on the Golden website listing for each individual color (Golden, 2017). Consult their relative ranking, with 1 being most opaque and 8 being most transparent. Look for high transparency ratings of 4 or above to contribute the most realistic results. Golden Heavy Gel medium, in either Gloss, Semi-Gloss, or Matte, retains the texture from the mold and controls the sheen. Semi-Gloss media is generally most useful for bookbindings. For flexibility, use the Acrylic Polymer Mediums GAC 100 and GAC 500 (Golden, 2017).

Mix and match the colors first, drying and testing samples on a scrap of blotter to compare against the object. Adjust hue and tint as needed. Make a reference card to show the sheen and the saturation of the acrylics in overhead and raking light. Add the other acrylic media to the paint mixture in the appropriate ratio and combine well in a clear glass or plastic container. Use everything at full strength; diluting with water will inhibit film formation on the silicone mold.

Place the blended acrylic mixture on the surface of the mold with a spatula, brush, or spoon. Using scraps of bevelled mat board or other broad implements like silicone baking spatulas or pottery tools, evenly pull the mix across the surface. Drop a piece of support onto the blend, letting it settle or tapping it into place without disturbing the surface. Allow the edges of the support to extend beyond the mold to aid in clean-up. Select and align the support with an eye towards the flexibility and edge preparation that you want to impart to your fill repair. The blend should dry overnight or 8-10 hours, depending on ambient heat and humidity. When dry, flip the mold over and carefully roll it back to reveal the textured fill material. In general, a textured fill prepared in this manner contributes 0.005-0.015 in (0.12-0.38 mm) additional thickness to the support substrate. Store prepared textured fills in folders or drawers as you would other repair materials.

To get a richer and more vibrant color-match, apply the acrylic blend in two or more color layers **(Figure 3, 4)**. Prepare colors to match the hue and transparency in both the textured peaks and follicular valleys on the original object surface. Working in reverse, the first layer added to the mold matches the peaks. Dimensional color-matching is most effective with Heavy Body colors of high transparency ratings (4 or above) and when applied thinly, pushing the mixture into the negative of the pattern with a broad implement. Allow to dry for a minute or two. Apply a second mixture across the entire surface of the mold, being careful not to disturb the first layer. Avoid the temptation to only use a layer of pigmented Heavy Body acrylic paint(s) since that will not integrate well, hold peaks, or be as flexible as the fully blended mixture of paint, sheen, and texture-holding acrylic components.

For use in book treatments, stabilize the volume as required. Surface clean the covers and exposed areas to reduce grime and oily residues from fingerprints. Test for solvents and then consolidate degraded leather as appropriate with hydroxypropyl cellulose, whether as a dried powder sold as Klucel G or Cellugel, a pre-made solution sold by Preservation Solutions. Do note for color-matching purposes that consolidation may darken the leather (Haines, 2002; Kite and Thompson, 2006). Stabilize the binding structure by reattaching loose or detached boards, rebuilding caps, reinforcing text-block to board attachments, or other internal repairs as necessary.

Figure 3: Rolling the mold away from a fresh sample texture with a thin mulberry paper support. @Reidell

Figure 4: Detail of textured cast from a leather surrogate with one layer (left) or two layers (right) of acrylic media to match colors found in peaks and valleys of original object. @Reidell

The dried material can be shaped to size by cutting, tearing, sanding, or bevelling with a scalpel as required. Films with paper substrates are best sanded or pared from the back to create an extended edge and remove visible fibers. Apply a textured fill to the object using common adhesives as appropriate for the object and the support substrate. At low temperatures textured fills can be used with dried, pre-coated heat-set adhesives like Lascaux 498 HV (Anderson and Reidell, 2009). Avoid adhesives prepared in solvents which can damage the surface of the acrylic texture. Trim to shape the repair around existing tooling or other decoration **(Figure 5)**. As needed, apply a few quick dots of acrylic inpainting to mimic the original adjacent leather grain to further recede the repair **(Figure 6)**. Additional tips from hands-on workshops have been collected into a one-page handout (Reidell, 2019).

Figure 5: A textured fill was pared from the back to reduce paper bulk at the edge of this narrow joint repair and trimmed to shape the repair around existing decoration. @Reidell

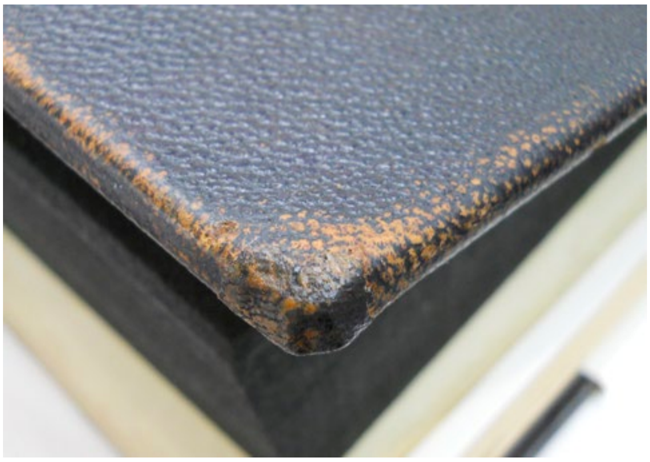

Figure 6: A few quick dots of acrylic inpainting were applied during treatment to the left half of this fill on the corner of a damaged cover board to mimic the original adjacent leather grain. @Reidell

Though created for and predominantly used in book conservation treatments, this technique has been adopted for other kinds of compensation repairs requiring detailed, three-dimensional surfaces on objects such as cased photographs, modern art, textiles, costume, and natural history collections. All of the individual components pass standard materials tests and are commonly used in conservation treatments.

Since introduction in 2010, hands-on workshops have been held at museums, libraries, and training programs in the United States for conservators and students from many specialties including book, paper, photographs, textiles, and objects. An informal survey this winter asked more than 40 past workshop participants for an update and critical evaluation of textured fills.

Most respondents reported that they have incorporated the technique into fills both large and small on books, cased photographic images, and three-dimensional objects. A quarter of respondents share that the technique has not been applicable for the treatments presented to them in their conservation practice. For those that have used it, they like the versatility and customization it gives their treatments. It is a consistent part of their treatment repertoire. They retain a library of textures within their lab to repeat the texturing process quickly. They store the textures in folders to reduce damage to the surface from dust or debris. With practice, they agree that the technique is fast and easy.

Some of their critical feedback relates to practice, particularly the time and effort it takes to select the right components, find a surrogate texture, or build a library of molds. One person reported that they have trouble gauging the volume of paint and gel needed. Conservators are always problem-solving, but they do have to respond to curatorial and institutional preferences, some of whom want more obvious repairs with less prioritization on aesthetics.

Others, particularly conservators who practice in a museum context, desire textures with exact compatibility and want methods of safely casting directly from an object which are still not possible given current supplies. Book conservators remain cautious about using textured fills for a full reback over the spine or in areas requiring high flexibility. They also share concerns that depending on storage conditions areas of acrylic components may block to adjacent objects. It is prudent to monitor the concerns shared among paintings conservators about the longevity of acrylic paints and their interest in more accelerated aging studies from conservation scientists (Jones, 2004). Accelerated aging and mechanical testing would be beneficial, particularly if practical outcomes could be related to leather desiccation levels as a way of providing treatment selection guidelines (ASTM, 2006).

Reassuringly, this feedback mirrors initial discussions about the technique, confirming that cautious optimism is warranted. However, after 8 years of wider use, practitioners reflect that the greatest features of the technique, versatility and speed, are recouped after a small investment of time to source surrogates and make the molds. As an additional practical technique available to a conservator it provides additional choice for aesthetic compensations fills and repairs. Overall, the technique is highly controllable, customizable, and cost-effective without sacrificing durability or strength.

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Materials

Heavy Body Acrylic Colors, 2 oz tubes (art supply store). Golden Artist Colors, Inc. 188 Bell Road, New Berlin, NY 13411-9527. +1-800-959-6543.
help@goldenpaints.com
www.goldenpaints.com/products/colors/heavy-body

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+41-44-807-41-41. info@lascaux.ch.
https://lascaux.ch/en/products/restauro/adhesives-and-adhesive-wax

Smooth-On Rebound® 25 Silicone Rubber (art supply store). 5600 Lower Macungie Road

Macungie, PA 18062. +1-800-762-0744.
https://www.smooth-on.com/products/rebound-25/

Biography

Sarah Reidell is the Margy E. Meyerson Head of Conservation in the Kislak Center for Special Collections, Rare Books and Manuscripts at the University of Pennsylvania. She specializes in the conservation treatment of rare books, paper, and parchment. She co-developed the textured fill technique with her colleague Grace Owen-Weiss at The New York Public Library while she was Associate Conservator for Rare Books and Paper (2006-2016). Prior to NYPL, she was Conservator for Special Collections in Harvard University Library's Weissman Preservation Center (2003-2006). Sarah received an MLIS and Certificate in Advanced Studies in Conservation from the University of Texas (2002). She is a Fellow of the American Institute for Conservation (AIC).

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SINTEVA, Développement d'un Cuir de Synthèse pour la Conservation-Restauration[1]

Ségolène Girard

Mots-clés
Cuir, Reliure, Comblement, BEVA 371, Similicuir, Fibres Végétales, Piñatex

Introduction

Traditionnellement, la restauration des reliures consiste à combler les zones lacunaires avec des pièces de cuirs contemporains dans la continuité des pratiques de reliure d'art. Depuis quelques décennies, les avancées scientifiques apportent un véritable bouleversement de la pensée éthique en conservation-restauration et remettent en question ces pratiques (Plenderleith, 1970). Les procédés de tannage moderne sont souvent opaques (Barbe et al., 2006). Ils se manifestent par des dégagements acides et des dégorgements de teinture (Haines, 1985).

L'utilisation de papier japonais enduit de peinture acrylique est une alternative aujourd'hui ancrée dans les pratiques d'atelier sans toutefois faire l'unanimité (Clarkson, 1992). En effet, si le papier japonais se montre chimiquement plus stable, certains professionnels lui préfèrent encore le cuir, souvent pour des raisons esthétiques (Etherington, 1995). C'est dans l'espoir d'enrayer l'usage - par défaut de tracabilité, de cuirs de qualités incertaines, qu'a commencé cette recherche et le développement d'un cuir de synthèse en alternative aux cuirs naturels.

Discussion

Originellement développée par Gustav Berger pour la consolidation des peintures sur toiles, la BEVA 371 (copolymère d'éthylène et d'acétate de vinyle) a été employée avec succès sur plusieurs pièces de collections ethnographiques et naturalistes (Kronthal, 2003). Sa stabilité sur le long terme, sa compatibilité avec le cuir et le retrait possible des comblements, font de la BEVA 371 un matériau adapté à la conservation-restauration des cuirs (Down et al., 1996).

Certaines expérimentations mettent en garde contre la mise en œuvre à chaud et sans intermédiaire de la BEVA 371 sur des cuirs déjà dégradés ou pour la prise d'empreinte du cuir. En la répandant à chaud sur un objet à traiter[2] puis en la décollant afin d'obtenir le même aspect de surface, on constate souvent des difficultés à détacher la BEVA 371 (Nieuwenhuizen, 1998). Notre expérience personnelle fait état d'un noircissement du cuir d'origine presque systématique accompagnant l'utilisation à chaud, sur des cuirs variés, et par diverses mises en œuvres de la BEVA 371.

Figure 1: BEVA® 371 original formula en solution © Ségolène Girard.

[1] L'ensemble des informations concernant la recherche et ses aspects techniques sont publiés dans « Ségolène Girard (2018) BEVA® 371-based Synthetic Leather, Journal of Paper Conservation, 19:1, 18-32, DOI: 10.1080/18680860.2018.1521018» accessible sur Taylor & Francis online. L'actualité de la recherche est sur http://loperatorium.fr

[2] La température de transition vitreuse de la BEVA® 371 original formula est T>68°C.

La BEVA 371 pourrait être intéressante pour restaurer les reliures, mais sa mise en œuvre par réactivation thermique posant certains risques de dénaturation dans le cas de cuirs dégradés, nous avons développé une technique pour tirer profit de ses avantages sans réactivation à chaud. Nous avons obtenu un cuir de synthèse – SINTEVA, en modifiant la solution de BEVA 371 avec des microsphères et des pigments minéraux[3]. Ces derniers permettent bien sûr la colorisation des comblements, mais ils ont également la fonction de charge, puisqu'ils améliorent la précision du moulage en évitant la rétraction due à l'évaporation des solvants. La structure gagne en porosité ce qui permet l'utilisation d'adhésifs cellulosiques en n'ayant recours à la chaleur qu'en amont de la restauration.

Figure 2: Surface d'un prototype de SINTEVA © Ségolène Girard.

Bien que l'aspect esthétique et la compatibilité de SINTEVA puissent le destiner à différents cas, il était nécessaire d'évaluer sa résistance en situation. Les sollicitations mécaniques répétées des livres sont un bon moyen de tester le matériau en condition de stress extrême. Nous nous sommes donc concentrés sur une altération propre au livre, la rupture du cuir au niveau des mors. Les techniques traditionnelles de reliure impliquent une parure et un affinement poussé du cuir pour assurer la pliure, faisant paradoxalement de la zone la plus fragile la zone la plus exposée. Lors des restaurations, le cuir ancien est souvent affiné de nouveau pour glisser la pièce de renfort, faisant de la résistance des matériaux employés pour le comblement une question cruciale.

Afin d'évaluer cette résistance, nous avons réalisé deux séries de tests ; un test de résistance à la tension comparant des échantillons[4] de BEVA 371 (S1a) à des échantillons standardisés de papier japonais enduits de peinture acrylique (S2a) adhérés à un plat de cuir de veau en défet, et une seconde série de test où des échantillons de SINTEVA (S1b) et (S2b) sont soumis au test d'endurance au double-pli.

Résultats obtenus

Le résultat obtenu pour les échantillons de papier japonais (S2b) – 118.6 double-pli, est sensiblement inférieur à la moyenne obtenue pour les échantillons de SINTEVA (S1b): 1885 double-pli[5].

- Les échantillons de BEVA 371 (S1a) ont une résistance à la tension inférieure aux échantillons de papier japonais (S2a). Cependant, on note que les échantillons de BEVA 371 n'entrainent pas le cuir à leur rupture, contrairement à ce qui est observé dans les mêmes circonstances avec les échantillons de papier japonais (S2a).
- La moyenne obtenue de 16 N pour les échantillons de BEVA 371 permet malgré tout une utilisation pour des livres dont le poids serait inférieur à 1,6 kilogramme[6].

A l'affût d'alternatives au cuir depuis le début de cette recherche, nous avons découvert Piñatex en 2015, un produit émergent avec l'ambition de créer un cuir entièrement végétal à partir de feuilles d'ananas et d'acide

[3] L'emploi de microsphères est suggéré par Nieuwenhuizen (1998). Cependant elle ne précise pas les propriétés apportées par l'ajout de ce composant dans la BEVA® 371 en film. Notre propre expérience nous a permis d'observer que les microsphères réduisent la brillance et améliorent la prise d'empreinte des comblements. Nous ajoutons à ces propriétés la possibilité d'emploi d'adhésifs naturels tels la colle d'amidon grâce aux structures creuses des microsphères.

[4] Les échantillons S1a et S1b mesurent 100 × 10 × 1 mm. Les échantillons S2a et S2b sont composés de deux couches de papier japonais de 30g/m2 adhérées l'une à l'autre en directions opposées par une couche de colle d'amidon de blé préparée à 20%. Ils sont enduits d'une unique couche de peinture acrylique Sennelier terre d'ombre brûlée, non diluée. Ils mesurent 100 × 10 × 0,4 mm. Evidemment, ces échantillons ne représentent qu'une standardisation d'une réparation de cuir au papier japonais. Le nombre de couches d'adhésif et de papier, la nature des adhésifs et le grammage des papiers varient considérablement d'un livre et d'un conservateur à un autre. Se référer à (Girard, 2018) pour plus de détails sur la composition des échantillons.

[5] L'endurance au double-pli du papier japonais a normalement une moyenne de résistance au double-pli supérieure à celle du papier machine qui est de 121 d-p (TAPPI T 1200 study, Wilkinshaw, 2013). Or, avec une moyenne obtenue de 118.6 d-p, on peut supposer que la multiplication des couches de papier, colle et peinture acrylique affaiblissent ces comblements.

[6] Par ailleurs, un renforcement de cette couche de BEVA® 371 augmenterait cette moyenne de résistance.

polyactique (PLA)[7] (Amass, 1998). Ses compétences physiques sont très intéressantes selon des critères de conservation[8] et son réseau fibreux rappelle certains matériaux déjà employés en restauration des cuirs[9].

Figure 3 : Fibres d'ananas © Ananas Anam.

Piñatex est disponible à la vente depuis 2018. Afin d'améliorer les propriétés de SINTEVA, nous lui associons Piñatex pour réaliser un matériau de comblement des cuirs versatile et répondant aux normes de la conservation.

L'utilisation de Piñatex en support de SINTEVA permet d'améliorer certains aspects de SINTEVA. L'utilisation de Pinatex en support de SINTEVA permet d'améliorer certains aspects de SINTEVA notamment :

– Supporter des charges et des tensions plus lourdes,
– Parer la strate fibreuse de SINTEVA qui sera aussi plus compatible et organique au contact du cuir[10],
– Faciliter la réversibilité en élaguant la surface de SINTEVA pour accéder aux fibres et les réhydrater,

Figure 4: Piñatex © Ananas Anam.

Les résultats encourageants de cette recherche et la réception enthousiaste de SINTEVA lors de premières présentations à l'IADA et à l'AIC nous conduisent à poursuivre son développement, et, nous l'espérons jusqu'au produit fini, pour permettre à nos confrères d'apprécier ses capacités.

Tout en reconnaissant la place historique et artistique du cuir dans notre patrimoine, nous espérons que ce matériau alternatif contribuera à réduire l'impact écologique de l'industrie des cuirs.

Remerciements

Cette publication est dédiée à Monsieur Michel David-Weill. Ma gratitude reste inchangée pour toutes les personnes qui ont participé à l'évolution et au développement de cette recherche et qui figurent dans le JPC 19.1, 38. Je n'en ai pas fait le report par souci de ne pas surcharger cet article, mais cela n'amoindrit en rien la sincérité de ces remerciements. Je tiens à remercier tout particulièrement Madame Carole Dignard pour sa relecture, Piñatex Anam Anam en me permettant de mettre leur documentation à disposition des conservateurs-restaurateurs, ainsi que Rosie Cook pour son aide précieuse.

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[7] L'acide polylactique ou poly(acide lactique), désigné sous l'acronyme PLA, est un polymère biosourcé par opposition aux polymères d'origine fossile plus courants (pétrole principalement).

[8] Couleurs par pigmentations certifiées GOTS, résistance à la chaleur >100°C, rempli les critères des normes ISO, etc. (Ananas Anam)

[9] Piñatex présente une structure hétérogène comparable aux papiers Japonais ou au Tyvek®.

[10] Dans les prototypes de 2018, SINTEVA est doublée de toile.

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Matériaux

Beva® 371 (copolymère d'éthylène et d'acétate de vinyle) : Gustav Berger original formula, CTS Srl, Via Piave 20/22 36077 Altavilla Vicentina (VI), Italie, https://www.ctseurope.com

Microballons phénoliques : SICOMIN, Monsieur Serge Gonzalez, B.P. 23 - 31 Avenue de la Lardière 13161 Châteauneuf-Les-Martigues, France

Peinture acrylique : Sennelier Couleurs du quai Voltaire, 3 quai Voltaire 75007 Paris, France, http://magasinsennelier.net

Pinatex (cuir végétal composé de fibres d'ananas et PLA) : Ananas Anam, Somerset House, South Wing Strand London WC2R 1LA, Grande-Bretagne, https://www.ananas-anam.com

Biographie

Titulaire d'un master en conservation-restauration du patrimoine papier de l'école de Condé (2016), **Ségolène Girard** se voit remettre par le jury une bourse d'étude pour poursuivre les recherches amorcées dans son mémoire sur les alternatives aux matériaux de comblement employés en restauration des reliures en cuir. Ces recherches aboutissent sur l'élaboration d'un matériau, un cuir de synthèse nommé SINTEVA - et sont présentées pour la première fois au Symposium de l'IADA en 2017 à Oslo, puis au Symposium de l'AIC en 2018 à Houston et publiées dans le Journal of Paper Conservation (JPC 19.1, 24-38). Ségolène Girard se consacre désormais à l'amélioration de SINTEVA en partenariat avec des ingénieurs textiles et des artisans verriers.

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Si vous souhaitez participer au développement de SINTEVA, n'hésitez pas à contacter l'auteur.

L'ensemble des informations concernant la recherche et ses aspects techniques sont publiés dans « *Ségolène Girard (2018) BEVA® 371-based Synthetic Leather, Journal of Paper Conservation, 19:1, 18-32, DOI: 10.1080/18680860.2018.1521018* » accessible sur Taylor & Francis online.

Going Green: Using Non-Toxic Catechin to Treat Denaturation in Leather and Skin Materials

Mari Hagemeyer

Skin and hide materials such as leather and rawhide have been exploited by human societies for millennia thanks to their favorable properties, chief among them their toughness and flexibility. These qualities are due to the inherent nature of the protein collagen, which is the chief chemical component of skin, as well as other biological structures in animals. In its natural state, collagen self-arranges into a triple helical structure, which is further organized in skin into a fibrous and flexible material. Although this material is strong and suitable for many uses, it is also vulnerable to destruction in a number of ways. Deterioration of skin and hide materials, like that of other materials, may involve chemical change (e.g. red rot) or material loss (e.g. waterlogging), but collagenic materials are also vulnerable to another deterioration pathway characterized by loss of the ordered structure of biological collagen.

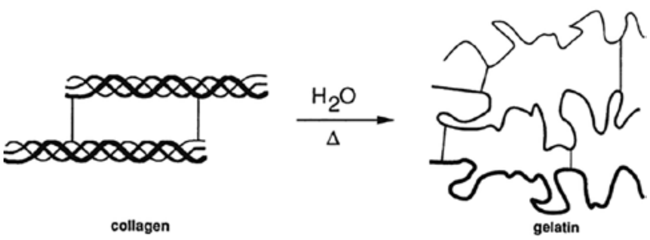

Figure 1: Effect of denaturation on collagen molecules *(Scott, 1986)*.

This pathway, which leads to total destruction of the material's ordered structure or "denaturation", is caused by exposure to free water and heat energy. This process causes a number of physical changes in the material, including darkening, embrittlement, and decreased water resistance. Unlike other common deterioration pathways, like red-rot and waterlogging, the pathway leading to denaturation is an isochemical process that does not involve the breaking of covalent bonds or loss of material. However, while these more treatable problems may be addressed by one of the numerous well-tested treatments currently in use, the only known method of addressing hydrothermal instability caused by disordering would be tanning or re-tanning the material, which is heavily invasive and stressful for the object. There is no conservation-appropriate treatment currently recorded in the literature.

As an attempt to address this problem, an experimental treatment was devised using catechin, a flavonoid commonly found in green tea and a chemical precursor to one type of tannin molecule. Previous research on the effect of catechin on pure collagen found that it was able to coagulate an aqueous solution of collagen, and increased the water resistance of a cast film of gelatinous collagen. In effect, the application of catechin acts as a gentle tanning treatment, without the need for the intensive pH adjustment, physical working, and fatting/defatting steps that accompany the application of vegetable tannins. Given these properties, catechin was judged an appropriate material to treat hydrothermal instability. In order to demonstrate the need for a dedicated treatment for hydrothermally destabilized skin materials, the effects of treatment with catechin were compared against those of two other treatments already in use for waterlogged leather: impregnation with polyethylene glycol (PEG) and treatment with Dow 1248 fluid, a commercial silicone leather treatment. These treatments were chosen as theoretical tactics a conservator faced with water-damaged leather might take.

Samples were cut from three different types of cowhide materials: rawhide, oil-tanned leather, and vegetable-tanned leather. These were partially denatured by placing them in a chamber conditioned to 80% RH and heated in an 80°C oven. The extent of the chemical disordering was characterized with differential scanning calorimetry (DSC). Once aged in this manner, one coupon of each tannage was treated with each of the three treatments tested. Catechin was applied in an ethanol solution, which was delivered in a paper pulp poultice; Dow 1248 fluid was applied directly by brush, and PEG was impregnated into the samples by submerging them in an ethanol solution of PEG 400 and driving off the solvent with gentle heating at 30°C, after which the samples were patted dry. After treatment, each of the treated coupons were examined, along with control coupons. Examination consisted of differential scanning calorimetry (DSC), Fourier-transform infrared (FTIR) spectroscopy, and fiber optic reflective spectroscopy (FORS). These analyses were targeted at examining how the chemistry and the water sensitivity of the tested materials changed as a result of treatment.

For the purposes of this study, any change in the treated coupons from the properties of the control was judged against a set of wanted and unwanted changes. Desirable change ("improvement") was defined as a reversal of the changes caused by ageing in the humidity chamber, that is, any property of the treated material which was more similar to that of the unaged control than the aged control. Unwanted change ("worsening") involved any change which intensified the divergence from the properties of the unaged control. Due to the limitations of the instrumentation available, three axes of improvement vs. worsening were defined: the shrinkage temperature, as determined by DSC; chemical change, as determined by FTIR; and color change, as determined by FORS.

DSC data	PEG treatment		Dow 1248 treatment		Catechin treatment	
Tannage	**Ts**	**Wp**	**Ts**	**Wp**	**Ts**	**Wp**
Rawhide	Ø	Ø	↓	↔	Ø	→←
Oil-tanned	↓	→←	↓	Ø	↑	→←
Vegetable	Ø	Ø	Ø	Ø	Ø	Ø
Armband	Ø	→←	Ø	→←	↓	→←

Figure 2: Effect of treatment on shrinkage temperature. The higher the shrinkage temperature (T_s), the higher the water resistance; the narrower the peak width (W_p), the more homogeneous the shrinkage behavior. No change is represented by Ø, while arrows indicate increase or decrease (↑/↓) and widening or narrowing (→←/↔).

Analysis showed that on average, catechin-treated samples had improved properties compared to the control and the other treatments. DSC results were the least conclusive, showing little divergence from aged controls; however, where divergence did occur, the effects of PEG impregnation and silicone treatment generally caused worsened properties, while catechin treatment generally caused improved properties. FTIR data showed that for all samples, the PEG-impregnated coupons were the most chemically altered, while catechin-treated coupons had little to no chemical alteration from unaged controls. It is important to note that in this case, "chemical alteration" only refers to the change in chemical composition of the system; it is unlikely that the PEG experienced any cross-linking with the collagen material. Finally, FORS data showed that while all aged samples did experience darkening, catechin-treated samples almost always experienced the least darkening.

Figure 4: Native American (probably Plains) leather armband treated with catechin. This treatment caused increased flexibility and water resistance in the damaged material.

Beyond the effects in the material, there are also several distinct advantages to catechin treatment with regard to safety and applicability. Of the three treatments tested,

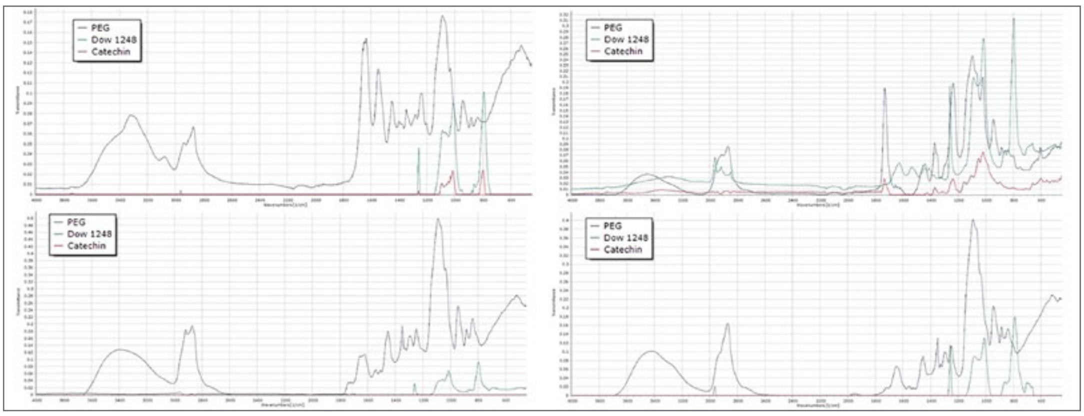

Figure 3: Chemical change in treated coupons, as represented by FTIR spectra. The above figures were derived by subtracting the spectrum of the control specimen from that of the treated coupon. Clockwise from top left: rawhide samples; oil-tanned samples; vegetable-tanned samples; and samples taken from a deteriorated leather artifact.

PEG impregnation was the least effective, and caused a number of undesirable side effects such as deformation of the coupons and an oily residue. PEG impregnation also took over a week to complete, and a significantly larger amount of treatment material than the other two treatments was needed. Some of these side effects may be addressed by improving the treatment process, but the lack of improvement in material properties cannot be expected to be similarly avoided. By contrast, while Dow 1248 fluid caused much more improvement than PEG impregnation in the treated coupons, it is highly toxic and harmful to the conservator. Catechin treatment, while it did not completely reverse the effects of the ageing process, did have promisingly positive results. In addition, it is safe to use, and application may be completed in only a few hours. In addition, while pure catechin is expensive, only a very small amount was needed, making this treatment economical as well. For all these reasons, the experimental treatment is considered a promising candidate for further research and possible future use. However, more study is needed to confirm these preliminary results.

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Biography

Mari Hagemeyer is a recent graduate of the UCLA/Getty Conservation program, and is currently working at The Walters Art Museum in Baltimore, MD as an Andrew W. Mellon Fellow in objects conservation. She has previously worked at institutions such as the Colonial Williamsburg Foundation, the Los Angeles County Museum of Art, and the Portland Art Museum, as well as with the U.S. Navy and the Maryland Historical Trust at their conservation laboratories. Her study interests include organic materials, especially collagenic materials, and Native American material culture. After her fellowship at the Walters is completed, she is hoping to continue her research on conservation of leather.

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The Set of Six XVIth Century Armchairs from the Collection of Palazzo Madama in Turin: Technical Study and Conservation Treatment

Loredana Mannina, Michela Cardinali, Anna Piccirillo, Paolo Triolo

Abstract

The conservation work carried out on a set of six armchairs with leather upholstery from the collection of Palazzo Madama in Turin has been adopted as an open project within the training program in leather conservation attended by the students of the Master's degree in conservation, hosted at Centro Conservazione e Restauro La Venaria Reale.

The set of Louis XIII style armchairs arrived to the Centre in poor conservation condition and with very little information regarding their history. A combined research through study of archival sources and style comparison became necessary to make up for the absence of data regarding the manufacture and dating.

Keywords

Louis XIII, Armchairs, Leather Upholstery, Imaging Techniques, RTI, Leather Appliques, XVI Century Leather

Discussion

A sole archival note was found to be referring to the Museo Civico di Torino set of armchairs with a brief mention to the set's previous belonging to the Trivulzio collection. It is known that the Museo Civico acquired the prestigious collection in 1935. The deal was made possible by the mediation of Pietro Accorsi, renowned antique dealer of his age, and supported by the King of Italy's son Umberto II Prince of Pindemont. The trade initially caused political discontent and temporary disorder, resulting in Mussolini outlawing the collection to be moved from Milan. However, Accorsi managed to reach a convenient agreement, obtaining outstanding masterpieces such as *Ritratto d'uomo* by Antonello da Messina and the *Trés Belles Heures of the Duke of Berry* miniatured by Jan van Eyck, alongside other objects from the collection.

The stylistic comparison with those of similar armchairs allowed to date the ones from Palazzo Madama's collection to the end of the 16th century and the origin of their manufacture to the north of Italy (**Figure 1**). With turned frame and leather upholstery, this type of armchair is a beautifully manufactured example of *Louis XIII* style furniture: essentially rectilinear in form, rather simple and severe, with leather upholstered seat and back panels. These chairs were of Flemish and Italian origin and known as «the low leather» or «Cromwell chair.» The back is of greater width than height. The legs are stiff and square with an H-form stretcher, plus an extra stretcher joining the front legs which both strengthens and decorates at the same time.

Figure 1: One of the six armchair from the Palazzo Madama armchair set

Gauffered, gilded and painted leather back panels are secured to the walnut frame with decorative gilt nails. The gauffered technique reminds the Italian bookbinding tradition of the XVIth Century, when gold appeared in such techniques for the first time. The seats' back panels were decorated by the means of heated finishing tools indenting repeating patterns, alternating with segmented lines. The main scene at the centre of the backrest is different for each armchair and their symbolism still unclear, existing somewhere in between courtly scenes and biblical narrative.

The decorative techniques employed for the backrests are also unusual and their understanding revealed to be challenging. The central scenes were partly gilded and painted directly on the seatback leather panel, whilst other details, such as the garments and the flesh parts of the bodies, could be described as some sort of inlays of painted material applied on the scene background, creating a slightly raised decoration. Due to the thick layer of aged waxes and soiling covering the surface, the complex decorative scheme was not fully understood at the very first examination. Furthermore, the paucity of similar decorative techniques reported in the relevant bibliography to use as comparison resulted in the need to investigate these materials purposely. A wooden trunk belonging to the Ca d'Oro's collection covered with leather decorated with the same motifs and techniques of the Palazzo Madama's chairs has been recognised and added to this research for a comparative study **(Figure 2)**, whilst a number of seemingly identically decorated artefacts from various collections are in the process of being identified and studied. It seems reasonable now to consider the hypothesis that this early decorative technique represents the signature of a distinct workshop. The research aims to shed light on the origin of this early technique, give recognition to the artisans, as well as deepening the understanding of the materials used to create these objects. Answers to

Figure 2: The trunk from Ca' d'Oro collection, Venice (attributed to venetian artisans, XVI Century

these questions may simultaneously add some valuable information to the knowledge about leather objects, as well as providing the foundation for the conservation strategy.

Venaria Reale Center's scientific department has offered an outstanding contribution towards the understanding of the technique and materials used by the still unknown workshop. By employing a thorough investigative process more details have come to light. A non-destructive range of multispectral **imaging techniques** were used to examine the decorative layers to answer initial questions **(Figure 3)**. These techniques were then combined with other more targeted investigations through point analysis, following focused sampling. Imaging techniques provided important clues about the backrests' surface morphology. By using a selected range of wavelengths in the electromagnetic spectrum, the imaging procedure allows to extend the object observation beyond the capabilities of the human eye, permitting meaningful comparisons within the assembly itself.

Reflectance Transformation Imaging (RTI) gave insight into minor surface details, typically not visible to the naked eye. It aided in the identification of tool marks,

Figure3: Imaging techniques performed:
a) Reflected visible light(VIS): Nikon D810 camera, 60mm micro Nikkor objective, n° 2 Ianiro 800 W diffused light projectors, X-Rite Color Checker;
b) Ultraviolet-reflected false colour (UVRFC): Nikon D810 camera IrUv, Peca 900(18A) and X-NiteBP1 filter Color Checker Macbeth, two UV Madatec led projectors (365nm);
c) Reflectance Transformation Imaging (RTI): NIKON D800, flash Nikon SB610;
d) Infrared-reflected false-colour (IRFC);
e) Infrared-reflected (IR) Nikon D810 IRUV camera, B+W 093 filter, n° 2 Ianiro 800 W diffused light projectors, X-Rite Color Checker

materials and layer build-up, manufacture techniques and in stylistic comparison. Zoomed images were studied to provide more local information and allow for more detailed observations.

Imagining techniques were followed by punctual analyses as X-Ray Fluorescence (XRF) for the pigments and metal leaf identification, scanning electron microscopy – energy dispersive X-ray analysis (SEM-EDX) and stereo microscopy to deepen the understanding of the decorative layers.

Lugol's iodine test was performed as indicator for the presence of starch, aiming to determine whether the inlays were made from painted paper or protein based material, such as leather or parchment.

The armchairs set required a complex conservation treatment to ensure their preservation for the future and suitability for open display **(Figure 4)**. The six armchairs arrived to the Venaria Reale Conservation Centre in considerably poor conservation condition, manifesting the state of negligence undergone over the years. Apart from structural damage to the wooden frame, the leather was soiled, heavily worn with extensive tears and losses, partly due to the incorrect tensioning promoted by the upholstery nails. Planar distortion and localized hardening were also caused by the combination of unsuitable tensioning and environmental conditions. The decorative surface was partly hidden underneath a build-up of waxy-oily soiling, with several paint losses and darkening of cupper based pigments. Some of the painted inlays were also missing.

Figure 4: The students from the Venaria Reale MS in conservation

The conservation project has been a challenging and rewarding training platform for the Venaria Reale MS students and will be formally published within trade journals.

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Biographies

Loredana Mannina is Conservation officer for the Historic Collections of Furniture and Decorative Arts at the Houses of Parliament. She is also lecturer at the University of Turin's MS in Conservation. Loredana holds a MS in Conservation and an official accreditation, both acquired in Italy. She is committee member of ICON gilding and decorative surfaces group.

Michela Cardinali is Head of the conservation laboratories and head of the advanced training and study school at the Centro Conservazione e Restauro "La Venaria Reale". Michela holds a diploma from the Higher Institute ISCR (Rome) and a Degree in Technology for the Conservation and Restoration of Cultural Heritage at the Faculty of Conservation of Cultural Heritage of the Tuscia University of Viterbo. She is also now member of the scientific committee of the Italian IIC group.

Anna Piccirillo is full time researcher at the Centro Conservazione e Restauro La Venaria Reale's scientific department. Anna holds a PhD in chemical science from the University of Turin, researching on ancient binding media with focus on the characterization of binding media mixtures.

Paolo Triolo is Art Historian and Multispectral Imaging specialist at the Centro Conservazione e Restauro La Venaria Reale. He is lecturer in Imaging techniques at the University of Urbino MS in Conservation and in History of pictorial techniques at the University of Genova MS in Methodologies for CH conservation (DISTAV) . Paolo holds a Ph.D in history and conservation of C.H. and a Postgraduate Specialisation at Advanced School of Art History, from the University of Genoa, following the MA in History of Art at the University of Turin. He gave lectures in internationals universitary projects for C.H conservation in Albania, Lebanon and Tunisia.

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Humidification Progressive pour le Nettoyage des Peaux et des Fourrures : L'Emploi de l'Argile, de Membranes Cellulosiques et du Nevek©

Camille Alembik, Thalia Bajon-Bouzid

Mots clés
Fourrures, Peaux, Nettoyage, Humidification Progressive, Argile, Membrane Cellulosique, Nevek©

Introduction

L'argile et les membranes cellulosiques sont de plus en plus utilisées et ont fait leurs preuves pour nettoyer, décoller ou remettre en forme (ou à plat) des œuvres textiles mais aussi des papiers ou autres œuvres de nature organique. Le Nevek©, Agarose formulée par la société CTS©, est utilisé pour le nettoyage des pierres et des peintures. Ces méthodes sont particulièrement utiles dans le cas où le substrat à traiter est fragilisé ou particulièrement sensible à l'humidité car l'humidification se fait progressivement mais aussi parce qu'elles présentent l'avantage de pouvoir utiliser des solvants apolaires. Plusieurs méthodes ont été testées sur des échantillons de peaux, de cuir ou de fourrures tachés afin d'évaluer leur utilité sur ces substrats. En effet, le nettoyage de ces matériaux pose souvent problème, que cela soit aussi bien pour les collections ethnographiques et d'art populaires, les collections d'objets d'art (assises et bureaux le plus souvent), les collections d'accessoires du costume ou encore les naturalia.

Discussion

Le Nevek© nous intéressait ici particulièrement car, du fait de sa formulation, il peut supporter aussi bien des solutions aqueuses que des solvants organiques, même apolaires comme la ligroïne, en les libérant de façon graduelle et contrôlée. En outre, les gels formés sont plus rigides que les gels d'agarose traditionnels et détrempent ainsi moins le substrat traité.

La montmorillonite est l'argile qui est utilisée dans l'industrie pour de nombreuses applications (fonderies, forages pétroliers, cosmétiques, etc…). Elle est caractérisée par un pouvoir adsorbant élevé, capable de retenir les impuretés hydrolysées et un fort pouvoir absorbant, notamment grâce à ses exceptionnelles propriétés de rétention de l'eau. En outre, comme pour l'eau, les molécules organiques polaires (en particulier celles qui ont des fonctions hydroxyles -OH) ont la capacité de se mélanger à cette argile. En cas d'excès d'acidité, le pH de la solution ne peut descendre au-dessous de 5,5. Elle s'emploie sous forme de poudre ou en pâte. Nous avons exploité ces deux aspects dans le cadre de cette phase de tests.

Les membranes cellulosiques régénérée Viskase© HS13 CLEAR, sont constituées de cellulose régénérée (environ 70 %), de glycérine (19 à 25 %), et d'eau (6 à 11 %). Elles sont employées dans l'agroalimentaire. Elles sont souvent utilisées pour des remises en forme (textiles, peaux ou autres matières organiques sensibles à l'eau). Leur neutralité, leur porosité et leur résistance sont des propriétés essentielles pour la conservation-restauration des objets du Patrimoine. Comme le Goretex© elles permettent une humidification progressive mais également contrôlée puisqu'elles sont transparentes. Dans le cadre de ces tests, elles jouent le rôle de contenant des argiles. La taille des pores de ces membranes permet toujours une circulation lente et progressive du solvant, mais retient ici les particules d'argile.

Trois types d'échantillons de peaux ont été sélectionnés :
- peau chamoisée **(Figure 1)**
- fourrure-peau de chèvre / teinture rose du pelage **(Figure 2)**
- Cuir de vache pleine fleur (1,5 mm) tannage végétal blanc **(Figure 3)**

Nous avons délibérément fait le choix de ne pas traiter les cuirs vernis qui constituent une problématique particulière.

Trois types de taches ont été appliquées sur ces peaux :
- Cosmétique /rouge à lèvre/tache grasse[1]
- Tache de feutres diluables à l'eau (rouge, bleu, vert, noir)[2]
- Tache de feutres indélébiles (rouge, bleu, vert, noir)[3]

Ces taches sont souvent parmi celles les plus répandues dans les collections patrimoniales.
- Plusieurs méthodes ont été testées sur ces échantillons tachés:
- Nevek© mis en gel ou non,
- pain d'argile montmorillonite sans interface et avec interface papier japonais[4],
- argile montmorillonite pure en poudre,
- argile montmorillonite en membrane cellulosique à différents pourcentages dans l'eau ou d'autres solvants (Ligroïne et éthanol).

Selon la méthode choisie, les temps de pause s'étendaient de cinq minutes pour le Nevek©, à douze heures pour les argiles en membranes cellulosiques.

Résultats et conclusion

De manière générale, on note que la méthode d'argile sur la membrane est difficilement exploitable sur des objets en trois dimensions. En outre, dans le cas de mélange avec des solvants apolaires, la circulation des solvants est trop lente. Concernant l'argile en pate, une interface de papier japonais ou autre intissé est nécessaire au vu des risques de résidus en application directe. Enfin, le Nevek© détrempe trop le substrat et il est nécessaire de le mettre en gel pour le traitement de ce type de substrat.

Concernant les taches grasses (rouge à lèvre), nous avions additionné à l'argile et au Nevek© de la ligroïne. Les résultats ont été particulièrement concluants pour la fourrure **(Figure 2)**. Les tests de nettoyage avaient ici été effectués en deux étapes : une première pose de Nevek© mis en gel pour diluer la tâche, puis une deuxième pose d'argile pure placée dans un coussin de papier japonais, afin d'absorber la tâche. Cette même méthode a été appliquée sur le cuir de vache ; la tache a également été retirée en grande partie.

Les taches de feutres diluables à l'eau sont celles qui se sont le plus atténuées et ce, quelque soit la technique choisie **(Figure 1)**.

Figure 1 : Test effectué sur une peau tachée de feutres lavables : avant et après intervention pain d'argile montmorillonite sans interface de papier japonais. Pauses de 15 minutes. ©Camille Alembik

Figure 2 : Test effectué sur une fourrure tachée de rouge à lèvre : avant et après intervention Humidification à l'aide de gel de Nevek© dans de la ligroïne et application d'argile pure à travers un coussin de papier japonais ©Camille Alembik

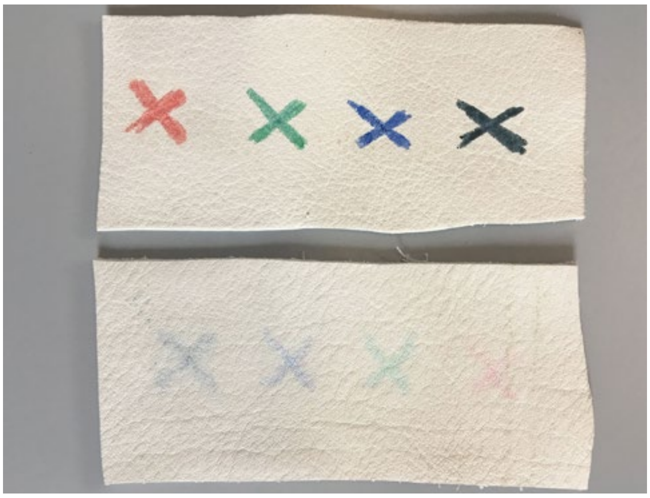

Figure 3 : Test effectué sur un cuir de vache pleine fleur taché de feutres indélébiles : avant et après intervention. Humidification à l'aide de gel de Nevek© dans de la ligroïne et application d'argile pure à travers un coussin de papier japonais ©Camille Alembik

[1] Rouge à lèvre CHANEL© REF : *Rouge ALLURE 138*

[2] Lot de douze (12) feutres ultra-lavable Monoprix© REF : 42750/26538R (rouge, bleu, vert et noir du lot).

[3] Lot de quatre (4) feutres permanents Sharpie© REF : 1985234 (rouge, bleu, vert et noir).

[4] Papier japonais Kozo 17 mg.

Concernant les taches de feutres indélébiles, nous avions additionné à l'argile et au Nevek© de l'éthanol mais les résultats n'ont pas été concluants **(Figure 3)**. D'autres tests avec d'autres solvants pourraient être effectués avec ces mêmes méthodes.

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Bouzid T., 2002. *Conserver ou retirer les interventions anciennes, étude de sept textiles islamiques médiévaux restaurés ou montés à la fin du XIXe siècle ou au début du XXe siècle, Mise au point et expérimentation d'une méthode de traitement des textiles collés très fragilisés, à l'aide d'argiles contenues dans des membranes cellulosiques*, Saint-Denis Inp. Département des restaurateurs du patrimoine, 151 p.

Matériaux

Nevek©, C.T.S. France, 26 passage Thiéré 75011 PARIS tel: 01 43 55 60 44 / 65 63 / www.ctseurope.com

Viskase© HS13 CLEAR (cellulose régénérée 70 %, 20% de glycérine, 10% d'eau https://www.viskase.com

Montmorillonite, argile en vente en pharmacie ou magasins de comestiques

Papier japonais Kozo 17 mg, C.T.S. France, 26 passage Thiéré 75011 PARIS tel: 01 43 55 60 44 / 65 63 / www.ctseurope.com

Rouge à lèvre n° CHANEL© REF :
Rouge ALLURE 138, magasins de comestiques.

Lot de douze (12) feutres ultra-lavable Monoprix©
REF : 42750/26538R (rouge, bleu, vert et noir du lot), Magasins Monoprix, France.

Lot de quatre (4) feutres permanents Sharpie©
REF : 1985234 (rouge, bleu, vert et noir). Papeteries.

Biographies

Camille Alembik est diplômée en conservation-restauration depuis 2010. Spécialisée dans matériaux organiques elle intervient depuis son diplôme, pour des collections ethnographiques (Musée du Quai Branly) des collections scientifiques (Musée de l'Air et de l'espace) mais aussi d'art contemporain (Collection Lambert en Avignon, CNAP, Musée d'Art moderne de la ville de Paris). Diplômée du Master II de Conservation Préventive, Paris 1, elle est consultante en conservation préventive depuis 2013. Elle a participé ou mené à bien des chantiers de collections (MuCEM, Musée Carnavalet, Musée du Louvre) mais également des études préalables, des campagnes de constats d'état associées à des conseils d'exposition ou de mises en réserves pour des collections variées (Le Mobilier National, Musée du Louvre, musée de l'Air et de l'Espace). Elle enseigne au sein de différentes formations en conservation-restauration et en conservation préventive. (Université Paris / Panthéon-Sorbonne, Ecole de Haute Etudes de Neuchâtel).

Thalia Bajon Bouzid est conservatrice-restauratrice de textiles depuis 2002. Elle a travaillé à de nombreuses reprises sur des collections de costumes (Musée des Arts décoratifs ; Galliera ; La Cinémathèque française ; …), de poupées (Museon Arlaten, Arles ; Musée des Arts décoratifs) et a été mandataire du groupement conservation-restauration du lot textiles ethnographiques pour le musée des Confluences-Muséum d'histoire naturelle de Lyon en 2012-2013, et pour le Museon Arlaten de 2011 à 2013 et co-traitante pour le lot objets composites depuis 2007. Elle enseigne des techniques de nettoyage grâce aux argiles depuis 2005 (INP, formations permanentes) et est chargée de cours depuis 2010, sur l'utilisation des membranes et argiles pour la restauration, (département des restaurateurs de l'INP, section textile et sections Arts graphiques et livres). Elle est également une des principales coordinatrices du groupe textile de la SFIIC (Section Française de l'Institut International de Conservation).

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Restoration of Water-damaged Parchment

Līga Paušus

Keywords
Parchment, Restoration

Introduction

In 2018 an inventory of the parchment document collection was conducted in the Latvian State Historical Archive to prepare this collection for full digitization. During the inventory it was found that some parchment documents could not be digitized or otherwise used without losing any of the original parchment fragments with text or seals due to their poor physical condition. As a result, there is an urgent need for conservation or restoration to stabilize the existing state and prevent its deterioration. This publication discusses the restoration process of one of this collection's parchment (date 1668).

Discussion

The document consists of one sheet of parchment with four red wax pendant seals **(Figure 1)**. Seals are attached to the parchment by pink silk ribbons. Document size: width 36.8 cm, height: 48.8 cm, ~4 cm wide fold at the bottom. The protective capsules were turned of wood, without covers (possibly missing).

Capsule 1: jammed, tied with a white cotton thread. The stamp is not pressed.

Capsule 2: small wood losses, pressed stamp (octagonal shape).

Capsule 3: small wood losses, uncolored wax can be observed at the bottom, red wax on the top (thickness 1.5 mm).

Capsule 4: small wood losses, wax in a different tone – reddish orange.

Two seals are lost, only fragments of ribbons remain.

The parchment was folded in eight parts. The text is written in dark brown ink. Parchment was covered with dirt, exposed to the effect of moisture. Along the edges there are large amount of tidelines, yellowing, browning. From the discoloration at the edges of stains, it can be concluded that the parchment was exposed to the moisture in the folded form.

As a result of damages mentioned above, parchment is deformed, slightly shrunk along the edges, very fragile around the perimeter, with lost parts of original material, especially in the corners. Text was fading, bleaching due to damage, smeared. Silk ribbons have become fragile, with losses, partially yellowed. Wax seals covered with dirt. Previously parchment was placed in a thin cardboard folder of inappropriate size that did not provide protection.

The parchment had been examined with an optical microscope. It was not possible to identify the animal whose skin was used to make the parchment. Parchment on both sides had been treated very similarly, it is hard to distinguish between hair and flesh side. The hair follicle patterns are not visible.

Process of the restoration: the parchment was dry cleaned with a microfiber cloth in the durable areas and with a soft brush in fragile areas (around the perimeter), wet cleaning (70% isopropyl alcohol-30% water), plasticized (70% isopropyl alcohol-23% water-7% glycerin), flattened and dried between wool felts and boards. As a result of the treatment, the fold lines are slightly aligned. Japanese paper and wheat starch paste glue was used for the repairs (loss, tears and fragile parts). Silk ribbons were dry cleaned with a soft brush, ends of ribbons were strengthened. Seals were cleaned with a dry, soft brush. Then the wax was covered with water-moistened cotton wool (like a compress). The wax was cleaned with moistened cotton buds and left to dry. Wood capsules were cleaned with cotton buds lightly moistened with 70% ethyl alcohol solution. The document after restoration is shown in **Figure 2**.

Conclusion

An appropriate quality cardboard box was made for the parchment with a removable base and special fastenings, to reduce the load on the fragile silk ribbons **(Figure 3)**. The parchment was attached to the base with transparent corners and removable strips (cut out from polyester sheet). Strips were attached with self-adhesive *Velcro* fastenings. Special fasteners for seals were made of thin cardboard. The removable base and the transparent fasteners ensure that it is not necessary completely remove parchment from package for use or viewing.

Materials

Japanese paper *Misumi natur* (71g/sqm, 80% kozu, 20% pulp) Japico, www.japico-shop.eu

Wheat starch paste

Self-adhesive velcro fastener

Polyester sheets, Preservation Equipment Ltd, www.preservationequipment.com

Biography

Līga Paušus works in National Archives of Latvia, Department of the Preventive Preservation for 4 years. Work experience – restoration of different types of papers, parchments and wax seals.

Education: The first level of higher professional education, qualification – restorer (Riga Building College, 2012). Master of Engineering Sciences in Materials Science (Riga Technical University, 2017).

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Figure 1: Parchment before restoration (obverse) ©National Archives of Latvia

Figure 2: Parchment after restoration (obverse) ©National Archives of Latvia

Figure 3: Storage box with special fastenings for parchment and seals ©National Archives of Latvia

Technical history
Histoire des techniques

Gilt Leather Threads in 11th-15th Century Textiles

Cristina Scibè, Caroline Solazzo, Isetta Tosini, Thomas Lam, Edward Vicenzi, Maria José González López

Abstract

For thousands of years metal threads have been used for the decoration of textiles and clothes to create luxurious objects. Between the 11th and the 15th centuries, gilt and silvered organic strips (made with animal skin, animal gut or paper) were among the metal threads most commonly used, either as flat strips or wound around a fibrous core. These types of metal threads were very popular due to their flexibility and reduced cost; indeed, the metal coating was applied in one or multiple thin layers on the organic substrate that made up most of the thickness of the thread.

While the use of paper as substrate was restricted to East Asia, animal substrates were widely used across Europe and Asia resulting in what has been called "membrane threads". The metal-coated organic threads have a layered and heterogeneous structure, of which the metal layer has mostly been the target of investigation due to the complexity of studying the organic component. In the present work, metal-coated skin threads from medieval Spanish, Sicilian, Middle Eastern, Central and East Asian textiles were investigated by a multi-analytical approach, combining for the first time Optical Microscopy, Scanning Electron Microscopy/ Energy Dispersive X-Ray Spectroscopy and Proteomics.

Keywords

Gilt Leather, Metal-Coated Organic Threads, Medieval Textiles, Proteomics, SEM-EDX, Optical Microscopy

Introduction

The use of gold and other precious metals for the decoration of clothes and textiles to create objects of luxury and power can be traced back as early as the Bronze Age.

Between the 11th and the 15th centuries, special type of metal threads largely used in weavings and rarely in embroideries, was historically known as "membrane threads". These threads were made by gilding/silver-plating an organic material, such as leather, parchment (vellum), membrane or paper, and then cutting the gilded material into narrow strips. These strips were used either flat (**Figure 1**) or wound around a fibrous core (silk, linen, cotton or other yarns) in the production of composite threads (**Figure 2**).

The introduction of the "metal-coated organic threads" represents a very important achievement in the development of metal threads technology. They were very popular and preferred to the earlier pure gold threads due to the flexibility of the wrapping materials and the reduced cost; indeed, the metal coating was applied in one or multiple thin layers on the organic substrate that made up most of the thickness of the thread. These features led to their extensive use in fabric decoration for a variety of textures and visual effects.

All the studies conducted until now dealing with "organic threads" show a lack of a unified nomenclature and classification. Historical literature often refers to "membrane threads" (made from membranous tissues) as "Cypriot gold", "Byzantine gold" but also as "skin gold", while some authors consider as "membrane threads" all types of gilt/silvered organic strips, generating a terminological ambiguity around them. Therefore, in the present paper, the authors will refer to this type of metal threads as "metal-coated organic threads", subdividing the category in three main groups according to the organic substrate: "metal coated skin threads" (made by leather or parchment strips), "metal-coated membrane threads" (made by membranous strips), and "metal-coated paper threads" (made by paper strips).

Figure 1: Magnified view. Gilded flat strip. Central Asia, 14th c.; Stralsund Museum, 1862: 16. Image acquired by HIROX KH-8700 3D digital microscope (Hirox-USA, Inc., NJ) by Cristina Scibè © Museum Conservation Institute, Smithsonian Institution

Figure 2: Magnified view. Gilt wrapped-skin strips. Italy?, possibly 13th c.; Cooper Hewitt, Smithsonian Design Museum, 1902-1385. Image by Cristina Scibè © Museum Conservation Institute, Smithsonian Institution

Metal-coated skin threads

It is unclear how early the practice of making metal-coated organic threads began. It is generally assumed that they were probably first manufactured in Asia. The finding in the Famen Temple (Fufeng County, Shaanxi Province) of a 6th century AD gilded organic thread, on which the substrate had completely degraded, represents the first evidence of the "organic" thread production in China (Karatzani, 2009). The spread to Southern Europe began probably from Byzantium, western Asian or African regions by the Levantine trade, through the ports of Cyprus, hence the name "Cyprus gold" or "Byzantine threads", as early as in the 10th-11th century.

According to the textile and scientific literature[1], and on the strength of archaeological evidences, while the use of paper substrate was restricted to the Far East (China and Japan), animal substrates were widely used across both European and Asian textile productions. Braun-Ronsdorf (1961) asserts that the presence of a gilt-leather thread in a fabric is a useful indication of its Far Eastern origin. According to Braun-Ronsdorf, gilt and silvered leather strips were first used for the decoration of silk brocades in the Far East as untwisted wefts. Then, the Mongol conquest of Persia in the 13th century led to the introduction of the gilt-leather technique into Persian brocade weaving and consequently in the Middle East. From there, beginning in the 14th century, these Chinese fabrics made their appearance in Western Europe and became very popular. No mention is made regarding the Arabian production of the Northern Africa, Iberian Peninsula and Sicily under the Muslim domination, which instead had developed its own production of gilt skin threads during the medieval times. To the best of our knowledge, the earliest evidence of gilt skin threads in Europe dates back to the 10th-11th century in al-Andalus; the 10th century "Pyrenees" Peacock tapestry and the early 11th century veil of almaizar Hisham II, both belonging to the Cordoba *Tiraz* manufacture (Borrego et al., 2017), and the 11th century shroud of St Lazarus from Autun, assigned to the Andalusí manufacture of Almeria (Rinuy, 1989).

Meanwhile, in European workshops (especially Italy and Germany) threads were mostly made with very thin animal membranes, usually reported as animal gut, but stomach or bladder membranes might have been used as well. The production started in the 13th and 14th centuries as a less expensive imitation of the "Cyprus Gold". If in Europe, from the early 15th century onwards, solid metal threads gradually replaced organic metal threads with the advent of the velvet weaving, in the Far East gilt paper and leather were still in use in the 20th century (Járó, 2003; Solazzo, unpublished data).

Not only their origin, but also their manufacturing techniques still raise several questions. Metal-coated skin threads have a layered and heterogeneous structure: the metal layer (in the form of powder or thin leaves) was applied on skin tissues (leather, parchment, vellum) by an adhesive medium (animal glue, egg or bole), before

[1] On the historical development of metal threads and their geographical spread: Braun-Ronsdorf (1961), Wardwell (1989), Indictor et al. (1989), Járó et al. (1990).

cutting the skin into narrow strips. The metal surface has mostly been the target of investigation; conversely, the distinction among the substrate materials (base layer and adhesive) has often been clouded in the literature, probably due to analytical limits. Until now, the investigation of the organic component has been mainly conducted by morphological analysis, which has proven to be a useful preliminary examination, yet a subjective one. Indeed, since it is based on visual identification, observations are influenced by variations along the threads and the appearance of the substrate that can be altered from its original. De Reyer's DNA amplification study (2002) has been one of the few studies conducted on the organic component by means of more advanced techniques beyond microscopic ones. However, on account of the extensive fragmentation of the DNA molecules and the presence of others protein-based materials in the complex structure of these threads, the 2002 study was inconclusive at the time. The resulting lack of a unified investigation method of these materials led to their confusing and incomplete classification. The recent proteomics application to the study of ancient animal membranes (Popowich et al., 2018), has opened new perspectives both in species identification of the base layer and in the characterization of the protein adhesive.

The present work shows some of the results of parallel research projects that the authors are carrying on with the aim to organize the knowledge acquired until now on these materials, providing at the same time new insights by a multi-disciplinary and multi-analytical approach to the subject. Correlating our data with textile research on medieval textiles, such investigation forms the hypothesis that it would be possible to relate materials and manufacturing techniques of a metal-coated organic thread to a specific period and workshop.

Materials and methods

A series of 12th-14th century textiles of Central and East Asian, Middle Eastern, Spanish and Italian origin were selected from various European and American museums, such as the Brandenburg Textile Treasury, the Stralsund Museum, the Terrassa Textile Museum and Documentation Center, the Modena Civic Museum of Art, the Prato Textile Museum, and the Cooper Hewitt Smithsonian Design Museum of New York.

We collected 76 samples of metal-coated organic threads, in detail 32 membrane-type threads and 44 samples of skin-type threads, trying to reach a representative number of samples for each period and textile center in order to determine and compare European (Spanish and Italian) and Oriental (Near East and Far East) patterns of fabrication.

The samples were investigated by a multi-analytical approach, combining traditional techniques such as Optical Microscopy (OM) and Scanning Electron Microscopy (SEM) /Energy Dispersive X-ray Spectroscopy (EDS) with proteomics. Here, we present selected results obtained on metal-coated skin threads. The present investigation can be considered as the first application of proteomics analysis, microscopy and metal analysis to the morphological and compositional characterization of the diverse layers of gilt skin strips.

SEM-EDS: was performed using an Hitachi S3700N scanning electron microscope (SEM) equipped with a Bruker 6|60 silicon drift X-ray detector and Esprit V2 analysis software for compositional imaging and analysis. Samples were analyzed at a working distance of 10 mm with a15 kV electron beam and < 1 nA of current. A large solid angle 5 segment backscattered electron detector was also used for average atomic number imaging. Hyperspectral X-ray imaging of the specimens allowed for extraction of spectra from compositional images. P/B ZAF matrix corrections were applied to raw X-ray data for quantification; these results were then normalized and reported in elemental mass per cent.

Optical microscopy: a cross-section of each sample was prepared by embedding a micro-fragment perpendicularly in polyester resin and polishing with silicon carbide discs (grit from p120 to p1200). The cross-sections were observed by Optical Microscopy in UV reflected light using a Zeiss Axio Immager A1 microscope, equipped with a mercury vapor lamp HBO100 with the Filter set 49 (excitation G - 365 nm, beam splitter FT – 395 nm, emission BP – 445/450).

Proteomics: starting with samples as small as 1×1 mm, the proteomes of each sample were characterized by nanoLC-tandem mass spectrometry (separation of peptides followed by mass spectrometry analysis on a Thermo Scientific Dionex Ultimate 3000 UHPLC system coupled to a Thermo Scientific LTQ Velos Dual Pressure Linear Ion Trap mass spectrometer), following a protocol for extraction and trypsin digestion of the proteins present in the whole samples adapted from (Solazzo et al., 2017). Data files were imported into PEAKS studio 8.5 (Bioinformatics Solutions Inc.) for searching against protein sequence information available in public databases (Uniprot for general searches against mammals and birds, and NCBI for searching collagen proteins for mammals and fish). In addition, because sheep (*Ovis aries*), goat (*Capra hircus*) and cow (*Bos taurus*) were found to be the most common species identified, the identification was validated through a series of distinctive markers from collagen type I and type III chains.

Results and discussion

Preliminary examination

The first step of the investigation was the examination of gilt skin threads directly on the textile, in order to take note of the variability of some technical features that describe the thread technology and that may be lost in the sampling. For example, in the same textile, we may find the presence of more than one type of metal thread. Then, a careful examination of the sample under a stereo binocular microscope was conducted to define the main morphological characteristics of the thread, such as the type of thread, its diameter, the strip width, and the wrapping direction (S or Z twist) of both the strip and the fibrous core. The samples belonging to the Asian textiles are typically of the flat-strip type. All the other samples are metal-wrapped threads. The threads belonging to European textiles are mostly Z-twisted around a silk core **(Figure 3)**, while the Middle Eastern skin strips are S-twisted around a linen core **(Figure 4)**.

Figure 3: Gilt skin thread. The strip is wound around a silk core in Z-twist. Spain, 13th c.; Cooper Hewitt, Smithsonian Design Museum, 1902-1-977. Image acquired by HIROX KH-8700 3D digital microscope (Hirox-USA, Inc., NJ) by Cristina Scibè © Museum Conservation Institute, Smithsonian Institution

Figure 4: Gilt skin thread. The strip is wound around a linen core in S-twist. Italy? Persia?, 14th-15th c.; Cooper Hewitt, Smithsonian Design Museum, 1902-1-271a. Image acquired by HIROX KH-8700 3D digital microscope (Hirox-USA, Inc., NJ) by Cristina Scibè © Museum Conservation Institute, Smithsonian Institution

SEM-EDS Analysis

Qualitative and semi-quantitative analyses were performed on the metal surface by using an energy dispersive spectrometer (EDS) system attached to the scanning electron microscope. By the micro-morphological examination of the metal coating, it was possible to distinguish mainly two gilding media: powder **(Figure 5)** and leaves **(Figure 6)**.

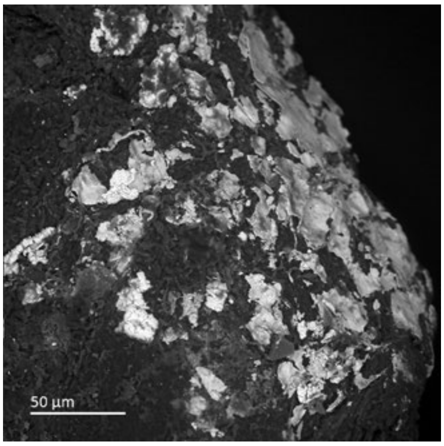


Figure 5: Scanning electron micrograph of a silver powder coating on a skin strip. Spain?, 13th c., Cooper Hewitt, Smithsonian Design Museum, 1902-1-229b. Image by Thomas Lam © Museum Conservation Institute, Smithsonian Institution

The accuracy of the quantitative analysis of the metal layer is highly dependent on its thickness and homogeneity. Gilt/silvered skin threads are a complex target of samples due to their uneven and thin metallic surface. Therefore, the values obtained for gold and silver must be considered as indicative of the original metal surface composition instead of absolute values. Consequently, the results of the metal layer composition will only be suitable for purposes of comparison with other published data, since most studies conducted on metal threads have been using SEM-EDS.

In this study, EDS analysis of the surface showed that the metal coating is mostly made of gold and silver, often with a higher amount of gold than silver in the Spanish and Sicilian samples (except for one sample that showed the presence of silver with traces of gold (<2.60 wt%)). In 14th century Middle Eastern, Central Asian and East Asian samples, the coating is made of well-refined gold. Our results agree with former scientific and historical investigations aimed at provenancing threads based on their metal composition. For those samples belonging to textiles of uncertain provenance, a tentative assignment will be made once the evaluation of all the analytical data has been carried out.

In order to understand whether the metal coating is made of a single or multiple metal layers, the EDS elemental mapping appears to be a representative method **(Figure 7)**. In the samples shown below, the homogeneous distribution of both the main elements, gold and silver, might lead to the conclusion that a single layer of gold with silver was used (A). While, the homogeneous distribution of silver and the discontinuous presence of gold might indicate the use of two metal layers (B), as in gilt-silver coatings.

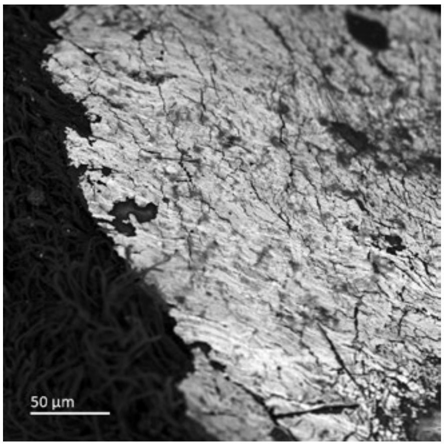


Figure 6: Scanning electron micrograph of a gold leaf coating on a skin strip. Italy, 14th c., Cooper Hewitt, Smithsonian Design Museum, 1902-1-292a. Image by Thomas Lam © Museum Conservation Institute, Smithsonian Institution

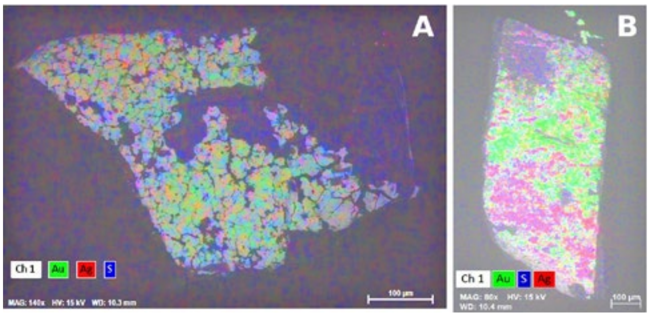


Figure 7: Results of the EDS surface mapping analysis. (A) Gold (higher amount) with silver can be detected on the surface of the strip. The spatial distribution of the elements is homogeneous. Spain, 13th c.; Cooper Hewitt, Smithsonian Design Museum, 1938-78-1. (B) Gold (lower amount) with silver can be detected on the surface of the strip. The spatial distribution of the silver is homogeneous while the presence of gold is detectable only in some areas. Spain, 14th c.; Cooper Hewitt, Smithsonian Design Museum, 1902-1-311. Image by Thomas Lam © Museum Conservation Institute, Smithsonian Institution

Comparison of the OM and proteomics analysis

The optical examination of the stratigraphy of gilt skin strips is necessary to understand their layered structure and to establish further analytical steps, to determine the thickness of the strip, and to identify the fibrous core. All the skin-type samples present the following layered sequence: metal coating, adhesive layer and base layer **(Figure 8)**. Few samples show the presence of a "lacquer" coat above the metal, already detected by the visual examination of the textile itself. Such "lacquer" might have been used as a varnish to give a specific shade to the gold leaves; further investigations will be needed to identify its nature.

Figure 8: Cross section micrograph of a skin strip, UV reflected light, 20× magnification. Spain, 13th c., Textile Museum and Documentation Center, CDMT 6005. Image acquired by Axio Zeiss Imager A1, by Cristina Scibè, METHIT PhD thesis © Opificio delle Pietre Dure

By cross section analysis, we can establish different typologies and production technologies of gilt strips. For example, the whitish or yellowish color of the skin might reveal the use of a parchment or vellum strip while a dark brown or blackish tone could be indicative of a leather produced by a vegetable tanning process. Due to the stretching process they undergo, the collagen fibers in parchment and vellum are aligned while in leather their distribution tends to be more random. Moreover, the presence of depressions left from depilated hair follicles is more often observable in leathers than in parchment or vellum. Finally, differences in the skin strip thickness might be representative of different animal skins or different skin regions. However, the advanced state of

Table 1: proteomics results of selected samples

Sample	Layer	Database	Species Latin name	Species common name	Protein	Score -10lgP	% coverage	# peptides
Central Asian, 14th century	Skin base identification	NCBI Collagen	*Ovis aries*	Domestic sheep	COL1A1	166.19	43	59
					COL1A2	164.00	46	52
					COL3A1	123.67	28	33
	Adhesive identification	NCBI Collagen	*Acipenser schrenckii*	Amur sturgeon	COL1A1	118.02	23	39
					COL1A2	157.16	48	67
Hispano-Moorish, 13th century	Skin base identification	NCBI Collagen	*Capra hircus*	Domestic goat	COL1A1	224.01	61	110
					COL1A2	211.98	62	81
					COL3A1	159.14	42	50
	Adhesive identification	Uniprot Aves	*Gallus gallus*	Chicken	OVALBUMIN	85.28	33	11

deterioration and damage of the skin materials often make such observations challenging.

In this regard, proteomics analysis was conducted to determine the origin of the organic components and the species used. Using nanoLC-MS/MS, all proteins that can be extracted from the skin substrate and a proteinaceous adhesive are characterized in one single analysis, thus minimizing the amount of sample necessary per analysis. The relevance and novelty of the present study is represented by the comparison of the cross section's morphological information with proteomics data **(Table 1)**. For the first time, we will be able to identify the different organic layers and "reconstruct" the manufacturing techniques of gilt organic strips.

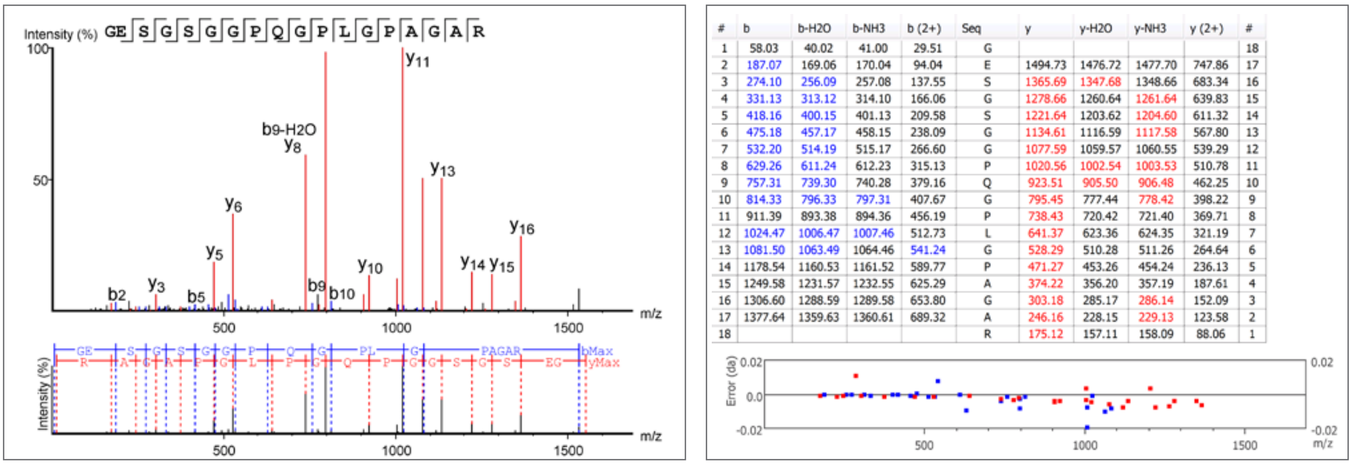
The proteomics results of a Central Asian thread **(Figure 1)** and a Spanish thread **(Figure 8)** are given in **Table 1**. In the Central Asian thread, the base layer was found to be made from sheep skin while the adhesive was identified as a fish glue with a best match found for Amur sturgeon. Due to limitations in fish sequences available (only two species of sturgeon have collagen sequences in NCBI), the exact species identification is still under review **(Figure 9** shows a species-specific peptide from sturgeon). In the Spanish thread, the base layer was found to be from goat skin, while the adhesive was identified as egg white from chicken due to the identification of ovalbumin.

Further research is under way to characterize the skin substrate from the adhesive separately; this would be particularly relevant in cases where animal glue from the same species as the skin substrate had been used in the adhesive.

Conclusion

This paper reports on an ongoing research project, which focuses on metal-coated organic threads. The outcomes of this research will considerably expand our knowledge in this field by answering some questions of great academic interest, and especially contribute to better define the different typologies of metal-coated organic threads by refining the organic substrate classification.

The data presented here are indicative of the variations on the morphological and technological characteristics



#	b	b-H2O	b-NH3	b (2+)	Seq	y	y-H2O	y-NH3	y (2+)	#
1	58.03	40.02	41.00	29.51	G					18
2	187.07	169.06	170.04	94.04	E	1494.73	1476.72	1477.70	747.86	17
3	274.10	256.09	257.08	137.55	S	1365.69	1347.68	1348.66	683.34	16
4	331.13	313.12	314.10	166.06	G	1278.66	1260.64	1261.64	639.83	15
5	418.16	400.15	401.13	209.58	S	1221.64	1203.62	1204.60	611.32	14
6	475.18	457.17	458.15	238.09	G	1134.61	1116.59	1117.58	567.80	13
7	532.20	514.19	515.17	266.60	G	1077.59	1059.57	1060.55	539.29	12
8	629.26	611.24	612.23	315.13	P	1020.56	1002.54	1003.53	510.78	11
9	757.31	739.30	740.28	379.16	Q	923.51	905.50	906.48	462.25	10
10	814.33	796.33	797.31	407.67	G	795.45	777.44	778.42	398.22	9
11	911.39	893.38	894.36	456.19	P	738.43	720.42	721.40	369.71	8
12	1024.47	1006.47	1007.46	512.73	L	641.37	623.36	624.35	321.19	7
13	1081.50	1063.49	1064.46	541.24	G	528.29	510.28	511.26	264.64	6
14	1178.54	1160.53	1161.52	589.77	P	471.27	453.26	454.24	236.13	5
15	1249.58	1231.57	1232.55	625.29	A	374.22	356.20	357.19	187.61	4
16	1306.60	1288.59	1289.58	653.80	G	303.18	285.17	286.14	152.09	3
17	1377.64	1359.63	1360.61	689.32	A	246.16	228.15	229.13	123.58	2
18					R	175.12	157.11	158.09	88.06	1

Figure 9 a-b: Example of species-specific peptide from Amur sturgeon: COL1A2, GESGSGGPQGPLGPAGAR, m/z 776.3818, z=2 of metal-coated skin-type threads. For the first time, the species identification of the base layer and the characterization of the protein adhesive was achieved in a single analysis, allowing the description of the threads beyond the sole analysis of the metal layer. The combination of proteomics with traditional microscopic techniques will contribute to uncovering different production technologies and to resolving the age and provenance of gilt organic threads. Indeed, the provenance study of medieval textiles has usually been done by comparing the patterns with other textiles of known age and origin. However, the extensive trade of raw materials (including metal threads) and movements of workshops and textile workers have somehow blurred the lines defining the origin of many medieval textiles. Not surprisingly, in the textile literature and in museum's inventories, fragments from similar textiles appear with varying geographical assignments. The ultimate goal of this project hopes to combine the analytical data from metal threads, along with those from fibers and dyes, with weaving techniques and patterns, thus revealing the complex nature and origin of the threads and their interworking towards the final textile.

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Carved Leather of the Caliphate Lineage: The Heritage of the West of the Iberian Peninsula – Beyond the Myth of Córdoba

Franklin Pereira

Abstract

Cordoba keeps on being praised for the arts of leather, namely guadameci/gilt leather and the heritage of al-Andalus regarding other aspects of artistic leatherwork. Nevertheless, in the lands that once were the Gharb al-Andalus – the West of the Iberian Peninsula –, the echoes of Muslim heritage at its peak of wealth were developed and recreated into leather upholstery by late 16th century. Stepped triangles, four-petal flowers on squares, double 8, feline within a dotted circle, palmettos, other developments of the acanthus, leaves in scrolls, do show that Portugal kept and developed the al-Andalus motives that we can find in stucco, silks, marble, bookbinding, illuminations and ivory; some of these motives pre-date Islam, and show its absorption of aesthetics of different cultures.

About 20 leather carved chairs, scattered in Portugal, need further study, opening new doors into a past where too little clarity still exists, in particular identifying raw materials (like the "*leathers of Cordoba*", or "*cordovan*"/ goat skin) with artistic work, or labelling guadameci after the Libyan city of Ghadames.

Most of these carvings on 5 mm thick cowhide were done using a sharp V-gouge, which takes a tiny strip of the dermis, similar to wood and stucco carvings. Very few tooling stamps were used: a dot, tiny ball and a curved non-sharp chisel are enough for such recreation of centuries-old patterns, which were considered official and worthy of the Christian elite – male nobility and clergy – that used such chairs. The fashions of the time, still rooted in the Islamic heritage, considered cushions and tapestries to sit on, and silks and gilt leather on the walls of the palaces; hence chairs were few and restricted. The Renaissance fashions and its new patterns for leather carving erased the former ones; besides a change in aesthetics, a more lightweight chair became the recipient for such change, and the old models were put aside. We had to wait a few more decades for the high-back leather carved upholstered chair to become more frequent in the Baroque style, and to be recognized as an icon of Portuguese furniture, also exported to other European countries.

Keywords

Carved Leather, Upholstery, Muslim Heritage, Iberian Peninsula, Portuguese Chairs

Introduction

Any map of the medieval Iberia Peninsula shows the Islamic domain of most of it, diminishing as the Reconquest moves south, and the several Christian kingdoms attain more power and land. The al-Andalus ruled most of Iberia during the early centuries under the Umayyad dynasty (8th-11th centuries) that originated in Damascus, losing its grip in the west, as the small kingdom of Portugal extended its domain, until the Algarve was finally conquered by mid-13th century.

Hence, "*Islamic Spain*" never existed; it's just a simplistic label away from the complex reality of the meeting of Islam and Christianity. After the marriage of Isabel and Fernando – the Catholic Kings – and the conquest of Granada in 1492, the several kingdoms got united and thus Spain was born. From then on, two countries have been ruling Iberia.

In many Spanish and Portuguese documents one finds the label "*cueros de Córdoba*" or "*coyrama de Córdoba*" – it simply refers to tanned hides from Cordoba, and nothing to do with artistic leatherwork. Also, in both countries, born out of the Reconquest, the term "*cordovam*"/"*cordobán*" means tanned goatskin, owning its name to the fame of Cordoba tanneries – a production prior to Islam, but developed under its rule. The label and tanning recipes spread to all of Iberia, and several rules pretended to keep such quality of tanning of goat-skins (Pereira, 2012: 25); again, it has nothing to do with artistic workmanship. To see in "*leathers of Cordoba*" or in "*cordovam*" some kind of aesthetics of art, is an invention of the 19th century Romantic era, mixed with a nationalistic point-of-view.

To make both fields clear it is important to understand the developments in leather art in the West of Iberia – former Gharb al-Andalus –, mainly the aesthetics in Portugal's early upholstery.

Discussion

The "*cadeira d'espaldas*"/armchair with backrest of late 16th century **(Figure 1)** is the main recipient for the carvings under study.

Figure 1: Type of armchair with backrest of late 16th century. Author's photo.

A few decades afterwards, due to the Renaissance and the change of dress codes, a smaller and light-weight chair became dominant **(Figure 2)**. Its leather carvings show different aesthetics, inspired in the new "*Roman*" style that became the main one in the decorative arts: acanthus, "*putti*", scrolls of flowers, coat-of-arms, lady with a parrot, or the double-headed eagle, became fashionable, and old patterns were put aside.

By the same time, Spain developed a similar basic structure of chair, called "*sillón frailero*" (monk seat); when upholstered with leather, its decoration is based in patterned stitching and some tooling – quite different from the carvings of the Portuguese chairs of the same decades. Therefore, the Portuguese model is specific and must not be misunderstood.

Figure 2: Early Renaissance type of chair of the first decades of the 17th century. Author's photo.

In spite of the former model in X (folding or not), shown in paintings, sculpture (woodcarvings, stone) and illuminations, in Portugal no such chairs reached us. The Spanish examples have tooling patterns, and only one in the Museum of Al-Hambra (Pereira, 2000: 245; 2000 A: 11) shows carvings according to the Sultanate of Granada's Nazari dynasty: coat-of-arms, braided laces, animals facing one another, similar to what is found in Granada Kingdom's pottery and stucco. Early Renaissance in Spain kept this type of scissor chairs; its structure presented woodcarvings, leaving aside the geometric engravings of the referred Nazari model.

Contrary to the light-weight chairs of the early 17th century, it is unlikely that these Portuguese armchairs with backrest of late 16th century were part of groups of 6 to 8 pieces – at that time former Moorish ways of sitting on pillows and mats on high-raised platforms (with tapestries and gilt leather on the walls), keeping the chair for the noble of the palace, were still in use. Thus, I believe that each of these chairs with backrest, in spite of having the same wooden structure (made by joiners and woodcarvers), is unique in its leather carvings, even if basic patterns have similarities.

The leather carvers for upholstery

Its makers, according to late 16th century documents, were the "*correeiros d´obra grossa*" – they produced, besides upholstery, harnesses and horse gear (except saddles, made by the saddlers), coffers, containers for weaponry, suitcases, whips. It´s quite possible that, due to the high quality seen in leather carving, specific artisans were more involved in this art. Chairs' models were standardized (Correia, 1926: 115, 117), and the Lisbon city council officially confirmed their structure with stamping (idem: 118; Guerra and Pereira, 2018: 46, 47). All the referred items were under the general label of "*course work*", as the light-weight goods (like bags, quivers, belts) were made by the "*correiros d'obra delgada*", using cordovan, cowhide and sheepskin (idem: 51). Several times the ordinances refers to the antiquity of models of chairs (idem: 47), obviously implying a repetition of techniques passed down the generations, or from master to apprentice. It is possible that most of these chairs were produced in Lisbon, due to its power as the kingdom's capital and trade organization.

Leather carving tools of the early phase

The carvings on 5-6 mm cowhide were done using a sharp V gouge, taking out a tiny strip of the dermis. A blunt chisel in a curve is mainly used to tool stepped triangles, usually in the left and right of the carvings, on the rectangular frame, carved with leaves in a SS structure. A dot, point or small curves are the tooling stamps used in such deep carvings. Exception must be made regarding a chair **(Figure 6)**: its detail makes me consider the artisan used an incision knife (along with a dotted stamp for the background).

Later on, leather carvers started using blunt chisels, setting aside the sharp V gouge. This set, with a growing number of tooling stamps – used for texture, shades, bevelling,… – was used during the Renaissance, Baroque and Rococo styles (Pereira, 2000 A: 12; 2000 B: 167-170; 2002: 220-223; 2015: 24-25; Guerra and Pereira, 2018: 63); it spanned centuries, and reached our days. It's on this wide collection that American tools are based, being nowadays elegant tooling stamps, sometimes "*Made in Taiwan*".

The aesthetics of the early leather carvings

It's in the diverse arts of medieval Iberia, in particular of al-Andalus, but also of the "*mudejar*" period, that one finds the roots and parallels for the early carved upholstery in Portugal. Thus, archaeology allows for the understanding of these aesthetics, a richness still pulsating as a courtly one, a few centuries after the fall of the Caliphate, and three or four centuries after Portugal achieved its actual geographical shape.

Observing these chairs, the patterns in their carvings can be considered and studied:-

Large floral braided strap

A large braided strap – similar to a stone carving of the 10th-11th century, probably from Madinat al-Zahra (Andalus, 1992: 243; Andalousies, 2000: 110; Esplendor, 2001: 165) – forms the frame of two seats, at the Museums of Viana do Castelo **(Figure 3)** and Patudos (Pereira, 2011: 160/figure 1A); each medallion keeps a four-petalled flower on a square. The central motif shows two palmettos with scrolls, surrounding a large eight-petalled flower. The richness of this carving – in both museums wrongly fixed in a light structure of chair (like the one in **Figure 2**) – also shows stepped triangles on the left and right, and an undulating inner frame. All this makes me consider this carving the purest piece of the Caliphate heritage.

Figure 3: Seat of a chair at the Municipality Museum of Viana do Castelo: two large braids keeping four-petalled flowers on a square, stepped triangles, and stylized palmettos. Author's photo.

Stepped triangles, in the left and right side of the frames

Triangles, carved by a curved blunt chisel, rest on the frames of the carvings **(Figures 3, 5, 7 and 9)**.

Stepped triangles are found in Oriental architecture and decorative arts (Creswell, 1969, II: 389; Asia, 2001: 77), prior to Islam, as well as at the Umayyad Palace of Khirbat al-Mafjar (Hamilton, 1959: 99, 102, 182); in al-Andalus, similar castellations are found in Madinat' al-Zahra and Cordoba's Mosque (Pavón Maldonado, 1990: table III – 12-100 and XXI-61-413; Pereira, 2000 C: 45). Such stepped triangles are also found in tile work of Granada.

In reduced size, a carving stamp for frames – called "*ear of cereal*" in Portugal –, also belongs to this lineage.

Four-petalled flower on a square, with its corners between petals

Also prior to Islam, such symbolic pattern – the union of the Sky with Earth – goes back to the textile production of Coptic Egypt (Kyblalová, 1967: 13), also used in architectural carvings in Khirbat al-Mafjar (Hamilton, 1959: 199) and Madinat al-Zahra (Pavón Maldonado, 1973: tabla XIII). In Muslim Lisbon, one finds this pattern on an ornamental stone (Portugal, 1998: 86 and 87). It kept on being used in al-Andalus tiles, in 16th century gilt leather of Portugal (Pereira, 2008: 209) and Spain (Art, 1992: 81 and 95), in Iberian medieval illuminated manuscripts, in architecture of Gothic times – like in the Monastery of Batalha, of late 14th century –, and in "*mudejar*" art in Seville and Toledo.

In a leather-bound Koran, of the 13th century (when al-Andalus was under the rule of the Almohad dynasty), the blind tooling repeats such pattern (Ricard, 1934: 80); it must be stressed, amidst the easily-carried objects, the book, as a messenger of Faith and ambassador of aesthetics.

The centuries-old four-petalled flower on a square in so many materials (Pereira, 2012 A) is one of the few patterns shared with gilt leather.

Again, **Figure 3** shows this pattern filling each large braid. Other leather carved upholstery uses this pattern amidst scrolls of foliage (Pereira, 2008: 212; 2016: 385).

Palmettos in two or four directions

The stylized palmetto is found in stucco carvings in Khirbat al-Mafjar, with a ring at its base, forming a patterned line or around a centre (Hamilton, 1959: 151/ fig. 114 a, 213). It's also seen at the Cordoba mosque (in mosaic), in Madinat al- Zahra, and in the art of the Taifa Kingdoms until the Sultanate of Granada (Andalus, 1992: 253; Pavón Maldonado, 1990: tabla III, nos. 19 and 26). In the west of the Iberia Peninsula, such palmetto is found in two stone carvings in Lisbon, from 8th-10th century (Portugal, 1998: 84 and 87), and in Mértola pottery (Cerâmica, 1987: fig. 76). **Figure 3** shows this pattern as its centre; a chair at the Ducal Palace of Vila Viçosa has similar palmettos, and a different border (Pereira, 2000 B: 14/fig. 2). **Figures 7** and **8** show other palmettos by the corners. Other carvings recreate similar palmettos (Pereira, 2009: 152/ figs 5 and 6; 2016: 380).

Acanthus leaf as orange buds

Heir of the Roman heritage, al-Andalus aesthetics kept on the classic acanthus leaf, stylized in rings and buds, like in Caliphate ivory caskets and stucco carvings in Madinat al-Zahra (Torres Balbás, 1943: 209-254); further al-Andalus dynasties, after the fall of the Caliphate, developed such stylized leaf, reducing it to simple curves and dots (Marçais, 1926: 275-278, fig. 155), sometimes filled with flowers (Ricard, 1924: 170, figs. 303 and 304; figs. 305-312; figs. 317-320) in several arts (Pavón Maldonado, 1990: 121, table XXI, no. 43). In leather carvings, figure 4 shows the full catalogue, based in upholstery.

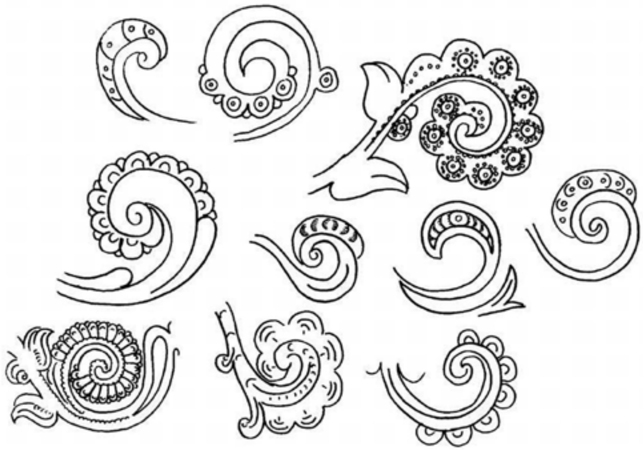

Figure 4: Drawing of the different developments of the acanthus in Portuguese leather upholstery of late 16th century. Author's drawing.

Tiny scrolls in foliage

Very small scrolls are found in floral ornaments of illuminations of several "*suras*" of the Koran, of the Taifa, Almoravid and Almohad epochs of al-Andalus, in the 11th and 12th centuries (Andalus, 1992: 304-311). In leather upholstery **(Figure 5)**, tiny scrolls are also seen in the stems around the coat-of-arms; like in several other ones, the viewer needs to get quite close to the carvings.

Figure 5: Back of a chair, removed from the wooden structure: stepped triangles, frame of flowers and stems in a SS structure, and tiny curves in the florals around the coat-of-arms. Piece from Guerra Junqueiro Foundation. Author's photo.

Birds and flowers in a very detailed floral work

A rare back **(Figure 6)** shows five birds (repeated in the left and right sides) amidst tiny foliage, all finely and precisely crafted. It has parallels to ivory carvings of the Caliphate (Ferrandis Torres, 1935; 1940; Andalus, 1992: 191-204), once again remembering the importance of small artefacts as spreading aesthetics. The Museum of Pontevedra (Spain) keeps a chair which back repeats such detailed carving; the borders are in waves (Pereira, 2000: 230/figures 6 and 6a, 231/figure 6b), also seen in other carvings (idem: 227/figure 4e).

Figure 6: Carved back in a backrest chair at Oporto's House-Museum of Guerra Junqueiro: the ivory "lineage". Author's photo.

Double counter-curved arch

Such structure is found in brocades, and even in architecture of the Gothic era (as in the referred Monastery of Batalha, in Portugal).

In this same carving **(Figure 6)**, its borders are of a double counter-curved arch pattern (having as centre a flower on a square); such design is found in 16th century gilt leather in Spain (Ferrandis Torres, 1955: figs. 49, 50, 59; Art, 1992: 80, 90, 91; Arte, 1998: 85). The early 16th century embossed gilt leather in the "*Charola*" in Tomar/Portugal also keeps this pattern, braided, and with Gothic foliage (Pereira, 2016 A: 14-16; 2018: 253).

Along with the four-petalled flower on a square, this is one of the very few decorative patterns shared with upholstery (Pereira, 2016 B: 19) – the gilt leather use was part of the "*Moorish*" heritage (soon to decrease and even become extinct in Iberia), and the carvings in cowhide were part of a rising fashion, due to the Renaissance's interiors' comfort.

Floral motives inscribed in SS

Several large frames of the rectangular backs and seats show floral motives inscribed in SS – they seem so archaic, a kind of "*ready-to-use*" pattern just needing a few touches to fill the frame. In several leather carvings **(Figure 5)**, the floral frames show a touching point of union of the symmetrical curves, made by a ring – called "*hebilla*" in Spain (Pavón Maldonado, 1988: 225) / buckle; this same author links this kind of frame to Sassanian, Umayyad and Byzantine art, being found in Madinat al-Zahra and Cordoba's Mosque as well (Pavón Maldonado, 1990: 111). More recent books help to understand its introduction to Iberia (Esplendor, 2001: 139) from the Middle east Umayyad and Abbasid empires (Andalousies, 2000: 17 and 28).

Architectural ornament has its counterpart in mobile arts; we find this kind of frame in an ivory box of the Taifa period of al-Andalus (Andalus, 1992: 249), and in a graveyard stone in Portugal, dated from the 12th century (Portugal, 1998: 249). The Renaissance would soon put aside such borders, substituted by the stylization of the acanthus leaf, close to the Roman heritage.

Rings uniting scrolls of leaves are also found in decorated bases of Madinat al- Zahra (Esplendor, 2001: 139), as well as in the ornament of the Mosque of Cordoba (Barrucand and Bednorz, 1992: 57), it is such ring unity with the floral scrolls that one can consider the roots of these Portuguese leather carved borders.

Braided circles

A large circle, braiding with four smaller ones, occupies the centre of a seat **(Figure 7)**, with palmettos by the corners; the frames also have braided floral motifs and stepped triangles.

A similar chair is in the church of Saint Peter, in Óbidos; its carved seat shows small differences in the leaves and inner carvings (less elaborated), and it does not have the stepped triangles on the outside of the large frames (Pereira, 2018 A: 200).

Another seat repeats these braided circles, also having palmettos and the four-petalled flower on a square; its large frame shows the development of the acanthus leaf (Pereira, 2008: 212).

Braided circles are seen in the Easter Umayyad palaces, and kept on being used in al-Andalus (Pavón Maldonado, 1989:

97-98); Madinat al-Zahra borders show similar examples: large circle with four similar features (idem: 101, tabla IV-41a), sometimes with florals inside (idem: 45, 46, 47 b).

Also in Caliphate carved ivories, these designs are used (Andalousies, 2000: 214), including a two-strand rope carved in each circle.

Two carved stones from Muslim Lisbon of the 9th-10th centuries also show a large circle braided with a smaller one (Portugal, 1998: 83, 85; Andalousies, 2000: 99; Esplendor, 2001: 95).

Figure 7: Seat of a chair: braided circles, palmettos by the corners, floral frame based on braided circles, and stepped triangles. Lisbon antiquarian collection. Author's photo.

Braided straps

Braided straps are found in one seat **(Figure 8)**, reminding us of the other developments of Islamic art, more usual in several materials, including gilt leather. They are called "*laçaria*"/"*interlazo*"/interlace.

The straps have inner carvings in a tiny undulating line, like the ones seen in other upholstery of the time **(Figure 3)**

Figure 8: Seat of a chair. Another Lisbon antiquarian collection: straps of more common arabesque of geometric inspiration. Author's photo.

(Pereira, 2000 B: 14; 2017: 17). The braided straps cover the full seat, leaving space for a stylized palmetto at each corner. The frames show a large undulating line. The leather carver tooled a row of small palmettos on the outside frames, in the left and right sides.

The gilt leather influence

Several carved upholstery examples seem to be inspired by the cushions to sit on, or from wall hangings. The way the stylized leaves intertwine in scrolls and spirals, protruding from braided stems or from an 8, is rooted in the "*mudejar*" heritage **(Figure 9)** (Pereira, 1998: 18; 2000 C: 62, 63, 68, 69; 2003: 516, fig. 17).

Due to the lack of gilt leather pieces prior to the 17th century, we fill this blank with this "*style*" of leather carvings.

Figure 9: Seat of a mid-17th century armchair: a central 8 braids with stems that turn into foliage; the frames are filled with stepped triangles. Another antiquarian in Lisbon. Author's photo.

Double 8 / Knot of Infinity

As the centre of scrolls with large half-moons (acanthus stylizations), we find in seats the Double 8 / Knot of Infinity – a clear Muslim symbol, sometimes with other recreations (Pereira, 2000 C: 71) –, fixed in a light structure chair **(Figure 2)** (Pereira, 2011: 161) or in a larger one with arms, already of mid-17th century.

Lion in a dotted circle

Already dating from the early 17th century, few chairs, of a light structure (like the one in **Figure 2**), do show a continuum of archaic patterns, like the lion inside a dotted circle, owing to a Sassanian matrix; such an ancient symbol, a metaphor of power, continues to be official in the seats for the wealthy **(Figure 10)**.

Figure 10: Detail of the back of a light chair, carved with a dotted circle, with a lion at its centre. Municipality Museum of Viana do Castelo. Author's photo.

Another chair (similar structure like the one shown in **Figure 2**) has the lion with a bird under its claw as the centre in its back (filling a shield), surrounded by scrolls with the large half-moons (developments of the acanthus according to the al-Andalus recreations) and two different types of birds (Pereira, 2000 C: 56, 57), again remembering carved ivories of al-Andalus (Ferrandis Torres, 1935, I: 28; Andalus, 1992: 193, 197, 199, 200, 202). Its seat is totally different, owing, in its large braids of circles, water lilies and leaves (with acanthus stylization), to an Eastern influence (Pereira, 2000 C: 56, 62 and 63) – again, this pattern seems to have come from a cushion to a wooden structure.

Conclusion

Such variety of patterns and designs show the wealth of aesthetics available since the establishment of al-Andalus.

Leather carvers of cowhide upholstery of late 16th century adapted such diversity to the rectangle structure of backs and seats, recreating aesthetics for their rich patrons (church and nobility), hence those designs were admitted as official and of the fashion.

We do not see drawings of the Romanesque or Gothic eras turning into leather upholstery; hence one must admit that the ones of the "*infidel*" were the appraised and official ones – a similar situation occurred in the gilt leather trade, with braids and laces, mainly inspired by late Islamic art.

As prior to the 16th century the fashions did not consider much the use of chairs – nevertheless, its structure can be studied (Pereira, 2000 C: 22-27) –, one must consider that these old patterns were also used in other leather items (trunks, containers, shields, baldrics), as well as in gilt leather (cushions and wall coverings) in the middle ages in Iberia.

Also to consider is the retrograde character of leather-work, along with techniques that belong to a past – still seen today (or until late 1990's) in other fields, it helps to explain the several Iberian Islamic patterns recreated until early 17th century. As the Caliphate collapsed by early 11th century, several kingdoms took control – it was the period of the Taifas. The new capitals pretended to keep on the wealth and brightness of Cordoba: "[...] *un bon nombre de ses artists durent émigrer* [in the beginning of the Taifa period] *dans les grandes villes de province ou l'art venu de Cordoue s'était depuis longtemps implanté et ici accédaient à la dignité de capitales politiques*" (Terrasse, 1965: 178) – this explains the heritage of patterns in the west (Gharb) of al-Andalus, which would be conquered by the Portuguese Christianity.

One must consider the importance of the easily-carried objects (book bindings, pottery, textiles, shields, tiles, mosaic, metalwork, and so on) as bearers of aesthetics and techniques: "*On ne saurait, en effect, passer sous silence ces courants orientaux, dont l'Espagne omeyyad était dèjá visitée.* […] *Le transport des objects mobiliers peut expliquer en partie ces contaminations à grandes distances*" (Marçais, 1946: 104). Thus the web of trades and markets becomes the highway for spreading patterns and art. Artefacts are also more easily destroyed by the passage of time and the change of fashions; the ones made of organic materials are the ones that suffer the most. Beyond their utilitarian side, ornamented artefacts – as well as architectural decoration, in particular the main buildings of the dynasties – show a view of the world, adding symbolism and identity.

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Biography

Franklin Pereira has been researching the History of leather since late 1980. In 1997-1998, he was a fellow of the Gulbenkian Foundation/Lisbon, writing the work "*Portuguese artistic leatherwork: a forgotten heritage*". Also in 1997, he received financial support from the Salaman Foundation (England), completing the work "*Leather decoration tools of the Iberian tradition since the 13th century*". He had a sabbatical leave in the academic year 1999-2000, to carry out a research on carved leather chairs in five regional museums. In 2005, he completed the M.A. thesis "*Leather and Islam in the Iberian Peninsula*". In 2017 he received the award "*Corium Dominus Magister*", in Spain, for his career in research and the communication of knowledge. Since 2016 he has been a researcher at Artis / Institute of Art History at the Faculty of Arts and Humanities of the University of Lisbon.

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Changes in Animal Husbandry Practices in America from the 17th Century to the Present: An Exploration of Potential Effects on Leather Quality

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Keywords
Animal Husbandry, Colonial America, Leather Quality

Introduction

The Leather Discussion Group was formed in 2016 by book conservators interested in acquiring a better understanding of leather and leather dyes used in conservation. The group initially aimed to determine the best products available to meet conservation needs, to make those needs more apparent to leather manufacturers, and to identify effective methods to evaluate a skin's quality and longevity.

Frequent meetings provided the groundwork to pursue these goals. Unused skins and discarded leather-covered boards were collected for testing and analysis. In 2017, a survey was sent to a group of conservators and tanners to gather information on leather practices. The questionnaire focused on what qualities binders and tanners look for in leather and the perceived change in the quality of leather skins over time. An exploration of previous leather studies in both Europe and the United States yielded information dating back to the first formal leather research in the 1840s. Ongoing conversations with leather chemists, tanners, and conservators in other disciplines continue to provide valuable feedback.

During a presentation at the American Institute for Conservation's 2018 symposium entitled "The Current Use of Leather in Conservation," the group discussed the need for a greater understanding of leather, a summary of previous and ongoing leather research, and an overview of proposed testing.

The testing undertaken included: organoleptic evaluation, tannin classification, species identification, patterns of protein damage, and tanning techniques using proteomic mass spectrometry to identify the source species of various leather samples; elemental analysis of leather samples using SEM-EDS to examine the elemental composition of leather samples from different time periods; presence/absence of salts using digital microscopy and XRD to determine the presence and composition of salts on leather surfaces or interstitial spaces; presence of pesticides and tanning agents using ambient analysis mass spectrometry to identify pesticides and tanning agents applied to the leather; presence of consolidants and dye identification using FTIR to identify the presence and composition of consolidants applied to the leather samples from different time periods, which may be contributing to leather breakdown.

Animal husbandry

Now, in 2019, the group is considering the potential impact of animal husbandry on skin quality. Changes in animal husbandry driven by increased worldwide meat consumption may affect the properties of the leather, a byproduct of that industry.

This poster explores the evolution of North American animal husbandry from the 17th century to the present and the potential impact of breed choices, diet regimens, environmental conditions, and abattoir trends on leather quality.

Domestic cows, sheep, goats, and swine are not native to the Americas. Livestock imported from Spain in the 1500s naturalized and are now considered 'landrace' breeds, well suited to native forage options and local climate. Colonists also imported livestock from Europe in the 17th century. These multi-purpose animals were often used for draft, milk and ultimately meat. **(Figure 1)**.

Figure 1

Specialized breeds, inspired by British agriculturalist Robert Bakewell, weren't widely utilized in America until the 19th century. These highly-engineered breeds excel in a certain trait such as dairy production or wool quality. The number of breeds increased significantly and multipurpose heritage breeds were surpassed by specialized breeds as farmers attempted to meet increased market demands. Does specialized breeding for milk or meat production affect skin composition? **(Figure 2)**.

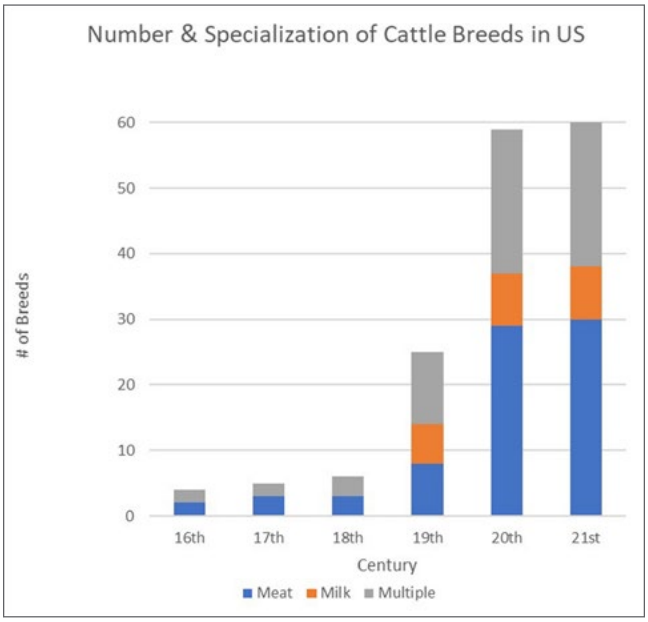

Figure 2

In the southern colonies, farmers typically practiced open woodland husbandry, allowing cattle, pigs, and horses to roam freely, foraging in the woods, marshes, or other open land. Herbivores had access to a variety of grasses, saplings, and roots. Colonists built fences to keep livestock *out* of fields, especially their primary crops - corn and tobacco.

Many common pasture plants in America were introduced from overseas and have naturalized. They initially arrived in the animals' guts, but later some were intentionally sown when native plants were considered insufficient forage for specialized breeds **(Figure 3)**.

Some Plants Introduced to North America by Colonists

Grasses	Herbs/Weeds
Early hairgrass (*aira praecox*)	Burdock (*arctium spp.*)
Velvet grass (*holcus lanatus*)	Wormwood (*artemisia vulgaris*)
Perennial Ryegrass (*lolium perenne*)	Dandelion (*taraxacum officinale*)
Timothy-grass (*phleum pratense*)	Sow thistles (*sonchus spp.*)
Canada bluegrass (*poa compressa*)	Yellow Toadflax (*linaria vulgaris*)
Annual bluegrass (*poa annua*)	Red & White Clover (*rifolium repens*)
Kentucky Bluegrass (*poa praetensis*)	Tansy (*tanacetum vulgare*)
Quackgrass (*elytrigia repens*)	Canada Thistle (*cirsium arvense*)

Poa annua Photo courtesy of Doug Goldman, hosted by the USDA-NRCS PLANTS Database

Figure 3

Initially livestock were raised for consumption, but by the late 1600s, as human populations increased, many farmers' goals transitioned to optimizing animal products for sale. This led to the practice of penning livestock, first in fenced pastures and later in confined stalls. Confinement changed animals' diets in notable ways, including the reduction in nutrient uptake from traditional forage. Supplemental feed in the form of corn, other grains, and the leafy tops of root crops provided these missing nutrients. Specialized breeds require increasingly specialized diets, and modern breeds are often unable to gain weight on forage alone. Now, the focus of commercial meat farmers is on 'fattening' animals quickly in preparation for slaughter, and supplemental feed is the norm. Does the shift from traditional forage to targeted diets for expedient fattening affect an animal's skin composition?

Southern farmers typically slaughtered livestock at 4+ years but modern animals are often under 2 years old. Slaughter traditionally took place in the fall, but it is now a year-round operation. Early abattoirs were close to farmers and tanners but now hides are sometimes shipped long distances. Does the age of the animal at slaughter, its seasonal coat changes, or the distance its shipped affect leather quality?

Skin defects from the animals' lives show up on the hide, but defects can also be imparted in the butchering. Electric prods, cuts, scores, or 'corduroy' on the hide mar it, leading to a lesser quality skin. Excess meat or fat on the hide can lead to spoilage. Minimizing the time between skinning and curing is essential to the quality of the finished leather **(Figure 4)**.

Summary

Modern breeds are more specialized, or engineered, than traditional ones. The transition from a pastured,

Figure 4

woodland diet to feeding livestock supplemental grains for 'fattening' has an observed impact on animals' muscle quality. Does it also impact the skin? Changes in the butchering and tanning process may affect the long-term preservation of the hide. How do bacteria, metals, or even the wrong type of salt introduced in processing and storage affect hide preservation?

Research into these questions is underway with a comparative analysis of historic bookbinding leather as well as raw skin and leather from traditional and modern breeds with known diets.

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Scientific development
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Impact of Old Conservation Methods on Leather and Parchment

Patricia Engel, Carla Soto Quintana, Sarah Fiddyment, Matthew Collins

Abstract

Practical conservation involves interaction with the material of the historical document. Since the Venice Charter conservators have been striving for "reversibility", as defined at the time; however, our recent survey methods virtually exclude this possibility. This means we must discuss in even more detail what information is kept and what information is lost by conservation treatment. The contribution describes a research project on conservation methods and their evaluation aimed at establishing the degree of preservation or loss of information kept in the material of the heritage items.

Keywords

Old Conservation Methods, Parchment, Change of Information Kept in Material

Introduction

The impact of conservation methods on cultural heritage items is a topic that has recently been understood as important and has therefore been suggested as a new research area at the AIC meeting in Houston in 2018. For the particular field of paper conservation, a survey of what was considered the most relevant literature of the past years has been published by Zervos (Alexopoulou and Zervos, 2016). Yet, the publication only covers a part of its intended field. It avoids any mention of changes in philosophical and theoretical approaches of the profession and does not attempt a survey of the cultural heritage item in its entirety, because Zervos only focuses on paper as text carrier. We recently presented a new survey taking the conservator's perspective (Engel, 2019).

Another shortcoming of so far done research is that the obviously outdated methods on conservation only rarely become a topic of research. The application of old methods, on the other hand, has been altering the information conveyed by the very material of manuscripts over many decades, therefore scholars such as philologists who increasingly include the information carried by the material itself into their research get misleading information.

Finally, literature in languages other than English is hardly recognised at all in recent research in this field, although these instructions on preservation techniques have influenced conservation activity over many decades and continue to do so.

The team of the European Research Centre for Book and Paper Conservation-Restoration therefore strives to intensify the research into the topic of so called "fingerprints" of old and outdated conservation methods and history of book and document conservation. This contribution aims to be one piece in the whole mosaic and clarify the possible impact of old conservation methods on leather and parchment conservation results, using recipes brought together by Otto Wächter (Wächter, 1982), one of the pioneers in graphic art and book conservation, whose ideas have been taken up Europe-wide. Better study of his ideas, suggestions and methods would clearly benefit the understanding of conservation-related findings in a large number of collections throughout Europe. This contribution became possible by the collaborative work of conservators with scientists in the field of proteomic (Engel et al., 2018).

Method

To demonstrate the above we started out with the analysis of Otto Wächter's "*Restaurierung und Erhaltung von Büchern, Archivalien und Graphiken,*" from 1982. The choice of the book was determined by two considerations: first, it was very influential in its time, as said above; second, it is difficult to interpret if you were not a pupil of Wächter, and Engel was his pupil. Wächter provides the recipes in a summary style, which makes it necessary to recall practical work with Wächter in the 1970s and 1980s in order to remember what was actually meant with the texts. In many cases no concentration are given for solutions and no description of how to apply a substance nor how long to let a substance react with, for example, a stain on the parchment is given.

As a first step all the materials had to be brought together or had to be prepared. There are several materials that are not available any more, of which natural sperm oil is the most significant for our research. Hunting sperm whales is now prohibited and therefore fresh natural sperm oil can no longer be procured. In some cases the application could be simulated without recreating the damage that should be treated with the individual substance and method, in other cases the re-creation of the problem had to be the first step and the application of the conservation method was the second step.

The decision as to whether or not the damage had to be recreated was based upon the question whether or not the research question like "Did the conservation method and material alter the parchment in its internal information?" could be answered without the re-creation or only by re-creating the damage. The latter was the case, for example, when the period of reaction of the substance with the parchment was dictated by the success of the result.

Both the conservation material and method and the re-creation of damage have been documented. All treatments were performed in the manner as close as possible to the manner and circumstances back in Wächter's days: all treatments were performed at around 18 °C and a relative humidity of around 50%. The parchment was made in Bucharest Leather Institute. The data frame of the procedure of parchment making from a goat skin is given in **Table 1**.

In any case one skin was used to make all samples and only in one case was another parchment used. Aged samples were used in the case the treatment was meant for softening. Aging was done for 60 days with a fluctuating temperature between 10 and 35 °C and a fluctuating relative humidity between 55 and 15% changing every 12 hours, accordingly.

Table 1: data frame of the procedure of parchment making

Soaking I:	600% water at 20°C Allowed to stay for 4 hours
Drain **Fleshing: manual**	
Washing:	400% water at 20°C, drain
Soaking II:	600% water at 20°C, drain 600% water at 20°C 4% salt 0.2-0.4% detergent 3-4 h stirring over night
Drain	
Liming	400% water at 25°C 4% lime 4% salt 0.3% detergent pH 11.5-12
Post liming	600% float at 25°C 2% lime Allowed to stay for 48 h
Deliming	500% water at 30°C 1% ammonium sulphate Stirring for 40 min; allowed to stay over night
Washing:	400%-600% water at 20-25°C Stirring for 60 minutes, allowed to stay over night
Rinsing and stretching	

The conservation recommendations by Wächter concerning parchment fall into 3 main groups, i.e.

- cleaning or stain removal,
- softening of hard parchment and
- bringing elements together, like mending tears or reattaching off-flaking elements of colour, which means adhesion in the wider sense.

There are a few other treatments, such as mitigating ink corrosion.

Discussion

In general the hypothesis can be summarized as follows: Wächter's recipes suggest that we are in danger of altering the information we can extract from the material with today's' means and measurements, as the approach to conservation treatments has changed over time. Specifically, we presume that all water containing applications would lower the shrinkage temperature of the parchment (Cohen, 2000), meaning the shrinkage temperature of the collagen fibres, a feature that equates to damaging or lowering the quality of the parchment (being, in a way, a starting point of damage) and is to be avoided in the course of a conservation treatment.

An alteration of the information about the animal identification can be expected of all recipes that contain DNA themselves and therefore add this to the parchment. Where use of DNA containing materials isunavoidable, it makes sense to use a form which is as far distant as possible from the conservation target. Thus, it is sensible to avoid mammalian glues to repair cultural heritage objects made from mammalian tissues such as parchment. Isinglass (fish collagen) is much less likely to obscure a genetic signal from a calfskin parchment than sheep or (worst of all) cattle gelatin. Conversely, in order to conserve fish leather it would be more sensible to use cattle gelatin than isinglass.

The inorganic material such as chalk in the parchment resulting from its production can be potentially traced geochemically. The use of earth alkali metals in the conservation treatment can interfere with the information of the original material. Also the presence of Borax might be irritating. Furthermore, we should take into consideration that such finds would also have an influence on our recent conservation decision-making and choice of conservation materials and conservation techniques. If water is a material which endangers parchment so severely, we should either avoid it or find alternative application techniques. This hypothesis was considered under a philosophical-ethical viewpoint and under a scientific view point.

The instrumental analysis should verify whether or not the information carried by the parchment was obscured and, if so, in what way. This would allow for a sort of retranslation of the information gained now into the information which was there originally. In an extreme case the entire story of survey of manuscripts by means of instrumental analysis might need to be rewritten.

Tests were carried on the new aged artificially parchment where parchment glue (made from goat and sheep parchment) was applied because this was suggested as a conservation measure to make the parchment soft in an old recipe. The question was whether or not the animals of the parchment and the glue would remain detectable with this method. Peptide mass fingerprinting (PMF) was performed using Matrix Assisted Laser Desorption/ Ionization - Time of Flight (MALDI-TOF) mass spectrometry (MS) to establish the species of animals used to make both the parchment and glue and to assess the level of damage (deamidation) present in the sample due to the manufacturing process. The question was whether or not the animals of the parchment and the glue would remain detectable with this method. The damage present in the sample due to the conservation treatment will be a second step.

To carry out the sampling the non-invasive technique (eZooMS) was used, based on triboelectric extraction involving the use of PVC erasers that allows us to interrogate parchment manuscripts without having to use more destructive samples (Fiddyment et al., 2015). Initially the use of MALDI-TOF mass spectrometry was opted, as it is fast, inexpensive and a useful basic identification tool or screening method. PMF is based on the analysis of one protein (in this case collagen) cut into smaller fragments (peptides) using an enzyme (in this case trypsin). The mass of these peptides is measured using MALDI-TOF mass spectrometry creates a profile or 'fingerprint' of the protein, which can then be compared to a reference database. With this method it was possible to determine the species used to make the parchment and also any additional species used to make the glue that might have been applied to the surface (Buckley, Collins, & Thomas-Oates, 2009).

Our preliminary results are as follows. All samples were identified as goat. By this method, it is also possible to determine a general value of deamidation, a particular type of damage that occurs in the collagen molecule when the skin is exposed to hydrolytic chemical reagents notably lime during its production process, which is defined as the Parchment Quality Index (PQI). This is expressed as a percentage, where a value of 100% corresponds to no deamidation, and therefore low or no exposure to lime, and a low value points to a more damaged molecule. The PQI values for this set of samples ranged between 74.4% - 93.3% for the rubbings and 76.2% - 100% for the fragments. These values would seem to indicate that the samples have had a well-controlled exposure to lime and that the subsequent surface treatments have had little effect on the levels of deamidation. In this instance, where samples were treated with glue it was found that both the parchment and glue are made of the same animal, and thus, it is much harder to determine where the damage is occurring (whether on the parchment as part of its production or from the glue) and will require further data analysis.

Conclusion

It is hoped the information which was provided through our analysis will assist conservators in their decision-making and give us a greater understanding of the processes that affect parchment stability and deterioration. Another suggestion in the conservators' hypothesis had been that the application of some of the products should lower the shrinkage temperature of the collagen. For that, shrinkage temperature must be measured as this method is also accessible to conservators.

There is much work to be done to understand the ways in which the 20th century conservation methods might have altered the information kept in the material of our cultural heritage, of which only one material and one series of instructions has been touched here.

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Biographies

Matthew Collins completed a degree in Marine Zoology (Wales) then a PhD in Geology (Glasgow, Scottish Marine Biological Information) before NERC and Royal Society Fellowships at Glasgow and Leiden (Chemistry and Biochemistry) and postdoctoral research at Bristol (Biogeochemistry). He first lectured in Biogeochemistry (Newcastle) before moving to York in 2003 to establish BioArCh, an interdisciplinary grouping of Biologists, Archaeologists and Chemists with access to shared space and facilities on campus, within the Bioscience complex. His research focuses on old proteins. He attempt to identify samples by differences in protein sequence, date samples by the extent of protein degradation and if both fail, to understand pathways of decay in archaeological materials

Patricia Engel holds magister, doctorate and habilitation degrees in conservation-restoration of cultural heritage of the universities of Fine Art in Vienna and Warsaw. She worked as assistant professor in Hildesheim HAWK, Germany and from 2010 on is heading the European Research Centre for Book and Paper Conservation-Restoration affiliated to ZKGS/DBU/University for continuing Education, Krems, Austria. Her focus is on key questions in written heritage conservation. She initiated and lead international projects (Getty, EU, FFG) on mould, paper-deacidification and ink corrosion. She also attempts to identify alteration in historical material by wrong conservation measures and ways to avoid them. She installed a new university chair for continuing education on interdisciplinary methods of written heritage conservation.

Dr **Sarah Fiddyment** received her BSc in Biochemistry from the University of Zaragoza (Spain) in 2006, having completed three years of medical school and two years specialization in Biochemistry. Her MSc and subsequent PhD (awarded in 2011) were both completed at the same university, working in the field of proteomics in cardiovascular research. She moved to the University of York in 2012 after being awarded a Marie Curie postdoctoral research fellowship to focus on the protein analysis of parchments throughout history. She is currently a British Academy Postdoctoral Fellow at BioArCh (Department of Archaeology, University of York) continuing her biomolecular analysis of parchment through history.

Carla Soto received her BSc in Chemistry from the Instituto Tecnologico y de Estudios Superiores de Monterrey (Mexico) in 2011. Her MSc was awarded by the University of Evora as part of the Erasmus Mundus Masters in Archaeological Materials Science in 2016. She is currently an Early Stage Researcher in the Marie Skłodowska-Curie ITN TEMPERA using proteomics for the biomolecular analysis of ancient and modern parchment, leather, and other skin products at Devro (Scotland) and BioArCh (University of York).

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A Multi-analytical Approach to the Characterization of Vegetable-tanned Leather

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Keywords

Vegetable-tanned Leather, Mechanical Analysis, Atomic Force Microscopy

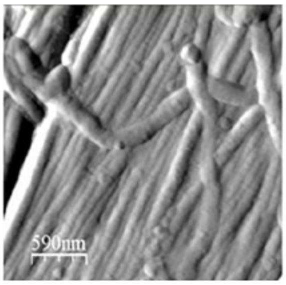
Introduction

Damage assessment of collagen in parchment using a multi-analytical and multi-scale approach was developed within the EU project IDAP (*Improved Damage Assessment of Parchment*) (Larsen, 2007). Our contribution focused on mechanical testing at the macro scale, under conditions of programmed RH (DMA-RH), and on Atomic Force Microscopy (AFM) imaging at the nanoscale to test the effects of accelerated ageing and the effects of nanoparticle-based conservation treatment of parchment (Odlyha et al., 2014). In the current paper, this combination of techniques was used to analyse vegetable tanned leather, in particular sumac. Preliminary results of some nanomechanical studies by AFM on leather fibres are also reported. Three case studies are presented herein: firstly a collaboration with English Heritage in which AFM was performed on leather fibres from historical bookbindings; secondly, a collaboration with Zentrum für Bucherhaltung (ZFB) in which the effects of accelerated ageing were measured by mechanical analysis. The third and final collaborative work was performed as part of the EU project NANOFORART (http://www.nanoforart.eu) in which the impact of novel nanoparticle-based conservation treatments was assessed. In all cases, it was necessary to evaluate the state of preservation of collagen; in the former in the leather bookbindings and the latter in modern and accelerated aged leather samples and in those treated using novel nano-based formulations designed for adjustment of pH and surface cleaning.

Results and discussion

Case study in collaboration with English Heritage

Fibre samples of (red and black) leather were removed from selected notebooks that Charles Darwin used to record his observations during his voyage in the Beagle. Their condition assessment was necessary prior to their display for the first time for at least 30 years. This was enabled by a major re-development project in English Heritage (EH) to commemorate the bicentenary of Charles Darwin's birth and the 150th anniversary of the publication on the Origin of Species. AFM was used to image the extracted fibres. Resulting images from samples of the red leather notebook (EH, ref: 88202318) showed aligned collagen fibrils with characteristic D-banding (**Figure 1** left). The average value from two good images gave a value for D-banding of 66.9 ± 3 nm, which is close to value expected in intact collagen (67 nm). Samples of the black leather notebook (EH, ref: 88202335) showed a complete lack of characteristic D-banding features (**Figure 1** right). This suggested that collagen responsible for the structural integrity of the black leather bindings was more damaged than in the red bindings. Elemental analysis (SEM/EDX) revealed that the red leather contained mainly barium indicating the presence of barium lake pigment, while the black leather contained predominantly iron and tin. Iron is known to promote oxidative degradation (Aroun, A et al., 2012),



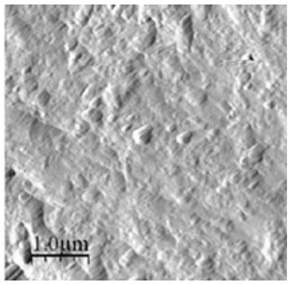


Figure 1: Representative AFM images of fibres from the red leather bookbinding (left) showing aligned collagen fibrils with characteristic D-banding, and of fibres sample of black leather bookbinding (right) showing complete loss of the collagen banded fibril structure.

and denaturation of collagen in iron gall ink locations in parchment (Boyatzis et al., 2016) and this could account for the more damaged state of collagen for fibres from the black leather.

Case-study study in collaboration with Zentrum für Bucherhaltung

As part of the NANOFORART project, it was necessary to perform accelerated ageing for the assessment of the long-term effects of novel nanoparticle-based conservation treatment. Project partner ZFB followed the procedure outlined in ISO 5630-5 for paper materials: leather (sumac) samples were aged at 150°C for 24, 48 and 96 hours. Following this treatment, mechanical testing using dynamic mechanical analysis at controlled RH (DMA-RH) was performed with samples mounted in tension to obtain values for the elastic or storage modulus (*E'*) and displacement (*D%*). With an increase in RH (at a rate of 1% RH/min), the value of the storage modulus slowly decreased as the sample softened as a result of the introduction of moisture within. This softening was accompanied by an increase in the displacement of the sample (**Figure 2**). In the IDAP project, it was demonstrated that the rate of displacement with RH proved to be a marker for the state of preservation of collagen in parchment: i.e. the more damaged (e.g. gelatinized) sample showed very low values of displacement with RH, while relatively undamaged samples showed a much higher rate of change in displacement. In the case of calf leather, accelerated ageing showed changes at the macro-scale in the storage modulus (**Figure 3**) and in its response to increase and decrease in RH.

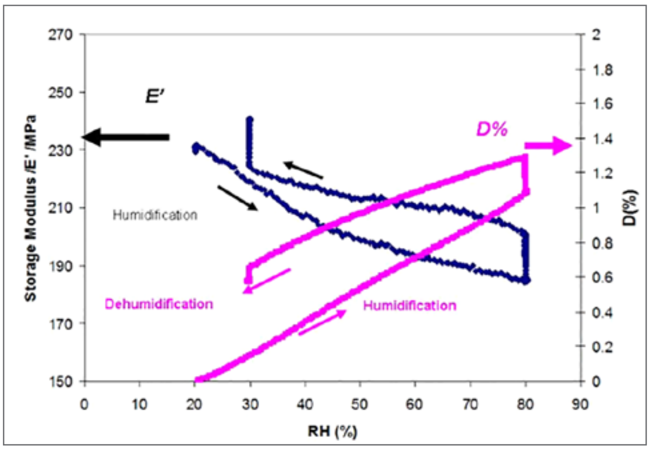


Figure 2: Plot of storage modulus, displacement (D%) and RH with time (mins). The storage modulus E' decreases with increase in RH and increases with decrease in RH. Displacement (D%) increases with increase in RH and decreases with decrease in RH.

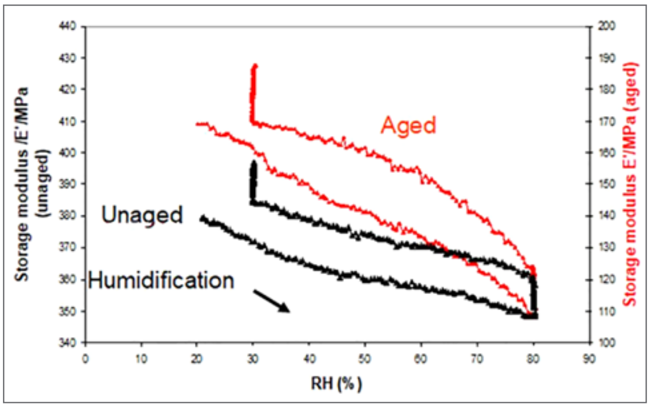


Figure 3: Plot of modulus (E') vs RH (%) for unaged (black) and aged leather (red). E' values at 20% RH for aged leather are much higher than for unaged. Change in E' values from 20-80 %RH is also higher for aged leather than for unaged.

Case study in the framework of the NANOFORT project

Novel conservation materials for pH adjustment and surface cleaning were mainly designed and supplied by CSGI (Centre for Colloid and Surface Science, University of Florence). Recent publications describe the nanomaterials developed by CSGI (nanoparticles dispersions, microemulsions, and gels for surface cleaning (Baglioni et al., 2015; Baglioni et al., 2016). For pH adjustment tests, nanoparticle dispersions were applied onto mock-ups and historical bookbindings. Subsequently, untreated and treated samples were subjected to accelerated aging tests by heating to 150°C for 24hours. The rationale was to determine how the conservation treatment would affect the samples and whether the nanoparticles provide a protective effect. Results from the mechanical analysis showed that for treated samples, there is no decrease in the measured displacement of the samples, indicating that no damage had occurred to the collagen in the leather. In addition, there was a minimum change in modulus of the treated sample after aging in comparison to the untreated sample, where a significant increase in modulus was observed (Baglioni et al., 2016). Preliminary measurements of mechanics at the nanoscale were also obtained via AFM. **Figure 4** shows results for unaged leather treated with calcium carbonate nanoparticles. The upper figures show the elastic modulus force maps. The lower figures show the variation in modulus (GPa) along the length of the two fibrils (μm) as designated by the white lines.

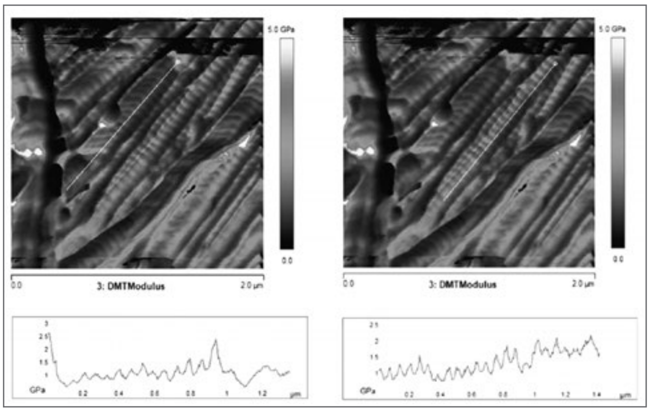


Figure 4: Modulus map obtained from force-distance curves collected by Atomic Force Microscopy (AFM) on leather fibres from an unaged sample treated with calcium carbonate nanoparticles. The variation in modulus along 2 selected fibrils (section shown by white lines) can be seen (left and right). The location on the right shows slightly higher values in modulus along the fibril compared to those along another fibril in the figure on the left.

Conclusions

AFM demonstrated its potential to discriminate between the state of preservation of collagen in historical leather fibres. The application of DMA-RH proved to be useful in monitoring the effects of accelerated aging of leather and in demonstrating whether the conservation treatment used has an overall beneficial effect. Samples showed a smaller increase in stiffness on aging and considerably less than the untreated aged samples. At the nanoscale, it is possible to view the distribution of modulus values. Reduction in stiffness reduces the propensity for embrittlement and cracking of the leather. The additional improvement in pH ensured that there was the protection of the leather from acidic hydrolytic degradation.

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Materials

Leather for accelerating ageing tests was provided by the Forschungsinstitut fur Leder und Kunststoffbahnen Freiberg, Germany.

Biographies

Dr **Marianne Odlyha** is senior lecturer, programme director of MRes Chemical Research and director of research centre "Scientific Analysis for the Preservation of Cultural Heritage" at Birkbeck, University of London. She has worked and collaborated on several EU funded research projects involving damage assessment of collagen in parchment and vegetable-tanned leathers (from macro to nanoscale), and preventive conservation involving the development and application of dosimeters for monitoring corrosive environments resulting from pollutant gases, including volatile organic acids. These projects have also included evaluation of conservation treatment of art objects including effects of humidification, canvas deacidification, and recent work on consolidation of canvases using nanocellulose based materials.

Dr **Angelica Bartoletti** completed her Ph.D. in Nanometrology applied to Heritage Science at University College London (UCL) in 2016, with a thesis on the application of scanning probe microscopy to collagen-based artefacts (parchment and leather). Before joining Universidade NOVA de Lisboa, she worked at Tate Gallery (London, U.K.), as a postdoctoral fellow on the EU-funded project NANORESTART, and as a conservation scientist. Her research interests include assessing the impact of traditional and innovative conservation treatments for cellulose, collagen-based artefacts, modern and contemporary materials (paints and plastics), with a focus on cleaning strategies. She is also interested in surface analysis techniques and in the application of innovative tools (such as Atomic Force Microscopy and Micro/Nano Thermal Analysis) in the field of heritage science for the characterisation of materials and their degradation behaviours at the nanoscale.

Dr. **Stephen Hudziak** graduated from Queen Mary University of London in 2004 with a BSc in physics. In 2009 he finished his Ph.D thesis titled: "Iron-Filled Carbon Nanotubes: Synthesis, Characterisation, and Applications". He now works at University College London, and is the nanotechnology laboratory manager in the electronic and electrical engineering department. His research interests include programmable ReRAM devices, force imaging with AFM, and surface morphology and characterisation studies of a wide array of materials.

Dr **Alexandra Bridarolli** is currently a conservation scientist at Getty Conservation Institute, LA. She did her PhD at the Eastman Dental Institute UCL London and SEAHA, the centre for doctoral training in Science and Engineering in Arts, Heritage and Archaeology, also at UCL. Her current research explores the use of nanocellulose for the consolidation of the canvas of modern paintings as an alternative to current practices and materials in use. Her main interests are the understanding of the visco-elastic mechanical properties of polymeric materials and the exploration of the possible relations existing between macro- and nano-scale properties.

Dr **Manfred Anders** is a specialist in Cellulose-, Paper- and Textile- Chemistry, Managing Director ZFB GmbH and ZFB Project Management GmbH. From 1990-1999 he was teaching assignment «Chemical analysis methods of textiles» at the Technical College for Economy and Engineering in Reutlingen. Between 1993-1998 he worked at the Steinbeis Transfer Center Textil Finishing in Reutlingen as Project manager for international research projects concerning the development of new finishing for textiles. Since 1997 he is employed at ZFB Zentrum für Bucherhaltung, Leipzig (Managing Director, Director of Research and Development Department – research focus on deacidification of books, archival material, maps; further improvement of deacidification methods; leather treatment; freeze-drying of wet books, archival material etc.; mould combating on paper; preventive conservation).

Dr **David Thickett** is Senior Conservation Scientist at English Heritage undertaking research on preventive conservation to inform and direct that area for English Heritage's collections. He has over 26 years' experience of researching this area with over 80 preventive conservation publications. Prior to that, he was a scientific officer, British Museum, researching preventive conservation. He has extensive experience in experimental environmental testing and measurement on a wide range of materials. Has been involved in several projects involving damage assessment if materials and design of environments suitable for their long term preservation.

Professor **Piero Baglioni** received his PhD from the University of Florence in 1977 and is a Full Professor of Physical Chemistry at the Department of Chemistry and CSGI of the University of Florence. He is the author of over 250 publications in the field of colloids and interfaces and pioneered the application of soft matter to the conservation of cultural heritage. He has produced several innovative methodologies that are applied worldwide.

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The Potential of Nonlinear Optical Microscopy to Non-invasively Quantify the Degradation State of Historical Parchments

Gaël Latour, Margaux Schmeltz, Sylvie Heu-Thao, Claire Teulon, Guillaume Ducourthial, Marie-Claire Schanne-Klein, Laurianne Robinet

Parchment was the main writing support material in the Middle Ages in Western Europe. It is made from an untanned animal skin, which is preserved by liming, scraping and drying under tension. Parchment is very sensitive to heat and water, which cause in extreme case the denaturation of collagen, its main constituent, to gelatin. The measurement of the shrinkage temperature, by differential scanning calorimetry (DSC) or the micro-hot table (MHT) method, is commonly used in the cultural heritage field to assess the degradation state of collagen-based materials. However, these techniques are invasive, as they require a sample, and destructive, which is an issue in the case of some historical artifacts. The aim of this work is to demonstrate the potential of nonlinear optical (NLO) microscopy, also called multiphoton microscopy, to investigate in a non-invasive and quantitative way the conservation state of historical parchments.

NLO microscopy enables three-dimensional (3D) imaging with micrometer-scale resolution based on an intrinsic optical sectioning, without any contact with the object. A key advantage is its multimodal capability, meaning the possibility to collect different nonlinear optical signals from a single excitation, in our case two-photon excited fluorescence (2PEF) and second harmonic generation (SHG) signals. 2PEF are emitted by a wide range of materials (fluorophores) in historical artifacts with specific absorption and emission fluorescence spectra (Latour, 2012). SHG signals are specific for dense and well aligned structures such as fibrillar collagen, and vanish for centrosymmetric materials such a gelatin. Accordingly, SHG microscopy provides structural information about the 3D organization of the fibrillar collagen within parchments and other skin-based artefacts (Latour, 2016; Robinet, 2017)

We investigated historical parchments at different states of degradation (well-preserved to gelatinized), and showed that SHG signals decrease in degraded parchments, while 2PEF signals increase **(Figure 1)**. To further characterize the molecular and/or macromolecular processes involved in this process, we use infrared nanoscopy. Since the analysis have to be performed at the fibers (~1-5 µm) or fibrils (~100 nm) scale, AFM imaging was coupled with IR illumination to collect IR spectra with nanometer scale resolution (nanoIR) (Latour, 2016). The correlation of NLO microscopy and nanoIR data provides unique morphological and chemical information about collagen degradation at different length scales. Most importantly, it validates that SHG signals are specific to well-preserved collagen, and 2PEF signals to gelatinized collagen in altered parchments (Latour, 2016). Moreover, the NLO microscopy provides 3D depth-resolved characterization, it is then possible to discriminate different states of degradation versus depth.

In order to quantify intermediate states of degradation, and especially early stages of degradation, we further implement polarization-resolved SHG (P-SHG) micros-

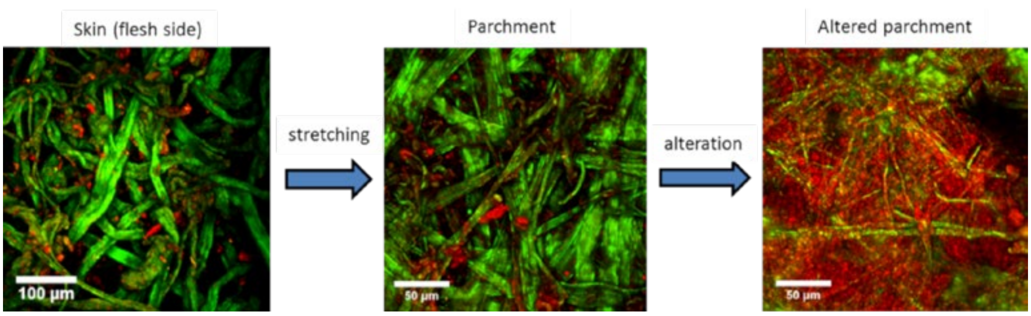

Figure 1: NLO imaging of skin, parchment and altered parchment (flesh side). Two-photon excited fluorescence (2PEF) is shown in red color and second harmonic generation (SHG) in green color.

copy: the SHG intensity is recorded as a function of the linear polarization orientation of the excitation beam for each pixel of the image. P-SHG microscopy provides two quantitative information about the fibrillar collagen: the main orientation and the degree of orientation disorder of the collagen fibrils at the submicrometer scale (**Figure 2**). P-SHG images are acquired in a set of modern parchments that were artificially degraded by exposure to dry heat for increasing periods of time. The degradation state of the collagen in these parchments is assessed using DSC. P-SHG data are in good agreement with DSC measurements and prove to be a complementary investigation tool that requires no sampling. Most importantly, P-SHG is shown to reveal the earliest states of degradation.

NLO imaging was applied to different historical documents to investigate the conservation state of the parchment. The first application concerns the Mappa Mundi of Albi, one of the first representation of the western world (Robinet, 2018). Dated to the 8th century, it was likely produced in France and was recorded in 2015 on the UNESCO Memory of the World Register. *In situ* NLO images carried out in different areas of this parchment confirm that it is well preserved, and further demonstrate that NLO imaging is a safe characterization technique for historical parchments. Recently the quantitative approach developed using P-SHG was applied to Chartres's medieval manuscripts (Robinet, 2019). At the end the 2nd World War, Chartres's library was partially destroyed and the large manuscript collections were exposed to fire and then water. The degradation states of the manuscripts are heterogeneous (**Figure 3**). P-SHG microscopy was performed on these manuscripts to assess their conservation state in different areas and determine in particular the effect of the restoration treatment applied to flatten the parchments. The measurements show differences in the collagen conservation state between the centre and the edges of the manuscript (**Figure 3**), however in the case of the restored manuscripts, the results show that the restoration by cold humidification did not alter the conservation state of the fibrillar collagen within the parchment.

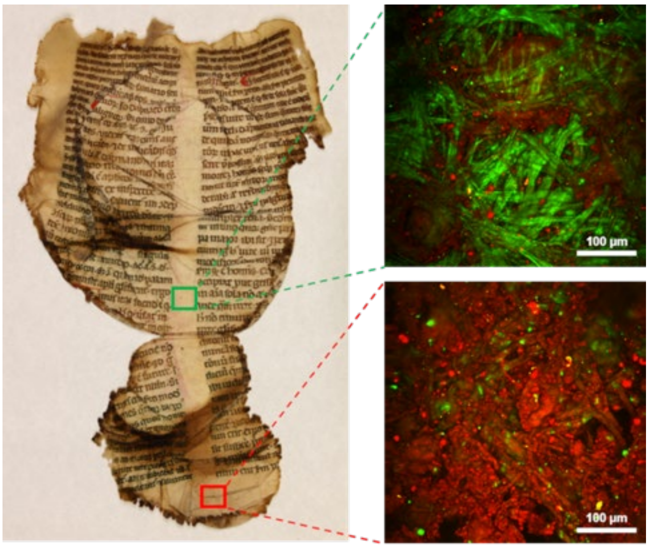

Figure 3: Investigation of the historical parchments from Chartres's library. At the center of the manuscript, some areas are well-preserved (SHG, in green) whereas in the border the fluorescence signals reveal the absence of fibrillar collagen (2PEF, in red). Scale bar: 100 µm.

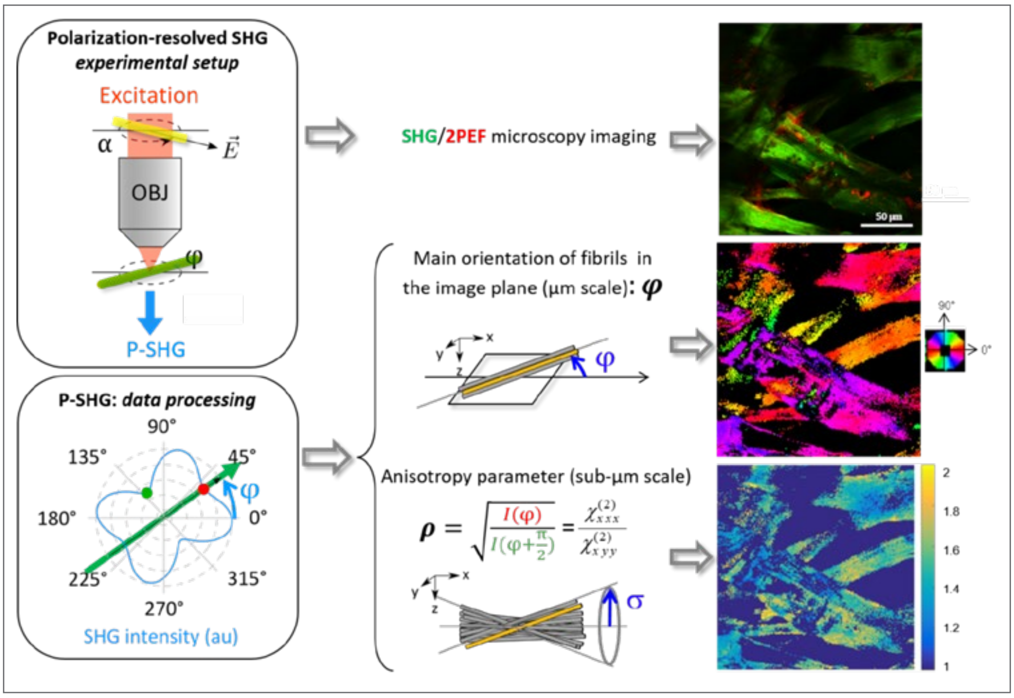

Figure 2: P-SHG imaging from an artificially degraded parchment (4 days at 100°C, grain side). Three types of information were extracted from these measurements: SHG and 2PEF intensity mapping, orientation mapping of the fibrillar collagen and the SHG anisotropy parameter that reveals the fibril disorder at submicrometer scale. Scale bar: 50 µm.

All these results demonstrate the high potential of NLO microscopy for *in situ* quantitative measurements of the conservation state of historical parchments. Moreover, this methodology could be extended to other cultural heritage materials giving off SHG signals such as cellulose or bones.

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Investigation of a Waterlogged Sample of Russia Leather by U(H)PLC-PDA and FT-IR Analysis

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Keywords
Russia Leather, Vegetable Tannin, Waterlogged Leather, Chromatography

Introduction

Leather is the material which results from the treatment of animal hides with tannins; a process that prevents putrefaction of the collagen protein found in the skin. Historically, a *vegetable tanning* process was achieved by placing the skin in baths containing plant fragments, such as, bark, leaves, fruit skins and seeds (Metche and Girardin, 1980). These materials contain high concentrations of tannins, which bind strongly to proteins. The identification of tannins extracted from leather artefacts is difficult due to their variation in individual chemical structures. Tannins can be split into two structural classes: hydrolysable and condensed. Hydrolysable tannins possess a core glucose unit, esterified with gallic or ellagic acid (gallotannins and ellagitannins), while condensed tannins are composed of a flavan-3-ol structure with β-type interflavan linkages (Hagerman, 2011). Tannins can produce complicated networks of polymers and oligomers, which both complex the proteinaceous collagen through hydrogen bonding and intermolecular dipole interactions (Thompson, 2006), making their analysis particularly challenging.

This project focused on the investigation of the prestigious *Russia Leather,* a type of leather that was in production from ca. 16th - 19th centuries and was desired for its high quality, as well as its distinctive smell, colour and waterproof properties. *Russia Leather* manufacture was a closely guarded secret and the exact 'recipe' was lost during the Russian Revolution (Mouquin and Blouet, 2017). The tannin source is believed to be a combination of birch and willow barks, and the tanning process was followed by a surface treatment with birch oil and subsequent dyeing. Birch and willow barks reportedly contain condensed tannins and it is reasonable to assume these will be present in resultant leathers (Falcão and Araújo, 2018). The treatment of the grain side (outer surface of the hide) with birch oil, imparts the distinctive smell and waterproof properties of *Russia Leather,* offering an additional distinguishing feature.

As part of this research, five samples of *Russia Leather* were recovered from various shipwrecks from around the world **(Figure 1)**. CR1 and CR2 were recovered from the same site off the coast of Finland, CR3 from Saint Nicholas, Russia, CR4 from Texel Island in the Netherlands and CR5 from the wreck of the Catharina von Flensburg (or Metta Catharina) off the coast of Plymouth. Analysis was carried out first on the well-preserved Metta Catharina sample (CR5) to determine if information could still be gained from the material. The results obtained on this sample and also reference samples of birch bark, willow bark and birch oil are discussed in this paper.

Figure 1: *Russia leather* supplied for analysis in this research: Juktenskobben (CR1, CR2), St Nicholas (CR3), Texel (CR4) and Metta Catharina (CR5).

Sample preparation & instrumentation

A micro-extraction of tannins was adapted from previous work carried out by Wouters on the analysis of historical leather (Wouters, 1993). Typically, 1 mg of leather or bark was soaked for 48 hrs in 200 µL of C_3H_6O:H_2O (1:1, v/v), followed by sonication for 2 hrs at 55°C. The liquid portion of the extract was filtered (Phenomenex, PTFE, 0.2 µm) and 100 µL was dried under vacuum using the Savant SPD131DDA SpeedVac Concentrator unit at 45°C and reconstituted in 50 µL MeOH:H_2O (1:1, v/v) for ultra-high performance liquid chromatography (U(H)PLC) analysis. The tannin extracts were analysed using an Acquity I-Class UPLC™ system from Waters Ltd. fitted with PDA detection (210-800 nm). The method used a BEH C18 column (1.7 µm particle size, 50 × 2.1 mm (length × i.d.). The elution was achieved with a gradient of MeOH in H_2O + 0.1% HCOOH from 5% to 95% MeOH in 10 min with flow rate of 700 µL/min (Mauguéret, 2016).

In addition, the historical leather samples were investigated using *in-situ* Fourier transform Infrared spectroscopy (FT-IR) to gain additional information on the collagen and possible presence of organic surface residues. A Bruker Alpha FT-IR Spectrometer with a diamond-ATR attachment was used on both grain and flesh sides of the leathers. To avoid interference from surface deposits, the surface of the leather sample was scraped. Spectra were recorded using 24 scans with a spectral resolution of 4 cm^{-1} over the absorbance range 4000-675 cm^{-1}. A reference sample of birch oil was analysed using a compression diamond cell in transmission. A Nicolet™ iN10 FT-IR spectrometer by ThermoFisher and the spectra was recorded using 64 scans with a spectral resolution of 4 cm^{-1} over the absorbance range 4000-675 cm^{-1}.

Results

The investigation of the extracts of willow and birch barks revealed complex chromatograms that will require further data interpretation, and only a couple of components could be identified **(Table 1)**. Both bark extracts showed the presence of condensed tannins, including protocatechuic acid (Rt = 0.54 min), a degradation product of the condensed tannin catechin. The birch bark extract was found to contain a number of compounds, possibly catechin derivatives (identified by their UV/Vis spectra, λ_{max} = 223, 276 nm). The willow bark extract presents a broad background, which is a non-specific indication of condensed tannins (Wouters, 1993). While protocatechuic acid was also detected in the willow extract, a particularity seems to be the presence of the flavonols myricetin, quercetin, kaempferol and traces of yellow chromophores, possibly flavonoid related (λ_{max} = 250-265, 355-372 nm).

The chromatogram of the extract of the *Russia Leather* sample (CR5), monitored at 254 nm is displayed in **Figure 2**. Despite the exposure to harsh archaeological conditions in a submarine environment, low concentration of tannins were observed in the sample. The sample exhibits the presence of protocatechuic acid (Rt = 0.54 min), two compounds possibly related to hydroxybenzoic acid (Rt = 0.89 min, λ_{max} = 229, 279, 301 nm and Rt = 1.64 min, λ_{max} = 217, 261, 294 nm), small amounts of ellagic acid (Rt = 3.15 min) and the aurone sulfuretin ((Rt = 4.20 min). Finally, urolithin C (Rt = 3.26 min), a degradation product of soluble redwood

Table 1: Compounds identified by U(H)PLC-PDA in the extracts from *Russia Leather* sample CR5, birch and willow barks.

Sample Code	Identified compounds	Retention time (min)	Additional features
CR5_CAT	Protocatechuic acid	0,53	Minor compounds possibly related to hydroxybenzoic acid (Rt = 0.89 min, λ_{max} = 229, 279, 310 nm & Rt = 1.64 min, λ_{max} = 217, 261, 294 nm)
	Ellagic acid	3,13	
	Urolithin C	3,26	
	Sulfuretin	4,2	
Birch bark	Protocatechuic acid	0,57	Condensed tannins Series of compounds possibly related to catechin (Rt = 2.87, 3.01, 4.00, 5.13, 5.21 and 5.36 mins, λ_{max} = 223, 276 nm) Unknown compound (Rt = 0.54 min, λ_{max} = 229, 283 nm) Minor compounds possibly related to hydroxybenzoic acid (Rt = 0.89 min, λ_{max} = 229, 279, 310 nm & Rt = 1.65 min, λ_{max} = 217, 265, 287 nm)
	Catechin (traces)	1,27	
Willow bark	Protocatechuic acid	0,58	Condensed tannins (broad background) Minor compounds possibly related to hydroxybenzoic acid (Rt = 0.89 min, λ_{max} = 229, 279, 301 nm & Rt = 1.64 min, λ_{max} = 217, 261, 294 nm) Traces of yellow compounds (Rt = 3.64, 4.00, 4.87, 5.00, 5.46, 6.11 mins, λ_{max} = 250-265, 355-372 nm)
	Catechin	1,26	
	Myricetin	3,55	
	Quercetin	4,23	
	Kaempferol	4,77	

was identified in this sample [Peggie et al., 2018]. This suggests that the leather was originally dyed red, as the use of sappanwood (*Caesalpinia sappan L.)* dyestuffs is known to have been used in *Russia Leathe*r production (Scientific American, 1867).

The infrared analysis also provides an insight into the preservation of the leather, with the strong amide I & II absorption bands around 1630 and 1540 cm^{-1}, indicative of the preserved collagen **(Figure 3)**. This result correlates well with the visual observation of the CR5 sample, which appears well preserved and retains some flexibility. The absorbance peaks at 2928 and 2856 cm^{-1} correspond to the stretching of C-H bonds from fatty acid compounds. Considering that CR5 was lubricated after excavation, these peaks likely originate from the

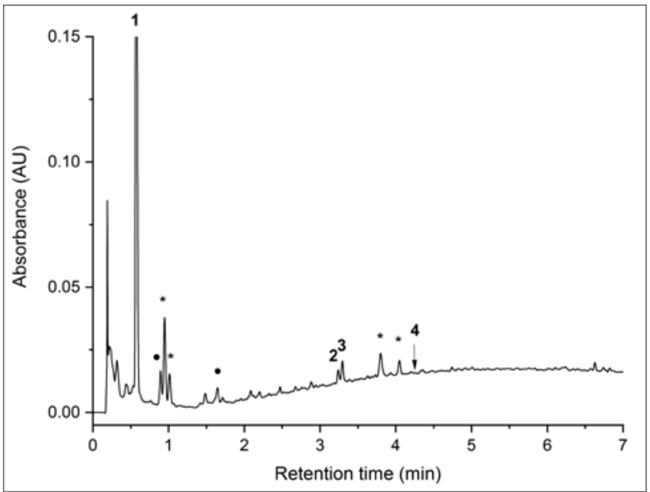

Figure 2: Chromatogram of the extract of *Russia Leather* CR5 sample monitored at 254 nm. Identified in the chromatogram are protocatechuic acid (1), ellagic acid (2), urolithin C (3) and sulfuretin (4). Compounds marked • possibly relate to hydroxybenzoic acid; compounds marked * do not display specific UV-Vis features.

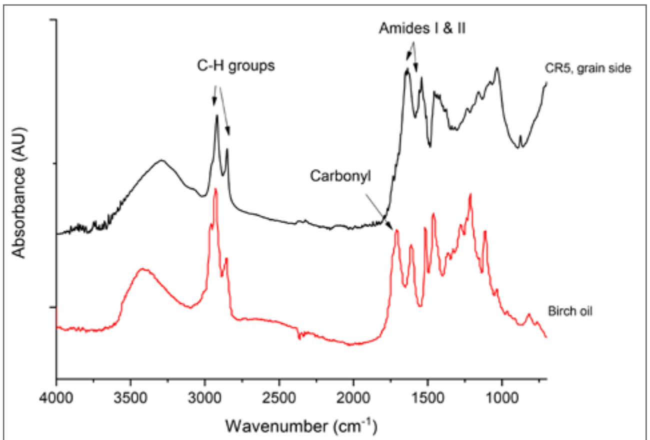

Figure 3: FT-IR spectra comparing the grain sides of CR5 (collected by ATR) and a reference of birch oil (collected in transmission). Note that the birch oil is displayed in absorbance to allow comparison with the leather sample. The spectra are offset for clarity.

oil-based compounds rather than the birch oil applied initially on this *Russia Leather*.

Conclusion

Preliminary results obtained from the analysis of the *Russia Leather* sample from the Metta Catharina (CR5) show the presence of residual tannins. U(H)PLC analysis confirmed the presence of condensed tannins and associated derivatives (protocatechuic acid), as well as small amount of ellagic acid and the presence of soluble redwood dyes. The FT-IR investigation showed the utility of this technique in characterising the degradation state of the protein in the leather and also in illustrating the presence of oil residues on the surface of the material. The analysis of the birch and willow bark samples demonstrated the complexity of tannin extracts, whilst highlighting the limitation of U(H)PLC analysis alone. The variability in the structure and size of tannins makes the full characterisation of these materials difficult. Future work will involve the analysis of the other *Russia Leather* samples. We anticipate that in-depth characterisation of tannins in this complex material will require the development of a combination of analytical techniques, including mass spectrometry.

Acknowledgments

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Méthodologie Analytique Optimisée pour les Échantillons de Cuir

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Mots-clés
Espèce Animale, Température de Dénaturation, pH, IRTF, Micro-échantillon, Cuir

L'accès à un prélèvement sur un objet du patrimoine est souvent limité, pourtant l'obtention de celui-ci est souvent indispensable pour obtenir une information complète sur les procédés de fabrication et l'état de dégradation du matériau. Pour un cuir, plusieurs informations peuvent être recherchées, telles que l'espèce animale de la peau, la nature des tannins ou l'état de dégradation, mais celles-ci nécessitent de faire appel à des techniques d'analyses différentes. Cette méthodologie propose de recueillir un maximum d'information à partir d'un échantillon unique de cuir de seulement 3 mg grâce à un plan d'expérience séquentiel et optimisé.

Exemple d'application

La méthodologie a été appliquée sur deux cuirs de Russie (neuf et ancien) et un gant **(Figure 1)**.

Le Cuir de Russie neuf a été fabriqué par Baker en 2013 à partir de peau de bovidé et des tannins extrait d'écorce de bouleau. Le *cuir de Russie CR5* provient du Metta Catharina, navire ayant sombré en 1786, sur les cotes de Plymouth, et excavé en 1973 (Blouet, 2013). Enfin, le *gant* blanc probablement mégissé est d'origine inconnue.

Analyse protéomique

Quelques fibres sont prélevées (~10 µg) et une analyse des peptides est réalisée après découpage de la molécule de collagène par une enzyme spécifique, la trypsine, selon la méthode de Kirby (Kirby, 2013). Les échantillons digérés sont purifiés et concentrés sur des pointes ZIPTIP avant d'être déposés sur une plaque inox. Les digests sont ensuite mélangés à une matrice d'acide alpaha-cyano-4-hydroxycinnamique pour être analysés par MALDI-TOF. Avec un laser pulsé Nd:YLF (Neodymium-doped yttrium lithium fluoride) à 345 nm, en mode positif et mode réflectron, l'acquisition des spectres est effectué entre 700 et 400 Da, avec accumulation de 2000 tirs. Un spectre de masse des peptides est obtenu et comparé à une base de données.

Par comparaison de spectre avec un référentiel de cuirs neufs et anciens constitué au CRC, les deux cuirs de Russie présentent tous les peptides marqueurs des bovins m/z marqueurs: 1105, 1208, 1427, 1580, 2131, 2853 et 3033 **(Figure 2)**. Ces peptides marqueurs sont issus des chaînes α1 et α2 du collagène de type I présent dans la peau.

Figure 1 : Echantillons sélectionnés : gant, cuir de Russie CR5 et cuir de Russie neuf

Calorimétrie différentielle à balayage (DSC) et mesure du pH

Pour la mesure de la température de dénaturation, les trois échantillons de 1 mg sont mis à tremper dans chacun 20 µL d'eau ultra pure pendant 2h à température ambiante, puis encapsulés pour l'analyse. Le calorimètre est chauffé à une vitesse de 10°C/min de 5°C à 120°C (Chahine, 2000). La température de dénaturation (Td onset) et l'énergie (ΔH) sont enregistrés.

Pour la mesure de pH (norme NF ISO4045:2018), les trois volumes d'eau de 20 µL sont réunis (V_{total} = 60 µL) et le pH de l'extrait aqueux est mesuré avec un pHmètre muni d'une microélectrode.

La mesure de la température de dénaturation Td et de l'énergie (ΔH) par DSC informe sur l'état de dégradation du collagène. Tous les échantillons analysés présentent une bonne conservation du collagène, car les valeurs de Td sont relativement élevées **(Figure 3)**. Etonnamment, les valeurs des deux cuirs de Russie sont proches, bien que le cuir CR5 a séjourné près de 200 ans dans l'eau de mer.

Les mesures de pH (pH>4,5) indiquent l'absence d'acidité nuisible pour tous les cuirs (norme NF ISO4045:2018). La valeur de pH nettement plus élevée pour le cuir de Russie CR5 s'explique probablement par son exposition à l'eau de mer qui a un pH généralement autour de 8.

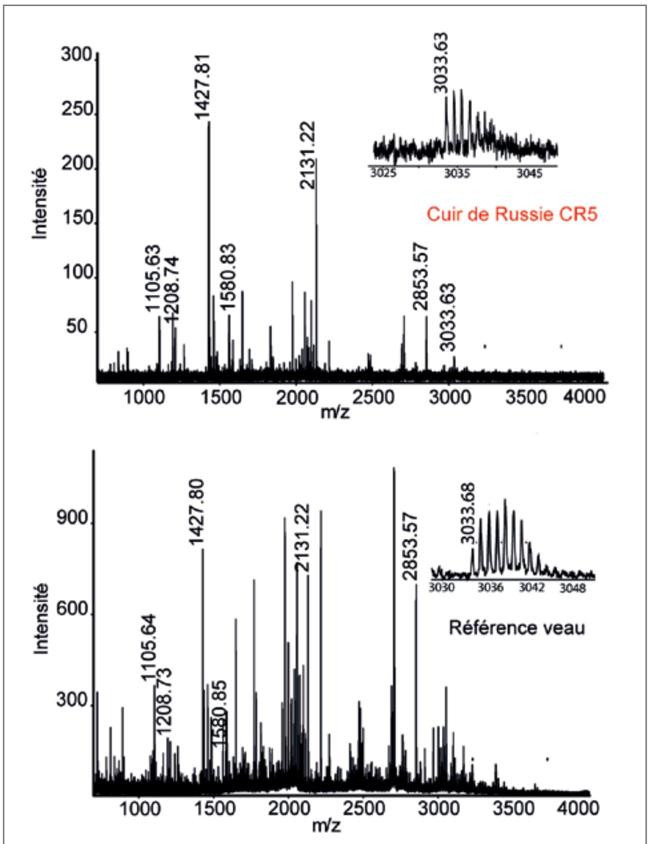
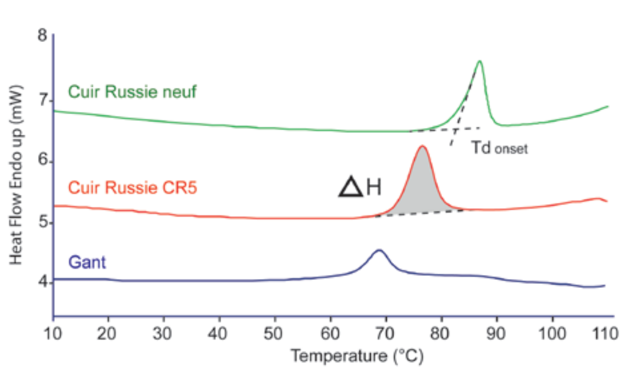


Figure 2 : Spectres MALDI-TOF du cuir de Russie CR5 et une référence veau



Echantillon	Td onset (°C)	ΔH (j/g)	pH
Cuir de Russie neuf	77,1 ± 2,0	21 ± 2	4,60
Cuir de Russie CR5	71,9 ± 3,0	18 ± 5	5,48
Gant	66,6 ± 2,0	17 ± 6	4,67

Figure 3 : Thermogrammes DSC et pH mesurés du cuir de Russie CR5, du cuir de Russie neuf et du gant

Analyse par spectroscopie infrarouge IRTF-ATR

Les 60 µL récupérés après la mesure du pH sont séchés à température ambiante et le résidu sec est analysé par spectroscopie infrarouge en mode ATR diamant. Pour chaque spectre, on effectue 32 scans avec une résolution de 4 cm^{-1} sur une gamme spectrale qui s'étend de 500 cm^{-1} à 4000 cm^{-1}.

L'analyse du résidu sec par spectroscopie infrarouge permet d'obtenir des informations sur les composés extraits du cuir, tels que des tanins ou des produits de finition.

Le spectre du résidu sec pour le cuir de Russie neuf présente les bandes caractéristiques d'un tanin végétal entre 2000 cm^{-1} et 700 cm^{-1} **(Figure 4)** (Falcão, 2013). Le profil du spectre pour le cuir de Russie CR5, est similaire, cependant les bandes sont moins bien définies, probablement du fait de l'altération des tanins végétaux. Dans les deux cas, la faible intensité des bandes ne permet pas d'être plus précis sur la famille de tanin.

Le spectre du résidu sec provenant du gant révèle la présence d'un composé sulfate, indiquant un tannage minéral. Bien que les bandes soient intenses et fines, une identification formelle n'a pu être atteinte probablement dû au fait qu'il s'agirait d'un mélange. Sur la base de la position des bandes, les composés les plus proches sont le sulfate de baryum et l'alun (sulfate double d'aluminium et potassium). Des analyses complémentaires sont nécessaires dans ce cas.

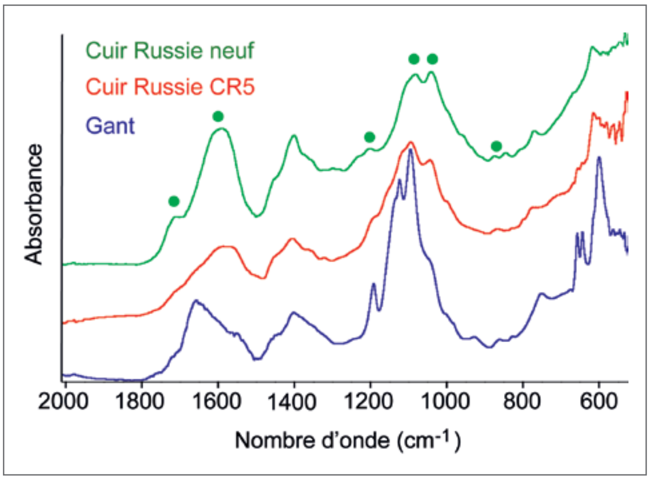


Figure 4 : Spectre infrarouge du cuir de Russie CR5, du cuir de Russie neuf et du gant

Conclusion

Cette stratégie analytique, applicable à tout type de cuir, permet d'accéder à un maximum d'information sur la nature et l'état de conservation du matériau, à partir d'une quantité minimale de matière. Les informations accessibles pourront cependant être limitées selon l'état de dégradation des différents constituants.

Cette approche peut encore être enrichie en couplant d'autres techniques d'analyses sans nécessiter plus de matière, telle que la chromatographie liquide sur l'extrait aqueux ou la spectroscopie Raman sur les résidus secs, pour tenter de préciser la nature des tannins et additifs.

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NF ISO4045:2018 Cuir_Essais chimiques_Détermination du pH et de l'indice de différence

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Elise Blouet est restauratrice indépendante, spécialisée sur le cuir. Diplômée du master de Conservation Restauration de Biens Culturels (Paris 1), elle a son atelier de restauration dans le Perche. Elle a menée de nombreuses recherches sur le cuir de Russie et a pu, en partenariat avec un tanneur basé en Angleterre, recréer ce cuir mythique.

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