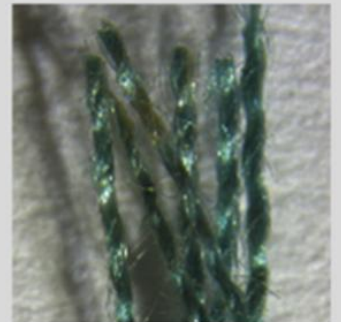
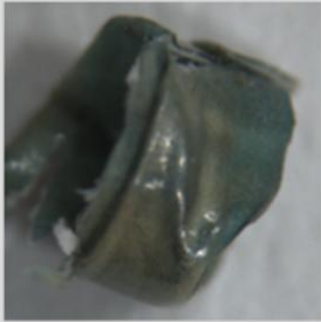


Dyes in History and Archaeology 44



National Gallery of Canada

Ottawa, Ontario, Canada

7 – 9 October, 2025

Preface

The Dyes in History and Archaeology Committee welcomes you to the 44th conference at the National Gallery of Canada. Since its foundation in 1982, DHA has established itself as a vital international forum for interaction, collaboration and discussion among conservators, curators, (technical) art historians, craftspeople, artists, independent scholars, scientists and academics from museums, universities, research centres and other public or private institutions.

The 2025 conference is the first to be held in Canada and will be followed by a workshop at the Canadian Museum of history on the topic of Indigenous dyes and dyeing in Canada. As in previous years, the 2025 conference has a diverse programme, with the specialities and research interests of DHA members represented by sessions that highlight dyes and organic pigments used in the past: analysis investigations and methodologies, historical dyeing techniques, reconstruction of dye colours from recipes, and many more.

Planning, organising and facilitating an international conference requires time, effort and resources. This year the planning partners include Jennifer Poulin (Canadian Conservation Institute, CCI, Government of Canada), Sheilah McKinnon, Marie-Hélène Foisy, and Ainsley Walton (National Gallery of Canada, NGC); and Jessica Lafrance-Hwang, Salina Kemp, and Caroline Marchand (Canadian Museum of History, CMH). The conference venue is the National Gallery of Canada, and the workshop and special event dinner venue is the Canadian Museum of History.

The CCI was founded in 1972 after the UNESCO World Heritage Convention and the passing of the *National Museums Act* in Canada. CCI has been serving heritage professionals from Canada and around the world for over 50 years. The Canadian Conservation Institute (CCI), a Special Operating Agency within the Department of Canadian Heritage, advances and promotes the conservation of heritage collections in Canada through its expertise in conservation science, treatment and preventive conservation. CCI works with heritage institutions and professionals to ensure these heritage collections are preserved and accessible to Canadians now and in the future.

The mission of the NGC is “through the visual arts, we create dynamic experiences that open hearts and minds and allow for new ways of seeing ourselves, each other, and our diverse histories”. Founded in 1880, the NGC has one of the finest collections of Indigenous and Canadian art in the world, as well as masterworks from numerous other artistic traditions, including European, American and Asian art, contemporary art, prints and drawings, and photography.

The CMH is Canada’s largest museum of human history. With roots stretching back to 1856, it is one of Canada’s oldest public institutions. Focused on the histories and cultures of what is now Canada, it is a respected centre of museological excellence, both across the country and around the world. Its overarching mandate is to enhance Canadians’ knowledge, understanding and

appreciation of the events, experiences, people and objects that reflect and have shaped Canada's history and identity, while also enhancing their awareness of world history and cultures.

We hope you enjoy the conference, and your visit to Ottawa!

The DHA Scientific Committee:

Joanne Dyer - Colour Scientist, British Museum

Jo Kirby – (retired) National Gallery, London

Jennifer Poulin – Senior Conservation Scientist, Canadian Conservation Institute

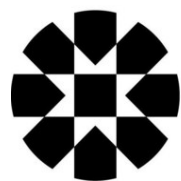
Ruth Ann Armitage - Professor of Analytical Chemistry, Eastern Michigan University

Dominique Cardon - Emerita Head of Research at CIHAM, National Centre of Scientific Research

Rachel Lackner - Research Associate, Metropolitan Museum of Art

Riikka Räisänen - Professor, University of Helsinki

Gregory D. Smith - Senior Conservation Scientist, Indianapolis Museum of Art at Newfields



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Canadian
Conservation Institute

Institut canadien
de conservation

DAY 1 – Tuesday, October 7, 2025

12:00 – 1:00pm Registration

1:00 – 2:00pm Welcome speeches and poster viewing

Poster Session 1. Chair: Sheilah McKinnon

Zahra Ahmadi*, Mahdi Safi, Neda Dahesh, "Identification of Dyes in the Amo-Oghle Carpet for the Regeneration of Color and Introduction of Dyeing Methods"

Václava Antušková*, Radka Šefců, "Synthetic organic pigments in modern Czech paintings"

2:00 – 3:00pm Hortense de La Codre*, Giovanni Verri, Madeline C. Meier, Maria Kokkori, "Purple from Madder: A Lost Recipe?"

Caitlin Gallupe, "Investigation into an Orchil Lichen Dye"

Timothy Greening, "The proof of the poison is in the purple pesticide? Synthesizing magenta dye in the 19th Century"

Stephanie Guidera*, Heather Hodge, Kathleen Martin, "A Foray into Fungal Dyes"

3:00– 3:45pm Break and poster viewing

Poster Session 2. Chair: Eva Eis

Lucía Gutiérrez, Adelphine Bonneau*, María Ana Castro, Analía Castro Esnal, "Dyes for life and death: Characterization and insights into the dyeing techniques of Alero Mazquiarán textiles, SW Chubut, Argentine Patagonia"

Anahí N. Herrera Cano*, Marta Maier, Eugenia Tomasini, María Eugenia Suárez, "Natural red dyes from bark and wood of the Wichís of central-western Formosa (Argentina): ethnobiological and chemical aspects"

3:45 – 5:00pm Viveca Mellegård*, Oliver Finnegan, Marc Vermeulen, "Color, Technique, and Colonial Entanglements: Exploring Surinamese Textile Histories from the Prize Papers Archive"

Irina Petroviciu*, Florica Zaharia, Silvana Vasilca, Florin Albu, "Dyes on cotton. Woven motifs in late 19th to early 20th century interior towels from Transylvania, Romania"

Riina Rammo*, Liis Luhamaa, Ina Vanden Berghe, Jonas Veenhoven, Anete Karlson, Ieva Pigozne, Riikka Räisänen, "Red dyes in the 18th-19th-century Estonian and Latvian textiles"

Marine Tipa, Adelphine Bonneau*, Agnès Gelé, "Exploring beauty standards in early 20th century Quebec: A study of cosmetics from a hotel and a private residence in Laval"

Krista Wright*, Liis Luhamaa, Debbie Bamford, Saara Tahvanainen, Riikka Räisänen, "Blue moments with berries and flowers – examining blue based on the ethnographic sources from Finland and Estonia"

5:00 – 6:00pm Reception, National Gallery Canada Foyer

DAY 2 – Wednesday, October 8, 2025

8:30- 9:00	Registration
Session 1. <i>A window into other worlds.</i> Chair: Jennifer Poulin	
9:00 – 10:20am	Islam Shaheen*, Paola Buzi, Margarita Gleba, Paula Nabais, Maria João Melo, Nagmeldeen Hamza, “The Colors of Tutankhamun: An archaeological study and documentation of the natural dyes found in the Tutankhamun textile collection” Ruth Ann Armitage*, Ann H. Peters, Avi Dragun, Malak Shehab, Jaime Williams, Imani Peterkin, Kathryn Jakes, John Southon, Collin Sauter and James Moran, “Comparing related Paracas mantles and clothing objects: dyes, dates, and more data” Cynthia Connelly Ryan*, David Kim, “Non-Invasive Characterization of Meso-American Organic Yellow Dyes”
10:20 – 10:50am	Break
Session 2. <i>Compass points.</i> Chair: Riikka Räisänen	
10:50 – 12:10pm	Noemí Cubas Martín*, Ian King, “Dyed not Dead: An Exploration of Medieval Icelandic Dyeing Tradition Using Reflectance Spectrometry (FORS and Spectragryph)” Jian Liu*, Ruqian Wang, Anikó Moór, “The Use of Natural Dyes in the 15th-19th Century Textiles in East and West” Laura Maccarelli, Ashley A. Freeman*, “Dyes analysis of an Iranian Lampas textile panel from the LACMA’s collection”
12:15	Lunch
Session 3. <i>Colour waves.</i> Chair: Jo Kirby	
2:00–3:20pm	Joanne Dyer*, Samantha Taylor, Rebecca Snow, Emma Turner, Andrew Meek, Olenka Horbatsch and Charlotte Wytema, “Cross craft colours: the unusual mauve washes observed in Hans Bol’s drawings” Katarina Batur, Adelphine Bonneau*, Maarten van Bommel, Irena Radić Rossi, “International Trade with Red Lake Pigments in the Late Renaissance Mediterranean: Understanding Composition of the Pellet from the Cargo of the Merchant Ship Gagliana grossa (Gnalić Shipwreck)” Delanie Linden, “Chevreul, Color Juxtaposition, & the ‘Flat Tints’ of Chinese Painting”
3:20 – 4:00pm	Break
Session 4. <i>Not terminally confusing.</i> Chair: Greg D. Smith	
4:00 – 5:00pm	Eva Eis, “Dyeing with a coffee cup? Challenging recipes from a 19th century dyer’s handbook” Peppi Toukola*, Juuso Laitila, Susanne K. Wiedmer, Petri Heinonen, Riikka Räisänen. “An optimized mild extraction method for the analysis of historical dyes by HPLC-DAD-Orbitrap-MS with application to Finnish historical dyes”
7:00pm – 9:00pm	Conference Dinner, Haida Gwaii Salon, Canadian Museum of History

DAY 3 – Thursday, October 9, 2025

8:30- 9:00	Registration
Session 5. <i>Not so simple.</i> Chair: Joanne Dyer	
9:00 – 10:20am	Paula Granados-Garcia*, “The Endangered Material Knowledge Programme: Dyes and Pigments as key elements of traditional material knowledge systems” Anete Karlson, “Research on the red color of the Lielvarde woven belt in Latvia” Liis Luhamaa, Riina Rammo*, Krista Wright, Riikka Räisänen, “A Simple Black: Traditions of Using Iron-Rich Mud for Dyeing in Eastern Baltic Region”
10:20 – 10:50am	Break
Session 6. <i>Modern times, accepted practice.</i> Chair: Ruth Ann Armitage	
10:50 – 12:10pm	Lynn Chua*, Diego Tamburini, Miki Komatsu, Peter Lee, Naomi Wang, Darryl Lim, Alexandra Green, “Red dyes in transition: investigating natural and synthetic colorants in Javanese batik textiles via HPLC-DAD-MS/MS and SERS” Burkhard von Rabenau, Victor J. Chen*, Gregory D. Smith, “Dye Analysis of 20th century textiles from the Toropalca Region of Bolivia” Diego Tamburini*, Zeina Klink-Hoppe, “Threads of war: scientific analysis of the dyes, fibres and mordants used in the production of Afghan war rugs”
12:15	Lunch
Session 7. <i>Colour complexities.</i> Chair: Dominique Cardon	
2:00–3:20pm	Jocelyn Piirainen, Associate Curator, Indigenous Ways and Decolonization, National Gallery of Canada Aurélie Mounier*, Julie Guiraud, Sarah Petitcola, Sophie Fontan, “Colours of FANS: Multiple uses, facets and materials under examination of non-invasive and contactless spectroscopic techniques (18th-19th C., Musée d’Aquitaine, Bordeaux, France)” Pauline Claisse*, Charlotte Marembert, Faustine Massera, Sarah Petitcolas, Rémy Chapoulie, Mohamed Dallel, Aurélie Mounier, “Reproducing Orchil: A Technical and Analytical Challenge”
3:20 – 4:00pm	Break
Session 8. <i>A poison chalice.</i> Chair: Jessica Lafrance-Hwang	
4:00 – 5:00pm	Maria Goretti Mieites Alonso*, Elena Basso, “LC-MS characterization of dyes in a Robe à la Circassienne. First evidence of Parelle D’Auvergne” Marc Vermeulen*, Sanne Berbers, “Beyond the Green: Arsenic-Containing Synthetic Blues and Toxicological Risks in Early 20th-Century Commemorative Textiles”
5:00 – 5:30om	Concluding remarks



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Poster Presentation Abstracts

Identification of Dyes in the Amo-Oghle Carpet for the Regeneration of Color and Introduction of Dyeing Methods

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Abstract

Persian carpets are internationally famous. Some of these carpets are more genuine because of their design, coloring, or weave quality, like “Amo-Oghle carpets”. Special tools and approaches for color detection are chosen based on the type of product and the required precision for color detection. The main objective of this research is to identify colors and dyes used in these special carpets, based on non-destructive methods [1,2]. Some samples of Amo-Oghle carpets, examined in this research, were photographed with the use of a color checker to capture their exact colors. And their color components were calculated by mathematical and descriptive methods. In addition, based on reflective data acquired by a spectrophotometer, the curves of reflection (R) and absorption (K/S) were attained for six hues of the Amo-Oghle carpet.

Afterwards, color similarity prescriptions were acquired with resultant amounts for the existing hue in the Amo-Oghle carpet. For this purpose, three red colors of the Amo-Oghle carpet, preserved in the carpet museum (with the property number 556), were considered the main samples. According to written and oral resources, the main dye for red hues in Amo-Oghle carpets is “kermes,” along with white alum as a Mordant. According to this and the common dyes of “madder” and “kermes” to reach a red hue in Iran, the samples colored with these two dyes were provided as proof samples and compared with the main hue of the carpet. The $L^*a^*b^*$ and C^* and h° amounts and the results show that the color similarity with experimental prescriptions for red hues in Amo-Oghle carpet is not possible and other possibilities must be considered for the employed dye (For example dyes combined of two or three components or the combination of madder with juglone, or synthetic dye).

Keywords: Color Regeneration, Amo-Oghle carpet, Dyeing

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2. Bruce MacEvoy (2015), *Guidelines for Color Harmony & Color Design*, <https://www.handprint.com/HP/WCL/tech13.html> Last revised 08.I.2015

Synthetic organic pigments in modern Czech paintings

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Abstract

The first synthetic organic pigments (SOPs) were developed and introduced to the market in the second half of the 19th century. As part of a long-term project, their use in paintings by modern Czech artists was investigated. Alizarin (PR 83) has been available on the market since the 1870s. It was frequently used from the late 19th century, for example, in paintings by the landscape painter Antonín Slavíček (1870–1910). It was an important pigment on the palette of Václav Špála (1885–1946) until the mid-20th century. Eosin was confirmed on a single painting by Vojtěch Hynais (1854–1925) from 1889. In the 20th century, more SOPs were identified. Among yellow pigments, Hansa Yellow (PY 1) was found in a work by Zdeněk Pešánek (1896–1965) from 1936, while PY 3 was identified in paintings by Emil Filla (1882–1953) from the 1940s. These pigments were also found in later works by Pravoslav Kotík (1889–1970) and Ota Janeček (1919–1996), both of whom also used Hansa Orange (PO 5). Among synthetic red pigments, PR 4 was the most frequently used, appearing in several artworks by Pravoslav Kotík, Ota Janeček, Kamil Lhoták (1912–1990), and Karel Pauzer (*1936) from the second half of the 20th century. Other red pigments—such as PR 3, PR 60, PR 68, and PR 88—were only sporadically confirmed. For most of these pigments, several years passed between their development and their adoption by Czech artists. Phthalocyanine Blue (PB 15) and Phthalocyanine Green (PG 7), however, became popular among Czech artists soon after their development, starting in 1940.

This work has been financially supported by the project of the Ministry of the Interior of the Czech Republic: The Development of a Strategic Cluster for Effective Instrumental Technological Methods of Forensic Authentication of Modern Artworks (VJ01010004).

Purple from Madder: A Lost Recipe?

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Abstract

Madder (*Rubia tinctorum*) is a well-known natural dye traditionally associated with hues ranging from orange to brownish red, and even violet shades in lake pigments when combined with specific mordants. However, a recent analysis of an ancient Egyptian textile revealed a purple-coloured area, with chromatographic results indicating the exclusive presence of madder-derived compounds. This unexpected observation raises the possibility that madder may have been used historically to dye purple, an application not previously documented in the literature.

While it is experimentally known that a purple shade can be achieved by adding calcium hydroxide to an aqueous solution of madder, no historical sources appear to document this practice. This study investigates the conditions under which madder can yield purple tones on wool using analytical techniques including reflectance spectroscopy, Raman spectroscopy, and chromatography coupled with mass spectrometry. Emphasis is placed on evaluating the stability of the purple hue, with one hypothesis suggesting that degradation over time may shift the original purple colour toward red, potentially accounting for its absence in historical records.

By intergrading experimental dyeing, analytical characterisation, and degradation studies, this research assesses the plausibility of madder-based purple dyeing in antiquity. The broader objective is to enhance our understanding of ancient dyeing practices and explore whether a now-lost recipe for purple from madder once existed.

Investigation into an Orchil Lichen Dye

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Abstract

Lichen dyes are naturally occurring colourants that were widely used throughout history for textile dyeing and select species are the source of “orchil” purple. This project focused on the investigation and analysis of textile samples dyed with the *Umbilicaria mammulata* lichen species to determine the lightfastness of this orchil dye. Researchers in recent years have developed analytical methods to identify orchil purple dyes on textiles, but studies on this species are still lacking. The experimental methodology included three phases: identification and methods of extraction and dyeing; accelerated light aging, colour spectrophotometry and fibre optics reflectance spectrometry (FORS); and data analysis. Recipes following both historical methods and contemporary recreation methods were used to create two ammonia-based dye bath solutions, employing either human urine or ammonium hydroxide, that dyed fabric samples of wool, silk and linen to mimic 18th-century textiles. Accelerated light ageing was undertaken at both Queen’s University in a Q-SUN test chamber and in collaboration with the Canadian Conservation Institute (CCI) in a custom fadeometer. Colour spectrophotometry and FORS then quantified changes from the different light exposure. CCI analyzed the samples before light aging to identify dye markers using gas chromatography-mass spectrometry, which offered a comparative dye analysis of the two ammonia-based dye bath solutions. This data contributed information about the identification and characterization of the properties of lichen-dyed textiles and provided knowledge on how to care for historical textile objects.

The proof of the poison is in the purple pesticide? Synthesizing magenta dye in the 19th Century

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Abstract

Although arsenic has a long history in the production of textiles, both as a mordant, and a component of green copper-based colourant, particularly in the second half of the 19th Century, it had other uses historically, such as in museum collections as a pesticide, or in chemical synthesis. Recent research worldwide using XRF analysis has begun to show significant amounts of arsenic in historic material not expected to contain arsenic. The telltale bright pinks and reds of contaminated objects, from historic microscope slide labels [1] to wallpaper has led to the conclusion that the source of this arsenic is a contaminant in the production of early synthetic organic colourants from aniline. In particular, the original synthesis route to fuchsine from toluidine and aniline used large concentrations of arsenic acid as a reagent. In fact, dye manufactures at the time were simultaneously producing commercial arsenical pesticides as a by-product from that reaction [2]. This poster aims to showcase some of the information in the historic literature, to indicate that, in particular, early red to purple aniline dyes were significantly contaminated with arsenic, which apparently remains in historic collection material to this day. As no amount of arsenic is considered “safe” on a surface, this will impact health and safety consideration around previously presumed innocuous objects, such as labels on vintage packages of needles [3]. Furthermore, the research offers a further look into the area of early organic industrial synthesis processes. It is hoped that by keeping practitioners in the field informed about this latent arsenic, research into the realm of inorganic contaminants in early synthetic organic colourants will be stimulated.

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A Foray into Fungal Dyes

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Abstract

Natural dyes are known to be sourced from numerous organic substances, from insects to plants. Fungi and lichen have historically been used and briefly explored in dye literature, namely by Dominique Cardon [1], however the cultural practice, breadth of colors available, and aging properties have been largely unpublished. Some colors can be identified visually, or have signatures in specific wavelengths, but many dyes continue to be mysterious. Conservators, curators, and communities alike are often unsure about the sources of dyes on cultural heritage objects. While a number of non-destructive characterization tools are available for certain colorants, the identification often requires a reference set for comparison. For fungi and lichen sources, this data currently does not exist. The International Fungi and Fiber Symposium [2] offers a biennial gathering of fiber and mycology enthusiasts. An array of samples, representing a rainbow of colors, created at this symposium have been studied and multimodal imaging characterization has been completed. Further, the longevity of the dyes have been examined using Microfading Testing (MFT) and spectrophotometry before and after accelerated aging. Future goals include conducting High Performance Liquid Chromatography (HPLC) to characterize the dyes and create a reference set to be useful for analysis of future cultural heritage objects.

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Dyes for life and death: Characterization and insights into the dyeing techniques of Alero Mazquiarán textiles

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Abstract

The Alero Mazquiarán site (SW Chubut, Argentine Patagonia) is a burial context where a unique funerary assemblage has been recovered. Associated with five individuals (three subadults and two adults), it includes painted leathers, textiles, glass and metal beads, leather boots, and ochre remains. Radiocarbon dates (uncalibrated) indicate an age of 312 ± 40 years BP (human remains) and 212 ± 35 years BP (textile fibers).

Beyond its regional uniqueness and exceptional state of preservation, this burial and its complex assemblage provide valuable insights into the intertwined relationships between different groups inhabiting the area during this period. Notably, some textile designs correspond to Andean groups from northwestern Argentina, more than 2000 km away, suggesting long-distance trade networks and the circulation of goods, people, and information.

In this context, this poster aims to examine fiber dyeing techniques by characterizing them through μ Raman spectroscopy, to better understand their manufacturing processes and, consequently, their contexts of production and use, especially relevant given the information conveyed by their designs. It is expected that this analysis will offer an opportunity to deepen the understanding of mobility, the circulation of goods, people, and knowledge on a broad geographic scale in this region; and to contribute to a better comprehension of the transformations in the lifeways of hunter-gatherer groups during periods of colonial expansion and the Argentine State-building process.

Natural red dyes from bark and wood of the Wichís of central-western Formosa (Argentina): ethnobiological and chemical aspects

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Abstract

Textiles made from chágua (*Bromelia* spp.) leaf fibres are a central part of the identity of the Wichí people of the Gran Chaco. Historically, different natural dyes obtained from local sources were used. This practice continues today [1].

Among the different colours that can be obtained from vegetables are red-brownish, black-blue and yellow-greenish. Red-browns are achieved by dyeing fibres with aqueous extracts of woods and barks of stems and roots of different species using wood ashes as mordants [1, 2]. The chemistry involved in these manufacturing techniques and materials has not yet been studied, so it is of particular interest. Also, although there are studies that describe the overall dyeing processes [e.g., 1-3], there is lack of in-depth information of the different stages (e.g. selection of the raw materials, dyeing, mordanting) and integrating it with chemical information. A thorough understanding of these procedures, including their ethnobiological and chemical aspects, is essential for different studies, for promoting the continuity of these practices, and for the proper conservation and preservation of museological Wichí textiles.

This work describes the Wichí techniques of red-brown dyeing using bark and wood, approached from an ethnobiological perspective. It provides a first characterisation of the colouring compounds based on information and materials collected during fieldworks conducted between 2016 and 2023 in the Wichí community of Tres Pozos (Formosa, Argentina). From interviews and participant techniques with 21 settlers, the different stages of the dyeing processes were described, focusing on the vernacular perspective and its correlation with the academic perspective. FTIR-ATR analysis revealed the presence of condensed tannins, mainly procyanidins, as the colouring matter. These compounds polymerizes on contact with the mordant changing the final shade. This study highlights the value of integrating ethnobiological and chemical information for a holistic approach to the conservation of this biocultural heritage.

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Color, Technique, and Colonial Entanglements: Exploring Surinamese Textile Histories from the Prize Papers Archive

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Abstract

This paper presents an interdisciplinary study of a little-known set of Surinamese textiles dated to 1795, from The National Archives' Prize Papers collection. Through non-invasive analysis (FORS, digital microscopy), the textiles were characterized as being dyed with indigo, potentially redwood, and—in some cases—what appears to be an insect-derived dye, based on absorbance features at 525 and 560 nm. While the presence of indigo and redwood is typical for the region, the use of insect-based red, alongside woven textile techniques – despite the absence of a deeply rooted indigenous weaving tradition in Suriname – challenges assumptions about local production and points to broader trade and material exchanges [2].

The collection comprises both printed and woven textiles with repeated vegetal and floral motifs, some presented in varying colourways, suggesting a function as swatches or sample pieces. Notably, the woven textiles—dyed red or yellow—differ from the printed majority, and their presence is striking given that Suriname lacks a documented weaving tradition [1]. These anomalies raise questions about importation, intended use, and their association with enslaved or formerly enslaved populations.

Further complexity arises from the archive itself: the textiles were physically separated from their accompanying Dutch-language correspondence in the 1960s, rendering key contextual information inaccessible. This study not only begins the process of materially characterizing the textiles but also aims to re-integrate them into their archival narratives. In doing so, it contributes to the recovery of forgotten textile histories embedded in colonial trade and underrepresented in traditional dye and textile scholarship.

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Dyes on cotton. Woven motifs in late 19th to early 20th century interior towels from Transylvania, Romania

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Abstract

Interior towels represent a distinct category of traditional textiles which were treasured as family heirloom, and survived until nowadays [1]. They carried valuable information regarding materials, technical and symbolic characteristics of textile materials produced at the time of intersection between the home textile industry and industrialisation. An exhibition of interior towels from Transylvania is planned to take place at Salbek Castle in Arad County, Romania, this summer. Belonging to the collection of Muzeul Textilelor, Băița and dated late 19th to early 20th century, the towels have a white background with colored motifs arranged at the ends. In most cases, the central part of the towels remains white. Red is the predominant color in the woven motifs while black, blue and yellow in small amounts, were added alongside red.

Analytical investigation of dyes was performed by liquid chromatography (LC-DAD and LC-DAD-MS), and the resulted data was corroborated with information provided by infrared spectroscopy (FTIR-ATR), X-ray spectroscopy (XRF) and optical microscopy (OM). Scientific investigation revealed that synthetic alizarin (1871) was used for red, indigo-based dyes for blue, and lead chromate/ basic lead chromate (1809) for yellow/ orange hues. Aniline Black (Pigment Black 1) (1863) and a sulphur-based black dye (Sulphur Black 1) (1896) were detected for black.

The poster discusses the results obtained together with information acquired on other textiles from Transylvania, from the same period [2-5].

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Red dyes in the 18th-19th-century Estonian and Latvian textiles

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Abstract

The ethnographic collections of museums in Estonia and Latvia are rich in textiles. Many of these belong to colourful festive peasant clothing dating to the 19th and 18th century. To understand how these textiles were dyed, researchers have compared the artefacts with archival records regarding dye plants, the shades obtained, and the techniques used. The first chemical dye analyses of these ethnographic textiles have been conducted in recent years, revealing information about the dye sources used. One pilot project was part of the Colour4CRAFTS initiative. The research had a primary focus on the red shades found in the 18th-19th-century belts and, to a lesser extent, other textile items. The textiles belong to the Estonian National Museum and Liepāja Museum in Latvia. During the 19th century, both countries were closely linked, as they were part of a joint administrative territory in the Russian Empire, with Riga as the commercial centre of the region. In this project, 14 visually red samples from historical textiles in Latvia and 22 from Estonia were analysed using HPLC-DAD at the Royal Institute for Cultural Heritage in Brussels. As anticipated, some samples were dyed red with dyestuffs that may have come from local plants. Additionally, imported dyestuffs, such as soluble redwood, madder, and Mexican cochineal, have been identified. Concluding from the results, rural families were familiar with various commercial dyes. Also, it was revealed in this study that more research is needed into local dye plants that are possible sources of red. With this poster we will give an overview of the preliminary results of these analyses and compare the information obtained with the ethnographical records.

Exploring beauty standards in early 20th century Quebec: A study of cosmetics from a hotel and a private residence in Laval

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Abstract

Recent excavations in the city of Laval, located in the province of Quebec, Canada, uncovered two red lipsticks and a pink nail powder bottle containing remnants of early cosmetics. These items were found in a hotel and a private residence, both dating from the late 19th to early 20th century. Discoveries of this nature are extremely rare, prompting analyses to examine their formulation and to clarify their chronological and societal context.

Initial investigations into the structure of the lipstick tubes and their mechanisms have narrowed the timeframe for these cosmetics to the early 20th century.

In addition, chemical analyses utilizing techniques such as Raman microspectroscopy, SEM-EDS, Fourier transform microspectroscopy, gas chromatography, and liquid chromatography were conducted. These tests identified the components of the lipsticks, revealing two distinct recipes that share common coloring materials, including iron oxides (hematite) and eosin dye. The ingredients for one lipstick include alum salts, castor oil, various waxes, and possibly apatite, while the other consists of clay, castor oil, and waxes. These compositions partially align with recipes described by Poucher in 1932 [1]. The pink nail polish is composed of gypsum and barite, though the source of its colorant remains unidentified.

These three cosmetic samples represent the first of their kind to be studied in the province of Quebec and offer valuable insight into the beauty standards of this region in Canada. They mark the beginning of further investigations into such artifacts.

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Blue moments with berries and flowers – examining blue based on the ethnographic sources from Finland and Estonia

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Abstract

It is well known that woad and indigo dye textiles quite permanent blue, but the historical sources from the Northern Europe mention several alternative dye plants used for blue and green.

A recipe from 1745 describes that beautiful colour was dyed with ripe berries of alder buckthorn (*Rhamnus frangula*) but instructs not to go outdoors to sunlight with the dyed garments [1]. The same recipe was still in use in Finland in the early 20th century [2]. European blueberries (*Vaccinium myrtillus*) (bilberries) were used to dye blue cotton fabrics for striped rag rug carpets and doll clothes [3]. In Estonia, European blueberry was mentioned by Baltic Germans in the 18th century as a local dye, and in ethnographic sources, it was recommended not to go out in the rain with blueberry-dyed clothes [4, 5]. In Finland, flowers of blue cornflower (*Centaurea cyanus*), red clover (*Trifolium pratense*), bluebells (*Campanula* sp.) and wild pansy (*Viola tricolor*) were used to dye blueish “ice colour” with alum.

Flowers and berries contain anthocyanins with poor light fastness. This became apparent when we tested our dyed wool materials with the ISO 105-B02:2014 standard for light fastness. However, washing fastness according to the ISO 105-C06:2010 standard resulted in relatively good values with some samples. Our dyeing experiments and colour fastness tests bring interesting new knowledge of the blue colours of the past and increase knowledge to recognize anthocyanin dyed historical textiles.

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Oral Presentation Abstracts

The Colors of Tutankhamun: An archaeological study and documentation of the natural dyes found in the Tutankhamun textile collection

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Abstract

There are three primary sources of knowledge regarding ancient Egyptian textiles: depictions of textile production, written descriptions, and surviving textiles, which are the focus of this research. Tutankhamun is widely known for the luxurious and beautiful objects found within his tomb, discovered by Howard Carter in 1922.

These textiles provide a fascinating glimpse into the nature and extent of a pharaoh's wardrobe during the New Kingdom. This collection is among the most important pieces of ancient Egyptian textiles. The tomb contained hundreds of textiles and cloths, many of which were dyed, found tied around the necks of statuary and stored in large chests. Some of the textiles were simple rolls of cloth, while others were part of elaborate ceremonial robes adorned with embroidery. The dyes have never been studied, and their manufacturing process remains unknown. The study will therefore apply multidisciplinary methods to understand the manufacturing techniques of the collection for the first time. Analytical techniques will be applied to eight samples as a preliminary analysis. EDXRF, HPLC-DAD, and fluorimetry in the Visible were applied and have yielded great results, which will help to study the dyes and this approach to studying dyes will provide new information about 18th Dynasty textiles.

The research focuses on the history of dyes from Tutankhamun's textiles to understand the significance of the dyes used in his textiles, which will generate substantive and new information about ancient Egyptian textile production, particularly those used by and during the rule of Tutankhamun. Understanding the dyeing technology will further our understanding of social, political, and religious ideology, as well as technical innovations in textile manufacturing, spinning, and dye recipes and application.

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Comparing related Paracas mantles and clothing objects: dyes, dates, and more data

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Abstract

The Necrópolis de Wari Kayan, at the Paracas site in the coastal desert of south-central Peru, is the largest archaeologically excavated mortuary complex of the pre-Hispanic Andes, and one of the best for preservation of textiles. The samples in this study are yarn fragments associated with textiles from Wari Kayan tomb 12 (bundle 382) collected by the late Dr. Anne Paul in 1985 at what is now the Museo Nacional de Arqueología, Antropología e Historia del Perú (MNAHP). Here we focus on yarns from 'unkuña' type tunics, skirts, and 'ñañaka' headcloths from inside the bundle, related to embroidered mantles in the Linear and Block Color styles on the outer layer. Sequential analysis includes screening for dyes with direct analysis in real time mass spectrometry (DART-MS) followed by extraction of the dyes for comprehensive analysis with HPLC. Remaining fiber material from this process can then be AMS radiocarbon dated and, with the material remaining from the minimally destructive plasma oxidation process, subjected to light stable isotope analysis. We report here on the comparison of the results from the mantles, presented at DHA43, with those of the inner textiles with similar coloration and iconography. The results will help inform models of the social relationships of production and exchange that facilitated the large-scale production of these artifacts and their deposition in particular tombs, new fruits of the project started over 40 years ago by Dr. Paul in her work with the Textile Department at the MNAHP.

Non-Invasive Characterization of Meso-American Organic Yellow Dyes

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Abstract

Plant-based yellows are particularly challenging colorants to distinguish between, yet they may be the most likely to use locally sourced raw materials and thus offer information about provenance or trade. This study explores this topic for the specific question of early meso-American codices from the pre-Columbian and Spanish colonial periods. About 100 early (pre-1600) codices are known world-wide, of which the Library of Congress is fortunate to have several in our collection. Scholars are keenly interested in the inks and colorants used to make these codices, and the materials of two in our collection have been studied [1]. However, not all of the organic colorants proved possible to identify. This project aims to improve our ability to characterize these materials non-invasively, applying a recently proposed protocol for distinguishing between plant-based organic yellows which gave promising results on a modest set of reference samples [2]. A larger set of over 200 reference samples was prepared using traditional Mexican dye plants and historically-plausible preparation methods, which were characterized using multiple spectroscopy and technical photography techniques. The resulting data set was used to test the applicability of the proposed analytical protocol. We found that, with our larger sample set, our samples did not split into the same groupings at each step of the flow chart as the proposed model, and weakly tinted samples often could not be clearly classified, but with a partially revised approach we do still see clear groups and differentiating markers between nearly all the probed plant sources. The ability to separate marigold and pericon by FCUV was particularly notable given their close biological relationship. Successes, failure points, and further directions for development will be discussed.

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Dyed not Dead: An Exploration of Medieval Icelandic Dyeing Tradition Using Reflectance Spectrometry (FORS and Spectragryph)

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Abstract

Throughout history, dyed textiles have served as markers of identity, status, and emotion. In medieval Iceland, their significance extended beyond the symbolic or aesthetic: for centuries, textiles also functioned as a form of currency [1]. Dyeing was therefore not only a matter of expression or appearance, but also connected to value, labor, and systems of exchange.

This study attempts to explore multiple dimensions of Icelandic dyeing traditions. To do so, we employed non-destructive Fiber Optics Reflectance Spectroscopy (FORS), processed using Spectragryph software [2], to build a prototype database for the analysis of dyed archaeological textiles. Following botanical and ethnographic research [3], we assembled a collection of 351 wool samples, including 64 undyed Icelandic wool samples, 28 experimental samples dyed with local and imported plants and lichens, and a set of dyed samples from ethnographic museum collections. These were originally donated in the mid-20th century by women who preserved traditional dyeing knowledge.

Once the database was established, we applied it to both secular and ecclesiastical contexts in Iceland. The database was tested on 63 archaeological textile samples from sites ranging from elite households to modest farmsteads across the preindustrial period. Results reveal coherent patterns: imported dyes and greater chromatic variety tend to cluster in wealthier sites and early pagan burials, while rural farmsteads mostly reflect more limited use of local dyestuffs.

Ecclesiastical contexts were targeted through the brilliantly dyed yarns present in 21 medieval embroidered works associated with Benedictine institutions [4]. Each color present on these textiles was cross referenced against our database. The results identify predominantly nonlocal dyestuffs, demonstrating the connections to communities abroad forged by the dyeing tradition.

The next phase of this research aims to refine the FORS methodology for archaeological and heritage applications, incorporating SERS to validate spectral interpretations and the identification of degraded/complex dye signatures [5,6].

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The Use of Natural Dyes in the 15th-19th Century Textiles in East and West

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Abstract

In this paper, dye analysis of historical textiles obtained from the China National Silk Museum, Beijing Arts Museum, and Budapest Museum of Applied Arts was carried out using High-performance liquid chromatography coupled with ion trap mass spectrometry (HPLC-IT-MS) and Surface-Enhanced Raman spectroscopy (SERS). The detection of coloring matters reveals natural dyes from the 15th to 19th centuries used in the East and West. Sappanwood and indigo were used to dye red and blue in Chinese and European textiles. However, dyer's madder and weld were only used for European textiles, whereas safflower and pagoda tree were frequently used for Chinese textiles. Interestingly, American cochineal, imported into Spain from Mexico since the early 16th century [1], was also identified in the Chinese dragon robe and saddle. This clue provides indirect evidence for global trade in the 17th century. Lac is another insect dye that can be extracted from several *Kerria* species; these scale insects are native to India, the Indochina Peninsula, and Southern China. According to the HPLC-IT-MS examination, only a single pink sample of the Chinese textile contains laccaic acids (the main colorants in lac), although lac was commonly used in European textiles at that time.

In addition to HPLC-IT-MS, this paper presents a novel SERS method applied to detect natural colorants in a single fiber. The Lee-Meisel silver colloids treated with potassium iodide (KI) exhibit a higher intensity of SERS signals compared to those in the previous reports [2]. Thus, anthroquinone and flavonoid dyes were successfully identified by the new SERS method in this research.

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Dyes analysis of an Iranian Lampas textile panel from the LACMA's collection

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Abstract

This study investigates the potential use of safflower (*Carthamus tinctorius* L.) dye in a Safavid-period (16th–17th century) Iranian lampas textile panel (M.58.31), held in the collection of in Los Angeles County Museum of Art (LACMA). Lampas is a luxurious patterned silk fabric, typically featuring a ground weave and a supplementary weft that creates intricate designs, widely used in Iran for furnishing and garments during the Safavid period. The research was prompted by an inquiry from another institution, which also holds a piece of the same lampas but believes it to be of a later date. This led LACMA's textile conservator and science teams to re-examine LACMA's lampas piece, along with other related Safavid-era textiles in the collection. The panel studied here represents only a portion of a once-complete lampas, with two smaller pieces in other collections reflecting the modern art market practice of cutting textiles into pieces.

Safflower is as a dye plant known for its bright red to orange hues. Native to the region between northern India and the Near East, it has historically been used in Egypt and parts of Asia. Peach-coloured yarns were found throughout the design of LACMA's lampas's piece. UV illumination revealed that certain fibres exhibited characteristic orange fluorescence, and these preliminary findings suggest the use of safflower dye. To investigate this hypothesis, a multi-analytical approach was employed, combining High-Performance Liquid Chromatography with Diode-Array Detection (HPLC-DAD), Fiber Optic Reflectance Spectroscopy (FORS), and fluorescence analysis. Comparative samples from six other Iranian textiles dated around 1600 were also examined for context. By combining advanced analytical techniques with comparative research, it offers a methodology for re-examining well-known textile types through a fresh lens. Furthermore, it raises broader questions about the diversity of dye sources, the extent of regional experimentation, and the possible influence of trade networks on local production.

Cross craft colours: the unusual mauve washes observed in Hans Bol's drawings

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Abstract

An unusual mauve wash, used extensively and in varying opacities by the Flemish artist Hans Bol (1534-1593) in his 1571 drawing, *St Peter walking on water* (registration number 1946,0713.962), was investigated as part of an ongoing British Museum project [1] and upcoming exhibition on early Netherlandish drawings.

Bol trained in Mechelen as a specialist of painting in watercolour on canvas. Later, working in Antwerp, he was an accomplished miniaturist, producing (miniature) landscapes in gouache with his workshop, as well as illuminated manuscripts [2]. Similarly coloured washes (often described as "lilac") were used by the artist in other drawings but was not common practice among his contemporaries. As little is known about his training and early years, material and technical evidence is vital to understanding his workshop practice, and the cross-pollination between drawing, painting, and miniatures in his workshop, which may have given rise to Bol's use of the mauve washes. This work is the first known pigment analysis of his drawings.

In considering possible sources for this mauve colorant, folium, a natural purple dye obtained from the seeds of the European turnsole plant (*Chrozophora tinctoria*), was proposed, as this was commonly used by manuscript illuminators [3]. However, a combination of non-invasive methods, including Multiband Imaging (MBI), Scanning macro-X-ray fluorescence analysis (MA-XRF) and fibre optic reflectance spectroscopy (FORS), was able to elucidate that an insect-based colourant, derived from kermes (*Kermes vermilio*) or a carminic acid-containing insect (*Porphyrophora* sp. or *Dactylopius coccus*) was employed by the artist. Both colourants would have been available in 16th century Flanders, with American cochineal (*Dactylopius coccus*) sent to the trade hub of Antwerp, on a regular basis by the Spanish from their Latin American colonies [4]. Bol's possible use of these colourants is situated in the wider context of commerce and industry in the global city of Antwerp.

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International Trade With Red Lake Pigments in the Late Renaissance Mediterranean: Understanding Composition of the Pellet from the Cargo of the Merchant Ship *Gagliana grossa* (Gnalić Shipwreck)

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Abstract

According to archival sources, merchant ship *Gagliana grossa* departed from Venice towards Constantinople in 1583 but sank under unknown circumstances near the islet of Gnalić in the Adriatic Sea. Underwater archaeological excavations have uncovered various colouring materials as part of the ship's trading cargo, including lead white, red ochre, vermilion, realgar, minium, and stibnite—some preserved in their original casks and others embedded in sediment within the ship's hold. Among the colouring materials discovered at the site, the discovery of the red lake pigment on the upper deck of the ship is particularly important [1]. The current project aims to establish a reference collection of colouring materials from the Gnalić shipwreck, by forming a sample collection at the Department of Archaeology and associated data in the form of an open-source database.

In Venetian historical documents, red lake pigments are referred to by different names, including *grana*, *laccha*, *verzino*, and *cremese* [2, 3], depending on the type and quality of the colorant used for their production. Although they were often a byproduct of the dyeing industries, the more expensive red lake pigments were extracted from textile clippings [3] and were extensively exported to the Islamic world [4]. While red lake pigments have been mentioned in various historical documents, including inventories of the Venetian colour seller shops, painting treatises, and documents of maritime insurance, and have been identified in particles of shiny red glaze on Renaissance paintings, they have never been found in complete, raw form at an archaeological site. With respect to this unique find, characterization analyses were performed with aim to understand the composition, including optical microscopic observations (optical microscope, SEM and microtomography), as well as elemental, molecular and structural analyses (SEM-EDS, Raman Spectroscopy, FTIR, HPLC, and XRD). Considering the results, the aim of this paper is twofold: the first is to understand the genesis of the pigment, and the second is to discuss possibility of co-relation of findings with secondary historical sources, contributing to the knowledge of trade with pigments in the late Renaissance Mediterranean.

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Chevreul, Color Juxtaposition, & the 'Flat Tints' of Chinese Painting

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Abstract

What is 'color'? More than just a pigment, color is chemical, physical, aesthetic, economic, social, and political. Most fascinatingly, it is a byproduct of colonial and imperial expansion. In my presentation "Chevreul, Color Juxtaposition, & the 'Flat Tints' of Chinese Paintings," I examine the politics of colorant chemistry and trade that undergirded the construction of tapestries at the well-known *manufacture des Gobelins* in Paris between 1800 to 1839. From the seventeenth century onwards, the production of textiles and oil paintings shared common technologies and concerns for quality colorants. In the early nineteenth century, French colorant chemists in the textile industry looked to painting—and specifically Chinese painting—to develop new scientific theories and to improve dyestuffs manufacture. French painters similarly were inspired by imported textiles and paintings to experiment with different modes of painting handling and color harmonies.

Chinese export paintings were fundamental to the historical relationship between tapestry-making and painting in France. From the late eighteenth to the early nineteenth century, imported Chinese paintings were rapidly collected and consumed in Paris. The saturated chroma and color juxtaposition of Chinese art shaped the color theories of Michel-Eugène Chevreul, chemist and director of the Gobelins from 1824 to 1885 (61 years), who encouraged both French *tapissiers* and painters to adopt the colorism of China. As I argue, nineteenth-century French textile and painting techniques depended on the improvement of local colorant chemistry at the metropole. But such innovations were importantly indebted to—and fundamentally shaped by—the brilliant hues of the "Orient."

Dyeing with a coffee cup? Challenging recipes from a 19th century dyer's handbook

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Abstract

A small dyer's handbook in the archive of Dr. Georg Kremer presents unexpected challenges. The handwritten recipes can be dated back to the early 19th century, but origin and author are unknown. This source is fascinating for its detailed instructions. The author must have been an experienced dyer, who wrote down 170 recipes for dyeing or printing on cotton, wool and silk. More than 80 dyed textile samples were sewed or glued into the book and demonstrate the results of the recipes. A colourful palette is achieved with natural dyes such as indigo or indigo carmine, cochineal, madder, alkanna, annatto, turmeric and quercitron. Furthermore, inorganic pigments like Prussian blue and chrome yellow are used.

Unfortunately, the text is characterized by regional accent and inconsistent spelling and is hard to understand even for native speakers. Language analysis was able to assign the origin of the author to the German county of Vogtland, covering parts of Bavaria, Thuringia and Saxony. The spelling or misspelling of the words may leave readers with a smile, but also makes it difficult to figure out ingredients, chemicals or dyes. While words like "Indigo", "Kunschelle" or "Orilan" are easy to identify, the meanings of "Gall" "Gali", "Galj" and „Galj“ are tricky to distinguish. In some cases, only the context provides an indication on the actual substance in use, such as sumac, potassium bichromate or potassium cyanide. Furthermore, the measurement units given in the recipes are problematic. Measures and weights in Germany differed regionally until the early 19th century. In addition, this dyer used vessels of vague volumes such as hand buckets or coffee cups. The presentation will explore the possibilities and difficulties of reproducing these recipes.

An optimized mild extraction method for the analysis of historical dyes by HPLC-DAD-Orbitrap-MS with application to Finnish historical dyes

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Abstract

With historical dye analysis aimed at dye source identification, sample pre-treatment is often required. The pre-treatment step involves the extraction of dye compounds and other possible marker compounds from historical textile samples. The challenge lies in extracting the chemical species exhaustively without significant compound degradation. Several mild extraction procedures have been developed to address this issue [1-3]. While most studies have focused on the extraction solvents, less attention has been given to the extraction conditions or the work processes.

In this study, self-dyed wool reference samples containing a wide variety of natural products found in dye plants, such as flavonoids, anthraquinones, and tannins, were used to develop a mild extraction method. The focus of the work was on optimization of the extraction conditions and the entire workflow for efficient and comprehensive compound extraction.

Importantly, all optimization steps and their effects on extraction yields were monitored using a state-of-the-art HPLC-DAD-HRMS method. The analytical method enabled group-specific profiling and quantitation of several polyphenolic compound groups, including the structurally complex tannins. This improved the analytical accuracy of natural products compared to conventional methods. Lastly, the applicability of the developed method was tested on selected Finnish historical yarn samples.

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The Endangered Material Knowledge Programme: Dyes and Pigments as key elements of traditional material knowledge systems

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The Endangered Material Knowledge Programme, launched in 2018 with funding from Arcadia and hosted by the Department of Africa Oceania and the Americas at the British Museum, provides grants to document and digitise critically endangered material knowledge systems from shell money and body painting to floating domestic dwellings and community ceremonial houses.

Material knowledge is defined in the context of the programme as the '[U]nderstanding of the resources, skills, technologies and social values necessary to create and maintain the material world around us'. This encompasses the knowledge systems associated with the making, use, repair and re-purposing of material objects, spaces, architecture, performance and environments. The programme centres on the making process and knowledge surrounding the 'mundane' artefacts that are entangled in the process of everyday life of communities and peoples all over the world.

To date, the EMKP has funded 125 projects to carry out work in over 60 different countries. Over the years, this has generated a support network of ca. 400 researchers and community members in collaboration with more than 100 partner institutions, museums and local organisations, including 29 Museums and universities only in the UK.

Dyes and pigments are amongst the oldest human technologies. For peoples and communities around the world, they represent much more than just 'colourants', they are the embodiment of different and superposed layers of knowledge, including ecological (understanding of plants, minerals, animals and environments), technological (tools, recipes, process) and cultural (meaning, aesthetics, trade...). To see them as part of material knowledge systems means recognising their importance as repositories and bearers of human experience, knowledge and culture. In this presentation Paula Granados Garcia presents the EMKP and reflects on the work that the programme is doing to support the documentation of dyes and pigments as key elements of traditional knowledge systems around the world.

Research on the red color of the Lielvarde woven belt in Latvia

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Abstract

The history of Latvian textiles encompasses a wide variety of woven bands, primarily from the 19th century. These were handwoven in multiple colours and techniques, many of which served as waistbands. One group— Lielvarde type woven belts — is included in the list of the Latvian Cultural Canon because of its decorativeness and sophisticated ornamentation. Today, it has become one of the symbols of Latvian cultural heritage. However, we know almost nothing about their dating, or the dyes used for the woven yarns. The lack of information in the museum documentation stems from the historically developed specifics of creating textile collections in Latvia. Dye analyses, colour measurements, and research on historical sources about the spread of dyestuffs in Latvia can provide new insights into the dyes used for Lielvarde belts.

Yarn samples from five historical textiles, kept in the collections of three Latvian museums (Liepāja History Museum, Andrejs Pumpurs Lielvarde Museum, and Limbazi Museum), were utilized in the study. Spectral reflectance measurements of the yarn samples were used to calculate their CIE XYZ values. Microscopic magnification of the samples revealed that the colour intensity inside the thread matches the outside, indicating high light fastness. We can identify the dyes used in the Lielvārde belts through research of written sources and chemical analyses of historical and dyed reference samples. In some cases, these analyses could clarify the dating of these objects, which was often determined based on subjective considerations. The practical dyeing experiments conducted within the research framework can provide information on specific dyeing recipes that can be applied today.

A Simple Black: Traditions of Using Iron-Rich Mud for Dyeing in Eastern Baltic Region

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Abstract

Black has been an important and versatile colour used for festive and everyday clothing throughout history. Very complex dye recipes were developed for dyeing high-end black fabrics for the nobility [1]. At the same time, black was dyed in the simplest ways, requiring very little equipment and no purchased commodities, for example, using iron from natural sources with abundantly available tannin-rich tree bark.

Recently, traditional dyeing techniques from Asia using iron-rich mud for silk and cotton have attracted attention of researchers [2-4]. Although having a long history, the use of iron-rich mud for dyeing in Northern Europe is less well-known.

This paper introduces the methods of iron-rich mud dyeing in the Eastern Baltic region based on archival and literature research. The sources reveal fascinating technical details related to mud dyeing dating to the 18th century. For example, how mud rich in iron was identified, what time of year the dyeing was carried out, what type of materials and fibre preparations were dyed this way, how the materials were placed in the mud, and for how long time. Also, which tree barks were used as tannin sources, and how textiles were treated after mud dyeing.

Among these historical descriptions there are several mentions that everyday linen clothes were dyed black with mud. However, nowadays, there are primarily festive clothes preserved in museum collections. To investigate and reveal the black colour of a rural practise at the end of 18th-century South-East Estonia, a recipe used to dye everyday linen clothes black was reconstructed. The complications of working with a dyeing method, where the success rests on finding naturally occurring substances in today's changed natural conditions, are discussed.

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Red dyes in transition: investigating natural and synthetic colorants in Javanese batik textiles via HPLC-DAD-MS/MS and SERS

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Abstract

Batik, a UNESCO-recognised wax resist dyeing technique, flourished along Java's North coast between the late 19th to early 20th century. This era witnessed global trade in textile materials, increasing demand for high quality batiks and the emergence of European synthetic dyes. In this complex historical landscape, the materiality of batik production from this region and across this period remains understudied.

A selection of textiles made by pioneering batik-makers during the late 19th-early 20th centuries was therefore examined for dye analysis. These textiles belong to the private Collection of the Family of Mr and Mrs Lee Kip Lee, the National Heritage Board of Singapore and the British Museum. The analyses focused on red, which is the dominant colour in all the textiles selected. Where available, blue and other colours were also analysed.

Surface-enhanced Raman Spectroscopy (SERS) was able to classify the red dyes into three groups, based on characteristic spectral features. Most samples were identified as *Morinda* sp., a natural red dye traditionally used in Indonesia. However, the other two groups of red dyes could not be identified by SERS, due to limited references. Analysis by High-performance liquid chromatography with diode array detection and mass spectrometry (HPLC-DAD-MS/MS) not only confirmed the use of *Morinda* sp. in most textiles but also revealed a variety of synthetic alizarin compositions, used either alone or mixed with other dyes, including *Morinda* sp., auramine and indigo.

Results suggest that these batik makers were engaged with synthetics to an extent, whether by choice or necessity, while probably still favouring natural *Morinda* red. This study highlights the advantages and limitations of SERS and HPLC-DAD-MS/MS in this context, but most importantly, contribute to a better understanding of how changing material availability and preferences have influenced batik production practices during this pivotal period.

Dye Analysis of 20th Century Textiles from the Toropalca Region of Bolivia

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Abstract

In the geographically isolated valleys of the Toropalca Region in Bolivia's Altiplano, aspects of Inca traditions appear to have survived into the mid-20th century as evidenced by women's use of an open-sided anacu (elsewhere abandoned in the 17th century) and the continued use of full-length men's tunics (prohibited following the Túpac Amaru II revolt of 1780). This research uses textile dye analysis by LC-DAD-MS to shed light on changes in weaving cultures during times of transition, when an indigenous culture moves from the use of natural to synthetic dyes. This can be limited to the change of colorants, but often is simultaneous with a change in material, design, use, and wear of the textile, or in some cases, the eventual abandonment of a textile tradition.

Twenty-three samples of various shades from red to blue were analyzed from ten women's nanakas and seven men's tunics. Radiocarbon dating of six textiles done so far places three before and three after 1950s. In 13 samples of varying shades of red, cochineal was the only dye present, while in two samples cochineal is present with either rhodamine or a mixture of synthetic dyes. In the eight purplish blue samples, various mixtures of synthetic dyes were found including orange II, ponceau 2G, acid red 88, fuchsin, methyl violet, methylene blue, acid black 1, and rhodamine B.

The data show that while synthetic dyes were likely available, cochineal remained the dominant colorant being used by indigenous people of Toropalca to create a range of red shades likely via different recipes. Additional analysis shows the use of variegated yarns made from pre-dyed fiber in a tradition that has not survived elsewhere, which may account for the presence of multiple dyes in some samples. These dye analyses will be correlated with on-going carbon-14 dating, XRF, and FORS analyses.

Title Threads of war: scientific analysis of the dyes, fibres and mordants used in the production of Afghan war rugs

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Abstract

War rugs started being produced in Afghanistan following the Soviet invasion in 1979 and represent a compelling example of how conflict can reshape traditional craftsmanship. These colourful textiles have attracted collectors for decades and sparked debate as symbols of resilience and political commentary but also as controversial commodification of human suffering. However, the manufacture of these complex objects has not been studied with a focus on the evolution of production techniques and materials adopted by their makers.

In the framework of the British Museum exhibition “War rugs: Afghanistan's knotted history” (4 October 2024 – 29 June 2025), a scientific investigation was conducted to study nine rugs from the collection. Approximately 65 samples were analysed by optical microscopy (OM), scanning electron microscopy coupled to energy dispersive X-ray spectroscopy (SEM-EDX) and high-pressure liquid chromatography coupled to diode array detector and tandem mass spectrometry (HPLC-DAD-MS/MS) to study the fibres, mordants and dyes used in the production of the rugs. Scanning X-ray fluorescence (MA-XRF) was also used to map the distribution of mordants.

The results revealed the intentional use of white and naturally brown wool to obtain specific colours. A wide range of synthetic dyes was detected, as expected considering the recent production of these objects. Nonetheless, natural dyes were still used in three rugs. An emodin-based colourant, possibly related to a *Rhamnus*, *Rheum* or *Rumex* sp. dye source, was detected in two shades of light brown. A berberine-based colourant consistent with the amur cork tree (*Phellodendron amurense*) was detected in one yellowish shade. Additionally, similarities in the synthetic dyes used for various rugs allowed them to be grouped with good correlation with the different styles of the rugs. These results represent the first scientific study of these objects and enable preliminary insights into the details of this complex craft that has evolved from centuries of carpet making in this area.

Colours of FANS: Multiple uses, facets and materials under examination of non-invasive and contactless spectroscopic techniques (18th-19th C., Musée d'Aquitaine, Bordeaux, France)

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Abstract

Fans have been rarely studied by their materiality point of view. Only one paper treats of the identification of wood, nacre and ivory [1] whereas fans are also constituted by paper, parchment, textiles, pigments, dyes metallic decorations... Beyond of its used to refreshing, fans are precious objects and serve a wide variety of purposes depending the social context (aristocratic role, spreading revolutionary ideas, weapon of war...). The production of fans seems complex and the superimposition of diverse materials required to combine contactless and non-invasive techniques.

Nine fans have been analysed from the Musée d'Aquitaine's collection, recently given by two collectors whose are making a donation of about 2000 fans from different provenances (China, Japan, France...) and era (17th to 20th C). The combination of various materials on a relatively small and non-flat surface presents significant challenges; this is why portable spectroscopic techniques were employed, including p-XRF, hyperspectral cameras, FORS, p-FTIR, LED μ SF and digital microscopes. This methodology has already been validated by Archéosciences Bordeaux in several other case studies (such as the Aubusson and the Lady and the Unicorn tapestries) [2,3], and has enabled a better understanding of the colouring of this selection of fans.

Analyses highlight the complexity of the manufacture of these objects. For example, the Chinese fan is made of a pure cellulosic paper leaf, onto which kimonos have been glued using dyed textiles, and faces have been cut from ivory and affixed. Regarding the colouring materials, a diverse palette of pigments and dyes was identified. These include mineral-based (azurite, ochres, cinnabar), synthetic (ultramarine blue, Prussian blue, Orange II) and natural (indigo, gamboge) sources. These interpretations were made possible by comparing the spectra with a reference database available in the laboratory [4,5], as well as with another database specifically produced for this study, and by employing cross-validation methods.

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Reproducing Orchil: A Technical and Analytical Challenge

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Abstract

Orchil, a violet dye extracted from lichens and known since Antiquity, was identified in *La Vue*, a tapestry from the renowned series, The Lady and the Unicorn. As previously presented at DHA 42, this identification raised intriguing analytical contradictions: while contactless methods such as hyperspectral imaging and fluorimetry indicated orchil's presence, HPLC–PDA analyses conducted on a microsample failed to detect it, highlighting the analytical challenges posed by degraded natural dyes [1].

To better understand orchil's instability and the reasons behind these analytical inconsistencies, a collaborative study was initiated with professional dyer Charlotte Marembert to reproduce the colour and prepare reliable reference samples. Following historical recipes, the dyeing process involved the use of *Lasallia pustulata*, ammonia-based maceration, and fine control of pH, oxidation and temperature. The variations in these parameters were systematically explored to assess their influence on the chromatic outcome and lightfastness of the dye.

Freshly dyed samples were subjected to accelerated ageing (100 hours exposure to a xenon lamp under controlled conditions), and analysed by HPLC–PDA and hyperspectral imaging. Results revealed rapid degradation of chromophores, with characteristic degradation products appearing within the first hours of ageing. It has also enabled the rediscovery of orchil in the tapestry *La Vue* and the tapestry *L'Ouïe*. This study underscores the importance of interdisciplinary collaboration between analytical research and traditional dyeing expertise, emphasising the need to adapt analytical methodologies when dealing with fugitive dyes such as orchil.

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LC-MS characterization of dyes in a *Robe à la Circassienne*. First evidence of *Parelle D'Auvergne*

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Abstract

As part of a conservation project on an 18th-century *Robe à la Circassienne*, liquid chromatography-mass spectrometry (LC-MS) was performed to identify the original dyes in various areas of the silk. The garment features a ground fabric with cool pink warp and white weft accented by vertical stripes in warm pink, blue, green, white and black. Our work raised intriguing hypotheses concerning the original appearance of the robe and provided the first scientific evidence for a historical arsenic-based process used in lichen dyeing.

Analysis from a light green stripe on the lower right of the robe identified weld along with degradation compounds from Brazilwood and indigo. While it is difficult to gauge original appearance solely from analytical data, this combination aligns with historical recipes describing bronze and wood tints [1]. The pink ground fabric contains orchil and brazilwood, which may suggest an initial color closer to reddish-purple than to the light pink shade visible today.

Orchil dyes obtained from different types of lichens have been used since antiquity. The most important dyeing method in Europe during the 18th century was named *Parelle D'Auvergne*. Despite its popularity, identifying this recipe in artworks remains challenging due to similarities between lichen species and the complex mixtures used in orchil dye production. Analysis with X-ray fluorescence spectroscopy detected arsenic in two areas of the pink fabric, suggesting the use of this historical process.

This recipe, originating in medieval France, resembled other in the use of a multi-day lichen fermentation process relying on ammonia derived from putrid urine; however, the first reference of the addition of arsenic to *Parelle D'Auvergne*, dates to the late 1700s [2].

Next steps of this project, include tracing the *Parelle D'Auvergne* recipe in other MET garments and further examining sections of this robe to deepen our understanding of its original appearance.

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Beyond the Green: Arsenic-Containing Synthetic Blues and Toxicological Risks in Early 20th-Century Commemorative Textiles

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Abstract

This paper presents findings from an ongoing investigation into First World War commemorative handkerchiefs, revealing the use of arsenic-containing synthetic organic blue colorants in printed designs. These handkerchiefs—produced as patriotic souvenirs—were submitted to the Board of Trade for copyright protection and are now part of an archival collection at The National Archives (UK). High-performance liquid chromatography coupled with photo diode array and high-resolution mass spectrometry (HPLC-PDA-HRMS), identified complex mixtures of basic synthetic organic dyes, with Basic Blue 11 (Victoria Blue R, C.I.44040) and Basic Blue 7 (Victoria Blue BO, C.I.42595) as main components. Elemental analysis confirmed arsenic, likely introduced as arsenic acid functioning as a precipitating agent during dye manufacture to form an insoluble salt prior to use in printing inks. Although arsenic-based agents have been occasionally used in the period around 1900 until the 1930's for the precipitation of basic dyes, non-arsenic alternatives were available such as tannic acid and tartar emetic acid, raising questions about the preference for arsenic despite these options. Microfadametry was used to investigate whether arsenic contributed to superior lightfastness, a characteristic crucial to the durability of printed textiles.

While analysis has focused on blue areas, the textiles are often multicoloured, including shades of yellow and red—colours that may similarly contain arsenic [1,2]. Its presence may be linked to availability as a by-product of early 20th-century industries, particularly mining and metal refining, making it a convenient, though hazardous, option. Detection of arsenic in some, but not all, items, also highlights variability in production practices and an under-recognized toxicological legacy. These findings have critical implications for access, conservation, and health and safety in collections. Unlike the widely acknowledged risks of arsenic-laced greens in 19th-century bookbindings, these vivid blues may pose significant handling risks. Framed within the growing field of bibliotoxicology, this research urges a re-evaluation of institutional protocols and greater awareness of hazards that extend beyond the familiar “poison green.” The danger may, in fact, lie in blue.

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