A SHORT HISTORY OF 18-19TH CENTURY BRITISH HAND-COLOURED PRINTS; WITH A FOCUS ON GAMBOGE, CHROME YELLOW AND QUERCITRON; THEIR SENSITIVITIES AND THEIR IMPACT ON AQUEOUS CONSERVATION TREATMENTS

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Abstract

Not much research has been done in the field of British hand-coloured prints in the 18th and 19th centuries. This paper provides a brief overview of the history and production of hand-coloured prints, the people involved, and the common materials used. Three sensitive yellow pigments gamboge, quercitron and chrome yellow, which were commonly used in hand-colouring are also discussed in detail, covering their history, physical and chemical properties, as well as methods of identification. These pigments were selected due to the common usage of yellow pigments in many hand-coloured prints, used both alone and as a mixture to achieve numerous shades of green and orange. Yellow pigments are also known to be very fugitive pigments, with these three pigments being some of the most sensitive. The details of their sensitivities are then used to provide possible aqueous treatment options for the conservation of hand-coloured prints, with focus on the removal of discolouration and soluble degradation products. Possible treatment options include double-screen washing, blotter washing, low-pressure table washing, partial immersion, and the use of rigid Gellan gels. Local and targeted treatment options as well as additional treatment steps like fixing and the use of templates are also discussed.

Introduction

The use of colour is evident in most art forms, adding depth, symbolism, expression and beauty to an artwork. It can be seen from the earliest practises, to the present. In the 18th and 19th centuries, the demand for hand-coloured prints amongst the British public increased dramatically. This growth in the market has led to large collections of such material in museum and archival collections.

Unfortunately, the addition of colour by hand to a print has often been viewed with criticism by artists and connoisseurs of prints. This process of adding colour has ‘dismembered thousands of books and ruined many fine prints’ (Griffiths, 1996: p. 113). By colouring a print that was made with the intention of it being black and white, the original intention of the artists’ work is lost. Old prints with colouring are almost immediately considered dubious, where the colour is assumed to be a ‘cosmetic addition’ made to either compensate for deficiencies, or to appeal to public demand (Dackerman, 2002). Hand-colouring can also be done at any time after printing, making it difficult to accurately determine the time of its application, and whether the colouring is contemporary to the print. These views of colouring

have led to the neglect of this entire phenomenon of printmaking. However, there is no doubt that these prints are historically and artistically valuable as many of them capture the social and political histories of the time. As such, this paper aims to provide an account of the process, industry, materials used, and conservation treatment of hand-coloured prints in Britain.

Research aims, methodology and resources

1. **This paper aims to:**

- Provide the first detailed account of the history behind the production of hand-coloured prints in Britain
- To contribute to the lack of research in the field of hand-coloured prints in Britain, with the view of informing conservators, art historians and conservation scientists
- To provide a reference of the physical properties of several commonly used yellow pigments to aid conservators in the visual identification of yellow pigments used in hand-coloured prints during this period. This informs conservation practice by aiding conservators in the industry who do not have access to instrumental analysis methods to narrow down the possible range of pigments in the print at hand, thereby providing immediate understand of the possible risks involved prior to aqueous treatment.

2. **The aims of this paper will be achieved by addressing the following questions:**

- How the social and industrial framework in Britain shaped the popularity of hand-coloured prints
- Who were the people behind the production and distribution of hand-coloured prints
- What were the common materials used in hand-colouring, specifically watercolour pigments
- What were the popular yellow pigments employed in hand-colouring, their availability, composition, and sensitivities with a focus on Gamboge, Quercitron, and Chrome Yellow
- What are the physical characteristics of common yellow pigments that will aid in their visual identification
- What are the risks associated with the aqueous treatment of hand-coloured prints containing fugitive yellow pigments

3. Literature Review

There exists several comprehensive studies of the British print industry including Timothy Clayton's *The English Print 1688-1802*, which provides a detailed overview of the distribution networks of English prints across the British Empire, as well as the attitudes and social context of the period under consideration, which contributed to the popularity of the print. Martin Hardie's *English Coloured Books*, although not primarily concerned with prints, provides an account of the history of colour in printed material, with brief mention of hand-colouring.

Publications focusing on the field of hand-colouring are scarce. Most notable is Elizabeth Miller's *Hand-coloured British Prints*, a catalogue of an exhibition held in 1987 at the Victoria and Albert Museum. It covers a brief overview of hand-colouring, and describes the materials and techniques of the industry. Susan Dackerman's *Painted Prints: The Revelation of Color* concentrates on hand-coloured Renaissance prints. While not completely in line with the focus of this research, it is ground-breaking in its re-evaluation of the importance of 'painted prints'. An article written by David Alexander in 1997 investigates the individuals behind the colouring of prints in the 17th and 18th centuries.

4. Case Study Survey

Hand-coloured prints from several institutions namely the archives unit at Alnwick Castle, The University of Aberdeen collection, and the Burt Hall Archive at Northumbria University were selected for observation based on the date of their production, provenance, and the presence of yellow pigments used in the hand-colouring. Several prints with differing yellow pigments from similar series were selected where possible for comparative study. These include *The Artist's Room*, and *The Cellar Quartetto* from *The Tour of Doctor Syntax, In search of a Wife* published by R. Ackermann in 1821, as well as several prints from *The Symptoms of Being Amused* and *Moments of Fancy* by Henry Alken, published by Thomas McLean in 1822.

The examination techniques used on these prints differed based on the availability of equipment at the various institutions. The prints were examined under magnification using a magnifying lens, or when possible, a binocular microscope in the range of 6.3x to 40x magnification with a fibre optics light angled to create raking light. Ultra-violet (UV) torches were used to record the behaviour of the yellow pigments under UV light and when facilities

allowed, prints were photographed and examined under infrared (IR) Reflectography and False Colour Infrared (FCIR) photography[1]. Their behaviour under these differing wavelengths were recorded to analyse the possible pigment compositions present. This data will be used as an aid in the visual identification of common yellow pigments via comparison with a chart of authentic painted samples described in section 5.

Due to the subjective nature of technical analysis, additional resources will also be consulted to add to these observations including technical case studies, artist treatises, manuals, and colourmen catalogues. Artist treatises, manuals and catalogues provide useful accounts of the materials recommended during the time, where to obtain such ingredients, recipes for the manufacture of pigments, and hints on the usage of colours. These were often written by the artists themselves, and were meant for other artists, or students of art. Such contemporary resources, although sometimes difficult to interpret, are rich and accurate sources of information.

5. Empirical Work

To aid in the visual examination of the selected case studies, as well as to provide a source of reference for conservators and conservation scientists, pigment swatches of several common yellow pigments including: Yellow ochre, Aureolin, Cadmium Yellow, Indian yellow, Messicot, Naples Yellow, Lemon Yellow, Chrome Yellow, and Gamboge were made. These samples also underwent technical examination, with the results compiled to serve as a reference point for the behaviours of these pigments under different wavelengths of light.

Chapter 1: A Brief History of Hand-coloured Prints in Britain

1.1 The popularity of hand-coloured prints

Since the beginnings of printmaking in the 15th century, prints have been available in both monochrome, and colour. The addition of colour seems a natural process to the finishing of a print, completing the image, giving it expression, form, and beauty. ‘Every passion and affection of the mind has its appropriate tint and colouring…it heightens joy, warms love, inflames anger, deepens sadness, and adds coldness to the cheek of death itself’ (*Reeves and Sons Amateurs’ and Artists’ Companion etc.*, 1851: p. 42).

[1] Also called Infrared False Colour (IRFC)

Prior to the late 18th century, the majority of illustrations were printed in black and white and finished by hand-colouring.[2] A hand-coloured print is a print that has had colour added over it after printing. It is sometimes known as a *coloured* print. In contrast, a *colour* print is one that has been printed using coloured inks (Gascoigne, 2011). Hand-colouring was usually done using watercolours, although prints coloured with gouache or even oils paints have been found.[3] These media were applied either directly using brushes, or through the use of stencils (Ward, 2009). Naturally, prints coloured with stencils allowed quicker production times, and were used to provide flat colour for objects such as playing cards and wallpaper (Hermans, 1987).

The need for colour was recognised by artists, publishers and consumers. As a result, even though hand-colouring prints was a tedious process, incurring high costs at the production end, it was done at a large scale to meet the demands of the public. Coloured prints sold at a premium, almost double the cost of a plain print, and people were willing to pay for them.[4] There were many reasons artists and publishers added colour to a print. The simplest and most obvious one, was for the purpose of decoration. Adding colour to a print made it more attractive, making it easier for a print-seller to sell, and more eye catching for a buyer. Prints were also used as carriers of information, instructing the public on various specialist subjects including fashion, botany, ornithology, etc., and colour was a means of accurately representing such information.

In the 18th and 19th centuries, the British public was increasingly prosperous, eager for entertainment and knowledge. Society was described as wealthy, curious and idle (*Remarks on the Importance of the Study of Political pamphlets etc.*, 1765). This period saw a surge in growth of the print industry. London had become the centre of the art world, and the place for the production of new prints (Clayton, 1997). The population had nearly doubled and people were moving into the cities. Literacy among the public and lower classes was steadily increasing. The flourishing economy created an increasingly wealthy public, stimulating immense growth in the artistic sectors. People were intellectually curious, eager for

[2] It should be noted that there have been a few instances of early woodcut illustrations printed in colour. The most well-known example of pre 18th century colour printing in England is in *The Book of St. Albans*, printed in 1486. It contains sixty-six printed pages, with coloured initials and coat-of-arms, printed using wood blocks inked with red, yellow, blue and green (Hardie, 1990).

[3] Gouache colours are made similar to transparent watercolours containing larger pigment particles and the addition of inert pigment like precipitated chalk, allowing transparent pigments to be rendered opaque (Mayer 1991: p. 293).

[4] During the 1730s, satirical prints were sold at sixpence plain or a shilling coloured (Alexander, 1997). Printed sheets for toy theatres were sold for a penny plain and two-pence coloured (Gascoigne, 2011).

knowledge and amusement, and this curiosity was seen across all social ranks. Art and connoisseurship became part of the everyday life of the English upper and lower classes and the luxury trade in London. There was no 'shortage of patrons or a deficiently educated public…the traditional patron/benefactor was lost in the surge of new customers: women, amateur artists, calico printers, interior decorators' (Lippincott, 1983: p. 73). The public was also politically aware, giving rise to an interest in political satires and caricatures.

The print industry supplied the needs of this public, often fuelling the fashions of the age. In the 1740s, the popular fad of having a print room emerged amongst the British nobility. These print rooms were rooms with walls covered with decorative prints, embellished with ornamental borders, a trend started by Lady Cardigan that continued to the Regency (Entwisle, 1970). Print-sellers responded quickly to this trend; 'Prints of all kinds for Pannels, Ceilings, &c. of the newest fashion' as well as 'One hundred different borderings[5] for hanging of rooms or Prints' were advertised by George Bickham the Younger.[6] It was also common for men to purchase caricatures to decorate their Billiard Rooms. Colouring of these prints to accommodate these trends was probably done not only to make the prints more striking, but to also have them take on the appearance of watercolour or even oil paintings, which were considered more valuable art forms.[7]

Another influencer of the coloured print was the increase in impact women had over the print industry. Much of the coloured prints issued during the time were aimed at the amusement and common interest of ladies, including series' of floral prints, and prints specific to their hobbies, including sewing, painting, japanning and basic print collecting. [8] Philip Overton advertised some of his prints as 'useful…for the Ladies as patterns for working and painting in water-colours, or Furniture for the Closet'.[9] He also advertised approximately five hundred prints sold coloured and plain of landscapes, flowers, birds, etc. for japanning.[10]

As mentioned earlier, many prints were purchased by hobbyists, who collected prints of particular subjects out of interest or study. Such subjects like entomology, botany and

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[5] Papers with printed or painted designs specifically used for decorating a room, or outlining details within a room.
[6] See *General Advertiser*, 8 October 1751
[7] From the catalogue of Stubbs's sale in 1807 it appears that he also offered impressions of his own prints coloured with oils to look like paintings, examples include *The Lion Devouring the Horse*, *The Lion*, and *Lord Pigot* (*Public Advertiser*, 17 May, 20 May and 3 June 1769).
[8] Prints of the same subject or series were often collected and bound in albums.
[9] See *Daily Post*, 9 February 1732
[10] See *Craftsman*, 25 October 1729

ornithology could hardly be fully appreciated in the simple markings of black and white. Hand-colouring added a wealth of information to these prints, and also made truer and more beautiful copies of the original. Satirical prints were a range of prints that were also usually coloured, as colour often symbolised part of the satire being presented. Fashion plates were also another set of prints that could not be fully appreciated without colour. Ackermann's *Repository of arts, literature commerce, manufactures and politics* featured fashion plates in every edition, advising and illustrating ladies and gents fashions (Jones, 2010).

1.2 The people behind hand-colouring

Unlike artists, etchers, and engravers, colourists are not usually acknowledged on a print. This may signify their lower position in the hierarchy of print production. This lack of acknowledgement makes it difficult to identify the individuals involved in the hand-colouring industry. Eye-witness accounts of this process in the 18th and 19th century have not yet been found, adding to the mystery of the entire trade. However, based on older accounts, advertisements, and personal journals, a basic idea of the people involved in the industry, as well as the process can be pieced together.

There have been incidents where a colourist was acknowledged on a print, but these are altogether rare. A collection of coloured plates was published by Rudolph Ackermann in 1826, where Part I and II of the publication entitled *Scenery Costumes and Architecture chiefly on the Western Side of India by Captn. Robert Melville Grindlay, Member of the Royal Asiatic Society & of the Society of Arts, &C.*, consisted of ten prints coloured by J. B. Hogarth, a water-colourist (see figure 1). Artists have sometimes coloured their own prints which can be seen in Eleazar Albin's (1731) *A Natural History of Birds*, which was described in the title page to be 'Published by the Author Eleazar Albin, and carefully colour'd by his Daughter and Self, from the Originals, drawn from the live Birds'. In 1731, Mark Catesby published *The Natural History of Carolina, Florida, and the Bahama Islands*, which contained two hundred and twenty hand-coloured plates coloured by the author. He described his selection of paints in the preface, choosing colours 'most resembling nature that were durable and would retain their lustre' (Catesby, 1731). William Lewin (1800), a naturalist and artist issued *The Birds of Great Britain, with Their Eggs, Accurately Figured*, which contained three hundred and twenty-three plates hand-painted by himself. In 1785, John Binns released James Bolton's *Filices Britannicae*, which was sold in plain or neatly

coloured, “the figures drawn, the plates engraved, and the prints coloured by the authors own hand”.[11]

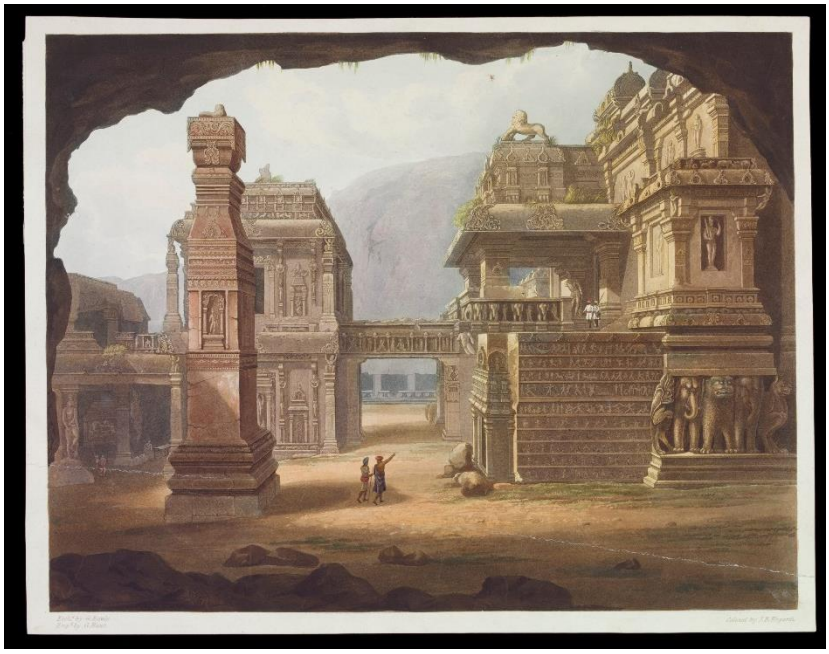

Figure 1 Robert Melville Grindlay (1786-1877), engraved by George Hunt. *View of the excavated temple of Kailasa, Ellora, India,* 1830 (Published), Hand-coloured aquatint painted by J.B. Hogarth. ©Victoria and Albert Museum, London.

Print-sellers and publishers were likely to have had colourists amongst their staff. Arthur Pond, a print-seller and connoisseur in the 1730s was known to have had his prints coloured by his servant Peter Maddox, Enoch Markham his shop assistant, and later further assisted by Thomas Black a drapery painter, and David Bellis a colourman and painting-restorer (Lippincott, 1983). These men were paid approximately two to seven shillings per print they coloured, except for Black who was paid a standard day wage (*Ibid.*).

American print-sellers Currier & Ives based in New York in the 19th century were well known for their hand-coloured prints. Their hand-colouring process has been described in full:

> The “stock prints” were colored, in the shop on the fifth floor at 33 Spruce Street, by a staff of about twelve young women and girls, all trained colorists and mostly of German descent. They worked at long tables, from a model. Many of these models were coloured by Mr. Maurer and Mrs. Palmer, and all were first approved by one of the partners. The model was put in the middle of the table, in a position that made it visible to all. Each colorist would apply one color, and then pass the print on to the next colorist, and so on until the print had been fully colored. It would then go to the

[11] *St. James Chronicle* or the *British Evening Post* (London, England), October 27, 1785 – October 29, 1785; issue 3845

> woman in charge, who was known as the "finisher," and who would touch it up where necessary. (Peters, 1976: p. 34)

It is possible that a similar process existed in the larger print-sellers in England. Rudolph Ackermann, a publisher of decorative prints and illustrated books offered work to European émigrés during the 'Reign of Terror' (1793-94) as engravers, draughtsmen and colourists (Ford, 1983). It is likely that these colourists worked on one print at a time, colouring it in full, or on a batch of prints, filling in all the prints, one colour at a time. An advertisement by a Dr Hill points to the use of such a 'factory' method of colouring, searching for print colourers 'to undertake a complete set of the prints of a vegetable system…used to colour for the shops in the large way, and good work and perfect cleanliness are expected. Patterns are given with them.'[12] The 'large way' mentioned by Dr Hill may signify the same process undertaken at Currier and Ives.

Apprentices in these print shops were also sometimes responsible for colouring prints. Turner and Girtin as young apprentice painters were known to have hand-coloured prints for Mr. John Raphael Smith, a Mezzotint engraver to supplement their income (*Reeves and Sons Amateurs' and Artists' Companion etc.*, 1851). Apprentices were promoted step by step in their fields and those working in print shops possibly spent two to three years colouring prints. Arthur Pond was also known to rely heavily on his apprentices, along with his assistant Thomas Black to manage the colouring of prints in his shop (Lippincott, 1983). Most of these resident colourists remain unknown, although a few other instances of named individuals have arisen.[13] In 1750, several plates of Kensington and Hampton Court were said to be 'coloured by the ingenious Mrs Chandler well known to be inimitable in her art' (Alexander, 1997: p. 166). Fan-sellers and their workers were also known to have coloured prints. Their presence as distributors of coloured prints indicates their skills as colourists (Clayton, 1997). Advertisements for print colourers often specified fan-painters as potential candidates, 'To flower and fan-painters, colourers of prints, &C. Wanted immediately'.[14] In 1734, subscriptions for *The Wonders of the Deep* were taken in by Martha Gamble, who also delivered the final prints in 1736. She was a fan-seller and may have been responsible for the colouring of the prints.[15] Advertisements looking for colourists also called for 'Fan-Painters

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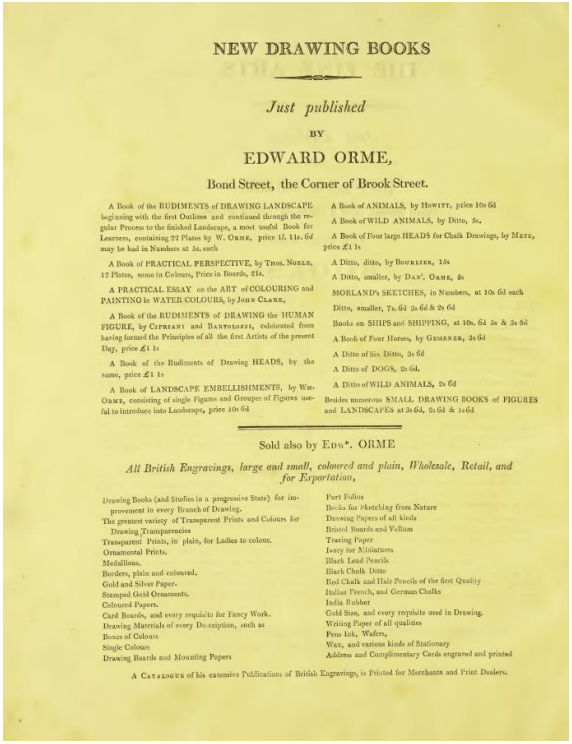
[12] *Gazetteer; New Daily Advertiser* (London) Wednesday 15 April 1772, Issue 13456
[13] See Appendix 4 for a small list of named colourists found
[14] *Daily Advertiser*, Thursday 31 October 1776 Issue 14312
[15] *Craftsman*, 2 February 1734; *London Evening Post*, 24-6 February 1736

and others who are used to the best Sort of this Business'.[16] In addition to their employees, print-sellers were also known to use colourists who worked from home. Many of Ackermann's colourists would report to the Repository daily with the latest batch of coloured prints for examination (Ford, 1983). Print colouring was observably not an occupation limited to men, it was a profession also undertaken by both women and children. In an occupational census in 1851, 130 men, and 54 women were registered as a 'Print colourer' (*The Census of Great Britain in 1851 etc.*, 1854: Table XXXIV).

While many prints were sold by print-sellers already coloured, some prints were sold specifically with the intention of colouring to be done by buyers interested in hand-colouring. The skill of hand-colouring was associated with the British upper class, an accomplishment for ladies and a skill for men. Henry Peacham (1634) believed it a skill necessary for gentlemen who travelled, stating that the washing and colouring of maps and tables of places would help commit them to memory. Prints were also advertised specifically for women to colour. Edward Orme advertised (see figure 2) 'transparent prints in plain for ladies to colour' (Clark, 1807). Numerous treatises mentioning print colouring have also been written over time showing the popularity of this pastime. These include *Academia Italica: The Publick School of Drawing, or, The Gentlemans Accomplishment*, by R. Q. & T. P, published in 1666, a *Book of dravving, limning, vvashing or colouring of maps and prints, or The Young mans time well spent* in 1666, *The Art of Painting in Oyl... to which is added the whole Art and Mystery of Colouring Maps and other Prints with Water-Colours* in 1701, *The Art of Drawing and Painting in Water-Colours. Whereby a Stranger to those Arts may be immediately rendefed capable of…Colouring any Print or Drawing in the most Beautiful Manner* in 1731, *A painters companion; or a treatise on colours …together with the beft methd of colouring maps, prints, views, &c*…in 1762, and *The Art of drawing and painting in watercolours wherein the principles of drawing are laid down after a natural and eafy manner; and youth directed in every thing that relates to this ufeful art…in 1779,* in which a section on water-colours instructs on the illumination of prints. Print colouring was also seen as a child's pastime, the recollections of a child's delights by Stevenson (1884) illustrates the joy that accompanied the colouring of prints.

[16] *Public Advertiser* 21 May 1761



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Single Colours
Drawing Boards and Mounting Papers

Port Folios
Books for Sketching from Nature
Drawing Papers of all kinds
Bristol Boards and Vellum
Tracing Paper
Ivory for Miniatures
Black Lead Pencils
Black Chalk Ditto
Red Chalk and Half Pencils of the first Quality
Italian French, and German Chalks
India Rubber
Gold Size, and every requisite used in Drawing.
Writing Paper of all qualities
Pens Ink, Wafers,
Wax, and various kinds of Stationary
Address and Complimentary Cards engraved and printed

A CATALOGUE of his extensive Publications of British Engravings, is Printed for Merchants and Print Dealers.

Figure 2 Advertisement from John Heaviside Clark's *A Practical Essay on the Art of Colouring and Painting Landscapes in Water Colours.* Published in 1807, printed and sold by Edward Orme.

In the early 19th century, while the popularity of caricatures declined, British aquatints of topography were popular (Miller, 1987). Large print-sellers like Ackermann were involved in the production of coloured plate books. He published a series of architecture and topographical views.[17] These prints were all hand-coloured aquatints, printed on Whatman paper and published in limited editions of 1,000 copies. This hand-colouring of 372,000 prints at a high quality required huge amounts of time and organisation, a huge feat compared to the simple process of colour printing (Ford, 1983). By the middle to late 19th century, the beginnings of colour lithography started the decline of hand-colouring.

On a whole, the colouring of prints was attempted by many individuals, from paid professionals and artists, to amateurs and even children. As such, large differences in the quality of colouring can be seen, even amongst the same series of prints where some may have been professionally coloured, while others were bought plain, and coloured by a child. Furthermore, some of these prints have been coloured in more recent times, with the aim of making them look like old colouring. With all these different contributors to the colour in old

[17] The Microcosm of London, 3 vols., 1808-1810 (104 aquatints); The History of the Abbey Church of St. Peter's Westminster, 2 vols, 1811-12 (80 aquatints); A History of the University of Oxford, 2 vols., 1813-14 (64 aquatints); A History of the University of Cambridge, 2 vols., 1814-15 (80 aquatints); and The History of the Colleges, 1 volume, 1816 (44 aquatints).

prints, it is necessary to understand the common materials used during the time, not just to sieve out the modern coloured versions, but to understand the risks involved when handling and treating these prints.

1.3 Materials and Methods

Before identifying the materials present in hand-coloured prints, it is necessary to understand how to differentiate hand-coloured prints from colour prints. While some hand-coloured prints were coloured in oil paints, body colour and gouache, watercolours were the most common medium for this process. Watercolour washes are a colloidal dispersion, containing small particles of pigment suspended in a liquid like water or gum. The pigment particles are applied in a liquid state, allowing the water molecules and particles to distribute evenly. The water then evaporates, allowing the particles to stick to the paper via the gum (Cohn, 1977). The most common gum used in the 18-19th century watercolours is gum arabic (Ormsby *et. al*., 2005). Gum arabic is derived from the Acacia tree and is classified as a lyophilic colloid.[18] When mixed with a liquid, high forces of attraction exists between the colloidal particles and the liquid. As such, these solutions are stable, and do not precipitate or coagulate easily (*Miller-Keane Encyclopedia and Dictionary of Medicine, Nursing, and Allied Health, Seventh Edition*, 2003). These properties are extremely useful in watercolours as gum arabic sustains an even dispersion of pigment particles in water until the water evaporates off the surface of the paper, and the pigment is gummed into place. It also allows for an effective wash where each particle of pigment is used in the most efficient manner, allowing the pigment to be spread over the largest possible surface while maintaining a strong colour. According to Hauser and Lynn (1940), stable particles that do not congeal have sufficient time to disperse evenly in positions of minimum free energy to each other, allowing a close packed dense sediment to form. Differing amounts of gum are needed for different pigments based on their differing properties. Colours that needed to stand out like blues and browns were more heavily gummed, and lighter tones like lake and vermilion were less gummed (Constant-Vignier, 1830, cited in Cohn, 1977). Some pigments like Gamboge required no gumming at all (Standage, 1896).

Watercolours were applied using brushes of different sizes, sometimes with the aid of stencils. Hand-coloured prints coloured using brushes are likely to be more detailed, with

[18] A colloid is a mixture of minute particles dispersed in a second substance. Lyophilic colloids refers to a colloid that readily absorbs solvents and distributes it evenly throughout the medium. (*Miller-Keane Encyclopedia and Dictionary of Medicine, Nursing, and Allied Health, Seventh Edition*, 2003)

shadings, and flourishes. Marks bearing the appearance of brush strokes may also be seen particularly along the edges of a colour (see figure 4). Hand-colouring executed using stencils are usually done with flat colour, over larger areas. Its usage will reduce the presence of brush strokes, making it slightly more difficult to identify hand-colouring (Gascoigne, 2011). If a single colour across the print appears misaligned with the printed image, it can suggest that a stencil has been used. Under magnification, pigment particles in watercolour washes can often be seen to settle at the wet/dry interface, leading to a darker edge. Washes applied by hand will often leave no areas of white in the painted area, unlike colour prints which often exhibit uniform white dots of uncoloured paper. Hand-coloured washes often appear uneven, where blobs of pigment have collected where the brush was lifted from the paper. Certain layers of pigment may lie above the inked areas of the print, as well as other washes (see figure 3). Occasionally, the watercolour may not have been precisely applied, leading to the wash spilling over the printed image, or slightly missing the edge of the printed image (see figure 3 and 4). Watercolour brushes were often made from red and brown sable hair from the tail of the kolinsky (brown sable was considered superior prior to the twentieth century), Siberian hair, and camel hair – both from the Russian squirrels' tails (Cohn, 1997).

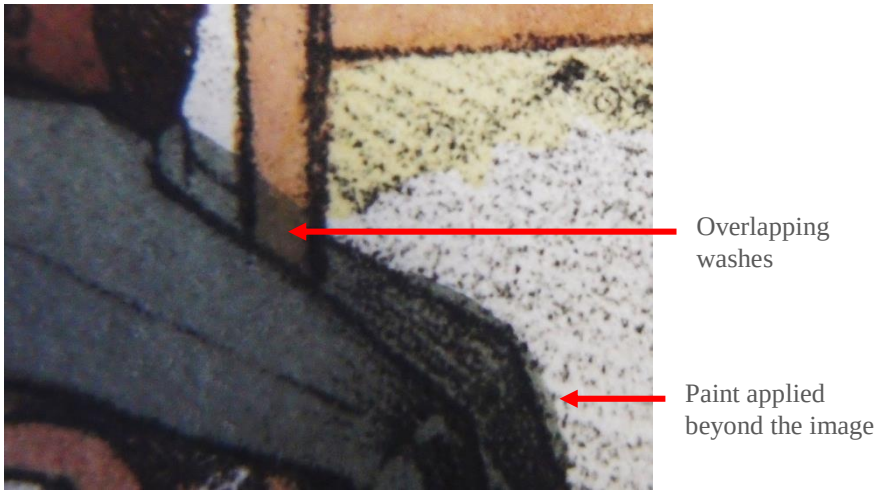

Figure 3 A close up image showing layers of washes applied by hand, as well as paint applied in a less-precise manner, spilling over the printed lines. Henry Alken (1785-1851) *Symptoms of coming from the Hunt, of Star Gazing, Going to the Hunt, of an Elegant Writer, of Toasting an old Friend*. Hand-coloured soft ground etching. Published by Thomas McLean, London, 1822. ©Alnwick Castle, Northumberland.

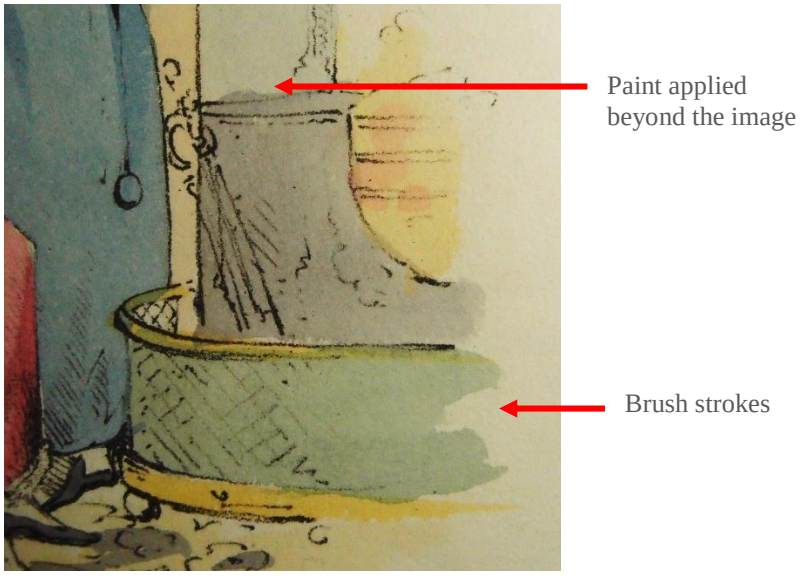

Figure 4 A close up image showing brush strokes as well as paint applied beyond the print image. Henry Alken (1785-1851) *Moments of Fancy, not a bit of fancy, a bit of fancy, all fancy and whim, a political fancy, a dangerous fancy*. Hand-coloured soft ground etching. Published by Thomas McLean, London, 1822. ©Alnwick Castle, Northumberland.

Colour prints on the other hand produce a more uniform result due to the consistency of pressure applied during the printing process. Sections may have the appearance of small dots of different shades spaced evenly; brush strokes would not be present unless hand-colouring was done as part of the finishing process. Should sections of the colour spill over the printed image, it will occur uniformly across the entire image due to misalignment of the colour plates (see figure 5). Artificial edges may also be visible that could not have otherwise be made using a brush.

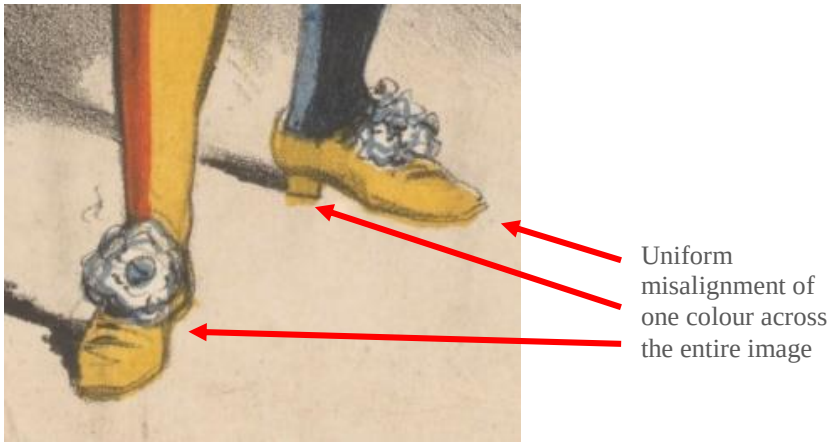

Figure 5 A close up image showing misalignment of the yellow plate used during printing. Alfred Concanen (1835-1886) (Lithographer) *The Troubadour's Rum Tum Tum*, Chromolithograph. Published by Duff & Stewart ca. 19th century. ©Victoria and Albert Museum, London.

Watercolours have evolved tremendously since the time of German artist Albrecht Dürer (1471-1528), who is often credited as the first master of the wash technique (Cohn, 1977). The greater understanding of pigment chemistry, as well as the discovery of new pigments has greatly contributed to development of watercolour pigments. In the 18th and 19th century, the common pigments used in hand-colouring included indigo, French ultramarine, cobalt blue, Prussian blue, red lake, vermilion, carmine, ochres, gamboge, chrome yellow, sap green, terre verte, Van Dyke brown, sepia, and Payne's grey.[19] A colourist could also mix colours, using three main primary colours e.g. Indian red, light red or red lake, mixed with yellow ochre and Prussian blue (Laporte, 1812).

Prior to the invention of watercolour pans, artists and their apprentices tended to prepare their own colours. However, preparations took time and the recipes for the preparation of pigments varied greatly. This affected the quality of the watercolours prepared. In the 17th century, colourman workshops sold paints to the general public. Once again, due to the lack of knowledge of the chemical properties of pigments, these products were not consistent in quality and were sometimes unstable. In 1781, dry-cake[20] watercolours were introduced by colourman William Reeves which immediately gained traction amongst artists. This invention was awarded 'the Greater Silver Palette' by the Society of Arts' Committee on Chemistry 'as a mark of approbation of their method of preparing pigments for painting in water colours.'[21] Unfortunately, dry-cake watercolours were not perfect, described as hard, gritty, and difficult to rub into washes (Redgrave, 1892). This led to the development of moist colours, where hygroscopic[22] agents like honey or glycerine were added to the cakes, making them softer and easier to dissolve. However, some criticized the moist colours as their sticky surface attracted dust and dirt, affecting the purity of the wash. The additional viscosity of the hygroscopic agents diminished the colloidal dispersion of the pigment particles, affecting the consistency of a wash when dry (Cohn, 1977). As such, dry-cakes were still recommended through the 19th century, and even underwent a revival in the early twentieth century due to their greater transparency and more brilliant wash quality (Finberg & Taylor, 1917). While dry-cakes are a likely medium for hand-colouring prints, moist watercolour pans, and self-prepared watercolours cannot be discounted.

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[19] See Appendix 1 for a list showing recommended watercolour pigments during the time
[20] Gum Arabic is added to the pigments during and after the pigments are ground in water. The paint is then dried into cakes. These dried cakes can be wetted up and used over and over again.
[21] Reeves & Sons advertisement, in Nisbet (1920: p.113).
[22] The tendency of a substance to absorb water

The convenience provided by watercolour pans led to the emergence of several well-known artist suppliers including Winsor and Newton, Robersons, Rowney, Ackermann's and Reeves. Watercolours work especially well on paper, which was probably the reason behind their popularity for hand-colouring prints. However, the most suitable properties in a paper for watercolours are not necessarily the best properties for printing. For example, engraving and etching require a softly sized[23] paper, which would mould itself to the grooves of the plate to pick up the printing ink. However, watercolours require highly sized paper to allow the fluid to remain on the surface of the paper. As such, either a medium sized paper may have been used during the printing process, or the paper was sized after printing, but before colouring. Sizing may have been executed using gelatine and alum, or alum and rosin. When papermaker James Whatman developed wove[24] paper, its smoother surface made it ideal for the use of watercolours. It quickly became popular for the printing of aquatints and caricatures (Clayton, 1997). Ackermann was also known to have hand-coloured aquatint plates printed on Whatman paper. Glazing was sometimes done on hand-coloured prints, more commonly in the foreground to add depth to the work. This was done on sized paper to prevent it from seeping through the paper. Glazing was most commonly done using gum Arabic. In 1843, Ackermann published drawings by Charles and Karl Bodmer which contained hand-colouring, finished with gum Arabic, in what was described to be a 'truly lavish book' (Ford, 1983: pp. 125-126).

Before the 1840s, most papers were handmade using cotton and linen fibres from old rags, with a rough[25] finish, and heavily sized (Hunter, 1978). It is unlikely that a hand-coloured print was produced on calendered or glossy papers due to the surface qualities needed for the use of watercolours. After the 1840s, hand-coloured prints could have been produced on either handmade or machine-made paper using rags, cotton fibre or wood pulp. Paper finishes included rough, HOT[26], and NOT[27].

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[23] Size or Sizing is a water-resisting agent, such as a glue or gelatinous material added to paper, during manufacture (engine sizing), or after the sheet is made (tub-sizing), to make the paper more or less impervious to ink or moisture (Labarre, 1969: p. 245).

[24] Wove paper is made using woven wire moulds. The paper surface is covered with a fine brass screening which when left in the paper, would leave a distinct impression resembling fabric. It offers a smoother surface than laid paper, which was more commonly used prior to the rediscovery of wove paper in 1750 (Hunter 1978: p. 126-127).

[25] Paper with a coarse surface, with larger and open grains (Krill, 1987)

[26] To achieve a smooth finish, paper is placed between polished plates and subjected to the pressure of heavy metal rolls. For an extremely smooth surface, these plates are heated in a steam-jacketed chamber before pressing (Hunter, 1978: p. 450).

Chapter 2: Yellow Pigments: A focus on Gamboge, Chrome Yellow, and Quercitron

2.1 Why Gamboge, Chrome Yellow, and Quercitron

Yellow is one of the three primary colours, a necessity on the artists' palette. As a pigment, it is commonly used alone, as well as mixed with blue pigments to produce a large range of greens, and red to produce orange. Yellow pigments are well known for being sensitive, often fading over time when exposed to light, and fugitive in water, solvents, and changes in pH. They are derived from several sources, including both natural, and artificial products. During the 18th and 19th centuries, the following yellow pigments were at some point recommended for use for water colouring: Yellow ochre (pre-history-present), Chrome yellow (1816-limited use at present), Aureolin or Cobalt Yellow (1852-present), Indian Yellow (15th century-1883), Lemon Yellow (1830-present), Naples Yellow (16th century-present), Gamboge (17th century-limited use at present), Quercitron (Early 19th-early 20th century), and Orpiment (Antiquity-19th century). The oldest of these pigments is yellow ochre, which was used by the ancient Egyptians. The chrome, cadmiums and cobalt yellows were discovered later in the mid-19th century.

With watercolours, the more durable, opaque pigments are less manageable, with larger particles that remain on the surface of the paper. Conversely, the beautiful, delicate, transparent colours with a strong capacity for washing, are the most fugitive (Gullick & Timbs, 1859). It is natural for less informed individuals to have used these beautiful yet fugitive colours, especially if they were affordable, and readily available. This section will focus specifically on gamboge, chrome yellow, and quercitron, covering their discovery, manufacturing process, characteristics, and working properties. These pigments are the focus of this paper due to their extremely sensitives natures, coupled with their beauty, affordability and ease of use, which contributed to their common usage during the time. Other pigments commonly used for hand-colouring will be studied in future research.

The identification of pigments on hand-coloured prints provides not just an insight into the common materials available during the time, but also the techniques, skills and concerns of the colourists. Understanding the common materials available also provides more information

[27] Referring to papers that are not hot-pressed, with a slightly rough and unglazed finish, produced by pressing wet paper against itself (Bower, 1999: p. 128).

to the conservator, allowing better understanding of the potential risks that may arise during treatment. Unfortunately, it is extremely difficult to identify materials without contact or sampling. Additionally, not many institutions or conservation studios have access to pigment identification methods such as Raman Spectroscopy, Scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM/EDX), Fourier transform infrared (FTIR), High performance liquid chromatography (HPLC) etc. While accurate identification is impossible via visual observation, knowledge of materials combined with a basic idea of behaviours of certain pigments can narrow down the possible range of pigments, allowing conservators to make more informed treatment decisions.

2.2 Gamboge

2.2.1 History

Gamboge is an organic pigment derived from the plant kingdom. It is made from the gum resin of various types of evergreen trees grown in South-East Asia, most notably of the genus *Garcinia*. Once extracted, the resin would harden and be sold in lumps, cylinders or cakes, yellowish brown on the outside and orange red on the inside (Riffault, Vergnaud, and Toussaint, 1874). Gamboge was not often seen in Europe and Britain prior to the 1600s, and was considered a novelty when the East India Company imported a batch in 1615 (Harley, 2001). While it has been listed as an oil colour), it is most often used in watercolour painting due to its transparent nature, clear and bright colour, and ease of use (Church, 1890; Weber, 1923. De Massoul described Gamboge to be ‘a most beautiful yellow, easy to use, and generally employed for water colours’ (1797: p. 146-147). It was also employed as a varnish for decorative items including metals, woods, and leather (Winter, 1997).

Gamboge was recommended for use in several artist treatises throughout the 18th and 19th centuries. In 1762, John Hoofnail recommended a tincture of gamboge for colouring prints. A tincture of gamboge (also called extract) was prepared by precipitating the colouring matter of gamboge in alcohol, giving the product a powdery texture that is miscible in oil, with improved colour, and usable for glazing (Field, 1835). In 1844, Fielding recommended gamboge as an ‘excellent water-colour’, ‘proper for mixing with other pigments’, ‘durable itself’ while protecting other colours (1844: p. 48). It was also listed as one of twelve pigments recommended to beginners.[28] John Clark (1848) used gamboge in his work and

[28] ‘To the beginner, we would venture to recommend, in his first attempts, not more than ten or twelve – as yellow ochre, gamboge, Indian yellow, burnt sienna, venetian red, lake, Vandyke brown, brown, pink, indigo,

suggested it in his treatise for drawing and painting in water-colours. Even in 1904, Gamboge was still listed as a watercolour, and was one of three yellows listed by Mary Breakell recommended for student-use due to its affordability. It was listed in Reeves and Sons's 1853 catalogue, Winsor and Newton's 1840s catalogues, Rowney's 1850s catalogues, and Roberson and Co.'s recipe book (c. 1860s).

2.2.2 Working Properties

Gamboge is reportedly easy to prepare, requiring little to no additives. Clark described a lump of gamboge to possess 'all the qualities required' to produce colour (1807: p. 9). It dries well and can be used with other colours (Standage, 1896). It was used on its own to produce a bright, transparent yellow, or mixed with blues like Prussian blue and Indigo for green, or burnt sienna for orange. It was also painted over white pigments. It has a refractive index of 1.58.

While recommended by many authorities including Field (1835) in the early to mid-19th century, it was later condemned, mostly due to issues with its lightfastness. Gamboge was described by Standage to vary in permanence, 'somewhat fugitive under certain circumstances', and 'occasionally darkens in tone' (1891: pp. 29-30). He also described Hooker's Green, a pigment comprised of a mixture of gamboge and Prussian blue to be 'not permanent but very serviceable' (1891: p. 36). Muckley listed it 'in the second order or permanence', which changes when used alone or combined with other colours (1893: p. 37). A report on the action of light on watercolours by Russell and Abney also listed gamboge as 'a colour that faded but did not entirely disappear' when exposed to light (Russell and Abney, 1888 in Standage, 1891: Appendix A).

2.2.3 Physical and Chemical Properties

Gamboge is composed of approximately 15-25% water-soluble, carbohydrate based gum, and 70-80 percent resin, which is soluble in organic solvents. Small amounts of esters, hydrocarbons, wax, ash residue, and vegetable detritus have also been reported (Dieterich, 1901; Winter, 2008). However, the exact quantities of these components differ greatly based on the source and variety of the gamboge. The resin in gamboge is composed mainly of gambogic acid ($C_{38}H_{44}O_8$) (see figure 6), which imparts the yellow-orange colour in the resin.

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cobalt, and raw umber; after a degree of facility has been acquired with these, the list may be enlarged' (Fielding, 1844: p. 11).

It also contains a carboxylic acid group, forming soluble salts with alkali. The phenolic groups present in the resin leads to a colour change from yellow to orange when an alkali hydroxide is added (Winter, 1997). Gamboge is also known to darken when exposed to ammonia, and can be bleached in strong heat (*Ibid.*).

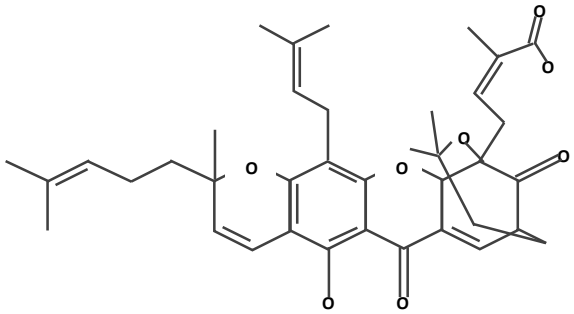

Figure 6 Chemical Structure of Gambogic acid

2.2.4 Methods of Identification

Gamboge under visible light appears as a bright, clear, translucent yellow. The gambogic acid present in gamboge possesses an amorphous structure, allowing dispersions of gamboge in water to be finely divided. This characteristic is seen under magnification on paper as a yellow stain on the paper fibres. Gamboge absorbs strongly under ultra-violet fluorescence, appearing a dark brown colour. Under infrared reflectography, gamboge transmits, appearing translucent. Using false-colour infrared photography, gamboge appears as a very pale yellow.[29] Gamboge can also be identified using instrumental methods of analysis like FTIR, Raman spectroscopy, and thin-layer chromatography.

[29] See Appendix 5 for a table showing properties of gamboge in visible light, UVF, IRR, and FCIR.

Figure 7 A close up of suspected gamboge pigment; photomicrograph at 20x magnification showing translucent, stain-like appearance of the pigment in the paper fibres in Theodor Friedrich Ludwig Nees von Esenbeck, Lithographed by H. von Arnz and A. Henry, *Verbascum Thapsiforme Schr*, (1828-1833) Hand-coloured lithograph, ©Burt Hall Archive, Northumbria University, Newcastle-upon-Tyne.

2.3 Chrome Yellow (Lead Chromate)

2.3.1 History

Chrome yellow is an artificial colour manufactured from the mineral chromium. Chromium was discovered in 1797 by Vauquelin, who determined the colouring power of the new element chrome (Harley, 2001). Chrome yellow was manufactured through the addition of a solution of lead salt (acetate or nitrate) to a solution of an alkali chromate or dichromate (Bearn, 1923). It can range from yellow to orange, depending on the quantities and concentrations of lead solution and alkali chromate used. Lighter shades were usually composed of lead sulphate, middle tones from neutral lead chromate, and darker/orange tones from basic lead chromate (Gettens and Stout, 1966).

It was introduced into the English market by Dr. Bollman, and was first listed by Field in 1835, who described chromates of lead to be beautiful and brilliant, light resistant, with ‘good body’, working well in both water and oil, but when used alone or in tint can ‘lose their pure colour’, and can ‘become black in impure air’ (1835: p. 11). Fielding listed it as one of the thirty most useful colours in watercolours. In the middle of the nineteenth century, he also stated that the various chrome yellows were in common use (1844: p. 48), and Clark (1848) listed chrome yellow as a suitable watercolour. In their study, Russell and Abney found chrome yellow to remain unchanged when exposed in an open tube, and also mentioned its permanence as a watercolour in ordinary atmospheric conditions (Russell and Abney, 1888,

cited in Standage, 1891: Appendix A). It was present in Winsor & Newton, Rowney and Reeves artist catalogues since 1835, and was still listed in Weber and co.'s 1923 catalogue. It was an affordable pigment, often sold at 1s per cake.

2.3.2 Working Properties

Chrome yellow is a brilliant yellow with good covering power due to its high refractive index of 2.3-2.7 and good tinting strength (Kühn and Curran, 1986). It was used alone, as well as mixed with Prussian blue for green cinnibar and chrome green. Chrome yellow was not often recommended due to its chemical properties which will be mentioned shortly, but also due to its brilliancy, which has been described to 'not accord with the modest hues of nature, nor harmonise well with the sober beauty of other colours' (Field, 1835: p. 77).

Various authorities discounted the use of chrome yellow, citing its inability to work well with other pigments, tendency to blacken, and poor lightfastness. Chrome yellow was said to severely damage other pigments, especially Prussian and Antwerp blues (Field, 1835; Taylor, 1887). The lead content of the pigment causes discolouration when exposed to sulphurous gases, compounds, and pigments of organic origin like Lakes, Indigo, Gamboge, etc. Breakell (1904) recommended that chrome yellows should be completely avoided for use in water-colouring.

2.3.3 Physical and Chemical Properties

Chrome yellow refers to pigments composed of lead chromate or lead chromate sulphate. The ASTM Standard identifies three main chrome yellow pigments: primrose yellow contains a minimum of 50% $PbCrO_4$, Lemon Yellow (or Light) contains a minimum of 65% $PbCrO_4$, and Medium contains a minimum of 87% $PbCrO_4$ (American Society for Testing and Materials, 1977). Other constituents of the pigment include lead sulphate, lead carbonate, and lead phosphate. Other additives or extenders[30] such as china clay and diatomaceous earth may also be added (Kühn and Curran, 1986).

The monoclinic crystalline structures of chrome yellow are known to darken and turn brown over time due to a photochemical reaction by visible and ultra-violet radiation (Weber, 1923; Kühn & Curran 1986). This darkening also occurs in the absence of oxygen and moisture, and in the presence of hydrogen sulphide (Church, 1890). When mixed with organic

[30] Extenders are inert, colourless or white body used to diffuse or dilute pigments, especially those with high tentorial strength, making them more economical to produce (Gettens and Stout, 1966).

pigments, chrome yellow may adopt a greenish tone, attributed to the reduction of chrome to chromium oxide. The addition of alkali will also cause chrome yellow to transform into red basic lead chromate.

2.3.4 Methods of Identification

Chrome Yellow under visible light is a brilliant, opaque yellow. The particles in chrome yellow are extremely fine and opaque and may appear under magnification as a thin layer of fine particles on the paper surface. Chrome yellow absorbs strongly under UV, appearing a dark brown colour. Under IRR, chrome yellow transmits, appearing transparent. In FCIR, chrome yellow appears as a pale yellow. Chrome yellow can also be identified using instrumental methods of analysis like X-ray diffraction and Infrared Spectroscopy.

2.4 Quercitron

2.4.1 History

Quercitron is a yellow dye derived from the inner bark of a group of oak trees known as *Quercus velutina* in North America. It was introduced to England by Dr Edward Bancroft in 1775, but was only used as a pigment for painting approximately fifteen years after its introduction (Harley, 2001). Quercitron was often put forward as the most durable of the yellow lakes (Field, 1835; Martel, 1859; Salter, 1869; Church 1890). A lake is prepared by precipitating organic extracts on mineral bases like aluminium of the oxides. The recommended white earth for fixing lakes was the white precipitate of alumina. (Taylor, 1887). Quercitron Lake was thus manufactured by extraction from the bark with water, the addition of alum, followed by precipitation with salt (Gettens & Stout, 1966).

Quercitron was used throughout the nineteenth century, and was sold under a variety of names including yellow carmine, Italian pink, brown pink, Dutch pink, English pink, and yellow lake (Taylor, 1887; Clarke, 2009). Quercitron was first mentioned by name by Field, who described it as ‘a beautiful yellow colour’ when ground (1835: p. 84). Smith (1827) used both Italian pink and brown pink in his treatise, although it is not clear if these were derived from the bark of the black oak tree. It was also listed (under English and Dutch pink) as one of the most employed yellows in a water-colour treatise published in 1843 (*The Hand-book of the elements of painting in water colours*, 1843). Standage described it to be a bright, transparent yellow that is ‘fairly durable when pure’ (1896: p. 43). In 1801, a treatise on Ackermann’s watercolours listed Ackermann’s Yellow, described to have a beautiful and rich

colour, similar to the tint of gall-stone (Ackermann, 1801). Harley (2001) suggests that this pigment may have been quercitron due to the similar description. Yellow lake and Italian pink were listed in the earliest Winsor & Newton, Rowney, and Reeves's catalogues.

2.4.2 Working Properties

Quercitron is a bright, transparent yellow. It was often used alone or combined with other yellows to 'add richness and depth', and good as a glaze or finishing colour (Field, 1835: p.84). It was easy to use and could be bought ready prepared. Quercitron could also be mixed with Prussian blue to produce olive green (*The Hand-book of the elements of painting in water colours*, 1843). Yellow lakes were not usually recommended for use due to its non-permanent qualities. Field (1835) categorised Quercitron Lake as a pigment that altered under the action of light, oxygen and pure air. Standage believed that all lakes 'should be used with caution and looked upon with suspicion (1896, p.43).' However, Quercitron must have still been in use in the late nineteenth, and early twentieth century as Breaknell (1904: p. 19) listed 'Yellow pinks, Dutch, English and Italian, Brown Pink, &C.' as colours that should be avoided in water-colour work.

2.4.3 Physical and Chemical Properties

The colouring constituent of Quercitron is quercetin ($C_{15}H_{10}O_7$) (see figure 8). Under magnification, it appears a light, greyish yellow which changes into a fine yellow upon the addition of alum. Quercitron is soluble in water and alcohol, sensitive to acids and alkalis, and light fugitive (Brill, 1980). It decolourises in the presence of acid, and turns yellow-brown with alkalis (Brill, 1980; Gettens & Stout, 1966).

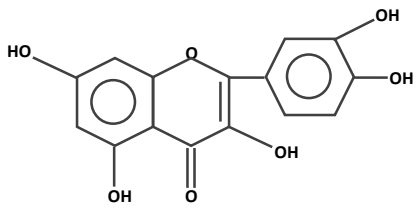

Figure 8 Chemical Structure of Quercetin

2.4.4 Methods of Identification

Quercitron is a bright, translucent colour under visible light. The fine particles of the pigment allow it to penetrate the fibres of the paper, appearing as a yellow stain under magnification. It fluoresces yellow under UV, transmits in IR appearing transparent, and appears a very pale yellow in FCIR photography. Quercitron can also be identified using instrumental methods of analysis such as HPLC.

2.5 Summary of the sensitivities of Gamboge, Chrome Yellow and Quercitron

	Gamboge	**Chrome Yellow (Lead Chromate)**	**Quercitron**
Light	Poor - Fades	Poor – darkens and turns brown	Poor - Fades
Organic Solvents[31] (e.g. IMS, acetone, etc.)	Resin component is highly soluble	Stable	Soluble
Alkali	Colour change to orange-red	Soluble – colour change to red	Colour change to yellow-brown
Water	Gum component soluble in water, leading to possible strikethrough of pigment	Insoluble	Soluble in hot water Insoluble in cold water
Weak acids	Insoluble	Insoluble	Decolourises
Inorganic acids	Insoluble	Soluble	Decolourises

Table 1 Sensitivities of Gamboge, Chrome Yellow and Quercitron

2.6 Limitations

Unfortunately, visual examination coupled with technical analysis cannot provide completely accurate results. The type and quantity of the medium, the size of the pigment particles, and the external conditions the print was exposed to all contribute to altering the appearance of a pigment. In addition, many yellow colourants display similar behaviours under UV, IR, and

[31] Organic solvents are compounds that have at least 1 carbon atom and 1 hydrogen atom. Organic solvents can dissolve oils, fats, resins, etc.

FCIR. It is therefore necessary to pair this information with the provenance of the artwork, and to weigh all sensitivities and risks of the pigments prior to treatment.

Chapter 3: The Aqueous Treatment of hand-coloured prints containing sensitive yellow pigments

3.1 Common types of damage seen on hand-coloured prints

In the eighteenth and nineteenth centuries, it was common for hand-coloured prints to be collected and bound into folios, thereby keeping them in relatively stable environments, away from light and other atmospheric pollutants. However, as mentioned in chapter 1, many such prints were used for decorative purposes, exposed for long periods of time to the elements, leading to physical and chemical damage.

The common types of damage associated with prints include (but are not limited to) discolouration, tears, abrasions and losses due to physical damage, the accumulation of surface dirt and other accretions that affect the visual integrity of the print, the build-up of brown spots due to mould or metal particles embedded in the support, and planar distortions of the support. The degradation and discolouration of paper are caused by external factors such as prolonged exposure to heat, light, air pollutants, and moisture. One of the main causes of discolouration is caused by photo-oxidation, when light, in the presence of oxygen causes oxidation of the components of paper, leading to the formation of carbonyl and carboxylic acid groups attached to the cellulose chain. This increases the number of conjugated double bonds, which absorb light in the visible region, causing discolouration seen in oxidised paper (Daniels, 1988). Oxidation also occurs during the natural ageing of paper (auto-oxidation), and can be accelerated by hydrolysis, where the cellulose molecules of the paper break in the presence of water, leading to shortened cellulose chains which results in the embrittlement of paper. Gaseous pollutants like sulphur dioxide and nitric oxides form acids in the presence of moisture and oxygen. These pollutants increase the acidity of paper, thereby increasing the rate of acid hydrolysis and/or catalysing oxidation (Banks, 1989). Internal factors of the paper like sizing and bleaching also contribute to the degradation of paper. A by-product of the degradation of the alum used in sizing is sulphuric acid, contributing to acidic build up in the paper. Oxidative bleaching during the

papermaking process forms carboxyl groups which also contribute to the acidic build up in a paper (Hey, 1979). Excess acidity in paper is considered to be the main factor of paper decomposition (Daniels, 1980).

The common types of damage the watercolour medium may experience include loose and friable media due to physical damage of the object, instability in the media leading to flaking or friability due to changes in relative humidity (RH), sigmoid cracks caused by poor storage and handling i.e. flexing or rolling an object, and cracking in pigment due to high pigment volume concentration (HPVC) and deterioration of the binder. Many of these issues are more commonly seen in thicker areas of paint, or gouache.

3.2 Possible issues of aqueous treatment of hand-coloured prints

Different types of paper react differently to the introduction of water due to various factors, including the type of paper, level of degradation, size, and structure (Keyes, 1994). Hand-coloured prints will mostly consist of medium weight, sized paper, made from cotton and linen fibres, or wood-pulp. Prints that were poorly stored and handled would have experienced some form of degradation mentioned above. Degraded papers tend to absorb water unevenly across the sheet. More degraded areas will absorb water faster, as cellulose chain scission caused by oxidation and hydrolysis produced more hydroxyl sites in those areas, attracting water molecules. Degradation of the size in the paper can also occur due to mechanical and biological damage, this may not occur evenly across the paper, contributing to the uneven wetting of a paper. Un-sized areas will absorb water quickly, which can lead to damage to the media, and distortions in the paper.

The stability of pigment during treatment is affected not just by their molecular and electronic structures, but by their manufacturing constituents including the binding agent and other additives (Daniels, 1995). In the case of hand-coloured prints from the 18th and 19th centuries, the binding agent is likely to be gum Arabic, and humectants likely honey, sugar, and glycerol are also likely constituents of the media. These additives are potentially water-soluble. Aged gum Arabic is known to swell in water during treatment, but is less likely to completely dissolve due to ‘the irreversible loss of water, and aggregation of polymer chains’ (Daniels, 1995: p. 31). Watercolours are also known to be less soluble with age (Daniels, 1995). Gamboge, Chrome Yellow and quercitron are extremely sensitive pigments, and treatment should be planned to protect their vulnerabilities.

Before discussing the possible conservation techniques that may be suitable for hand-coloured prints containing fugitive pigments like gamboge, chrome yellow and quercitron, it is necessary to reiterate the importance of maintaining the integrity of the object. Conservation treatment should ensue with the aim of improving the long-term stability of the object while preserving the essential characteristics of the paper and media. Aqueous treatments cause irreversible changes to the support and media of an object. No two prints will react exactly the same way during treatment, it is up to the conservator to determine the best treatment method for a particular object, through a thorough assessment of the risks and benefits involved.

3.3 Conservation treatment of hand-coloured prints

Conservation treatments commonly adopted for the treatment of prints include surface cleaning, humidification and washing, alkalisation, consolidation, and repair. Other treatments like backing removal or adhesive removal may also be necessary depending on the needs of the print. This chapter will examine the suitability of frequently used aqueous conservation treatments for the treatment of hand-coloured prints containing sensitive yellow pigments. It will cover the risks and benefits of each treatment, and provide recommendations for practice.

3.3.1 Removal of surface dirt

Before commencing any form of aqueous treatment, it is first necessary to remove any foreign particles from the surface of the artwork. These particles can include dust, dirt, insect excrement, mould spores, or other surface deposits, which can disfigure, obscure, abrade, cause stains, and increase acid levels in paper due to the metallic impurities in dust and dirt that can be converted via hydrolysis into sulphuric or nitric acid (Paper Conservation Catalogue, 1992). The removal of these degradation material is strongly recommended prior to aqueous treatment which can drive these particles further into the interstices of the paper, preventing later removal.

As with all conservation treatments, the method of treatment should be considered based on the nature of the object at hand. Surface cleaning has its risks and can cause altercations in an object such as planar distortions, abrasions, tears and losses, and roughening and lifting of paper fibres. For example, severely degraded or fragile papers cannot withstand the abrasive nature of certain surface cleaning methods like erasers, or vulcanised rubber sponges. In the

case of hand-coloured prints, a soft brush is recommended to remove loose dirt across the entire print followed by grated eraser using gentle motions while avoiding areas with media to prevent any losses of pigment. It is for the conservator to decide if the type, stability, strength and level of deterioration of the paper can withstand surface cleaning with the grated eraser. Special care should be taken around tears and losses to prevent further damage.

3.3.2 Removal of discolouration, staining, and other soluble degradation products

While visual examination and technical analysis make it possible to infer the possible reactions the media and support will have when exposed to the various solutions and solvents involved in conservation treatment, it can never be done with absolute surety. Prior to aqueous treatment, the support and media should undergo spot testing with the proposed treatment solutions to ensure the object can withstand interventive treatment. Spot testing should be carried out in discreet areas, and all varying states of deterioration in the media and support of the print should be tested. Attributes like age (mentioned above) may influence the response of watercolours, where suspected quercitron, chrome yellow, and gamboge pigments may not react as expected during spot testing. Treatment should however continue with caution.

Severely degraded prints would benefit from washing and alkalisation treatments to remove harmful soluble degradation products and water-soluble pollutants, thereby improving the aesthetic and long-term stability of the print. Washing can also improve the strength and flexibility of paper by rehydrating and regenerating fibre-to-fibre bonding (Cumming & Colbourne, 1998). Alkalisation also aims ‘to convert the paper from an acidic to an alkaline condition’ (Hey, 1979: p. 66).’ Unfortunately, hand-coloured prints are exposed to numerous risks when undergoing such treatment. The watercolour pigment on the prints are susceptible to changes in colour, and surface qualities (Cook & Mansell, 1981). Paint applied in thicker layers are also vulnerable to solubility, as well as swelling during treatment (Maynor, 1993). Prints containing yellow pigments like gamboge, quercitron and chrome yellow are extremely sensitive, reacting to organic solvents, water and alkali, all of which are common solutions introduced during aqueous conservation treatments. The following materials and techniques aim to provide the conservator with greater control over moisture during treatment, to allow aqueous treatment to continue in the presence of such sensitive media.

3.3.3 Fixing fugitive pigments

Prior to beginning aqueous treatment, fixing via the creation of a film over the media can be done to protect the media against water, reducing the loss of sensitive pigments. Gamboge and quercitron, are sensitive to organic solvents like IMS, acetone and xylene, common solvents used in conjunction with fixatives like Paraloid B72, and Klucel-G, which are therefore not recommended for use during the treatment of such prints.

Cyclododecane is a 'waxlike hydrocarbon material' which can be used as a temporary fixative (Brückle et. al., 1999: p. 162). It can be evenly applied in a thin layer over the media as a hot melt using a heated spatula due to its low melting point. It is non-toxic, requires no solvents, and sublimates at a rate of 0.03mm per 24 hours (Hangleiter, Jägers, and Jägers, 1995, in Bluher, Haberditzl, and Wimmer, 1999). It should be applied on both sides of the paper, using a light box. Care must be taken during treatment as dimensional changes between the film and the paper can cause small cracks in the film, allowing water to penetrate the media. Wrinkles and tensions can also be observed around the film after treatment which can be relaxed after light introduction of moisture (Bluher et al, 1999). Application should be done with care to reduce producing a 'halo' effect around the media, caused by the fixative being applied beyond the media, preventing the area from undergoing aqueous treatment, trapping discolouration and degradation products. This treatment is a suitable option for prints with small areas of gamboge or quercitron, or even other water-sensitive watercolours. Past studies have shown the use of cyclododecane to be more effective on thicker papers with sizing, which correspond to the papers used in earlier hand-coloured prints (Brückle, Nichols, and Strickler, 1999).

3.3.4 Humidification prior to washing

Humidification introduces moisture to the paper and medium evenly, and slowly, in a controlled manner, also making the paper more responsive to subsequent aqueous treatments (Bruckle and Banik, 2012). Humidification treatment is also beneficial to prints with uneven sizing due to degradation, allowing size and un-sized areas to absorb water at a similar rate during washing. When a paper is wetted before washing, discoloured material will be rapidly released on immersion, making treatment more effective (Hey, 1979). Humidification is beneficial to hand-coloured prints, especially those with thickly applied pigment, controlling the expansion and contraction of the paper, thereby reducing stress that may lead to the dislocation of media (Kosek, 2012). Humidification also relaxes the paper, removing

distortions which in turn allow a more even wetting during treatment. Care should be taken during humidification treatment to avoid physically touching areas with pigment due to the swelling of the binding agent, which may cause changes to the surface of the media. Humidification must be done prior to double-screen washing, partial immersion, and low-pressure table washing.

The use of a humidification chamber is recommended for the treatment of hand-coloured prints. This can be created using photographic trays and a sheet of Perspex as a cover. An ultrasonic humidifier can serve as a source of moisture with the print positioned away from the tube to prevent condensation from dripping onto the print. The RH should be maintained around 80%. The print should be supported on a sheet of Reemay/Bondina of similar texture to prevent contact with the artwork. Hand-coloured prints can also be humidified using a dahlia spray or ultrasonic humidifier without a chamber. While a slightly more aggressive method of humidification, it allows the introduction of moisture quickly, but gently using a very fine mist. This allows the print to begin washing treatment quickly. Such a course of treatment may be undertaken due to the sensitivities of the pigments involved, where the prints should not be exposed to elevated levels of humidity for long periods of time (Gamboge). The verso of the prints should be checked regularly to ensure no strikethrough of the pigment occurs. Wetting agents like IMS should be avoided due to the sensitivities of the pigments in question (Gamboge and Quercitron).

3.3.5 Methods of washing and alkalisation

Washing and alkalisation treatment can expose the media and support of the hand-coloured print to numerous risks, including irreversible changes to the support, leading to changes in colour, tone, opacity, thickness, texture, loss of sizing, fillers, coatings and additives, and changes in the dimensions of the paper (*Paper Conservation Catalog*, 1990; *Paper Conservation Catalog*, 1985). Sensitive media can respond adversely to the introduction of water and alkali, leading to changes in colour, bleeding, loss, and strikethrough. The need to treat such sensitive objects have led to the development of several less aggressive methods of washing and alkalisation to reduce the possibility of pigment migration during treatment. These include double-screen washing, blotter washing, washing using the low-pressure table, partial immersion, and the use of rigid Gellan gels. While these methods are less effective than immersion washing, they are safer, offering more control (Kijima, et. al., 2007).

However, the risks of bleeding and loss of sensitive pigments still remain, and discretion is needed to decide the suitability of each type of treatment with the object at hand.

The use of double-screen washing is suitable for prints with thick layers of paint, and/or prints on more brittle supports, with multiple tears and losses. This technique allows the print to be fully supported from the beginning, to the end of treatment. It also allows easy removal during aqueous treatment should anything adverse occur. Two washing screens larger than the print are placed screen-to-screen in a photographic tray. Weights are placed over the trays to secure the screens. The water level is then brought up to the bottom of the top screen, and air pockets removed using a syringe. The humidified print is then placed on the screen. Washing using this method should only be used for prints containing non water-soluble pigments, or pigments that have been fixed. Alkalisation using this method should not be attempted on prints containing gamboge, quercitron or chrome yellow that have not been fixed as bleeding, loss, and changes in colour will occur.

Blotter washing is a less aggressive method, suitable for discoloured prints with soluble media, also providing support for physically damaged prints. An open blotter wash is recommended instead of the sandwich technique to avoid contact the blotter and the pigment which could lead to damage. Blotter washing utilises capillary action to draw discolouration from the support. Two damp sheets of blotter larger than the print are placed at the bottom of a tray. The blotter should be slightly less damp than the print, allowing it to draw moisture and discolouration from the print. These should be covered by a sheet of Reemay/Bondina of similar texture, and the print laid over it. The tray will then be covered using a sheet of Perspex, preventing the object from drying out. If necessary, the object should be re-humidified. The print should be observed throughout treatment, as the blotter absorbs discolouration, a new damp blotter should replace it. An even contact between the object and the blotter is necessary to reduce the formation of tidelines. May be a suitable treatment option for prints containing quercitron and chrome yellow.

The low-pressure table is a washing method that applies suction to direct the flow of water and other aqueous solutions through the object. The supported (by screen or Reemay/Bondina) humidified print is placed over an absorbent material on the low-pressure table, and the desired moisture is introduced in a controlled manner using a spray, brush or dropper. The low-pressure table is a suitable method which also allows for targeted, localised treatment (Weidner, 1974). The sensitive areas of the print are masked using Reemay and

Melinex, and water and alkali can be introduced to non-sensitive areas of the print. Care must be taken to ensure the print is fully humidified during treatment to prevent cocking or creases formed due to uneven drying on the low-pressure table. This method can be used for the washing and alkalisation treatment of prints containing gamboge, quercitron and chrome yellow, provided the sensitive areas are masked during treatment, and the introduction of aqueous material is properly controlled, minimising the risks of lateral movement of such material into the sensitive areas of the object. Possible strikethrough of pigment should also be closely monitored.

Partial immersion is a washing method that uses the high surface tension of water to allow full immersion of stable areas of a print, while keeping the sensitive areas afloat. The humidified print is float washed in a bath over a support of Reemay, with the area to be submerged placed closest to the body. Using a brush, a water line is drawn along the object, defining the area to be submerged. The edges of the support are then pushed gently into the bath while keeping the print afloat, allowing it to become fully saturated. The area of the object that is to be submerged is then gently pushed beneath the waterline, using a brush or fingertips. Prior to removal, the edge of the water should be feathered out to prevent the formation of tidelines. The print should then be lifted out appropriately without allowing the water to flood the non-submerged areas of the object. Once again, alkalisation should not be attempted on prints containing gamboge, quercitron or chrome yellow using this method unless fixed as bleeding, loss, and changes in colour will occur. Short wash cycles of 15 minutes with rapid drying can also be considered with this option to reduce prolonged high levels of humidity to prevent strikethrough of gamboge.

In recent years, more studies have been undertaken regarding the treatment of works of art on paper using rigid aqueous Gellan gels[32], an aqueous treatment method that can be used on papers with sensitive media (Iannuccelli & Sotgiu, 2010; Möller, 2014; Sullivan, et al, 2014). The gel removes soluble degradation products via capillary action. The Gellan gum gel is prepared in concentrations of 1-4% in water, depending on the absorbency of the paper (Möller, 2014). The dispersion is then heated to boiling point using a microwave, and poured into a basin to cool, and form into a gel. The print should be treated from the verso, where the gel is placed on a sheet of Perspex, an interweaving layer of Japanese paper with similar surface qualities to the print is placed over the gel, and the print placed recto-up over the

[32] Rigid aqueous Gellan gels are a microbial exopolysaccharide that allows a constant and controlled release of water onto the paper (Iannuccelli & Sotgiu, 2010: p. 25).

paper (Iannuccelli & Sotgiu, 2010). The print should then be covered with a sheet of Melinex to prevent it from drying. A sheet of Perspex can also be placed over the print as a light weight with an interweaving layer to ensure even contact between the gel and the print, however, possible loss of pigment should be taken into account (Möller, 2014). This method also allows for local treatment of stains, where the gel can be cut and applied locally to stains, or the gel can be placed over a template cut out of Melinex, masking sensitive areas. Sullivan *et. al*. (2014: p. 18) successfully treated stains on a lithographic print locally using hybrid gels. These gels can also be used in combination with alkali, enzymes, chelating agents and bleaching agents should treatment require.

In a situation where a large portion of the print is made up of one of these sensitive pigments, and fixing and masking of the sensitive area is not a viable treatment option, the local treatment of staining can be another possibility. This can be done using poultice materials like Fuller's earth, methyl cellulose, paper pulp, etc. Local treatments can be risky, causing tidelines, planar distortions, dimensional changes and other physical and chemical differences between treated and untreated areas of the print (Paper Conservation Catalog, 1990). Care must be taken to feather out tidelines during treatment with water, or IMS (if sensitive media will not be affected) to prevent them from setting. Poultice materials should be applied using interweaving layers to reduce possible residues in the paper fibres.

Washing/ alkalisation technique	**Benefits**	**Risks**	**Additional Measures to protect the media**
Double-screen washing	Suitable for fragile prints with large tears Minimises contact with media during removal, especially important for thick impasto areas that swell during treatment Can support an object from start to end treatment	Air pockets may form beneath the screen, causing uneven wetting May cause bleeding, loss or strikethrough of sensitive media	Fixing
Blotter Washing	May avoid swelling of media	May cause unwanted movement of media or	Fixing

	Allows control of moisture levels	strikethrough Uneven contact with blotter is possible and may result in discolouration or the formation of tidelines Slow process	
Low-pressure Table Allows introduction of alkali	Good control over force, speed, and direction of flow of water/alkali Local treatment possible Restricts movement of the paper during treatment	Cannot be used for torn objects May cause strikethrough, flattening, change, or loss of media May cause creases Uneven drying, distortion, and dimensional changes in the paper are possible (Albro et al. 2008)	Fixing/Masking sensitive areas during treatment
Partial Immersion	Can maximise treatment in 'safe' areas while keeping sensitive areas under control	May cause unwanted movement of media or strikethrough Possible formation of tidelines No control over immersed area Danger of highly absorbent papers sinking	Fixing
Rigid aqueous Gellan Gels Allows introduction of alkali	Local treatment possible Biodegradable and non-toxic No structural or surface modifications to the support (Iannuccelli & Sotgiu, 2010) Minimal residues remain on the support Ease of application and removal Can be used with enzymes,	May cause lateral movement of media, or loss of media if a weight is applied	Masking sensitive areas during treatment

	chelates, alkali, and bleaching agents		
Local stain removal Allows introduction of alkali	Local treatment possible without risk to sensitive media	May cause tidelines Planar distortions possible Residues of poultice materials may remain in paper fibres leading to changes in colour over time	

Table 2 Risks and benefits of several washing and alkalisation methods in relation to hand-coloured prints

3.3.6 Materials suitable for treatment

Deionized or reverse osmosis water is recommended for treatment due to the varying compositions of tap water that introduced many unknown variables to treatment. For alkalisation, both calcium hydroxide and magnesium hydrogen carbonate are good options, dependant on the type of paper being treated, the sources of acidity, as well as the needs of the object. Magnesium hydrogen carbonate should be avoided with prints on supports made from wood-pulp. The creation of an alkali reserve should be avoided due to the possible colour change of the alkali sensitive pigments in question. Ammonium hydroxide diluted to pH 9 can also be applied locally to stains avoiding all media as it may lead to colour change.

3.3.7 Additional treatment options

Bleaching is not recommended due to adverse effects it can have on an artwork, including yellowing of the paper, damage to the fibres and media, remnants of bleaching residue in the support, changes in the pH of the paper (*Paper Conservation Catalog*, 1989). Bleaching is also known to affect the colour of many organic pigments, especially risky for gamboge and quercitron. Colouring in pigments occur due to the presence of conjugated bonds, as most bleaches work to break this conjugation, pigments may undergo changes to colour or fade (Feller 1971). Bleaching treatment will also require further washing and alkalisation to remove post-treatment residues, and neutralise acidic compounds formed during the bleaching process. It should be used as a last resort if all other methods of stain removal are insufficient. If the condition of the print can withstand bleaching, oxidative processes like light bleaching (with a template to mask of areas with media), or dilute hydrogen peroxide can be carried out locally. Local application of dilute hydrogen peroxide can be done on the

low-pressure table, or through the use of gels. Thorough washing and alkalisation should follow bleaching treatment.

As most hand-coloured prints are single-sided, tears can be repaired from the verso using strips of Japanese paper. The strips should be cut to shape and feathered if possible to produce a less obtrusive and more flexible repair. Losses can also be treated through the attachment of an infill. The repair papers should be of similar or slightly less thickness to the object, and have a similar texture, and colour. They should also be flexible, ensuring the reinforcement will tear instead of the support should the print be mishandled. Chain lines and grain directions should also be matched, to ensure the expansion and contraction rates of the two papers match. Infills should always be the same colour, or lighter than the original support. A small amount of wheat starch paste (of a thick creamy consistency) or methyl cellulose can be used as an adhesive due to their flexibility, strength, and good ageing properties. The adhesive should be made to an appropriate consistency, as too wet adhesive can lead to tidelines, distortions and bleeding of the media. Pulp infills applied locally using the fritted disk is a possible treatment method if the losses or tears are located away from any water-sensitive media (gamboge and quercitron). This will provide a more aesthetic result.

3.3.8 Drying and Flattening

Controlled drying is recommended for hand-coloured prints after aqueous treatment. It allows moisture to be released slowly, reducing stress on the paper and media, and leads to less distortions. A sheet of blotting paper is placed at the base of a photographic tray larger than the print. The print, while supported on a sheet of Reemay/Bondina, is placed on the blotter. The tray is then covered with a sheet of Perspex, while leaving a small gap to allow for air circulation. The blotting paper should be changed within the first hour. If necessary, and when the media allows, prints in the final stages of drying can be transferred to the nipping press between sheets of fresh blotters and an interweaving layer of similarly textured Bondina/Reemay to remove any planar distortions likely to form. The interweaving layer provides additional protection to the media.

Conclusion

This research has discussed some of the materials present in hand-coloured prints, and the impact of these materials on conservation treatment. Specifically, the presence of fugitive pigments like gamboge, quercitron and chrome yellow adds a range of complexities when

considering aqueous conservation treatments like washing and alkalisation. Less intensive methods like double-screen washing, blotter washing, low-pressure table washing, partial immersion, and the use of rigid Gellan gels are possible treatment options. Additional treatment steps like fixing are also recommended to prevent loss, bleeding, colour change, strikethrough and lateral movement of the sensitive pigments. Localised treatment combined with the use of templates are recommended for washing (prints with gamboge and quercitron) and alkalisation treatments (prints with gamboge, quercitron and chrome yellow). These measures also help to reduce the swelling of the gum, loss of soluble additives in the binder (sugar, glycerol, honey), and reduce possible changes in the paper as well as the media. As with all conservation treatment, it lies with the conservator to choose the best treatment option based on the materials present, the needs, and condition of the artwork.

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A book of dravving, limning, vvashing or colouring of maps and prints: and the art of painting, with the names and mixtures of colours used by the picture-drawers. Or, The young-mans time well spent. In which he hath the ground-work to make him fit for doing any thing by hand, ... By the use of this work, you may draw all parts of a man, ... And directions for birds, beasts, landskips, ships, and the like. Moreover, grounds to lay silver or gold upon; and how silver or gold shall be laid or limned upon size; and the way to temper gold and silver, and other mettals, and divers kinds of colours, to write, or to limne withal upon vellum, parchment, or paper, and how to lay them upon the work which thou intendest to make; and how to varnish it when thou hast done. How also to diaper and shadow things, and to highten them, to stand off: to deepen them, and make them glister. In this book you have the necessary instruments for drawing, and the use of them; and how to make artificial pastiles to draw withal. Very useful for all handicrafts, and ingenuous gentlemen and youths. By hammer and hand, all arts do stand (1666) London: Printed by M. Simmons.

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Roberson and Co. Recipe Book (c.1860s) MS.788.1993, 116 Fitzwilliam Museum Cambridge.

R. Q. & T. P (1666) *Academia Italica: The publick school of drawing, or, The gentlemans accomplishment: being the ingenious, pleasant and antient recreation of the noble, and the honour of arts, wherein you have plain examples and directions to guide you to the knowledge, first, of the noble and useful art of drawing, with a discourse of all the external parts of mans body, whereby it plainly appeareth how one part joyneth to another, by which means the judgement is well informed of every parts plyableness, and therefore the knowledge of the anotomy [sic] is of great concernment to this most admirable art : secondly, the manner of washing or colouring maps and prints, with the names of several colours proper for that purpose, and how they may be mixed, and what colours set off best together : as also how you should shadow things to cause them to shew more natural and beautiful : with instructions what you must do to*

paist [sic] maps or prints smooth on cloth or paper : and likewise what you must do to them to cause them to bear your colours and varnish : with divers rare secrets for making, ordering, and preserving of colours, the which was never fully and really discovered until now. London: Printed by Peter Lillicrap.

Salter, T. W. (1869) *Field's Chromatography; or, A Treatise on Colours and Pigments, as used by Artists. An Entirely New and Practical Edition: Revised, Rewritten, and Brought Down to the Present Time*, London: Winsor and Newton.

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Smith, T. (1827) *The art of drawing in its various branches : exemplified in a course of twenty-eight progressive lessons, calculated to afford those who are unacquainted with the art, the means of acquiring a competent knowledge without the aid of a master : being the only work of the kind in which the principles of effect are explained in a clear, methodical, and at the same time familiar style*. London: Printed for Sherwood, Gilbert and Piper.

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Taylor, J. S. (1887) *A Descriptive Handbook of Modern Water-colour Pigments Illustrated With Seventy-two Colour Washes Skilfully Gradated by Hand on Whatman’s Drawing Paper*, London, Winsor and Newton, Ltd.

The Art of Drawing, and Painting In Water-colours: Whereby a Stranger to Those Arts May Be Immediately Rendered Capable of Delineating Any View Or Prospect with the Utmost Exactness; of Colouring Any Print Or Drawing In the Most Beautiful Manner; and of Taking Off Medals Instantly, by Various Ways, Never Before Made Publick: Intermix'd with Several Curious Receipts for the Use of Painters, Statuaries, Founders, &c. With Instructions for Making Transparent Colours of Every Sort; Partly From Some Curious Personages In Holland, France, and Italy; but Chiefly From a Manuscript of the Great Mr. Boyle; Particularly a Receipt of That Gentleman's, for Making a Blue Colour Equal to Ultramarine. The fourth edition. (1731) London: Printed for J. Peele.

The art of drawing, and painting in water-colours. Wherein the principles of drawing are laid down after a natural and easy manner; and youth directed in every thing that relates to this useful art, according to the practice of the best masters. To which are annexed, familiar directions whereby a stranger in the art of drawing may be readily taught to delineate any view or prospect with the utmost exactness; of colouring any print or drawing in the most elegant manner; and of taking off medals, &c. instantly, after a variety of different ways never before made public; intermixed with curious receipts for the use of painters, statuaries, founders, &c. With instructions for preparing, mixing and managing all sorts of water-colours used in painting, so as to represent nature in the greatest perfection. (1779) London: Printed for G, Keith.

The Book and Paper Group of the American Institute for Conservation of Historic and Artistic Works (1985) ‘Chapter 20: Alkalization and Neutralization’ in *Paper Conservation Catalogue*. 2nd edn. Washington D.C.: American Institute for Conservation Book and Paper Group.

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edn. Washington D.C.: American Institute for Conservation Book and Paper Group. pp. 1-38.

The Book and Paper Group of the American Institute for Conservation of Historic and Artistic Works (1990) 'Chapter 16: Washing' in *Paper Conservation Catalogue.*7th edn. Washington D.C.: American Institute for Conservation Book and Paper Group. pp. 1-49.

The Book and Paper Group of the American Institute for Conservation of Historic and Artistic Works (1992) 'Chapter 14: Surface Cleaning' in *Paper Conservation Catalogue*. 8th edn. Washington D.C.: American Institute for Conservation Book and Paper Group. pp. 1-43

The Census of Great Britain in 1851 comprising an account of the numbers and distribution of the people, their ages, conjugal condition, occupations and birthplace etc. (1854) London: Longman, Brown, Green, and Longmans.

The Hand-book of the elements of painting in water colours, with practical instructions for mixing and shading the same (1843) London: H. G. Clarke and co.

Ward, G. W. R. (ed.) (2009) *The Grove Encyclopedia of Materials and Techniques in Art.* New York, Oxford University Press, Inc.

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Winter, J. (2008) *East Asian Paintings: Materials, Structures and Deterioration Mechanisms*, London: Archetype Publications Ltd.

Appendix 1: Common pigments used in Britain in the 18th and 19th century with data gathered from various artist treatises and manuals

Source	Yellow	Red	Blue	Green	Grey	Browns	White and Black	Others
The Art of Drawing, and Painting In Water-colours…of Colouring Any Print Or Drawing In the Most Beautiful Manner etc. (1731) London: Printed for J. Peele.	Gamboge Yellow Ochre Mulberry Yellow	Carmine	Ultramarine Indigo				Indian Ink	
Smith, J. (1701) *The Art of Painting in Oyl. Wherein is included each particular circumstance relating to that art and mystery etc.* London: Printed for Samuel Crouch.	Gamboge Orpiment	Cochineal. Red Lead. Orpment. Carmine. Vermilion	Indigo. Blue Bice. Ultramarine	Copper Green Grass Green Gamboge and copper green mixture	Liquor of Myrrh	Burnt Umber		
The Hand-book of the elements of painting in water colours, with practical instructions for mixing and shading the same (1843) London: H. G. Clarke and co.	English and Dutch Pinks Gallstone Gamboge Ginger Yellow King's Yellow Saffron Yellow Yellow of French Berries Yellow from Mulberry-root Yellow Ochre	Indian Lake Crimson-Carmine. Crimson-Cochineal	Blue Bice. Blue Verditer French Blue Indigo Litmose Prussian Blue Saunder's Blue Ultramarine	Artificial Green or Sea Green. Green Bice Sap Green Transparent Green		Bistre, Brown Ochre Burnt Umber Burnt Terra de Sienna Cologne Earth Dragon's Blood Gardiner's Brown Madder Brown Purple Brown Sepia Unburnt Terra de Sienna Vandyke Brown	Indian Ink Ivory Black Keating's Black Chalk White Chinese White Egg Shell White Flake White Silver White White Lead	
Standage, H. C. (1891) *A Handbook of the chemical and artistic qualities of*	Aureolin Cadmium Yellow Chrome	Venetian red Indian Red	French ultramarine Cobalt blue	Oxides of Chromium Viridian	Ultramarine ash Neutral tint	Brown madder Reuben's madder	Ivory black lamp black blue black	Purple madder Purple lake

Water-Colour Pigments etc.	yellow Naples yellow Yellow ochre Mars yellow Raw sienna Roman Ochre Brown Ochre Indian yellow Brown pink		Cerulean blue Prussian Blue Antwerp Blue Indigo	Hooker's green Sap green Terre Verte Emerald Green	Payne's grey	Bistre Burnt carmine Burnt umber Cologne earth Sepia Raw umber		Violet carmine
Breakell, M. L. (1904) *The Wallet Series. Water-colour painting*, London: Edward Arnold.	Pale and Deep Lemon (or the Daffodil Cadmium Yellows) Transparent Gold Ochre Yellow Ochre Aureoline AVOID: The Chromes, pale and deep. Patent Yellow. True Naples Yellow. Orpiment, Yellow Pinks, Dutch, English and Italian. Brown Pink, &c. Alizarin Yellow.	Light Red Venetian red Cobalt Rose Rose Madder Madder Carmine Chinese Vermillion AVOID: All the Cochineal Lakes and some of the vermilion's, Dragon's Blood, &c.	Real Ultramarine French Ultramarine Permanent Blue Cobalt AVOID: Prussian Blue Antwerp Royal Indigo The Copper Blues Verditer	Terre Verte. Viridian (transparent Oxide of Chromium). Oxide of Chromium. AVOID: Verdigris and other Copper Greens. Emerald. Sap. Brunswick. Hooker's Green. Olive Lake. Green Lake. Prussian, &c.	AVOID: Made up Greys, such as Payne's Grey, &c.	Cyprus Umber. "Transparent" or Cappagh Brown Sepia Brown Madder AVOID: Bitumen. Asphaltum. Vandyke	Blue-Black. Charcoal Grey	Cadmium Orange Burnt Sienna Purple Madder Mineral Violet Cobalt Violet.
The art of drawing, and painting in water-colours. Wherein the principles of drawing are laid down after a natural and easy manner etc. London: Printed for G, Keith.	Gamboge, French berries Yellow ochre Gall stone Saffron Dutch pink	Carmine Vermillion (if you can hide the print lines) Indian red	Indigo Ultramarine Prussian blue Blue bice	Sap green Verdigris			Indian Ink No Ivory Black	
Clark, J. (1848) *Elements of*	Yellow ochre	Indian red	Indigo			Sepia	Lamp black	

drawing and painting in water-colours: being supplement to the elements of drawing and perspective, published in chambers's educational course etc.	Raw sienna Burnt sienna Gamboge Chrome yellow Indian yellow	Red Lake Carmine Vermilion Venetian red	Prussian blue Antwerp blue Ultramarine			Bistre		
Laporte, J. (1812) *The progress of a water-coloured drawing etc.*	Yellow ochre	Madder lake Light red Indian red	Prussian blue					
Reeves and Sons Amateurs' and Artists' Companion, with an Almanack for the year 1852	Gamboge. Yellow Ochre Roman Ochre Indian Yellow Yellow Lake Brown Pink Italian Pink	Indian Red Light Red Vermillion	Indigo Prussian Blue Cobalt Blue			Sepia Burnt Sienna Burnt Umber Madder Brown Raw Sienna Vandyke Brown Cologne Earth.	Coal Black Lamp Black	Orange Chrome
Fielding, T. H. (1830) *Index of colours and mixed tints*[33]	Yellow ochre Gamboge	Light red Red lake	Indigo			Van dyke brown Burnt sienna		
A book of dravving, limning, vvashing or colouring of maps and prints etc. (1666) London: Printed by M. Simmons	Yellow Berries Saffron Light Masticote	Vermillion Lake Red-Lead	Blue Bise Indigo Blue Verditer	Verdigreece Verditer Green Sap Green Copper Green		Spanish Brown Umber	Printers Black Ivory Burnt Ceruse White Lead	
R. Campbell (1757) *The London tradesman etc.* Printed by T. Gardner[34]	Yellow Ochre Mulberry Yellow	Carmine	Indigo Ultramarine				Indian Ink. NO Ivory Black	
Smith, T. (1827) *The art of drawing in its various branches : exemplified in a course of twenty-eight*	Gamboge Italian Pink Raw Sienna Yellow Ochre	Vermillion Carmine Red Lake Light Red	Indigo Prussian Blue Cobalt Blue Antwerp			Burnt Sienna Burnt Umber Cologna Earth Vandyke Brown	Lamp Black Indian Ink Constant white	

[33] Fielding, T. H. (1830) *Index of Colours and Mixed Tints, for the use of beginners in landscape and figure painting.* London: Printed for the author.

[34] R. Campbell (1757) *The London tradesman, being an historical account of all the trades, professions, arts, both liberal and mechanic now practifed in the cities of London and Weftminfter*. Printed by T. Gardner.

progressive lessons etc.	Roman Ochre Indian Yellow Gallstone Brown Pink Raw Umber AVOID: Yellow Lake	Madder Lake AVOID: Indian Red, Red Lead aka Saturnine Red	Ultramarine			Sepia		

Appendix 2: Recipes for several pigment components

2.1 Recipe for Alum-water

Recipe 1

> Take a quart of fair water, and boyl it in a quarter of a pound of Allum, feeth it until the Allum be diffolved, then let it ftand a day, and the make ufe of it. With this water you must wet over your pictures, that you intend to colour, for it will keep the colours from finking into the paper, alfo it will add a luftre unto the colours, and make them fhew fairer, and it will alfo make them continue the longer without fading, you muft let the paper dry of it felf after you have once wetted it, before you either lay on your colours, or before you wet it again , for fome paper will need to be wet four or five times. (*A book of dravving, limning, vvashing or colouring of maps and prints etc*., 1666: p. 10)

Recipe 2

'Alum-water – take four ounces of roche-alum, and a pint of pure spring water; boil it till the alum is thoroughly dissolved; filter it through blotting paper, and it is fit for use'. (*The Hand-book of the elements of painting in water colours etc.* 1843: p. 52)

2.2 Recipe for Gum-water

Recipe 1

> Take clean water a pint, and put into three ounces of the cleareft and whiteft Gum-Araback, and let it ftand until the Gum be diffolved, and fo mix all your colours with it, if the Gum-water be very thick it will make the colours fhine, but then your colours will not work fo eafily, therefore the beft is, that the water be nor made too thick nor too thin. (*A book of dravving, limning, vvashing or colouring of maps and prints etc*., 1666: p. 10)

Recipe 2

> Gum – Dissolve an ounce of the best white gum-Arabic, and half an ounce of double refined sugar, in a quart of spring-water; strain it through a piece of muslin; then bottle it off for use, keeping it free from dust. (*The Hand-book of the elements of painting in water colours etc.* 1843: p. 53)

Recipe 3

> Take the whitest sort of gum-Arabic, bruise and tie it in a piece of woollen cloth; steep it in spring water till dissolved. If too stiff, which is known by the shining of the colors, add more water; if too weak more gum. With this water you may temper most of your colours. (*The Hand-book of the elements of painting in water colours etc.* 1843: p. 53)

2.3 Preparing Gamboge

Recipe 1

'Gamboge – This is a rich and mellow color of nature's own production. It dissolves freely and immediately when brought into contact with the most simple fluid; it sometimes requires help, but in general it will shade itself. This pigment requires neither grinding nor gumming and produces an

endless variety of the most beautiful tints.' (*The Hand-book of the elements of painting in water colours etc*. 1843: p. 27)

Recipe 2

'It diffolves the Minute the Water touches it, therefore wants neither grinding nor gumming.' (*The delights of flower-painting etc.* 1756, p. 14).35

[35] *The delights of flower-painting. In which is laid down the fundamental principles of that delightful art. To which is annexed, a curious defcription of the manner in which fifty of the moft capital flowers are now finifhed by the feveral Masters in that branch; being an introduction to paint all sorts of flowers & c. to which is added a catalogue of the colours proper for the execution of them, their names, qualities, and manner of preparing*, (1756) 2nd edn. London: Printed for D. Voisin.

Appendix 3: List of prints hand-coloured by J. B. Hogarth

Grindlay, R. M. (1826) *Scenery Costumes and Architecture chiefly on the Western Side of India*, London, Published by R. Ackermann.

Prints within:

Scene in Bombay, From a drawing by Captn. Grindlay. London. Pub$^{d.}$by R. Ackermann, Strand 1826. Engraved by R. G. Reeve, (Col^{d}d) Coloured by J. B. Hogarth.

Approach of the Monsoon, Bombay Harbour, From a drawing by W. Westall A. R. A. London. Pub$^{d.}$by R. Ackermann, Strand 1826. Engraved by T. Fielding, (Col^{d}.) Coloured by J. B. Hogarth.

The Shaking Minarets At Ahmedabad. Drawn on the spot in 1809 by Captn. Grindlay. London. Pub$^{d.}$by R. Ackermann, Strand 1826. Etched by G. Hawkins, Engraved by T. Fielding, (Col^{d}.) Coloured by J. B. Hogarth.

Ancient Temple at Hulwud, Painted by F. Witherington from a drawing by Captn. Grindlay. London. Pub$^{d.}$by R. Ackermann, Strand 1826. Engraved by G. Hunt, (Col^{d}.) Coloured by J. Hogarth.

The Rajah of Cutch with his Vassals. London. Pub$^{d.}$by R. Ackermann, Strand 1826. Drawn by Captn. Grindlay, Engraved by R. G. Reeve, (Col^{d}.) Coloured by J. B. Hogarth.

Approach to the Bore Ghaut, Drawn by W^{m}. Westall A. R. A. from a painting by Lt. Col. Johnson. C. B. Pub$^{d.}$by R. Ackermann, Strand 1826. Engraved by T. Fielding, (Col^{d}.) Coloured by J. B. Hogarth.

View in the Bore Ghaut. Drawn on the spot in 1803 by Wm Westall A R A, Pub$^{d.}$by R. Ackermann, Strand 1826. Engraved by T. Fielding, (Col^{d}.) Coloured by J. B. Hogarth.

View from the Top of the Bore Ghaut. Drawn on the spot in 1803 by Wm Westall A R A, Pub$^{d.}$by R. Ackermann, Strand 1826. Engraved by T. Fielding, (Col^{d}.) Coloured by J. B. Hogarth.

Dowlutabad, the Ancient Deo Gurh, Painted by W. Daniell Esq. R. A., from a drawing by Capt. Grindlay, London. Pub$^{d.}$1826 by R. Ackermann, Strand & W^{m}. Sams, St. James Street, Engraved by R. G. Reeve, Coloured by J. B. Hogarth.

Great Excavated Temple at Ellora, Drawn on the spot for the Hon. Lady Hood by Capt. Gridnlay 1813, London. Pub$^{d.}$1826 by R. Ackermann, Strand & W^{m}. Sams, St. James Street, Etched by G. Rawle, Engraved by G. Hunt, Coloured by J. B. Hogarth

Appendix 4: List of print colourists found

Last Name	First Name	Trade Dates	Location	Address	Trades	Notes
Evans	Thomas	1790 - 1790 uncertain	London		Print Finisher	Print colourer. [See F P Thompson `Making of English Working Class' (1980), p 171 (pg. 156 in google books version)]
Langham	Jospeph	1799 - 1799	London			Print colourer
Richards	Charles	1802 - 1805	London	30 Robert St, Bedford Row (1802). 17 Theobalds Rd (1805)		Print colourer, oil painter &c
Heath	William	1802 - 1802	London	Stangate, Lambeth		Print colourer
Scales	John	1802 - 1805	London	6 York Row, Newington Butts		Print restorer
Bridge and Waddington		1809 - 1809	Manchester, Lancashire	Oxford Rd		Print glazer
Garrard	Thomas	1821 - 1821	London	Barrett St, Princes Rd, Lambeth		Print colourer, insolvent debtor
Timms	William	1821 - 1821	London	Newman St, Oxford St		Print tinter, insolvent debtor
Strawford	George	1824 -1824	Manchester, Lancashire	63 Tib St		Print glazer
Woodfield	James	1824 -1824	Manchester, Lancashire	Garrat Rd		Print glazer
Connolly	Thomas	1824 -1824	Manchester, Lancashire	3 Marden's Ct, Cannon St		Print glazer
Thackray	Robert	1824 -1824	Manchester, Lancashire	4 Tarr's Ct		Print glazer
Teal	Robert	1824 -1824	Manchester, Lancashire	94 Spear St		Print glazer
Chittey	Charles	1839 - 1839	London	23 Trafalgar St, Walworth		Print colourer
Hatswell	J	1839 - 1839	London	St John's Sq, Clerkenwell		Print colourer
Hazle	James	1839 - 1839	London	26 Smith St, Goswell St	Map/chart maker, Print finisher	Print colourer. Map-colourer.
Lickley	John	1844 - 1845	Liverpool, Lancashire	50 Gt Nelson Tce (1844)	Map/chart maker, Print finisher	Print colourer. Map-colourer.
Hazle	James	1846 - 1846	London	34 Northampton sq. Clerkenwell	Map/chart maker,	Print colourer. Map-colourer.

					Print finisher	
Standish	Jospeph	1846 - 1846	London	40 Lower Kennington lane	Print finisher (coloured)	Probably same as Joseph Standish of 40 Mansion house St.
Eales	Charles J	1847 - 1847	London	Oxford Market, Westminster	Print Finisher	Print mounter, insolvent debtor 1847

Appendix 5: Pigment Swatches

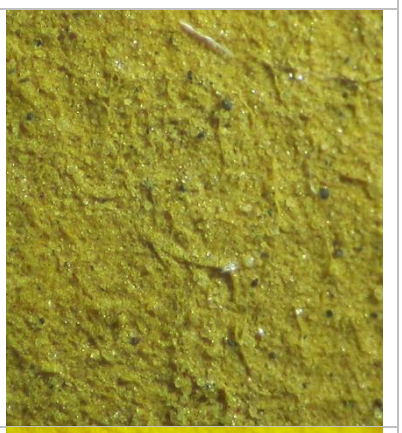
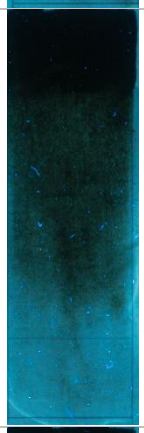
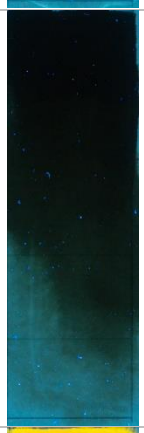
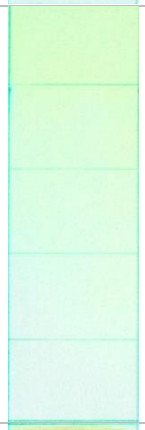
5.1 Preparation of pigment swatches:

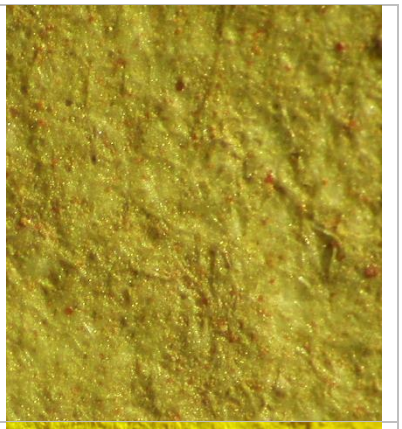
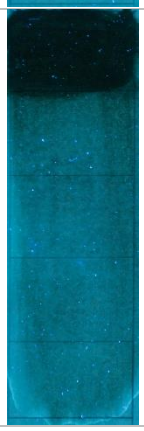
Two sheets of Whatman filter paper were laminated while held under tension on a wooden board using 4: 1 wheat starch paste, diluted to a thin, cream consistency. The swatches were marked using graphite. Approximately 2g of each pigments was grounded when required using a glass muller over a glass slab. Gum Arabic was used as the binder for the pigments as it was the most widely used binder for watercolour pigments in the 18th and 19th centuries. The pigment was painted on using a sable watercolour brush. All the swatches were painted out on the same day to ensure similar technique, application, and pressure on brush. The swatches were dried under weights and between blotters in the fume cupboard, before being humidified and pressed to prevent delamination and distortions.

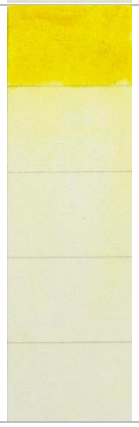
The swatches were then photographed under visible light, UV fluorescence, IR reflectography and FCIR photography. For UVF photography, the swatch was observed using Black light Blue (BLB) tubes, and a Kodak Wratten 2E filter was placed on the camera lens, blocking all wavelengths below 420 nm. For IR imaging, A Kodak Wratten 87c filter was placed on the camera lens to block all wavelengths below 820 nm. The FCIR image was created by illuminating the object with tungsten lamps. Both visible colour and IR images were taken using an IR sensitive camera without moving the object. A digital composition was then made by combining the two images and changing the colour channels via Adobe Photoshop CS7.

Visible light/UV/Raking light camera	Canon 6D Canon EF 50mm f/2.5 Compact Macro Lens Filters: 52 Skylight IR Lens: B+W 67 093 IR IR block: B+W 52 486 UV IR Cut MRC UV Kodak Wratten 2E HOYA 52mm UV [0] Macro lenses: Kood Close Up N04 52mm, N02, N01
IR Camera	Fine Pix Fuji Film S3Pro Digital Camera Lens: Nikon AF Nikor 35mm 1S-2D Filters: 52 Skylight IR Lens: B+W 67 093 IR IR block: B+W 52 486 UV IR Cut MRC
Micrograph's camera	Nikon Coolpix 4500, 4.0 Meg Pixels 4 x zoom 7.85-32mm Zoom Nikkor 1: 2.1-5.1
Lights	Studio Lights: Bowens SL855 Raking: Kodak Carousel S-AV 2010 projector UV: UVLight Technology Bulbs used: NAAVA LT36W/073 IR: Tungsten halogen Floodlight tripod by Faithful Power Plus. Maz 500

5.2 Pigment swatches:

	Visible Light	UV Light	IRR	FCIR	Magnification (20x)
Yellow Ochre					
Aureolin (Cobalt Yellow)					
Cadmium Yellow Medium (Winsor and Newton)					
Indian Yellow					

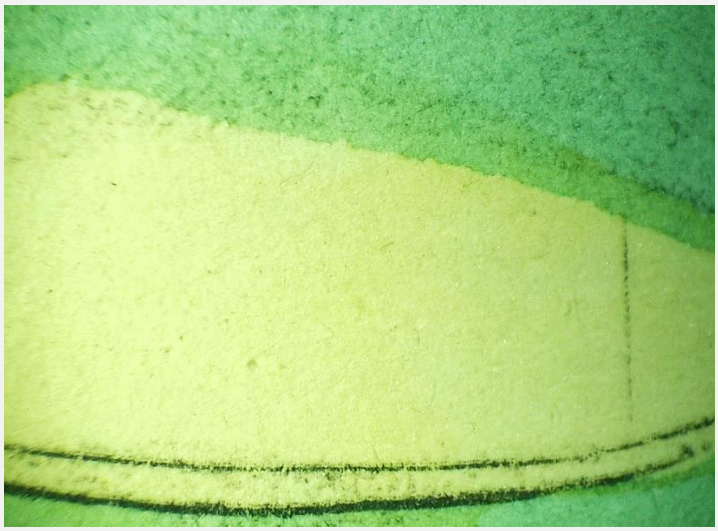
Litharge or Messicot					
Naples Yellow					
Lead-tin Yellow (Dark)					
Lemon Yellow (Deep)					

Chrome Yellow					
Strontium Chromate					
Barium Chromate					
Gamboge					

Extract of gamboge					

Appendix 6: Case Study Survey

IDENTIFICATION DETAILS	
Title: Rolandson, *The Artists Room* **Date:** 1821 **Printer/Publisher:** R. Ackermann **Description:** Hand coloured aquatint taken from the Tours of Doctor Syntax, depicting three men and a woman sitting at a table in what appears to be an artists' room. A blank canvas on an easel is pictured in the foreground	 ©University of Aberdeen

TECHNICAL EXAMINATION	
Technique Watercolour wash applied using a brush. Yellow pigment is present on the vest of the man in the middle wearing a blue coat, and the table in the foreground. The yellow is a very pale, transparent yellow. Likely faded. Under magnification, the pigment appears like a yellow stain on the paper fibres. No strikethrough of the pigment is present.	 © University of Aberdeen A macro-photograph of the yellow pigment

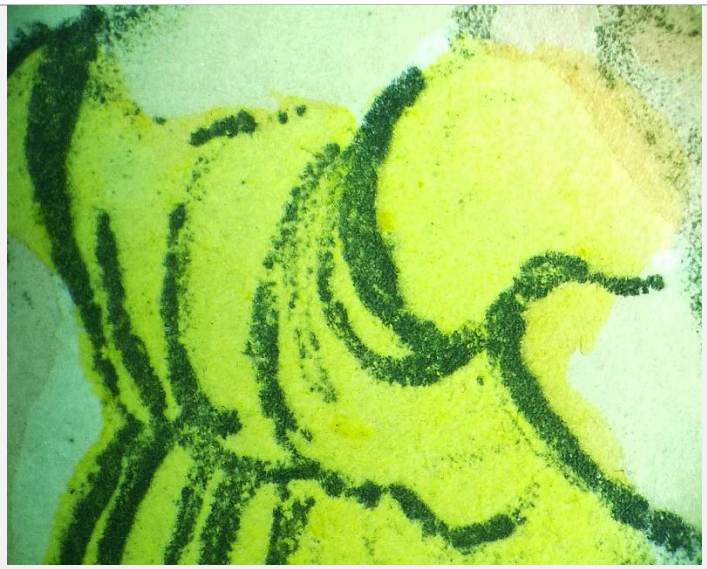
VISUAL APPEARANCE					
Visible Light	**UVF**	**IRR**	**FCIR**	**Magnification**	**Inference**
A very pale, transparent yellow	Absorbs under UV, appearing a dark orange	N/A	N/A	N/A	Possibly Gamboge due to aging characteristics, date, and appearance

IDENTIFICATION DETAILS	
Title: Rolandson, *The Cellar Quartetto* **Date:** 1821 **Printer/Publisher:** R. Ackermann **Description:** Hand coloured aquatint taken from the Tours of Doctor Syntax, depicting two men smoking after a heavy drinking session, beside them is a gentleman trying to win the affections of a serving maid. Barrels of beer are present in the background.	 ©University of Aberdeen

TECHNICAL EXAMINATION	
Technique Watercolour wash applied using a brush. Yellow pigment is present on the vest of the man in the middle. Two shades of yellow are present, most likely the same pigment applied in different intensities. It is a very pale, transparent yellow similar to the one in *The Artists Room*. Likely faded. Under magnification, the pigment appears like a yellow stain on the paper fibres. No strikethrough of the pigment is present.	 © University of Aberdeen A macro-photograph of the yellow pigment

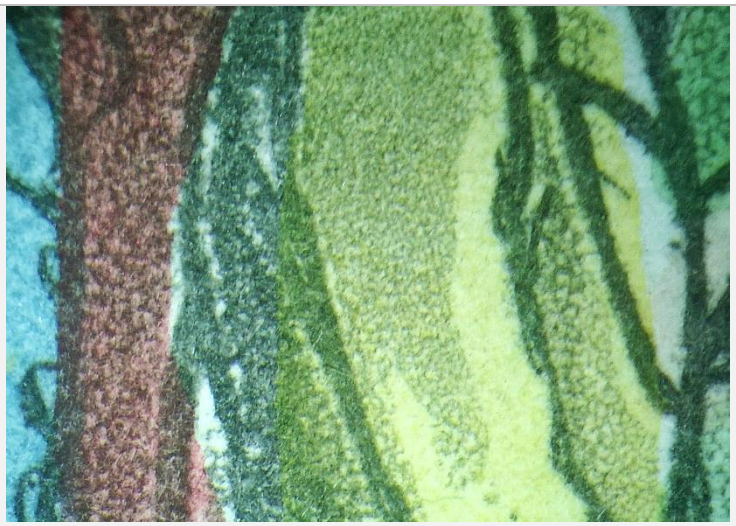
VISUAL APPEARANCE					
Visible Light	**UVF**	**IRR**	**FCIR**	**Magnification**	**Inference**
A very pale, transparent yellow	Absorbs under UV, appearing a light brown	N/A	N/A	N/A	Possibly Gamboge due to aging characteristics, date, and appearance

IDENTIFICATION DETAILS	
Title: Rolandson, *Dr. Syntax_Rural Sports* **Date:** 1821 **Printer/Publisher:** R. Ackermann **Description:** Hand coloured aquatint taken from the Tours of Doctor Syntax, depicting a group of men and women dancing to the tune of a fiddler outside a barn house.	 ©University of Aberdeen

TECHNICAL EXAMINATION	
Technique Watercolour wash applied using a brush. Yellow pigment is present on a lady's dress, blouse, and scarf. It is a bright, transparent yellow. Under magnification, the pigment appears like a yellow stain on the paper fibres. No strikethrough of the pigment is present.	 © University of Aberdeen A macro-photograph of the yellow pigment

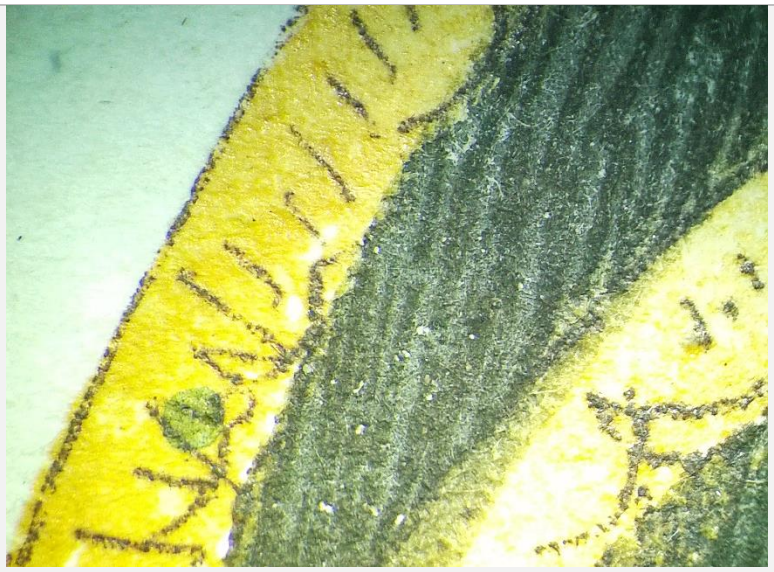
VISUAL APPEARANCE					
Visible Light	**UVF**	**IRR**	**FCIR**	**Magnification**	**Inference**
A bright, transparent yellow	Absorbs under UV, appearing dark orange	N/A	N/A	N/A	Possibly Gamboge due to date, and appearance

IDENTIFICATION DETAILS	
Title: *The Jubilee Naval Action on the Serpentine in Commemoration of the Battle of the Nile* **Date:** 1814 **Printer/Publisher:** T. Palser, Surrey side West Bridge **Description:** Hand coloured aquatint depicting people celebrating a naval re-enactment of their victory against France at the edge of a lake.	 ©University of Aberdeen

TECHNICAL EXAMINATION	
Technique Watercolour wash applied using a brush. Yellow pigment is present on the ships, as well as the coats of several men. It is a bright, transparent yellow. Possibly faded. Under magnification, the pigment appears like a yellow stain on the paper fibres. No strikethrough of the pigment is present.	 © University of Aberdeen A macro-photograph of the yellow pigment

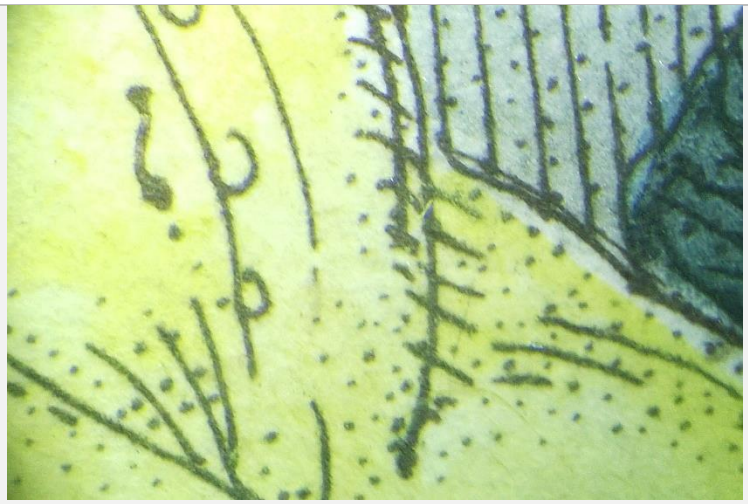
VISUAL APPEARANCE					
Visible Light	**UVF**	**IRR**	**FCIR**	**Magnification**	**Inference**
A bright, transparent yellow	Absorbs under UV, appearing light orange	N/A	N/A	N/A	Possibly Gamboge due to date, and appearance. Also possibly other yellow lakes

IDENTIFICATION DETAILS	
Title: *The Cryer, alias the Bellweather* **Date:** 24 February 1797 **Printer/Publisher: S.** W. Flores, 50, Picadilly **Description:** Hand coloured aquatint from the *Folios of caricatures, lent for the evening* depicting a caricature of the town crier reading the news.	 ©University of Aberdeen

TECHNICAL EXAMINATION	
Technique Watercolour wash applied using a brush. Yellow pigment is present on the hat, buttons and shoe buckles of the town crier. It is a dark, mustard yellow, relatively translucent. Under magnification, the pigment appears shiny, moderately opaque and sits on the surface of the paper fibres. No strikethrough of the pigment is present.	 © University of Aberdeen A macro-photograph of the yellow pigment

VISUAL APPEARANCE					
Visible Light	**UVF**	**IRR**	**FCIR**	**Magnification**	**Inference**
A dark, mustard yellow.	Absorbs very strongly under UV, appearing dark brown	N/A	N/A	N/A	Possibly yellow ochre due to date, and appearance.

IDENTIFICATION DETAILS	
Title: Rowlandson, *Irish Jaunting Car* **Date:** May 1814 **Printer/Publisher:** T. Rowlandson **Description:** Hand-coloured etching depicting a cart full of passengers. A second cart can be seen in the background.	 ©University of Aberdeen

TECHNICAL EXAMINATION	
Technique Watercolour wash applied using a brush. Yellow pigment is present on the woman's dress in the foreground, and on the cart in the background. It is a bright, translucent yellow that has been applied rather unevenly. Possibly faded. Under magnification, the pigment appears like a yellow stain on the paper fibres. No strikethrough of the pigment is present.	 © University of Aberdeen A macro-photograph of the yellow pigment

VISUAL APPEARANCE					
Visible Light	**UVF**	**IRR**	**FCIR**	**Magnification**	**Inference**
A bright, translucent yellow	Absorbs under UV, appearing orange	N/A	N/A	N/A	Possibly gamboge or other yellow lakes (Italian pink)

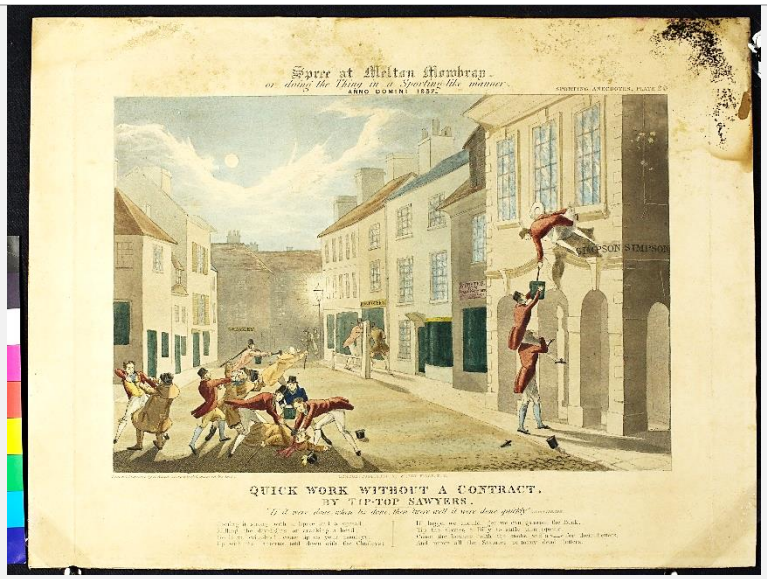
IDENTIFICATION DETAILS

Title: Henry Alken, *Quick work without a contract*

Date: 1837

Printer/Publisher: R. Ackermann

Description: Hand-coloured engraving depicting some men fighting in a street between rows of houses with cleaning brushes, and others climbing over one another to clean windows.



TECHNICAL EXAMINATION

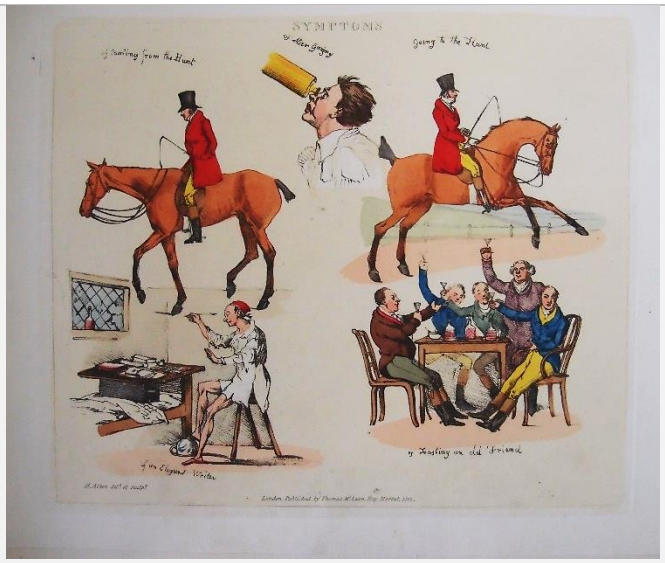
Technique

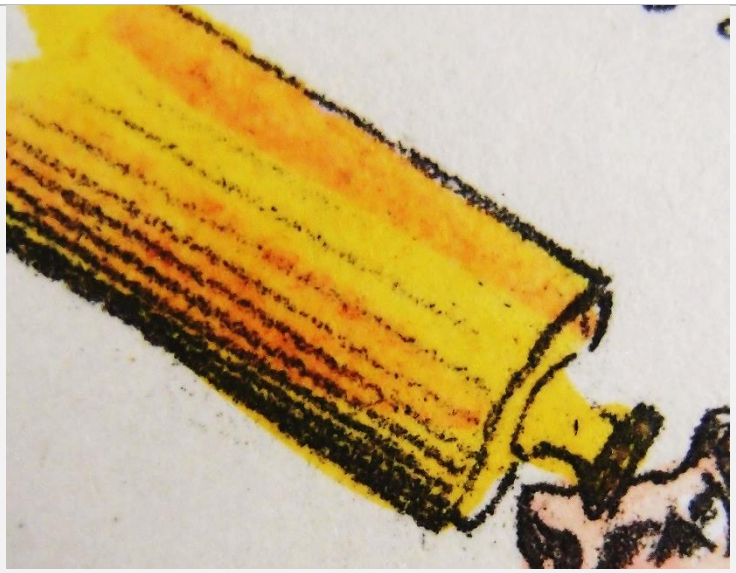
Watercolour wash applied using a brush. Yellow pigment is present on a man's vest on the far left. It is a bright, translucent yellow. Under magnification, the pigment appears slightly shiny, like a yellow stain on the paper fibres. No strikethrough of the pigment is present.

A macro-photograph of the yellow pigment

VISUAL APPEARANCE

Visible Light	UVF	IRR	FCIR	Magnification (20x)	Inference
A bright, translucent yellow	Absorbs under UV, appearing orange	Transmits	A very pale yellow		Possibly gamboge or other yellow lakes (Italian pink)

IDENTIFICATION DETAILS	
Title: Henry Alken, *Symptoms of coming from the Hunt, of Star Gazing, Going to the Hunt, of an Elegant Writer, of Toasting an old Friend* **Date:** 1822 **Printer/Publisher:** Thomas McLean, Hay Market **Description:** Hand-coloured soft-ground etching from *Symptoms of being amused*.	 ©Alnwick Castle, Northumberland

TECHNICAL EXAMINATION	
Technique Watercolour wash applied using a brush. Yellow pigment is present on the telescope, the breeches of both horse riders, and the pants and shirt of a man sitting at the table. It is a brilliant, translucent yellow, with a mustard undertone. Under magnification, the pigment appears like a yellow stain on the paper fibres.	 © Alnwick Castle, Northumberland A macro-photograph of the yellow pigment present

VISUAL APPEARANCE					
Visible Light	**UVF**	**IRR**	**FCIR**	**Magnification (20x)**	**Inference**
A brilliant, slightly mustard, translucent yellow	Absorbs strongly under UV, appearing dark brown	N/A	N/A	N/A	Possibly gamboge or other yellow lakes (Italian pink)

IDENTIFICATION DETAILS

Title: Henry Alken, *Moments of fancy, real English fancy*

Date: 1822

Printer/Publisher: Thomas McLean, Hay Market

Description: Hand-coloured soft-ground etching from *Moments of Fancy*.

TECHNICAL EXAMINATION

Technique

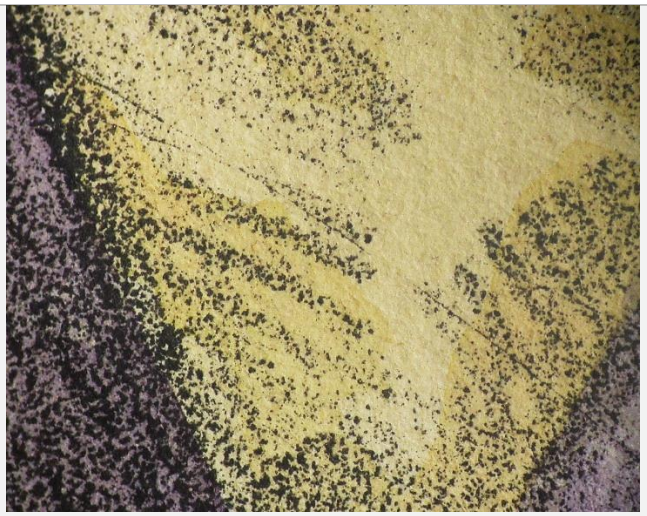
Watercolour wash applied using a brush. A brilliant, translucent yellow pigment is present on the breeches of the figure in the far right. Under magnification, the pigment appears like a yellow stain on the paper fibres. A second, pale, translucent yellow can be seen on the carriage door. It also appears as a stain under magnification.

A macro-photograph of the two yellow pigments present

VISUAL APPEARANCE

Visible Light	UVF	IRR	FCIR	Magnification (20x)	Inference
A brilliant, translucent yellow; A very pale, translucent yellow	Absorbs strongly under UV, appearing dark orange; appears a slightly darker yellow under UV	N/A	N/A	N/A	Possibly gamboge or Italian pink; possibly yellow lake or Indian yellow

IDENTIFICATION DETAILS	
Title: Pigal, *Quelle Scie!* **Date:** 1822 (possibly hand-coloured later) **Printer/Publisher:** Cher Gihaut et Martinet **Description:** Hand-coloured lithograph from *Scenes de Société* depicting an old woman and a young woman with their arms linked. The young woman has an irritable look on her face.	

TECHNICAL EXAMINATION	
Technique Watercolour wash applied using a brush. A light, translucent yellow pigment is present on the skirt and sleeves of the old woman. Under magnification, the pigment appears like a yellow stain on the paper fibres.	 A macro-photograph of the yellow pigment present

VISUAL APPEARANCE					
Visible Light	**UVF**	**IRR**	**FCIR**	**Magnification (20x)**	**Inference**
A light, translucent yellow	Appears a light yellow under UV	Transmits	A pale yellow		Possibly Quercitron