

John White's Materials and Techniques

Timea Tallian

Today most professional painting materials such as brushes and paints are sold ready-made in specialist art shops. In comparison, most 16th-century artists had to prepare their paints and equipment themselves. Some raw materials for paints were available in England but most had to be imported from large trading ports such as Antwerp or Venice. Usually they could be obtained from apothecaries.

John White painted on paper with fine pigments, bound together with a water-soluble resin called gum arabic. In 16th-century England, this method was referred to as 'limning' (see Katherine Coombs' paper in this collection). Today we describe this technique as 'watercolour' or 'aquarelle', as water is used as a solvent for the paint. This description can be misleading, as the term watercolour is nowadays strongly associated with 18th-century and later watercolour paintings or aquarelles, where the paint was applied on the paper in translucent washes, where the paper appeared to glow through the wash or where areas of paper were left uncovered for highlights.

As Katherine Coombs explains, the term 'limning' is closely related to manuscript illumination, which has some differentiating features, including the use of powdered gold and silver leaf and the application of opaque matt layers of unmixed expensive pigments. These were prepared from colourful minerals like azurite, lapis lazuli (blue), malachite (green) or cinnabar (red). Other pigments for limning were made from naturally occurring coloured earths (ochres), produced by chemical processes (e.g. lead pigments) or by modifying dyes derived from plants and insects (e.g. indigo and Indian lake). Whereas watercolour or aquarelle paints were usually strongly gummed, the mat 'body colour' for limning required more pigment and less gum. Also this opaque foundation layer or body colour was usually kept in a middle tone, on which highlights and deep shadows could be build up gradually in fine semi-transparent stipples, hatches or cross hatches of colour (similar to the 'modelling' of engravings).

We have no contemporary records of how exactly White worked. Close examinations of originals show that he worked as much with transparent washes as with the described typical limning technique, building up the painting with fine hatches on top of an opaque body colour base. Recent instrumental analysis of White's palette allowed the following pigments to be identified unambiguously: lead white, vermilion, azurite, smalt, indigo, yellow ochre, red ochre, carbon black and powdered gold and silver.¹ These pigments are fairly typical for the period and for limning in general² and will be discussed in greater detail.

Treatises on limning (of portrait miniatures) by the famous English Renaissance artist Nicholas Hilliard,³ those by Edward Norgate,⁴ related manuscripts⁵ and printed books on the subject⁶ describe the sophisticated techniques to prepare the pigments and the binder in surprising detail and represent

invaluable sources of information.

When studying these contemporary sources it becomes clear that limning was not considered to be a decorative art but a professional tool. In fact it was used in an equivalent manner to modern day photography and high quality colour prints in books. Limning could be used for illustrations in travel journals, for military purposes like mapping, heraldic images and decorative borders in documents, for painting counterfeits from life, for studies of flora and fauna or for illustrating histories.

Generally they were not made to be framed or to be hung on a wall but as illustrations for albums and portfolios. Well-known exceptions are exquisitely painted small portraits (later called portrait miniatures), which were mounted in gold lockets and pendants. The latter represent the highest quality limnings, as the most precious materials were used for their making. Misleadingly, the term limning was also occasionally used for minor techniques like the hand-colouring of prints and maps with transparent washes of watercolours. This technique required no special ability or knowledge and was referred to by some authors as 'washing' to differentiate it from limning.⁷ Often cheaper transparent paints made of light fugitive organic dyes were used for this purpose. The art of limning as used by White or Hilliard requires good draughtsmanship, specialist knowledge of materials and techniques and good observation from nature. Hilliard states that limning should be practised by artists from an educated (and wealthy) background, and as it is a very clean and outstanding art form he describes it as mostly fit for the use of gentleman.⁸ Henry Peacham additionally states in his book *The Gentleman's Exercise* (1612) that limning is not as smelly as oil painting and does not stain the expensive (silk) clothes worn by the gentry, as watercolour stains could be easily removed.

As mentioned above, we have no direct records of White's working methods. We don't know if he took his materials ready prepared to America or if he prepared pigments *in situ*. Also we can't state categorically whether he painted his images during his stay or back in England. Although he clearly studied the living specimens, particularly the fish, which could be kept alive for some time in a container on board ship, it is likely that White did not always paint directly from life 'in the field', but also made his nature studies from dead, dried and conserved specimens in an enclosed studio either abroad or at home. There he would have had a steady light source and would have not been disturbed by direct sun, wind or insects. Hilliard recommends:

Let your light be northward, somewhat toward the east, which commonly is without sun shining in. One only light: great and fair let it be, and without impeachment, or reflections of walls or trees [...] in a place where neither dust, smoke, noise nor stench may offend.⁹



Figure 1 Graphite, a naturally occurring mineral used for drawing



Figure 3 Gum arabic as a resin and as powder. Gum arabic is a water-soluble resin obtained from a sub-Saharan species of the acacia tree, *Acacia senegal*, also known by the common names rudraksha, gum arabic tree, or gum Senegal tree. It is native to semi-desert regions of sub-Saharan Africa as well as Oman, Pakistan and northwest India. The gum is drained from cuts in the bark.



Figure 4 Brushes, shells and palette (reconstruction by the author)

For the images of Native Americans White probably prepared sketches of costumes and particular features from life, which he used later as a base for his paintings. One indication that White did not paint entirely from life is that his images of Native Americans show formulated features such as very similar feet with an elongated big toe and the manner of drawing limbs is very formulaic, being repeated in the images of the Picts as well as the Algonquians.

Under drawing

The under drawing of some of White's images has been identified as graphite, which is also commonly used for drawing today (Fig. 1). The 16th-century term 'black lead' is a misnomer, since graphite does not contain any lead. Generally pre-drawing for limning was done lightly with the brush and diluted paint directly on the paper or vellum (fine parchment). Such pre-drawing would remain largely invisible. Hilliard usually used brush pre-drawings although there is one exception of an unfinished portrait miniature where beside brush drawing also a line of graphite could be identified (Fig. 2). We need to consider that brush drawings and lines with coal, black or white chalk are difficult if not impossible to identify by instrumental analysis. On a finished painting it would be hard to differentiate those materials from the pigments used for the painting. For this reason we can't exclude the possibility that White also made brush drawings or used also other drawing materials beside graphite.



Figure 2 Unfinished miniature of an unknown lady by Nicholas Hilliard, Victoria & Albert Museum, P.8-1947. This picture clearly shows the limning techniques of making a pre-drawing which brush and applying an opaque body colour for the skin tone and the blue background.

Paint preparation and equipment

Hilliard recommends storing the purified and refined pigments as dry powder in paper envelopes or boxes of ivory, 'that I may easily temper them with my finger in a shell, adding gum at discretion; so have I them always clean and fair and easier to work'.¹⁰ Because of technical limitations it is not possible to get analytical evidence of what kind of binder White really used. There is little reason to doubt, however, the use of gum arabic, which was the most common binder for limning. Hilliard recommends: 'the gum to be gum arabic of the whitest and brittlest, broken into white powder' (Fig. 3).¹¹ Sometimes it was difficult to temper gum and pigment directly in the shell, as some pigments like vermilion or ivory black do not easily mix with water. In this case it was necessary to prepare the paint on a grinding stone. Hilliard's treatise mentions the use of a 'grinding stone of fine crystal, serpentine, jasper or hard porphyry at the least'.¹²

The ready-prepared paint was thinly smeared with a finger around the inside of a mussel shell. When the paint had the right consistency it would remain as a thin layer on the smooth mother-of-pearl. If too gummy the paint would peel off and flake and if too little gum had been used than it would powder off when touched with a finger. Once the paint dried inside the shell it could be easily reactivated by the addition of water. Colour shades were mixed on a mother-of-pear or ivory palette.

Detailed information on painting equipment for limning can be found in a manuscript in the British Library,¹³ which was probably written by Hoskins, an apprentice of Hilliard.¹⁴ These detailed descriptions amongst others were used by the author of this essay for the reconstruction of brushes made from squirrel hair (from the tail) mounted in quills (Fig. 4). Those 'brush tips' of various sizes could be put onto on a handle made from wood (e.g. ebony) or ivory. It is possible that White kept his shells, brushes and palette in a 'pocket deske' as described by the Hoskins manuscript, which would have been very handy for travelling:

The box being open, & the lidd thereof turned quite backwards, the lidd is then a Desk to Limn upon, & the Ribbon is for sticking your pictures in, when you work them. There must be allsoe a stiff wire stuck fast, & upright in the inside of the box [...] to put on your Pencills, whose sticks must have holes for that purpose [...] Your box thus made [...] with 3 or 4 peices of Bayes [...] to lay between your Shells of Colours, to keep them from stirring, & fridgeing in the box.¹⁵

Figure 5 Lead white has formed as flakes on a lead coil, which was exposed to vinegar fumes and carbon dioxide for about a month (reconstruction by Carmen Krisai-Chizzola).



Figure 6 Red lead or minium as paint in a mussel shell (reconstruction by the author)



Figure 7 Vermilion as a red powder stored in a paper envelope



Figure 8 Azurite as mineral, powder and paint in a mussel shell (reconstruction by the author)



Figure 9 Shells with earth colours, yellow, red and brown ochres (reconstructions by the author)



Artificial pigments

Artificial pigments are not a modern invention but were a side product of early alchemical experiments and have been used since classical times for cosmetic and painting purposes. Lead pigments in particular were very popular, as they provide good coverage and were ideal to create very thin but opaque paint layers. The use of lead white was avoided after the invention of zinc white at the end of the 18th century, as it has a tendency to tarnish when exposed to hydrogen sulphide, a gas produced by coal fires. Analysis showed that lead white was used by White as the main white and as a base for the skin tone. Lead white is made by exposing lead plates to vinegar fumes. This process creates lead acetate, which reacts with carbon dioxide from the atmosphere and forms a white corrosion layer on the lead – white lead (basic lead carbonate – $2\text{PbCO}_3 \cdot \text{Pb}(\text{OH})_2$) (Fig. 5). When lead white is roasted it first becomes a light yellow: massicot or litharge (lead oxide – PbO). When it is heated more it turns orange/red: red lead (lead tetroxide (Pb_3O_4)) (Fig. 6).

Another red is vermilion (mercuric sulphide – HgS), which occurs naturally as the mineral cinnabar. Often, however, it was produced synthetically by exposing sulphur to mercury fumes. Despite its poisonous nature painters often used this vivid red, as its colour can't be obtained by any type of red ochre and is much darker than red lead (Fig. 7). Instrumental analysis suggests that vermilion was used by White in small quantities to emphasize features like lips.

Mineral pigments

Mineral pigments in the 16th century were made and refined with elaborate and often secret methods. According to analysis results White seemed to have used azurite (copper carbonate – $2\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$) (Fig. 8) and smalt (glass coloured by the presence of cobalt) as cheaper alternatives to the very expensive blue made from the semi-precious stone lapis lazuli (natural ultramarine).

Earth pigments

Ochres or earth pigments provide the main source for White's reds, yellows and browns (Fig. 9). Yellow ochre (Iron(III)-oxide hydrate) and red ochre (Anhydrous iron(III)oxide) in various shades were the most important pigments of White's palette for the paintings of Native American life. It is possible that White also used and purified locally occurring earth pigments. In this case he would have used the same pigments that the Native Americans used for their body painting and to decorate items of daily life. This, however, was not something that tests were able to prove. (See Janet Ambers *et al.* paper in this collection.)

Organic pigments

Organic pigments are difficult to identify by instrumental analysis. The main exception is indigo. A black blue derived from plants, either woad (*Isatis tinctoria*) and Dyer's Knotweed (*Polygonum tinctorum*), which grows in temperate climates and Indigofera species in the tropics. Indigo has also been an important pigment for limners, enabling them to produce greens by mixing this blue with a yellow such as ochre. Green areas analyzed on botanical drawings such as foliage did not yield any results with instrumental analysis and therefore they must be assumed to be organic in nature. It is possible that



Figure 10 The picture shows the incrustation of the lac insect, which consists of thousands of dead bodies of the female insects (*Kerria lacca*) formed around a twig, the extracted red dye applied on cotton wool and as Indian lake in a shell.



Figure 11 Charred cherry stones were used in the 16th century to produce fine black pigments (reconstruction by the author).



Figure 12 Powdered gold leaf bound with gum arabic in a shell. Gold paint produced this way is commonly called 'shell gold' (reconstruction by the author).



Figure 13 Animal teeth mounted in wooden handles were used to burnish 'shell gold' and 'shell silver' (reconstructions by the late Jim Murrell, V&A).

White used 'sap green' produced from unripe buckthorn berries (*Rhamnus sp.*).¹⁶

Although there is no analytical evidence it is also quite likely that White used 'lake pigments' such as Indian lake. Until the 18th century 'lake', without further qualification, usually indicated red pigments only. Incrustations of the lac insect (*Kerria lacca*) were imported into Europe from India, and yielded both red dyestuff and, as a by-product, shellac used as wood polish (Fig. 10). Lake pigments are prepared by the precipitation of a soluble organic dye onto an insoluble, inorganic, adsorptive substrate.¹⁷ Also a dyestuff made from shellfish could be identified on a painting of hermit crabs, which could be a paint-stuff of North American origin. Organic

pigments tend to be fugitive to light. Therefore we need to consider that some colours on White's paintings have changed their appearance. Their storage in albums, however, might have helped to preserve the original shades.

Carbon black

The analyzed blacks in White's paintings are predominantly carbon based. Hilliard mentions the charring of fruit stones to obtain good blacks for fine painting. The practical reconstruction of carbon blacks based on 16th-century recipes by the author demonstrated that the carbonization of fruit stones and twigs worked equally well in a metal stove, a traditional clay stove, a bonfire and in various containers (Fig 11).¹⁸ This suggests that it is a fairly straightforward process that could have easily been done by the miniaturists themselves at home and abroad.

Metal pigments

Shell gold (Fig. 12) was applied for final touches and then burnished. This was possibly done with a tooth burnisher made from the tooth of a dog or smaller animal (Fig. 13). Metal paints were made by grinding the off-cuts of gold or silver leaf with a sticky medium such as honey or a thick solution of gum arabic. This was likely to be done on a flat plate with the side of the hand or a finger, and then the resulting gold paste was refined by washing and filtering through cloths. White used shell gold for emphasizing flames of a bonfire, which must have created a wonderful three-dimensional effect when it shimmered in the sunlight or when turning the pages of the album. Also the use of shell silver must have closely replicated the effect the reflecting scales of living fish. Unfortunately these special effects were lost; because of water damage, most of the gold is now irreversibly stuck to the offset.

The fragments of gold that have remained are not very visible in particular in the dim light conditions of a museum's display. Unfortunately the silver of the fish scales has tarnished from being exposed to hydrogen sulphide in the atmosphere and is now irreversible black dots, lines and areas of grey. This may be the main reason artists have stopped using shell silver for watercolour painting.

Conclusion

Although White's paintings show features of modern watercolours, the use of powdered gold and silver leaf clearly identifies White's paintings as being rooted in the medieval tradition of limning or book illumination. In addition, White's use of less gummed matt paint and of a certain range of pigments are typical of limning.

Although we have no records of exactly how John White worked, information from treatises related to limning of portrait miniatures, in particular by the limners Nicholas Hilliard and Edward Norgate, provide us with information on contemporary working methods and equipment. According to these sources, the equipment for limning would not have been difficult to transport to America. Pigments and powdered gum arabic could be carried in paper envelopes. Ready-prepared paint in mussel shells as well as brushes and an ivory palette could have been transported in boxes such as the 'pocket deske' as described by the Hoskins manuscript.

Mineral and poisonous artificial pigments (containing lead or mercury) would have been difficult to prepare abroad. It is possible, however, that some other pigment such as ochres made from natural earths, dyes from plants and shellfish or carbon blacks also could have been made from local materials. It is quite likely that White painted and collected as much information *in situ* but also refined pictures by taking sketches and specimens home to England.

Acknowledgements

For art historical advice, I am indebted to Kim Sloan (British Museum) and Katherine Coombs (Victoria & Albert Museum); for information on scientific analysis, to Janet Ambers (British Museum); and for advice concerning artists' materials and techniques, to Alan Derbyshire (Victoria & Albert Museum).

Notes

- 1 Verbal communication with Janet Ambers from the British Museum. The analysis has been conducted using optical microscopy, Raman spectroscopy and X-ray fluorescence analysis (XRF).
- 2 R.D. Harley, *Artists' Pigments c. 1600–1835: A Study in English Documentary Sources*, London, 2001. Harley describes contemporary pigments and documentary sources of 16th- and 17th-century England. Information about earlier sources can be obtained from M. Clarke, *The Art of All Colours – Mediaeval Recipe Books for Painters and Illuminators*, London, 2001. Summarized information about medieval artists materials can be also found in: D.V. Thompson, Jr., *The Materials of Medieval Painting*, London, 1956.
- 3 Manuscript copy of Nicholas Hilliard's treatise, Edinburgh, Laing III 174, with a parallel modernized text. R.K.R. Thornton and T.G.S. Cain, eds, *A Treatise Concerning the Arte of Limning by Nicholas Hilliard together with 'A more Compendious Discourse Concerning ye Art of Limning'*, Manchester, 1992.
- 4 Complete edition of the second version of Edward Norgate's *Miniatura*, Bodl. Tan. 326. with review and extracts of other manuscript copies. J.M. Muller and J. Murrell, eds, *Edward Norgate, Miniatura or the Arte of Limning*, New Haven and London, 1997.
- 5 List of manuscript treatises related to Norgate's treatise, Muller and Murrell, *supra* n. 4, 220–21:
 - (1) Edinburgh, Laing III 174, 15–16; published in Thornton and Cain, *supra* n. 3, 96–105.
 - (2) London, BL Sloane 228, 3–23.
 - (3) London, BL Sloane 1950, 12–12v.
 - (4) London, BL Harl. 6376, 1–83.
 - (5) London, BL Sloane 3907, 1–31.
 - (6) London, V&A, NAL, L.995–1906, 1–143.
 - (7) London, Royal Society, 136, title page, 1–53.
 - (8) Oxford, Bodl. Tan. 326, 1–86.
 - (9) Cardiff, National Library of Wales, 21753b, 89–116v.
- 6 List of printed books related to Edward Norgate's treatise, Muller and Murrell, *supra* n. 4, 223–24:
 - (1) *A Book of Drawing, Limning, Washing*, 1652; later editions 1660, 1666. After 1666, revised under the title of *Albrecht Dürer Revived* (no. 4, below).
 - (2) A. Browne, *The Whole Art of Drawing, Painting, Limning and Etching*, 1660.
 - (3) *Academica Italica*, 1666.
 - (4) *Albrecht Dürer Revived*, 1666 (revision of no. 1 above).
 - (5) *The Excellency of the Pen and the Pencil*, 1666.
 - (6) A. Browne, *Ars Pictoria*, 1669.
 - (7) W. Salmon, *Polygraphice*, 1672.
 - (8) A. Browne, *An Appendix to the Art of Limning*, 1675.
 - (9) R. Blome, *The Gentleman's Recreation*, 1686.
 - (10) *Art's Masterpiece*. Late 17th century.
 - (11) J. Evelyn, *Sculptura*, 1662.
 - (12) W. Sanderson, *Graphice*, London, 1658.
- 7 This is clear for example from contemporary book titles such as *A Book of Drawing, Limning, Washing*, 1652 (later editions 1660, 1666). After 1666, revised under the title of *Albrecht Dürer Revived*. A recent useful book on this subject is S.S. Dackerman, *Painted Prints: The Revelation of Color*, Baltimore, MD, 2004.
- 8 Thornton and Cain, *supra* n. 3, 73.
- 9 *Ibid.*, 73–4.
- 10 *Ibid.*, 92.
- 11 *Ibid.*, 73.
- 12 *Ibid.*, 73.
- 13 The original 'Hoskins manuscript' (known as 'Gyles' book') is in the British Library (BL, Harley 6376), London. A manuscript copy can be found in the National Art Library (NAL, R.C.A. 20-995-1906), London. (Extracts are published in Muller and Murrell, *supra* n. 4, 237–52 and in J. Murrell, *The Way Howe to Lymne – Tudor Miniatures Observed*, London, 1983, 76–9, 80–4, 92–3.
- 14 Murrell, *supra* n. 13, 76–9.
- 15 'Hoskins manuscript', *supra* n. 13, fol. 14.
- 16 Information obtained from Janet Ambers (scientist at the British Museum).
- 17 The pigment is formed by the chemical reaction when a suitable reagent (generally alum) is added to an aqueous solution containing the dyestuff and other chemicals such as sodium or potassium carbonate. These chemicals react with the alum to form the substrate, an insoluble product of the reaction. During the reaction the dyestuff becomes intimately combined with the substrate.
- 18 T. Tallian, *Reconstruction of Nicholas Hilliard's Materials and Techniques*, a thesis submitted in partial fulfilment of the requirements of the Royal College of Art for the degree of Master of Philosophy, May 2007, The Royal College of Art/Victoria & Albert Museum, London, 61–7.