Science and art in the RHS Reeves Collection

Light beams shone at the paintings reveal the degree to which the pigments might fade

KATE BAILEY & CHARLOTTE BROOKS show how sophisticated analytical techniques have given new insights into the pigments and methods used by Chinese botanical artists in the early 19th century

THROUGHOUT 2013 and 2014 we were part of a team working with scientists at the Victoria and Albert Museum (V&A) and Nottingham Trent University (NTU) investigating the RHS Reeves collection of Chinese botanical drawings. The project looked at the materials used in 19th century Chinese pictures and sought to compare the RHS Reeves Collection with a small selection of similar export paintings held by the V&A.

The RHS Reeves Collection comprises eight substantial volumes of botanical pictures collected by John Reeves during his time in Canton (now Guangzhou) and Macau in China (Bailey 2010a, 2010b). A tea inspector with the East India Company and corresponding member of what was then the Horticultural Society of London (now RHS), he sent back drawings and plant specimens in batches between 1817 and 1830. The fact that the pictures were numbered and that the Society's minutes recorded the receipt of numbered batches of drawings, makes them especially valuable for research.

During the 19th century there was a fashion for sending pictures from China, but most that survive have no recorded date and the identity of the original collector has been lost. Valuable additional information was gleaned from two of Reeves's

All photographs: RHS Lindley Library

The painting of *Rosa chinensis* 'Semperflorens' was found to contain a broad range of pigments

notebooks held at the Natural History Museum; these record a few of the plant drawings, the name of the Chinese artists and the amount they were paid by Reeves. It is rare to find the names of the artists who painted so many pictures sent back from China at this time.

Aims of the research

The aim of the research was to discover how the pictures were made – the pigments, the method of production and the papers used. Because the project also included a selection of pictures from the V&A, it was hoped that comparisons could be made. Unlike the RHS Reeves Collection, those at the V&A were acquired from booksellers in the UK in the late 19th and early 20th centuries. The dates and painters' names are unknown.

Chinese painting styles and materials are usually very different from those found in European works. The RHS collection is particularly informative because two distinct methods of picture-making are in evidence. Most of the pictures were made on fairly thick, heavily sized Western papers, usually Whatman, which was almost certainly obtained by the East India Company for this purpose. However, the albums are also interspersed with small watercolours on fine, very white Chinese papers, where the paint appears to have been applied in thin washes. Reeves gave these pictures a separate reference system and, although it seems that they were painted by his usual painters, Akam, Akew, Akut and Asung, they were collected by him rather than commissioned.

Previous historical research had revealed the way in which pictures were generally produced in the artists' studios of China Street and New China Street in Canton at this time. This involved a uniquely Eastern method of painting using ground mineral pigments and organic dyes which were repeatedly covered with washes of alum and animal glue solution to protect the paper and paint. The V&A pictures are typical of the pictures that were produced for visitors in large quantities and sold as souvenirs, in the days prior to photography. A further point of interest was to discover whether the Reeves pictures matched what was already known about the materials and production methods of Chinese export art, as the painters were likely to have come from the same Canton studios and would have been used to working for Western markets.

Scientific exploration

We identified a number of pictures from the Reeves collection for testing, seeking as wide a range of dates, colours and paper types as possible. We wanted to find out which pigments were present and, in particular, whether they contain Prussian blue (a manufactured colour exported from Europe) or the traditionally used blue indigo (derived from plants such as *Indigofera tinctoria* and *Isatis tinctoria*).

One limitation was that the Raman microscope could only take unbound pictures of a certain size, but we eventually narrowed our selection to 32 pictures. ➤

Due to the valuable nature of this collection, traditional methods of sampling by taking minute amounts of paint from the surface with a fine needle for microscopic examination were not an option. However, we had access to analytic instruments that could tell us a lot more. This project brought together physicists and chemists using five, non-invasive, analytical methods. One of the unique aspects of this study was the combination of several instruments and analysis techniques, including new instruments built at NTU.

Infra-red imaging of the painting of *Wisteria sinensis* (above) revealed the use of graphite pencil for under-drawing during the early stages of its creation (right). The pencils were supplied by Reeves.

Testing methods

Selected Reeves pictures underwent initial microfade testing. A narrow but intense beam of light was directed onto several points on each picture and the light reflected back was collected by a spectrometer to determine whether they would fade and, if so, what the rate of fade would be. This was compared to an index known as the Blue Wool standard. This index is a valuable tool for curators and conservators because it tells them the maximum allowable light levels for each picture, before visible damage occurs. All except one of the pigments demonstrated stability equal to or better than ISO Blue Wool 3, which is a good result.

Once we were confident that the pictures met this standard and would not be adversely affected, further tests were carried out using optical coherence tomography (OCT) which probes the paper surface to reveal its structure. In addition, multispectral imaging allows for large areas of the paper to be read under near infra-red light, to reveal any hidden lines beneath the painted layers. These tools allowed us to determine something of the process for creating the pictures and a tentative identification of the artists' materials.

The pictures were then subjected to Raman spectroscopy, which involves focussing a laser beam onto the picture at selected points and 'reading' information conveyed by the scattered light. This is a non-invasive, non-destructive way of identifying some pigments, even when they have been mixed. Vermilion mixed with lead white to produce pink is a common combination, and was found on pink petals. Raman was able to detect inorganic pigments made from finely ground minerals such as green malachite and blue azurite. It is less helpful at identifying organic pigments, such as lac and cochineal (red scale-insect dyes). These red dyes can be identified using microfade at low light level. These techniques were supplemented by X-ray fluorescence (XRF) which indicates chemical elements present such as lead, arsenic and chromium.

Whereas OCT and multispectral imaging provide an impression of a large area of the picture, microfade, Raman and XRF all involve scrutinizing minute points on the picture, or, in the case of Raman, individual particles. When used in combination they allow for a wealth of information to be uncovered. For example, the materials used in Chinese papers derived from plant material differ greatly from those found in Western papers of the period, which usually contain a high rag content. When OCT is combined with XRF we can see not only the paper structure but discover what type of size had been applied to the surface during manufacture.

Material revelation

As the study was intended as a pilot, and scheduled to last only 12 months, there was a limit to the number of pictures that could be analysed. Although only a small proportion of the RHS Reeves pictures were included in the study, the results can be applied to much of the remaining collection. Of all those tested, the paints and papers were found to be more stable than ISO Blue Wool 3. This critical information was not only necessary for the safe continuation of the study, but can also be used to inform decisions about any future plans to display the pictures.

Tests revealed that the majority of the colours were those typically used by Chinese painters. The organic pigments include yellow gamboge (derived from *Garcinia*, a tropical tree) and indigo, lac and cochineal.

Fine examples of these organic pigments can be seen on the illustration of *Rosa chinensis* 'Semperflorens', where the petals were painted using lac or cochineal. Cochineal was imported from the West and lac, derived from the lac insect, is a similar product more commonly used in the East. The inorganic paints used in the rose painting included lead white, red lead, green malachite, blue azurite, vermilion, smalt (finely crushed blue glass), hematite and yellow ochre. There were many instances where analysis revealed paint mixtures – malachite, gamboge and indigo were found together in some of the leaf areas of the rose painting. In other paintings, an orange produced by mixing red lead and vermilion was present in some fruit depictions. These findings accord with information in Chinese painting manuals. They confirm that the Chinese painters were mainly using locally sourced pigments typically found in export art.

Distinguishing pigments

It is hard to distinguish between lac and cochineal pigments by eye. They are very similar in colour, both being derived from scale insects. Lac, produced from the lac insect was commonly used in the East, whereas the cochineal beetle, originally from Mexico, was used to make a dye that was then imported to China.

However, the presence of chrome yellow on one of the *Camellia japonica* pictures was contrary to all expectations. As this picture is no later than 1830 and is probably from the early 1820s, it quite possibly represents the first use of this pigment in China by Chinese artists. Chrome yellow is a Western colour, a natural form of lead chromate discovered in Siberia in the 18th century. The earliest record as an artists' colour is from 1818 but it did not appear in a Winsor and Newton catalogue until about 1850.

East India Company records show that while Reeves was in London in 1817 he began preparations to send back botanical drawings from Canton. It is known that he sourced copies of plant illustrations to use as reference documents. It may be that he went to one of the many London colourmen and bought the new pigment to take back to China with him.

The first use of chrome yellow in China was detected in this painting of *Camellia japonica* cultivars

Under-drawing

Previous observation had strongly suggested that at least some of the paintings were under-drawn with graphite. The use of graphite pencil was not common in China, and when surgeon and naturalist Clarke Abel travelled there in the early 19th century he exchanged pencils for plants. Instead, Chinese artists used watered down carbon ink which became invisible when the painting was complete. Infra-red imaging revealed unexpected, but extensive, pencil-like under-drawing on paintings such as *Wisteria sinensis* and one labelled 'phobium' by Reeves ➤

(subsequently identified as *Scolopia*).

There are two virtually identical paintings of phobium and it looks as though pencil was used to draw the outlines. Comparisons using overlay between some of the RHS Reeves pictures and his own duplicate collection held at the Natural History Museum show that these were copies drawn independently, rather than tracings.

The pencils would have been supplied by Reeves from the Company's stationery office in Canton. No graphite was found on the smaller pictures painted in the traditional way on Chinese papers. This indicates that the four painters

By overlaying the two similar paintings of phobium it is made clear they are are copies rather than tracings

used Western techniques on Western papers for commissioned pictures, but reverted to traditional methods on Chinese papers which were bought separately by Reeves.

Paper analysis

The paper structures in both collections were also analysed. OCT was used to distinguish between short-fibred Western papers (such as Whatman) and long-fibred Chinese papers. Although the distinction is usually apparent to the naked eye, the Chinese papers in general being thinner, whiter and lighter than Western papers, there were instances in this collection where larger, thicker, beige Chinese paper was used, so it was useful to have confirmation.

It was also possible to determine which papers had a typically Chinese alum and animal glue size, applied during the painting process to protect the paper and painted surface. None of the Western papers had been sized in the Chinese manner, whereas the Chinese papers in the V&A collection had been sized with alum and glue as would be expected, but only one of the Chinese papers tested from the RHS collection had been sized in this way. This is surprising, and again suggests that Reeves's Chinese painters were modifying their painting method, perhaps to speed up the painting.

Significance of the project

This research was the subject of a paper presented to the International Institute of Conservation Conference in Hong Kong in 2014. This was the first time that these complementary methods of non-destructive analysis had been applied to watercolours. They had previously only been used on cave paintings at Dunhuang in China by NTU scientists. The information revealed about the pictures in the V&A and RHS collections could not have been discovered in any other way. It is hoped that other researchers will follow suit and more will be discovered about other works of art.

For the RHS, far more is now known about its Reeves pictures and, importantly, this will inform future conservation decisions and display policies. The cooperation between scientists, interns, art curators, conservators and researchers from the three organisations continues to be fruitful and it is hoped that this will pave the way for further collaborative projects.

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PROJECT TEAM AND FUNDING

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BIBLIOGRAPHY

Bailey, K (2010a) The Reeves collection of Chinese botanical drawings. *The Plantsman* n.s. 9(4): 218–225

Bailey, K (2010b) Chinese leaves. *The Garden* 135(12): 816–819