JOAN WRIGHT, MICHELE DERRICK, RICHARD NEWMAN, AND MICHIKO ADACHI

The Colors of Desire: Examination of Colorants in *Beauties of the Yoshiwara*

INTRODUCTION

From the simple two- to three-color *benizuri-e* prints of the 1740s to the complex full color printed *nishiki-e* or brocade prints, Suzuki Harunobu's 1765 calendar prints are thought to have ushered full color printing into the world of Japanese woodblock prints. Still early in the development of full color printing, Harunobu's five volumes of *Beauties of the Yoshiwara* published during the final year of his life in 1770 can be seen not only as a masterpiece of his designs for book illustration (Toda 1931) but also as a compelling example of how artisan-printers might have developed a palette during the early years of full color printing. The frontispiece of each volume of *Beauties of the Yoshiwara* displays an image that sets its mood and poetic subject; *cherry blossoms (spring), cuckoo (summer)*, *moon (late summer/early autumn), falling leaves (autumn)*, *and snow (winter*). Within each volume, courtesans are shown engaged in activities, accompanied by their name, the brothel where they worked, and their poem contributing to the book's seasonal theme. The colorants found in the first edition of *Beauties of the Yoshiwara* were examined as part of an ongoing study into the colorants of Japanese woodblock prints at the Museum of Fine Arts, Boston (Derrick, Newman, and Wright 2017).

The color palette for woodblock printing during the Edo period has been conjectured based on historic sources and current evaluation of color tones, but few technical studies have been done to further investigate and define the exact materials (Kendo 1929). It is known, however, that the colors used were composed of both organic and inorganic materials, derived from plants (organic) and mineral compounds (inorganic). Each color lends its distinctive character to a printed image. For the most part, organic colorants appear transparent and inorganic pigments opaque.

Organic colorants thought to be commonly used are:

Yellow: gamboge (*tō-ō*), turmeric (*ukon*), Amur cork tree (*kihada*), gardenia (*kuchinashi*), Japanese pagoda tree buds (*enju*), mountain peach (*yama-momo*), silver grass/eulalia (*kariyasu*), and Toringo crabapple (*zumi*)
Blue: dayflower (*aobana*) and indigo (*ai*)
Red: safflower (*benibana*) and sappanwood (*suo*)

Inorganic pigments thought to be commonly used are:

Yellow: ochre (*ōdo*) and orpiment (*sekiō*)
Brown to Orange: iron oxide red (*bengara*), red lead (*tan*), and vermilion (*shu*)
White: calcium carbonate (*gofun*), white lead (*empaku*), and mica (*kira*)
Black: ink (*sumi*) made from soot and animal glue

ANALYTICAL METHODS

For this study, 66 out of the 166 courtesans depicted in the book were analyzed with multiple points analyzed per figure. Careful observation of how pages were printed in combination with nondestructive analysis of selected pages provided a snapshot view. Every illustration was surveyed using a stereo binocular microscope at 50× magnification in order to determine which colors were overprinted. The illustrations were also viewed under UVA radiation to reveal the characteristic fluorescence or absorption properties of the individual colors. X-ray fluorescence provided information on the chemical elements found in inorganic pigments.[1] The red and yellow organic colorants were indicated by excitation-emission matrix (EEM) fluorescence[2] and the blue colorants were identified by fiber-optic reflectance (FORS). FORS can be used to readily distinguish between dayflower and indigo, even in mixtures that appear green or purple. The parameters of the analysis methods were thoroughly vetted using printed references of traditional Japanese colors that were prepared in-house from solutions of authenticated materials onto Japanese *hōshō* paper sized with *dosa*, a mixture of alum and animal glue. Pure materials, as well as mixtures and overprinted colors were examined. These techniques, both visual and spectroscopic, provided beneficial but partial views of the whole. All data had to be viewed together in order to gain insights. Even so, these methods were not always sufficient to

Papers presented at the General Session, AIC's 46th Annual Meeting, May 29-June 2, 2018, Houston, Texas

answer all questions for the characterization of some materials, such as the plant-based yellows (flavonoids). Moreover, because of the potential for colorant mixtures, all analysis points on each image were examined by all methods.

RESULTS

The results of this study indicated that color variations and multiple hues were not only produced by altering proportions, but also by creating multiple colorant and pigment mixtures, including some with three or more components. Greens were overwhelmingly a mixture of indigo and orpiment with the printers showing an ability to print a wide range of green tones from the beginning. A few instances of indigo with gamboge alone or with added orpiment were found, as well as dayflower printed over turmeric to imitate a bronze patina on a vase. Yellows were most often a mixture of orpiment and turmeric. A soft beige tone that frequently appeared in volumes one and two was revealed to be a mixture of a flavonoid with calcium carbonate. Of the yellow colors available to printers during Harunobu's time, gamboge did not appear as often as expected on the pages examined.[3] Purples were consistently a mixture of safflower and dayflower, a combination that was preferred throughout the course of Japanese woodblock printing during the Edo period. Blues were dayflower and indigo, although indigo was never found as a single colorant and only as a mixture with another color. Dayflower is known as one of the most fugitive colorants and throughout the book it appears in numerous hues, some of which could have changed over time from their original appearance of blue to a yellow/tan color (Sasaki and Coombs 2005). It was also found during this study that discolored dayflower resulted in spectra similar to that of a flavonoid.

Throughout *Beauties of the Yoshiwara,* an impressive array of red to pink tones were employed. These reds and pinks were mostly madder and safflower. Although not mentioned as a "known" colorant in the historical literature, madder was frequently found. Both madder and safflower were used as a single color but also as a mixture. Sappanwood was present but only found as part of a mixture with the other reds. In some cases, this combination was used to print over orpiment to yield a deep red-orange. Madder was not detected as a component in any of the purple to brown colors that were analyzed but sappanwood was found in one instance as a mixture with dayflower to create what visually appears to be a dull brown with a faint purple cast. Also, the pinks and reds were noticeably brighter from volume three onward. Brown to orange-brown tones found in all volumes were comprised of iron oxide red. This inorganic pigment was routinely used alone but was also present in mixtures. Iron oxides were present in complex mixtures with red lead, orpiment, and turmeric. Red lead was never found printed by itself and no instances of the use of vermilion were found.

Overprinted colors were also observed throughout. Microscopic examination of overprinted areas often showed individual colors within the paper fiber interstices as well as along the edges of printed regions. Yellow was most often overprinted with reds and pinks to produce an overall orange tint. Assorted colors such as blue, purple, green, and brown, in addition to reds and pinks, were used to overprint and fashion elaborate patterns onto clothing. One of these overprintings found was an unusual and possibly unique shade of brown, which was identified as safflower over an indigo/orpiment green. This particular combination captures the look of glossy varnished wood.

CONCLUSION

The profusion of colors and innovative mixtures seen in the first two volumes appears to give way in the last three volumes to a comparatively restrained palette. These volumes can be viewed to anticipate the standardization that takes place as full color printing develops. During the years that followed Harunobu and as print production matured, the development of a standardized palette was likely advantageous for both efficiency and economy within the increasingly commercialized world of publishing. As research continues to expand our knowledge of the materials and techniques employed during the Edo period to produce woodblock prints, undoubtedly there will be more questions to answer and further mysteries to solve.

ACKNOWLEDGMENTS

The authors would like to thank Jacki Elgar, Pamela and Peter Voss, Head of Asian Conservation (MFA, Boston); Sarah Thompson, Curator of Japanese Art (MFA, Boston); Maskao Tanabe, Deputy Director and Chief Curator of the Chiba City Museum of Art. We would also like to thank Kaeley Ferguson and Marta Sliwa for their assistance in analyzing the prints.

NOTES

1. For this study, elevated elemental levels were attributed as follows: silicon (mica), calcium (calcium carbonate), iron (yellow ochre-hydrated iron oxide, or iron oxide red), lead (red lead or lead white), arsenic (orpiment—arsenic sulfide), and mercury (vermilion—mercuric sulfide). It is noted, however, that these attributed compounds are based on the previously listed set of expected inorganic pigments for Japanese prints in conjunction with the visually observed color for each region. It is possible that other pigments could also be present.

2. EEM fluorescence produced unique three-dimensional spectral patterns for most red (safflower, sappanwood, and madder) and yellow (turmeric, Amur cork tree, flavonoids, and gardenia) colorants. There are over 5,000 types of flavonoid compounds that occur in plants and most produce yellow or blue colors. The following yellow colorants are primarily composed of multiple flavonoid-type compounds: Japanese pagoda tree buds, mountain peach, silver grass/eulalia, and

Toringo crab apple. This group produced fluorescent patterns that were indistinguishable from each other, so, for this study, the presence of that pattern was generically called "flavonoid."

3. Gamboge may have been more frequently used but was only indicated by our analytical techniques when a yellow color was determined to be organic but did not fluoresce significantly.

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JOAN WRIGHT
Bettina Burr Conservator
Museum of Fine Arts, Boston
Boston, MA
joanwright@mfa.org

MICHELE DERRICK
Schorr Family Associate Research Scientist
Museum of Fine Arts, Boston
Boston, MA
mderrick@mfa.org

RICHARD NEWMAN
Museum of Fine Arts, Boston
Head of Scientific Research
Boston, MA
rnewman@mfa.org

MICHIKO ADACHI
Sherman Fairchild Fellow
Museum of Fine Arts, Boston
Boston, MA
madachi@mfa.org