Michaela Paulson
University of California, Los Angeles/Getty Master's Program
Supervisor: Ellen Pearlstein

Visible effects of adhesive and pressure on color in kingfisher feathers

Structurally colored feathers render color through physical scattering of light rather than pigments. There is an expected, but heretofore unexplored, effect of adhesive choice and pressure on the color of these materials. Further, such feathers are generally considered to be more light-stable than pigmented examples. In the current study, structurally colored blue kingfisher feathers are used to examine these effects in order to guide conservation treatments and preventive care.

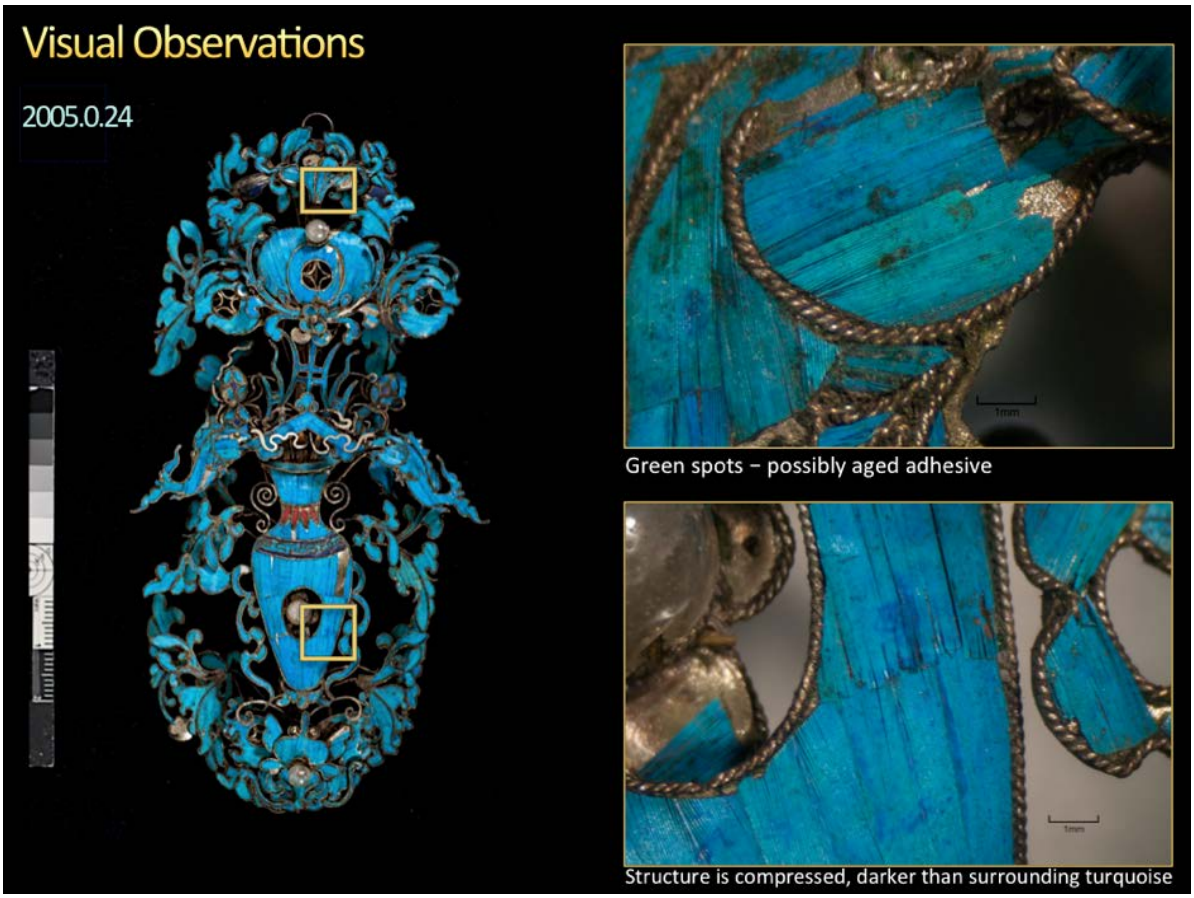
The Chinese tradition of *tian-tsui*, literally 'dotting with kingfishers', describes a technique of cloisonné style jewelry that utilizes blue, blue-green, and purple feathers instead of fused glass powder. The feathers are adhered to a backing, usually metallic, though occasionally composed of thick layers of paper. This technique appears in Chinese culture from as early as the first century BCE, though surviving examples date most prevalently to the Qing dynasty (19th century) (Chambers et al. 1981, 32). The early featherwork items were not restricted to jewelry, but also appeared in the form of feather mosaics on clothing, bed coverings, and palanquins (Chambers et al. 1981, 32; Garrett 1994, 86). Such items are now ubiquitous in museum collections. Through a technical study of kingfisher feather jewelry from the Ruth Chandler Williamson Gallery at Scripps College in Claremont California, as well as accelerated light aging studies and pressure tests completed on mocked up samples of recently plucked kingfisher feathers at both the UCLA/Getty and the Getty Conservation Institute labs, I evaluate the effects of original and conservation/restoration adhesives and coatings, and effects of mechanical interactions, on the structural colors of the feathers.

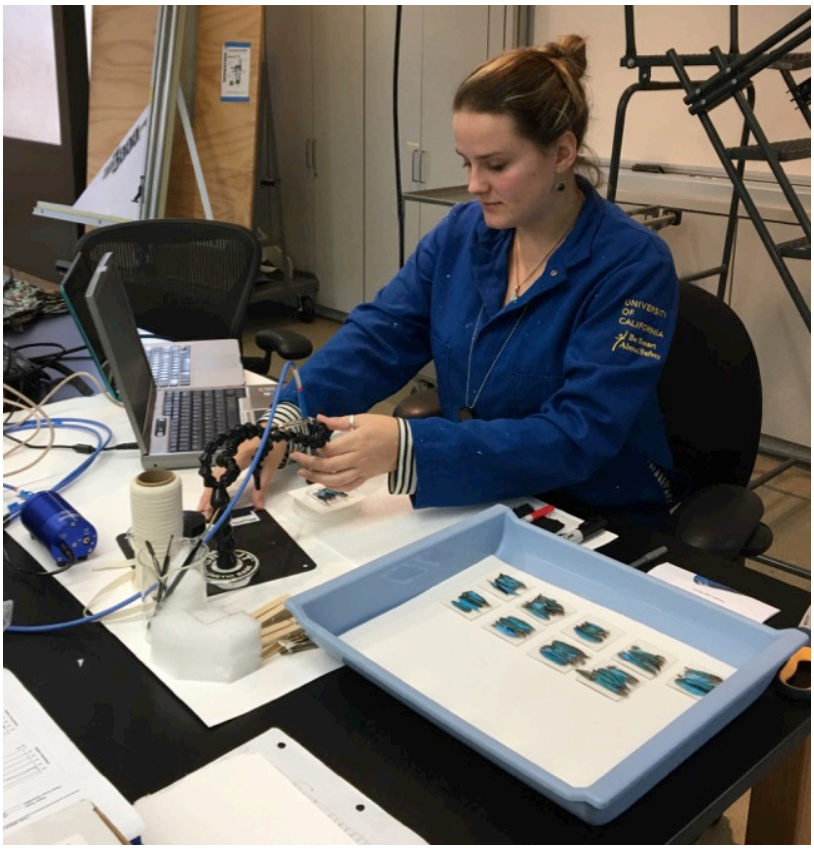
For the experimental part of the study, feather specimens from skins of *Halcyon smyrnensis*, the White-breasted Kingfisher, donated by the United States Fish and Wildlife Department, were plucked, trimmed, and adhered onto inert quartz glass plates and subjected to three methods of light aging, with color measurements occurring before and after aging. The accelerated light aging methods included museum conditions (free of ultraviolet radiation), window conditions (ultraviolet radiation present), and high intensity UVA conditions, with an additional control group kept in the dark. Adhesive systems tested were those documented as having been used originally or in the conservation of kingfisher featherwork, including: protein glues (isinglass

and gelatin), funori, methylcellulose, and Paraloid B-72. Characterizing the adhesives used on the Scripps collection items provided supporting technical evidence.

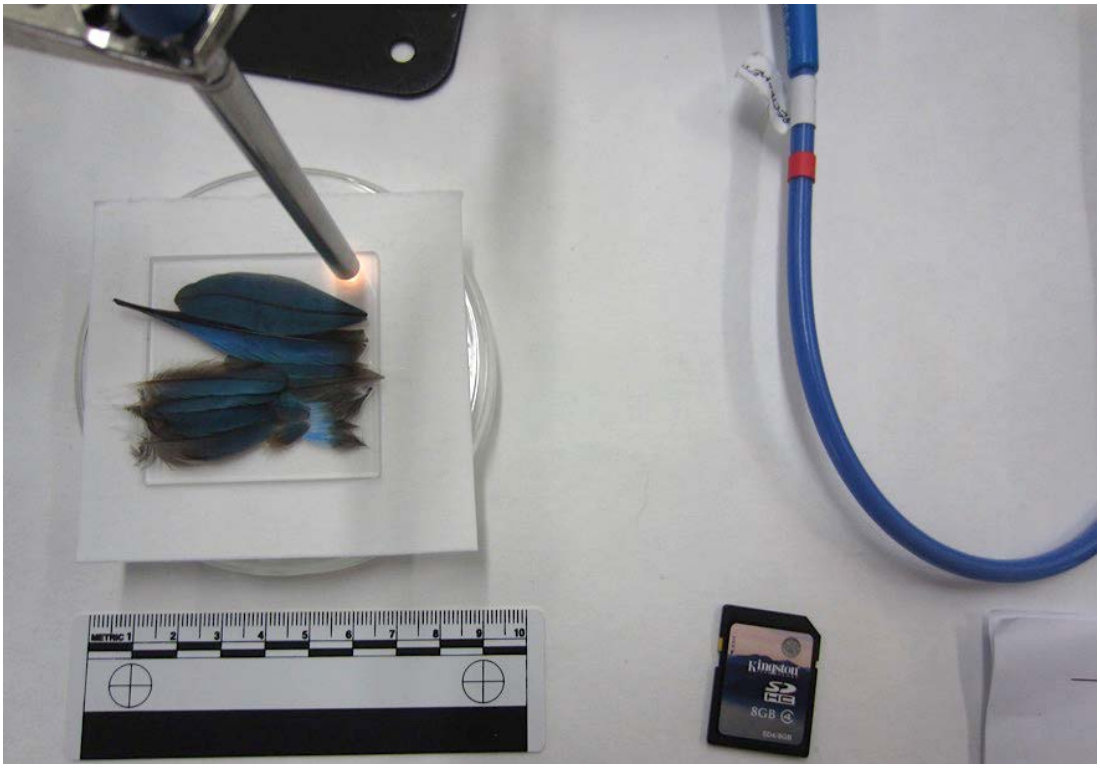
Taken together, the results of this study provide insights into kingfisher feather *tian-tsui* technology, and the effect of adhesive systems and mechanical actions on the preservation of color within these structurally colored feathers. Findings will be presented about the color stability, both separately and upon interaction with different adhesives, leading to recommendations for adhesive choices for the conservation of such featherwork. Further, results of mechanical disruption of kingfisher feather coloration will be illustrated. Experimental work and technical analysis provide an enhanced understanding of a complex material, effectively aiding its conservation and preservation.

Objects from the Ruth Chandler Williamson Gallery, Scripps College





Positioning FORS probe over feather mock-up



Preparing to take a measurement of feather color

Table: Characteristics of Kingfisher Cloisonné Objects

Object number	*Feather color*	*Substrate type*	*Adhesive type*	*Other decoration*	*Chinese Character*
2005.0.14	turquoise, blue, purple	Au, Cu, Ag, Ni, Hg, (Fe); pin Au, Cu, Ag, Ni, Zn	proteinaceous	pearls, red and green gems	yes, in featherwork
2005.0.17A	turquoise, purple	Cu, Au, Pb, Ni, Zn, (Fe); pin similar, higher proportion of Zn	N/A	N/A	N/A
2005.0.17B	turquoise, purple	Cu, Au, Pb, Ni, Zn, (Fe)	proteinaceous	N/A	N/A
2005.0.23	turquoise, purple	Cu, Pb, Zn, Ni, Au, (Fe); pin is similar but without Pb	Cellulose nitrate	tissue paper fills, red gems	yes, in featherwork
2005.0.24	turquoise, purple, red	Cu, Ag, Zn, Ni, Pb, Au, (Fe)	proteinaceous	pearls	N/A
2005.0.25	turquoise	Cu, Ag, Pb, Ni, Zn, Au, (Fe); pin Ag, Cu, Pb, Zn, Au	beeswax	multicolored gems, green jade	yes, stamped into pin
2005.0.27	turquoise	Cu, Ag, Pb, Zn, Ni, Au; pin Ag, Cu, Au, Zn, Pb, Ni, (Fe)	N/A	green gem	yes, stamped into pin
2005.0.30	purple	Ag, Au, Cu, Pb, Zn; pin Cu, Ag, Pb, Zn, Au, (Fe)	beeswax, protein, and carbohydrate	green jade, pearl, blue spheres (lapis?)	yes, stamped into pin
2005.0.39	turquoise	Ag, Cu, Zn, Au	N/A	red paper	yes, stamped in metal
2005.0.41	turquoise	Ag, Cu, Zn, Au	N/A	red paper	yes, stamped in metal
2005.0.fragment	blue, purple	Cu, Zn, Ag, Au, Sn	proteinaceous	faux pearls	N/A

CIELab Results for each adhesive/feather type

Gelatin, 5%, changes between unaged control and after 30 days aging, white background

Feather type	Control			Window			UVA			Museum		
	L*	a*	b*	L*	a*	b*	L*	a*	b*	L*	a*	b*
Body feather	Decrease in value	Shift to red	Shifts to blue	Increase In value	Inconc	Shifts to yellow	Decrease in value	Shifts to red	Shifts to blue	Inconc	Inconc	Shifts to yellow
Flight feather	Increase in value	Shift to red	Shifts to blue	Decrease in value	Shifts to green	Shifts to yellow	Decrease in value	Shifts to red	Shifts to yellow	Decrease in value	Shifts to green	Shifts to blue

Isinglass 5%, changes between unaged control and after 30 days aging, white background

Feather type	Control			Window			UVA			Museum		
	L*	a*	b*	L*	a*	b*	L*	a*	b*	L*	a*	b*
Body feather	Increase in value	Shifts to red	Shift to blue	Decrease in value	Shifts to green	Shifts to yellow	Decrease in value	Shift to red	Shifts to blue	Inconc	Shift to red	Shifts to blue
Flight feather	Inconc	Shifts to red	Shift to blue	Increase in value	Shifts to green	Shifts to yellow	Decrease in value	Shift to red	Shifts to yellow	Decrease in value	Shift to red	Shifts to yellow

Funori 5%, changes between unaged control and after 30 days aging, white background

Feather type	Control			Window			UVA			Museum		
	L*	a*	b*	L*	a*	b*	L*	a*	b*	L*	a*	b*
Body feather	n/a	n/a	n/a	Increase In value	Shifts to green	Shifts to yellow	Decrease in value	Shift to red	Inconc	Decrease in value	Shifts to red	Shifts to blue
Flight feather	(neg L*s before aging)	Shifts to red	Shifts to blue	Increase in value	Shifts to green	Shifts to yellow	Decrease in value	Shift to red	Shifts to yellow	Decrease in value	Shifts to red	Shifts to yellow

Methycellulose 2%, changes between unaged control and after 30 days aging, white background

Feather type	Control			Window			UVA			Museum		
	L*	a*	b*	L*	a*	b*	L*	a*	b*	L*	a*	b*
Body feather	Increase in value	Shift to red	Shift to blue	Increase in value	Shifts to green	Shifts to yellow	Inconc	Shifts to red	Inconc	Increase in value	Shifts to red	Shifts to yellow
Flight feather	Increase in value	Shift to red	Shift to blue	Decrease in value	Shifts to green	Shifts to yellow	Decrease in value	Shifts to red	Shifts to blue	Decrease in value	Shifts to red	Shifts to yellow

Paraloid B-72 5%, changes between unaged control and after 30 days aging, white background

Feather type	Control			Window			UVA			Museum		
	L*	a*	b*	L*	a*	b*	L*	a*	b*	L*	a*	b*
Body feather	Inconc	Shifts to red	Inconc	Increase In value	Shifts to green	Shifts to yellow	Inconc	Shift s to red	Shifts to blue	Increase in value	Shifts to red	Inconc
Flight feather	Increase in value	Shifts to red	Shifts to blue	Decrease in value	Shifts to green	Shifts to yellow	Decrease in value	Shift to red	Shifts to blue	Decrease in value	Shifts to red	Shifts to blue