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The History and Analysis of Pre-Aniline Native American Quillwork Dyes

Christina Cole
christinal.cole@gmail.com

Susan Heald
healds@si.edu

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CHRISTINA L. COLE AND SUSAN HEALD
colecl@udel.edu and healds@si.edu

Before European traders introduced glass beads, indigenous communities across North America used brightly colored porcupine quills for decorating surfaces of clothing and utilitarian objects. While many sources exist describing how quills can be folded and stitched or otherwise applied, there are very few sources describing the dye technology used to color quills before the introduction of synthetic aniline dyes in the 1850s; this is especially true of Eastern Woodlands quillwork, which is the focus of this study. In addition, very few technical studies have attempted to analyze the dyes used on Native American quillwork, even though there has been interest among non-Native scholars and Native American artisans. Visiting Native American artists and interns at the National Museum of the American Indian (NMAI) have often asked if some type of analysis is possible. The results of this study provide a better understanding of Eastern Woodlands dye technology for coloring quills.

The North American porcupine is a large rodent whose range covers much of Canada and the western and northern portions of the United States, including Alaska. Porcupine quills are stiff, pointed, modified hairs, about one to three inches in length. The porcupine uses its quills as a defense mechanism. Quills can detach and become lodged in the skin of an attacker and prove difficult and painful to remove after they become embedded.

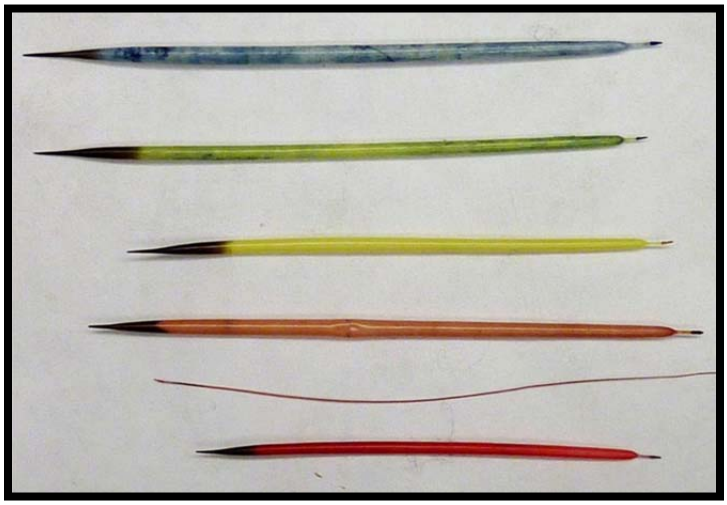

Figure 1, left. *Plucking quills from a porcupine hide. Image by S. Heald.*
Figure 2, right. *Dyed quills, ready for making quillwork. Image by S. Heald.*

To obtain quills for quillwork, one must pluck them from a porcupine's skin (Fig. 1). The porcupine skin shown here was soaked in water overnight and nailed to a piece of plywood. After plucking, quills are separated from softer underhair and guard hairs and are sorted by size. The quills are then washed, dyed, dried, and then stored in small bags for future use. (Fig 2) When quills are worked into decoration, they are dampened to make them pliable.

Native American quillworking traditions are widely distributed across North America and represent many communities. Examples shown in this presentation illustrate this distribution and are included in the publication for NMAI's exhibition "Infinity of Nations" which runs from October 2010 to October 2020 at the George Gustav Heye Center in New York City. Pieces from the Subarctic region of Canada include a Cree bag, circa 1850 (NMAI 127176), a Cree Metis man's coat, ca. 1874 (NMAI 191253), and a Denésoliné (Chipewyan) sash/belt, ca. 1890 (NMAI 196338). Examples from the Northern Plains region

include a Sahnish (Arikara) cradle cover, ca. 1880 (NMAI 141539), a Sicangu Lakota (Sioux) man's shirt, ca. 1850 (NMAI 176694), and a contemporary horse mask (NMAI 267046) made in 2008 by Juanita Growing Thunder Fogarty (Assiniboine (Stoney)/Sioux). A spectacular example from Northern California is an Elizabeth Hichcox (Wiyot/Karuk) basket (NMAI 221927), ca. 1920, which includes yellow quills in the weft twining. The Eastern Woodlands region is represented by an outfit that was collected in the 1790s by Andrew Foster, a British army officer, stationed at Fort Michilimackinac at the juncture of Great Lakes Huron and Michigan. The exhibited outfit consists of nine items; four of these items have porcupine quillwork that illustrate a variety of quillwork techniques described below.

Figure 3. *Detail of quillwork on feather spine on Foster feather headdress, NMAI 242000. Image courtesy of the National Museum of the American Indian, Smithsonian Institution; photo by S. Heald*

Native Americans found many ingenious ways to use porcupine quills for decoration. One method is to wrap dyed and flattened quills around a rigid substrate, such as the wooden stick. The example shown in Figure 3 from the Foster feather headdress (NMAI 242000) also integrates quills perpendicular to the wrapped quills to form woven checkerboard pattern. (Fig. 3) Often, dyed and flattened quills are folded and stitched with sinew to a semi-tanned hide or skin substrate in geometric or curvilinear patterns; Figure 4 shows three rows of a zigzag pattern on the toe of the moccasin (NMAI 242012). (Fig. 4) This moccasin also has a central loom-woven panel where the quills are used as a type of non-continuous, supplementary warp. Unflattened quills can be cut and strung like tubular beads as shown in the finger-woven legbands (NMAI 242006) in Figure 5 (Fig. 5); these legbands also have flattened quills wrapped around groups of warp yarns to form a decorated warp fringe. Two other common examples of Eastern Woodlands quillwork not illustrated in this paper are plaited quillwork wrapped around a wooden substrate, and the insertion of quills into birch bark to form parallel rows of quills in blocks of color, which often creates bold geometric designs.

The precise geographic boundaries of the Eastern Woodlands culture area vary with time period considered. Currently, the area is defined as the region bounded to the east by the Atlantic Ocean, to the west by the Mississippi River, to the south by the Gulf of Mexico, and to the north by a line equidistant between the Great Lakes and Hudson Bay. The region may be further divided into northeastern and southeastern subareas along a line running from the Dismal Swamp on the Atlantic Coast at the North Carolina/Virginia border to the western Ohio Valley drainages. This quill dye study focused on a portion of the northeastern subarea north of the Ohio Valley and Maryland/Pennsylvania border—an area which coincides with the southeasterly boundaries of the natural habitat of the North American porcupine and with the Iroquoian and Central and Eastern Algonkin language groups.

Figure 4. *Detail of quillwork on the toe of a moccasin, NMAI 242012. The center section features loom-woven quillwork, bordered by flattened quills stitched in a zigzag pattern. Image courtesy of the National Museum of the American Indian, Smithsonian Institution; photo by S. Heald.*

Figure 5. *Detail of quillwork on finger-woven legbands, NMAI 242006. The blue and yellow "beads" are unflattened quills. A decorative fringe was made by wrapping flattened quills around warp yarns. Image courtesy of the National Museum of the American Indian, Smithsonian Institution; photo by S. Heald.*

The absence of contemporary Native American accounts of quill dyes used between the early 1600s and 1856 leaves colonial travel journals, twentieth-century anthropological studies, and modern histories of European and North American textile industries as the basis for today's understanding of early Eastern Woodlands quillwork dye technology. A list of nearly 50 natural dyes from plants and animals on both sides of the Atlantic can be compiled from these Euroamerican sources—a list which can, in turn, be used to develop instrumental analysis methods for dye identification.

This instrumental-based dye study was designed to be representative of quilled objects within the collections held by five major North American ethnographic museums: the Mashantucket Pequot Museum and Research Center; the McCord Museum of Canadian History; the National Museum of the American Indian, Smithsonian Institution; the Peabody Museum of Archaeology and Ethnology; and the University of Pennsylvania Museum of Archaeology and Anthropology. According to the objectives and preferred analysis modes identified by Native and non-Native quillworkers, museum professionals, and

academics, quill dyes on 53 objects (126 samples) were analyzed by a universal analysis method based on fiber optic reflectance spectroscopy (FORS), X-ray fluorescence (XRF), and liquid chromatography-mass spectrometry (LC-MS). Details of the analysis procedures and specific colorants identified are described elsewhere.[1] The remainder of this paper broadly considers these findings in relation to the body of Eastern Woodlands quillwork dye literature.

Literature reports on early Eastern Woodlands yellow quill dyes are in fair agreement with colorants identified in this study, with most yellow dyes likely derived from indigenous North American sources. Two plants were directly associated in the literature with yellow quillwork: goldthread (*C. trifolia* (L.) Salisb.), and goldenseal (*H. canadensis* L.), with the majority of the associations for goldthread. The primary colorant for both plants is berberine, identified in nearly 40% of the yellow quillwork analyzed in this study. For one quarter of the yellow samples, the presence of gallic acid or juglone supports the assertion that bark "teas" were used. Although the bark of almost any North American tree may have been used, the quillwork dye literature specifically names mockernut hickory (*C. alba* (L.) Nutt.), gray alder, sumac (*Rhus* spp.) bur oak (*Q. macrocarpa* Michx.), maple (*Acer* sp.), elm (*Ulmus* sp.), and butternut (*J. cinerea* L.).

Of note, quercetin was not identified in any of the quillwork analyzed, casting some doubt on the literature assumption that black oak tree bark (*Q. velutina* Lam.) was used by Native Americans to dye porcupine quills yellow. No colorants associated with young or old fustic—dyestuffs used by the European and North American textile industries—were identified. Finally, in agreement with its recorded role as an Eastern Woodlands medicinal plant only, none of the colorants of Canada goldenrod, *S. canadensis* L., were found in analyzed yellow quillwork, either.

According to the literature, black and brown quills were obtained by dyeing with baths containing various combinations of North American tree bark. The identification of juglone, gallic and ellagic acids, and hamamelitannin singly and in various combinations on half of the black or brown quillwork analyzed supports the use of butternut, bur oak, maple, elm, gray alder, mockernut hickory, American chestnut, and various species of North American sumac; the use of black walnut (*J. nigra* L.) cannot be confirmed because no myricetin was identified in any of the extracts.

Approximately 20% of the black and brown quillwork analyzed contained blue or yellow colorants. When found with tannins—colorants traditionally associated with black or brown dyes—the blue and yellow dyes were interpreted as additions to a dye bath likely made of tree barks, in order to adjust the tone of black or brown quills obtained. In some cases, however, only blue colorants were identified on black quillwork, suggesting that a blue dye was mixed with other unknown materials—perhaps red and yellow dyes—in order to produce a "compound" black dye. Compound dye procedures to obtain black as a secondary color through the systematic mixing of other dyestuffs do occur in the literature by the mid-nineteenth century, but are absent from eighteenth-century quill dye accounts.

Several species of indigo, cranberry, blueberry, and grape were suggested by the literature as quill dyes for blue or purple. Indigotin (from indigo), delphinidin, cyanidin, or malvidin (all anthocyanidins found in different combinations in the wild berries) were identified in nearly 75% of the blue or purple quillwork analyzed in this study. For the extracts identified, indigotin was found singly or in various combinations with the anthocyanidins in 64% of the samples; delphinidin, cyanidin, or malvidin were identified in 52% of the samples.[2] No evidence of any other natural blue or purple dyes was found.

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[1] See Christina Cole, "The Contextual Analysis of pre-1856 Eastern Woodlands Quilwork Dyes Through Identification by Liquid Chromatography-Mass Spectrometry" in the bibliography.

[2] Percentages exceed 100% because indigoid/anthocyanidin combinations were counted in each colorant class' total.

Interestingly, these same anthocyanidins found on blue quills were also found in some examples of red quillwork, implying that single dyestuffs (various wild berries) were used to color quills both blue and red. The apparent, and presumably deliberate, manipulation of dye bath chemistry to produce such different colors suggests a much more complex early Native dye technology than is presented by the current literature.

Finally, early Eastern Woodlands red quill dyes—as for yellows—were derived primarily from indigenous North American sources. The most frequently named dyestuff in the literature for producing red quills is *G. tinctorium* (L.) Scop., or stiff marsh bedstraw. For nearly one quarter of these red quillwork analyzed, alizarin or purpurin was identified, with a few red areas containing both colorants. Alizarin and purpurin are characteristic colorants of dyes derived from plants of the *Rubia*, *Relbenium*, and *Galium* genera—the latter of which stiff marsh bedstraw is a member. While it could not be conclusively determined if the alizarin or purpurin identified in this study was derived from stiff marsh bedstraw versus another closely-related species of the three genera noted, to the extent that this study's analysis set is representative of all early Eastern Woodlands quillwork, identification of colorants associated with stiff marsh bedstraw on a majority of red quillwork supports the literature impression that this red dye was popularly used for quillwork.

Of the red dyes typically understood as having been introduced by European settlers, carminic acid—the primary colorant of cochineal, a dye isolated from *D. coccus*—was identified on only 10% of the quillwork analyzed. The lack of documented cochineal trade routes extending north from Mexico into the Eastern Woodlands culture area cannot refute the literature assumption that the use of cochineal as a quill dye was due to European contact. Colorants for the other insect-derived red dyestuffs, kermes and lac dye, were not found.

Overall, the results of this technical study of early Eastern Woodlands quillwork housed in North American museum collections argue for a re-evaluation of a long-standing attitude regarding early Native North American dye technology. At least for the time period addressed in this study (Contact to 1856), an implied abstract understanding of natural dye chemistry suggested by the apparent dual use of single dyestuffs for both red and blue speaks to a sophisticated, not primitive, technology. The limited incorporation of European dyes and the implied continuity of use of indigenous dyestuffs throughout the Eastern Woodlands culture area to 1856 argues for a sustained material cultural tradition despite rapid change experienced as a result of North American colonization and later acculturation policies.

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