CAEM 222: Conservation and Ethnography
Midterm Assignment
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Understanding and Promoting Cultural Heritage: Native Americans of Southern California

An individual's weaving proclivities are exhibited throughout a basket, not only in skill and precision, but in the types and processing of materials. In Southern California, Yucca, Deergrass, Juncus, and Sumac are common basket weaving materials. However, methods of decoration vary, specifically, how materials are dyed to create ornate patterns and imagery. In discussion with Cahuilla weaver, Roseann Hamilton, it was learned that there are several popular methods for dyeing Juncus, a monocot of the *Juncaceae* family that grows in wet marshy regions (Pearlstein et al. 2008, 190).

In cases where Juncus has been dyed a deep brown or black, individual weavers have particular dye preferences. Leaves and stems of walnut, cottonwood, and elderberry plants, and iron can be used to achieve a very dark brown or black colors. Though individual weavers have individual preferences, the resulting color can be from three possible reactions: from iron ions, from tannic acids present in plant materials, or from a possible combination through the reaction of tannic acids with iron salts to create gallotannins. Iron can have detrimental effects on organic materials, as is seen in books and paper conservation with the common phenomena of "fallout" caused by iron-gall ink, as iron ions react with peroxides, a byproduct of the oxidation of organic materials, and forms reactive hydroxyl groups (Kolar et al., 2006, 167).

Plants like walnut, cottonwood, elderberry, and even sumac can be used as *direct dyes* because they are rich in tannic acid and do not necessitate additional substances to form durable bonds with plant materials (https://www.fs.fed.us/wildflowers/ethnobotany/dyes.shtml). As seen in the deterioration of vegetable tanned leather, tannins cause the pH to drop and the presence of tannic acid causes the denaturation of collagen. It is unknown whether tannins would have the same effects on cellulose based materials. Gallotannins would have the combined effects of the iron ion and tannic acid modes of deterioration.

There are several methods available to conservators that can be applied to investigate the methods of dyeing Juncus, including non-invasive non-destructive techniques like x-radiography and x-ray fluorescence spectroscopy, and invasive, destructive techniques like microchemical tests.

Iron as a colorant can affect material density which can be visible on an X-radiograph; this makes dyed fibers appear more radio-opaque in the x-ray image, however there is no standard kV used for x-raying basketry. Portable x-ray fluorescence spectroscopy (XRF) can also be used to detect iron. Both x-radiography and XRF can be used to non-invasively detect iron in baskets. XRF provides elemental information of a material by analyzing the secondary (fluorescence) x-rays emitted from the material excited by primary beams.

Spot tests for iron, using potassium ferrocyanide, can be performed on small samples of dyed material (Pearlstein et al. 2008, 192). Microchemical tests used on leather to observe whether or not vegetable tannins are present may also indicate the presence of vegetable tannins on plant materials. There is the Vanillin-Hydrochloric acid test for condensed tannins and the Rhodanine test for hydrolysable tannins. As these tests are designed for vegetable tanned leather, they may not produce diagnostic results for plant materials. It also may be the case that vegetable tannins are naturally present in the reed materials used for basket weaving. If this is the case, then the microchemical tests for vegetable tannins will not be conclusive.

By experimenting with these microchemical tests on a known reference sample supplied by weaver Roseann Hamilton, and detached fragments from the basket pictured below, I aim to deduce the specific chemical reactions involved in the preferential deterioration of the dyed Juncus stitches. The reference sample obtained from Cahuilla weaver, Roseann Hamilton was prepared by steeping the Juncus in water with cottonwood and elderberry plant materials in a cast iron pot.

X-radiography of the basket to detect ferrous dyestuffs was inconclusive. The basket was x-rayed at 24 kV and the dyed stitches were no more radio-opaque than the undyed stitches **[Figure 5]**. Additional x-rays at a lower kV may be more successful. XRF was more successful at determining the presence of iron **[Figure 6]**; the spectral overlay shows the two peaks for iron, the low peak (in blue) of the undyed area, and the high peak (in red) of the dyed Juncus. Spectra were collected from three different areas of each the dyed and undyed areas and in every case there is a stronger signal for iron on the dyed Juncus.

The potassium ferrocyanide test for iron was positive on both the reference sample and the basket sample **[Figure 8]** indicated by the formation of a blue color in the test solution. The vanillin-hydrochloric acid test for condensed tannins and the Rhodanine test for hydrolysable tannins were both negative **[Figure 9]**. However, these tests were designed to detect these tannins in vegetable tanned leather and may not provide conclusive results when tested on plant materials. The pH of each was determined by allowing small samples of the reference material and basket samples to soak in distilled water in small test tubes for fifteen minutes. pH strips were then wetted with water from each test tube. The basket sample was much more acidic (pH between 3 and 4) than the reference sample (pH between 6 and 7) **[Figure 10 & 11]**.

It appears that the preferential deterioration of the dyed Juncus is similar to the deterioration of cellulose based paper caused by iron gall ink. The corrosive behavior of the iron ions reacts with the peroxides formed during the oxidation of cellulose resulting in further depolymerization of the cellulose. This creates a brittle cellulose substrate that is more easily broken and lost.

The following images show the documentation and study of a Luiseño basket constructed from a Yucca start, Deergrass foundation, Sumac stitches, and dyed Juncus stitches.

Figure 1: Diffuse Light Photography shows the overall aesthetic condition of the interior of the basket. It also shows how most of the lost stitches occur on the dyed Juncus and at the rim.

Figure 2: Diffuse Light photography shows the overall condition of the exterior of the basket. More stitches are lost than on the interior, though these losses are still primarily restricted to the dyed Juncus.

Figure 3: Interior of the basket detail. The dyed Juncus stitches are in a stable condition.

Figure 4: Exterior of the basket detail (reverse side of *Figure 1*). There is a preferential loss and weathering on the dyed Juncus stitches than on the Sumac stitches.

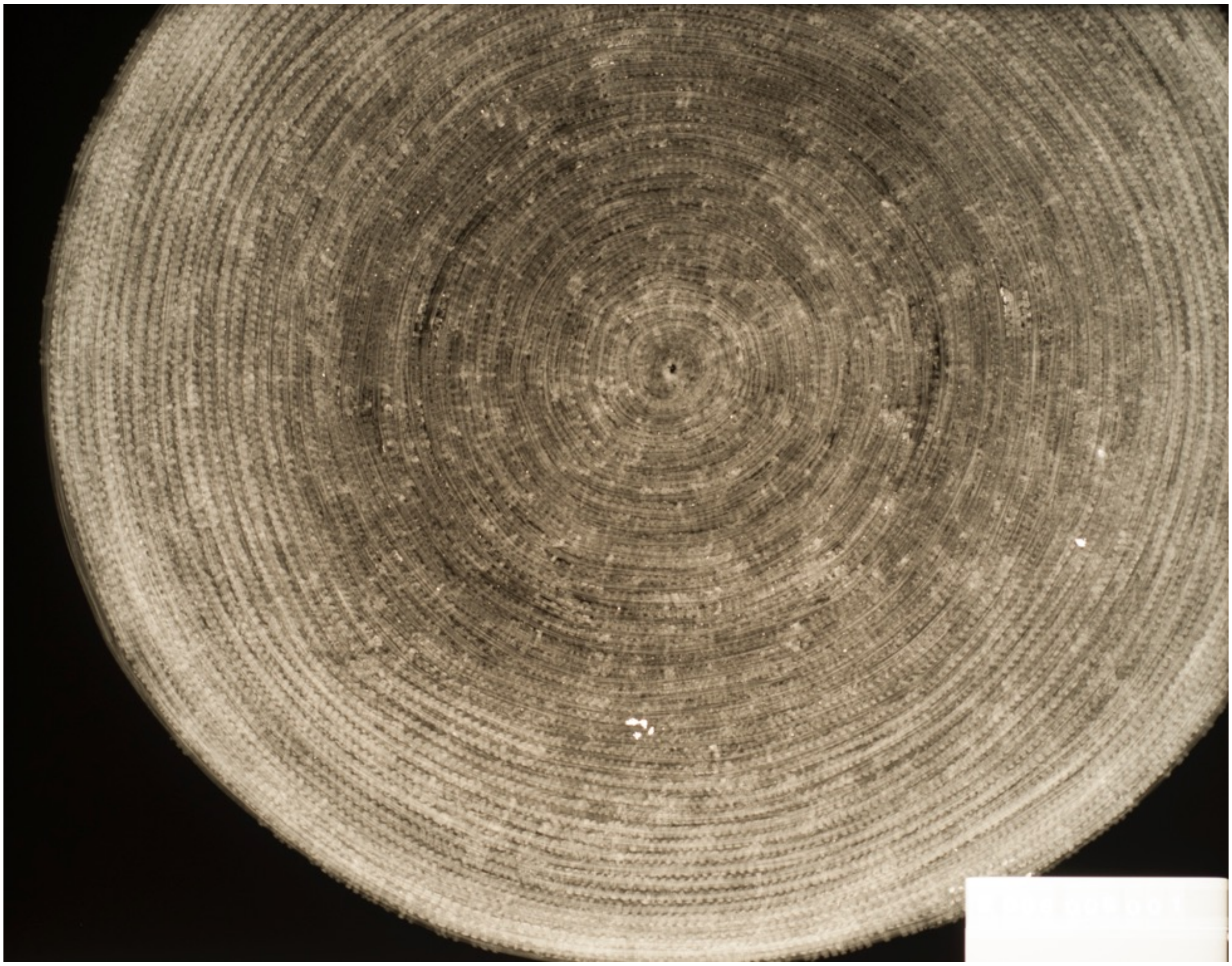


Figure 5: X-Radiograph. 24 kV, 5.75 mA, 105 second exposure. The design created by the dyed Juncus stitches are not visible. Using iron to dye the Juncus should have enough of effect on density that the dyed stitches would appear more radio-opaque, but it is clear in this image that they do not.

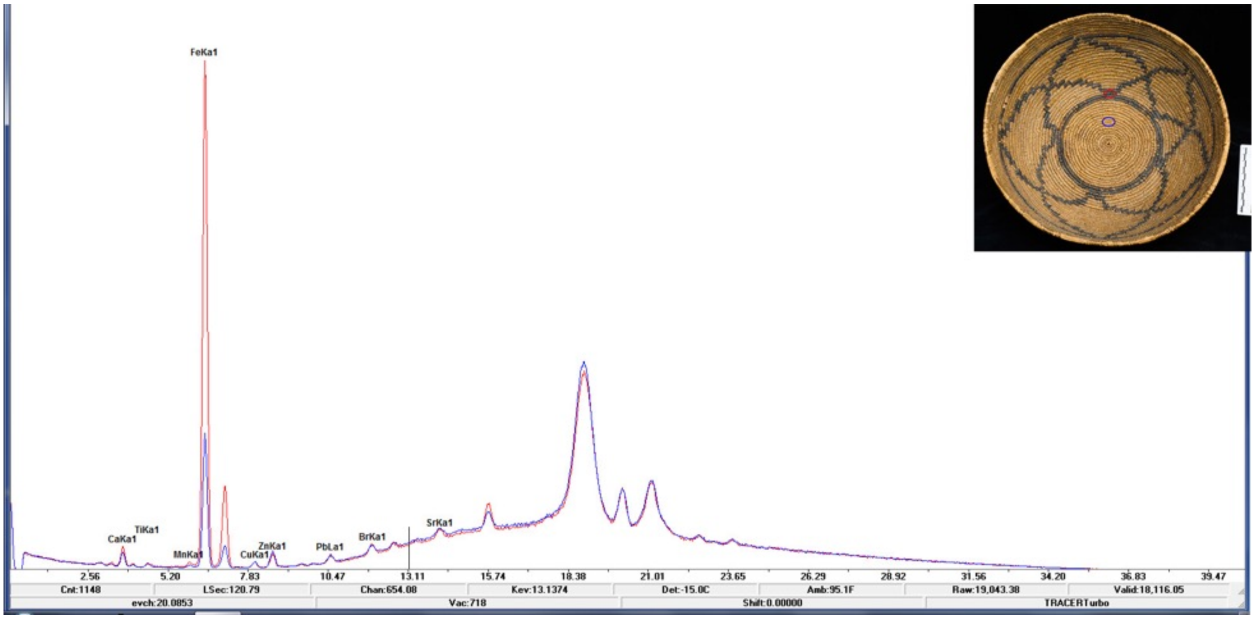


Figure 6: XRF Spectral overlay obtained with a Bruker handheld instrument. 40 kV, 11µA, Ti (1 mil) and Al(12 mil) filter (yellow). The red spectrum was collected from a section of dyed Juncus. The blue spectrum was collected from the undyed Sumac stitches. There is a much stronger peak for iron (Fe) on the dyed Juncus than on the undyed sumac which suggests the use of iron in the dyeing process.

Figure 7: In this photomicrograph it is evident that the dyed Juncus has cracked in several areas.

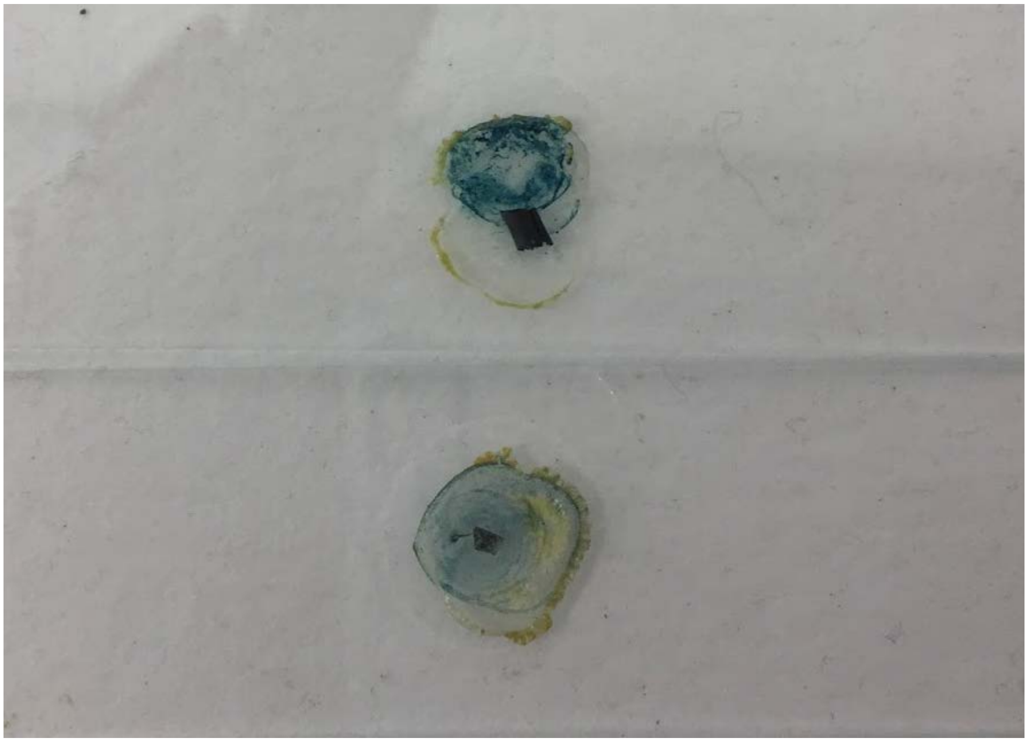


Figure 8: Potassium ferrocyanide test for iron. Reference sample (top) and basket sample (bottom) both tested positive, indicated by the development of a blue color.

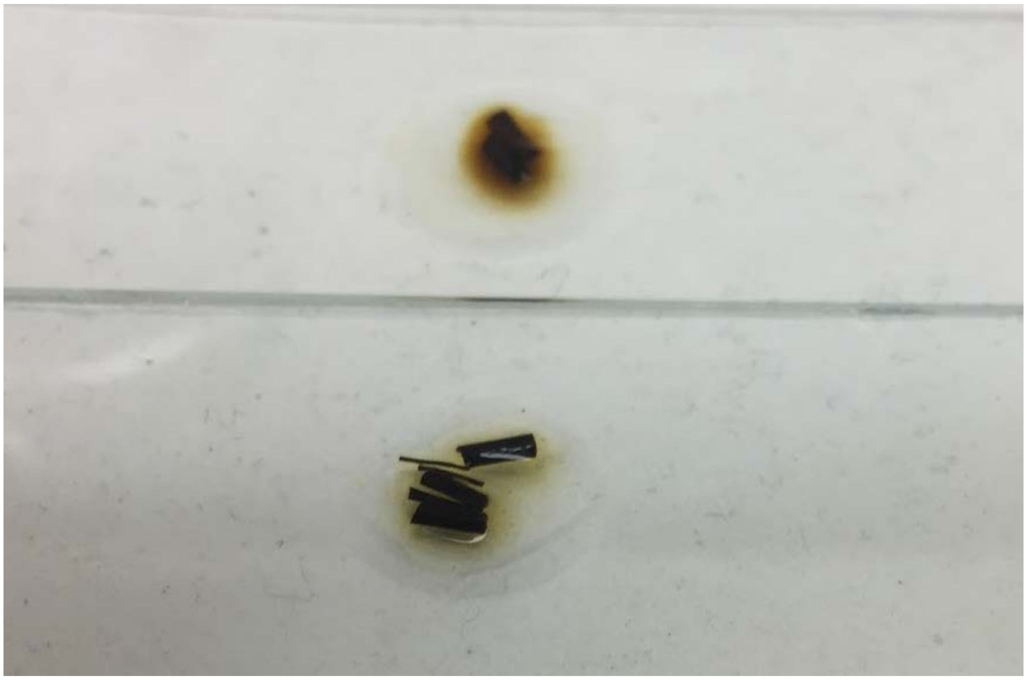
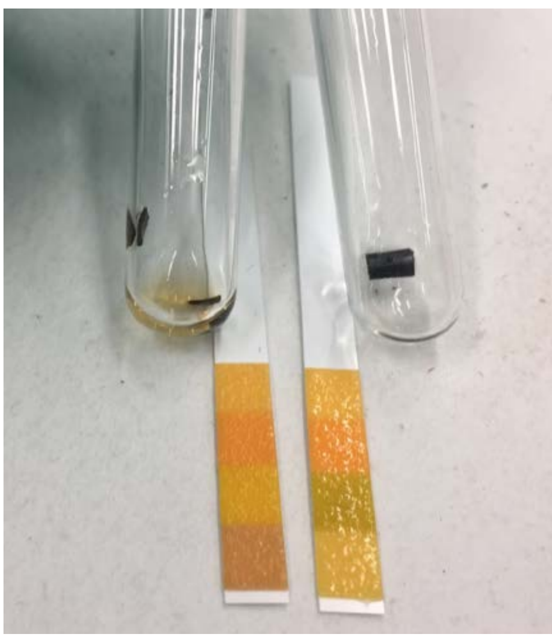


Figure 9: Rhodanine test for hydrolysable tannins: negative. A positive result would have resulted in the formation of a bright pink solution. Basket sample (top), reference sample (bottom).



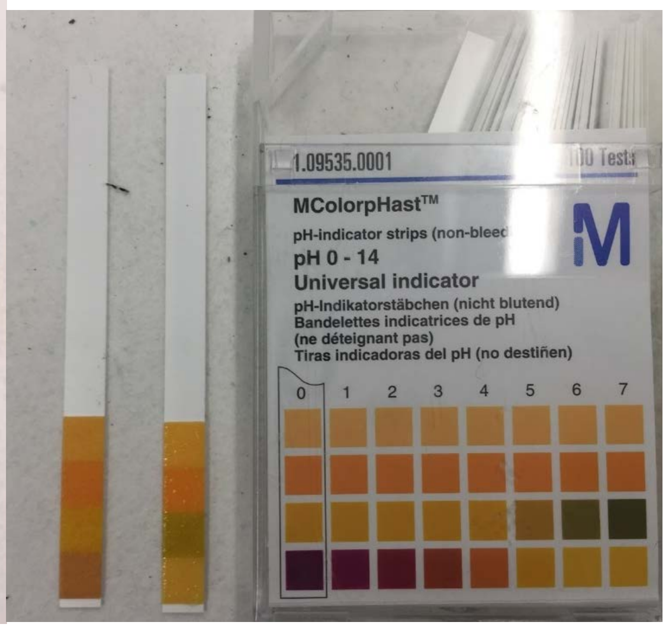


Figure 10 & 11: pH test strips of the basket sample (left) indicated a pH between 3 and 4 while the pH test strip for the reference sample was closer to neutral between 6 and 7.

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