

Less of You, More of My Ancestors: The Conservation Treatment of Polynesian Barkcloth

INTRODUCTION

The robust library preservation program and leadership in the creation and management of digital resources of Cornell University Library (CUL) promote better access to collections for instruction and research by conserving original materials and building and maintaining digital collections. In fall 2016, CUL's Conservation Lab was contacted by the College of Human Ecology, Department of Fiber Science and Apparel Design (FSAD), to treat a collection of barkcloth from the Cornell Costume and Textile Collection in preparation for digitization. Barkcloth was the subject of the author's final project for the graduate certificate at the University of Iowa Center for the Book (UICB). At that time, the culture and history of Polynesian barkcloth, its methods of manufacture, and conservation practices were researched, and a large Tongan barkcloth stored at the Research and Production Paper Facility (University of Iowa, Oakdale Campus) was conserved and donated to the University of Iowa Libraries Special Collections. The research completed for that project, in part presented here, significantly informed and directed the recent treatment at the CUL Conservation Lab.

ABOUT THE COLLECTION

The FSAD collection includes more than 10,000 items of apparel dating from the 18th century to the present, as well as a substantial collection of ethnographic textiles and costumes. The goal of the FSAD's digitization request was twofold: to create a complete visual record of the barkcloth collection for the first time and to add the collection to the Cornell Costume and Textile Collection's online database. The result of this initiative would increase access to the fragile barkcloth by students and scholars.

The 12 pieces of barkcloth brought to the Conservation Lab for this project had origins throughout Polynesia. Together

they represent at least four of the islands (Fiji, Hawaii, Samoa, and Tonga), with a handful listed as "unknown" origin. Known information about the circumstances of accession and history prior to acquisition is noted in their catalog along with a brief description and additional relevant information acquired at the time of accession—for example, "This was made by a Samoan princess and presented many years ago to Commander W.E. Sewell of the U.S. Navy" or "no information, from Hawaii, very old...Donor: Mrs. Edward Devereaux...received by her father Mr. E.R. Embree, who was a Rockefeller foundation official. Tapa cloth gotten when family lived in Hawaii."

TREATMENT OBJECTIVE

The condition of each piece of barkcloth varied significantly; however, the main concerns that affected the long-term preservation of the pieces and presented obstacles to quality image capture were shared by most. Folded and rolled storage left stubborn horizontal and vertical folds in the support, creating shadows and obscuring design elements. Flaking dyes, brittle fiber supports, tears and breaks, and oversized dimensions made transport and image capture in a small studio space both cumbersome and a risk for potential further damage. The barkcloth in their current condition could not be used for instruction or accessed by researchers. The treatment objectives were to enhance the long-term preservation of the barkcloth through sympathetic conservation treatment, particularly the stabilization of weakened areas in advance of digitization, and to provide a storage solution to prevent risk of further damage.

APPROACH

Taking the time to fully understand a collection is a necessary initial step in any conservation treatment. Familiarity with the raw material helps predict how the item will react in treatment, over time, and in different environmental conditions. Awareness of historical and cultural significance reveals

use and value, both past and present. Knowledge of manufacture processes explains observable characteristics, helps identify qualities of historical and artifactual significance, and may even suggest the place of origin. Consultation with literature and colleagues identifies treatment practices, presents options, and informs treatment decisions.

THE RAW MATERIAL

The production of barkcloth, also called *tapa*, was once practiced widely throughout the Pacific, eastern Asia, and Africa. Among the Pacific Islands, it was known to the natives in their own languages: *siapo* (Samoa, Futuna), *ngatu* (Tonga, Uvea), *ahu* (Tahiti), *masi* (Fiji), and *kapa* (Hawaii). As the name suggests, barkcloth is a cloth-like material made from the inner bast fibers of select plants. The most prevalent fiber source throughout the Pacific was the *Broussonetia papyrifera* of the Moraceae family, more commonly known as paper mulberry (fig. 1). Depending on the geographic region, other varieties of the Moraceae family were also used, notably the *Artocarpus* (breadfruit) and the *Ficus* (fig and banyan) (Neich and Pendergrast 1997). Additional sources of fiber were obtained from the poison tree (*Antaruis toxicaria*) in the far eastern tropics and the Mamaki (*Pipturus albidus*) in Hawaii (Leonard and Terrell 1980). Each fiber produced a cloth of its own color, quality, and fineness. Manufacturing practices and decorative techniques produced further variations. Traveling with Captain James Cook at Tahiti in July 1769, Joseph Banks, the expedition's botanist, wrote in his journal (Hooker 1896), "of this thin cloth they have as many different sorts almost as we have of linen; distinguishing it into different fineness and the different materials of which it is made" (Brigham 1911, 10; Leonard and Terrell 1980, 22).

CULTURAL SIGNIFICANCE

Paper mulberry does not grow natively on the Pacific Islands but was transported there by the ancestors of today's inhabitants when they began to migrate from the Asian mainland 7000 to 9000 years ago (Ewins 1987). It was among the items of necessity (food, fresh water, livestock, and plants) selected for their sea voyage and needed upon arrival for settlement. Transporting paper mulberry required great care, with its survival depending upon shelter from the salt water of the ocean and the use of fresh water to keep it alive (Ewins 1987; Meyer 1988). This was not a risk-free undertaking, suggesting the significance of both the plant and the material made from it to the people who made the effort to bring it across such vast distances.

Additionally, the environmental conditions of the islands varied, some being more favorable for growth than others. Orientation to the trade winds, rainfall, elevation, and soil composition all played a role in the vegetation. For example,



Fig. 1. Paper mulberry at the Research and Production Paper Facility, University of Iowa, Oakdale Campus, 2012.

among the islands of the Tongan archipelago are the raised coral islands of the eastern chain, and those in the west formed by volcanic action. Those in the east have greater elevation, receive an ample amount of rain, and have soil composed of a sandy coral base and volcanic ash. These characteristics provide an environment in which paper mulberry can grow in abundance and a location that supports manufacture (Kooijman 1972, 297).

Historically, the communities of women were responsible for the manufacture of barkcloth. Men played an indirect role, and the degree of their involvement varied by island. They were responsible for making the implements needed for their manufacture—the wooden beaters and anvils, carved designs on bamboo stamps, and wooden printing boards. The women of the village were responsible for harvesting of the bark, beating and manufacture of the cloth, preparation of the dyes, and construction of the vegetal (pandanus leaves, coconut midribs, sennit, etc.) printing tablets used in their decoration.

USE

Traditional uses of barkcloth range from utilitarian household purposes (curtains, room dividers, bedding, mosquito nets,

bandages, candle wicks, and clothing) to ceremonial (burials, deaths, births, taxes to the chiefs, and offerings to the gods). Certain colors and styles were reserved for nobility. If one were aware of these cultural nuances, one would be able to gather cultural significance by sight.

MANUFACTURE

Understanding the manufacturing processes can inform our observations about these artifacts, indicating reasons for current conditions, predicting future concerns, identifying provenance, and serving as a visual witness to the methods used by practitioners. The fundamental steps of barkcloth production were shared; however, the specific processes involved varied by location. Harvesting, preparation, beating, implements used, decoration techniques, and patterns each contribute to the unique qualities and characteristics that make one place of origin distinct from another.

In the most general terms, the practice was to harvest the fiber and separate the outer bark from the inner bark. The inner bark was then cleaned and beaten on a wooden (or stone as sometimes used in Hawaii) anvil, often hollowed for resilience and musical resonance. The cleaned narrow strip was beaten until it became a soft, widened, thin piece of cloth expanding in width from about 2 in. to 14 to 18 in. Larger pieces of cloth were made by overlapping the edges of the smaller beaten strips and adhering them together with a starch adhesive (e.g., arrowroot). Thickness was determined by the number of layers, usually two, and more for items such as bedding. With the exception of traditional Fijian cloth, the practice was to lay the upper layer perpendicular to the lower.

The growing season and cultivation of plants used for barkcloth were well defined. Throughout the islands, the growth of paper mulberry was monitored; attention was given to cutting the off-shoots of small branches that would result in holes in the harvested bark. The stalks were cut when the plant was 12 to 18 months old, about 9½ to 11½ ft. in height, the “thickness of a man’s thumb” (Kooijman 1972, 213), or when the “green bark becomes silvery white” (Kooijman 1972, 299).

The color and character of the undecorated cloth were determined by the fiber chosen and the subsequent manufacturing processes. In fact, the initial stages of the harvest and preparation of the bast fiber were very much akin to those practiced in Japanese papermaking—the ideal fiber being pristine and free of blemishes. Only fiber of this quality would produce the finest sheet of *washi*. Speaking of Hawaiian *kapa*, Samuel Kamakau writes, “well-made tapa must be cleaner than moonlight; clearer than snow on the mountains” (Kooijman 1972, 102). Steaming, retting, smoking, soaking, and drying each further influence color and quality of the barkcloth produced. In addition, the way each of these steps was carried out produced further variation. For

example, retting in mud versus retting in salt water, soaking the bast fiber in fresh water rather than salt water, and the duration of the soak produced different results (Doyal 2001).

Various beating methods were found throughout the islands, including folding and beating in bundles, beating strips individually, and felting. The sides, save at least one, of the wooden mallets (beaters) (fig. 2) used to beat out the bast fibers were grooved. The grooves of each side often varied in width and depth. Initial beating was done with the coarsest side of the beater, moving progressively toward the smooth. In Hawaii, this process was at times taken one step further—a final beating using a beater with a carved surface (fig. 3) imparted texture and pattern into the finished cloth (fig. 4).

As the technology spread throughout the islands, influence from one island to the next can be seen both in shared methods of manufacture and visibly in characteristics of the cloth decoration. Despite these commonalities, distinct practices, patterns, motifs, and the overall look to a finished cloth developed on each island. The designs and patterns were applied by a variety of methods: freehand, stencils, stained with local dyes, smoked, and/or printed (fig. 5).

Before the introduction of synthetic dyes, native plants were used to create dyes and impart color to a finished cloth. It is no longer known exactly how these dyes were made, but it is known that they were often made from the bark, fruit, and roots of local flora—for example, brown from the bark of the candlenut tree, reddish brown from the bark of the *Bischofia javanica*, black from the soot of burnt candlenut kernels, and yellow from the root of the *Curcuma viridiflora* (Kooijman 1972, Appendix: Table E).

The use of vegetal design tablets to transfer patterns or designs onto the cloth was practiced in Samoa, Tonga, and Fiji. These tablets, called *upeti* in Samoa, *kupesi* in Tonga, and *kupeti* in Fiji, were constructed of two layers of pandanus or

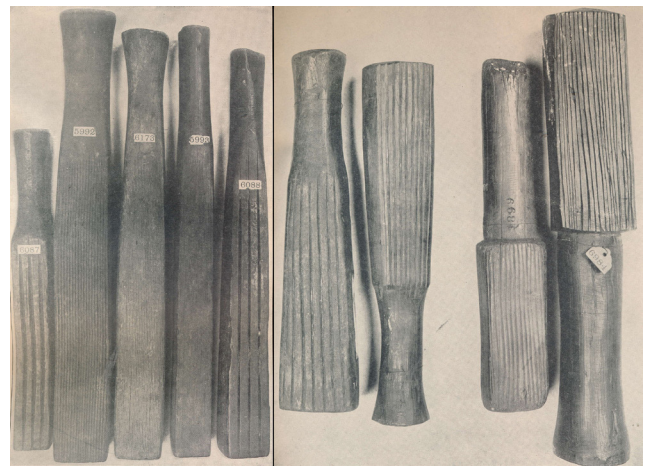


Fig. 2. Left: Tahitian beaters with grooved parallel sides. Right: Flared beaters (Tonga) and irregularly grooved beaters (Solomon Islands). Images from Brigham (1911, Appendix: Plates 6 and 7).

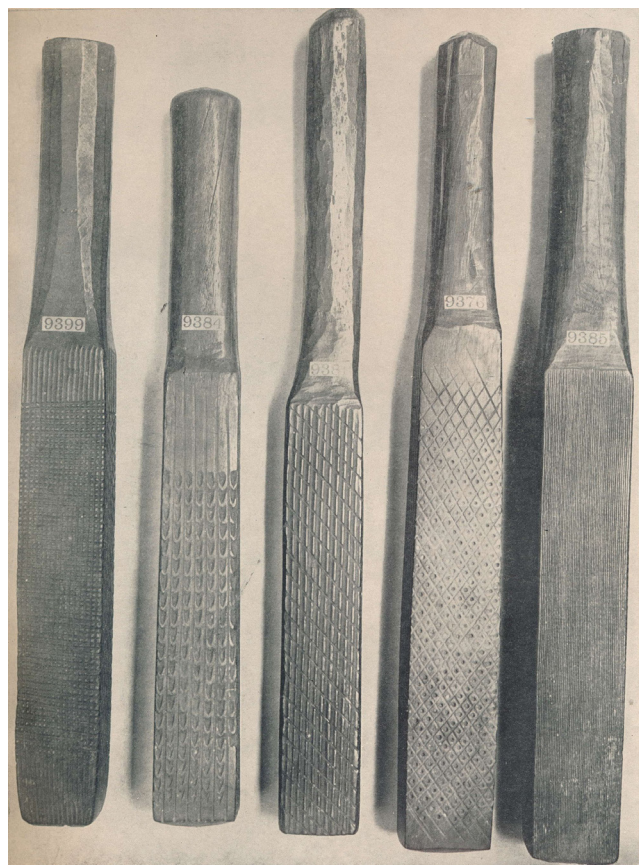


Fig. 3. Hawaiian beaters carved with patterns to impart texture. Image from Brigham (1911, Appendix: Plate 3).

coconut leaves. The top layer carried a relief pattern most commonly created from pandanus leaves, sennit, coconut midribs, bamboo, and hibiscus fiber. A rubbing technique was used to transfer the relief pattern to the beaten cloth (figs. 6, 7).



Fig. 4. Left: An undecorated piece of barkcloth from the Cornell FSAD collection. Right: Detail showing the texture imparted by a patterned beater.

The use of vegetal design tablets began to decline in the early 20th century after the introduction of metal tools proved the use of carved wooden boards a more durable alternative. Arkinstall (1966) notes this change in her graduate thesis, quoting Margaret Mead writing of Samoa in 1930: “But so well defined is the province of tapa making as women’s work, that men have not exercised their imagination on the carving of these boards.” Arkinstall further adds, “Thus, the patterns on the rubbing boards have become somewhat stereotyped. The women are not happy with the situation, but since wood carving has traditionally been men’s work, they do nothing but sit by as their patterned tapas become less and less interesting” (Arkinstall 1966, 119).

Within the Cornell FSAD collection are examples that clearly display the use of vegetal tablets and carved wooden boards (figs. 8, 9). Dyes of a darker color (black, dark brown, brownish red) were often applied freehand to the recto, highlighting chosen aspects of the design. The patterns from the vegetal printing tablets and carved wooden printing boards are more visible on the verso, making it possible to identify the plant material used to create the relief, repeating patterns, and number of tablets used to create the design. This information perhaps can assist in identification of origin or reconstruction of the manufacture process.

SIGNS OF DETERIORATION

Mechanical stresses, light exposure, fluctuations in relative humidity, biological agents, and pollutants each contribute to further deterioration of barkcloth. Exposure to light weakens fibers and contributes to color fading. Relative humidity that is too low or fluctuates causes the fibers of the cloth to become brittle, weaken, and break down. Dust can cause stains, attracts insects, and promotes mold growth (Bishop Museum 2012). As cellulose breaks down, pH decreases, increasing the potential of acid deterioration (Hill 2001).

The dyes, pigments, resins, gums, paints, and oils used to decorate and finish barkcloth can become faded and brittle over time. As a result, the media begins to flake. Consequently, the cloth below the colored area will also become brittle and stiff—breaking, tearing along folds, or separating along the grain, leaving holes (Hill 2001) (fig. 10). Specific to Samoan barkcloth, brittleness, insect damage, and acid deterioration are prevalent due to the use of arrowroot paste to join sections and the use of the acidic dye made from *Bischofia javanica* (Bishopwood) (Rose et al. 1988).

In traditional methods of island storage, large pieces of barkcloth were stored in rolls among the rafters of the home, often in areas affected by cooking smoke. Although the cooking fire kept the cloth dry and free of mold and the aldehydes in the wood smoke acted as a preservative against biodeterioration, the exposure to smoke allowed for the collection of soot, which leads to deterioration over time (Hill 2001).



Fig. 5. Methods of decoration found among the Cornell FSAD collection. Left: Freehand. Center: Stenciled. Right: Freehand over a design transferred from a carved wooded board.

There are, however, parts of the manufacturing process that inherently strengthened the quality of the cloth produced. Steps taken during the prebeating processes and the nature of the beating and drying processes each involve aspects that promote the longevity of the cloth.

The practice of soaking or steeping the bark for several hours prior to beating encourages a stronger and more flexible cloth. As a result, bacteria and fungi from fermentation cause the plant cell wall material to break down, allowing the pectin and hemicelluloses that normally stabilize the cell walls of the living plant to be redistributed during soaking. Because of this redistribution, the resulting cloth is more flexible. The pectin and hemicelluloses that remain in place add strength to the fibers and, consequently, to the cloth (Hill 2001).

During beating, the grooves on the face of the beater spread the fibers and alter their parallel orientation to one that is angled and interlocking, as well as allow excess water and air to escape. This interlocking, rather than parallel, orientation is stronger and less prone to lateral tears that most often occur parallel to the grain of the cloth's fiber (Hill 2001).

In the drying process, the barkcloth is stretched out in the sun. The high UV content of the tropical sun stunts the growth of micro-organisms (Hill 2001). It is the following stages of decoration, use, and storage conditions that most contribute to deterioration.

BACKGROUND RESEARCH ON CONSERVATION PRACTICES

Published research from the 1980s and 1990s (Rose et al. 1988; Wright 2001) narrating conservation projects of barkcloth collections at six separate institutions (Exeter City Museums, Manchester Museum, British Museum, Harvard Peabody Museum, Queensland Museum, and Bishop Museum) provided an overview of the needs of collections varying in scale and scope and offered solutions to meet these needs. The conservation projects described by these reports have ranged from the study of one specific item to large-scale renovation projects involving the rehousing of entire collections. En masse, the research identified potential signs and



Fig. 6. Vegetal printing tablets, Field Museum of Natural History, Chicago, 2012.

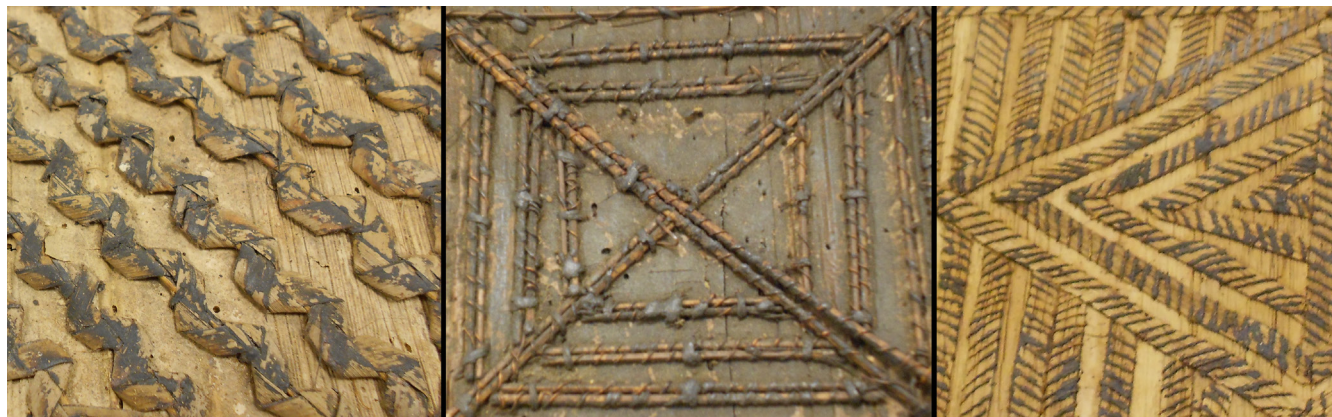


Fig. 7. Details of vegetal printing tablets, Field Museum of Natural History, Chicago, 2012.

causes of deterioration and discoloration, discussed treatment options, and addressed storage concerns.

Although the treatment of barkcloth is unique to each item, the organization and general measures taken to determine individualized treatment shared commonality among the reporting institutions. The goal of renovation projects was to preserve and render the collection more safely accessible to study by assessing the current condition, providing necessary treatment, and developing appropriate storage. Projects focused on scientific analysis aimed to identify catalysts of deterioration.

The recent treatment at CUL's conservation lab was driven by the need to address condition concerns to safely and successfully digitize the 12 pieces of barkcloth and improve their condition for use in instruction and research. The approach taken by CUL follows that of a renovation or relocation project—the barkcloth needed treatment prior to digitization

and a storage solution that served the needs of preservation and accessibility. The result of digitization would be threefold: expansion of the online catalog, improved condition of the original cloth, and updated storage solutions—each facilitating use in instruction and research.

TREATMENT APPROACH

The research and conservation efforts referenced previously differed in scope and purpose and therefore did not follow the same sequence of steps. However, they do provide an approach outline when developing a conservation treatment



Fig. 8. Example of the use of a vegetal printing tablet in the Cornell FSAD collection. Detail of recto and verso. The patterns seen on the verso are indicative of the use of a vegetal printing tablet. The origin of this cloth was labeled as “unknown.” Considering that this method was used most notably in Samoa and Tonga, and the designs are similar to known cloths of each location, it is likely that one or the other is the place of origin.



Fig. 9. Example of the use of a carved wooden board in the Cornell FSAD collection. Detail of recto and verso. The patterns seen on the verso are indicative of the use of a carved wooden board. The origin of this cloth was labeled as “unknown.” Considering that this method was used most notably in Samoa and Tonga, and the designs are similar to known cloths of Samoa, it is possible that Samoa is the place of origin.



Fig. 10. Left: Flaking dyes. Center: Loss. Right: Tears.

plan. Renovation and relocation projects began with description and condition surveys to address the safety of transport and treatment needs of the items. Description surveys considered size, patterns and designs, colorants, and fiber, whereas condition surveys noted physical qualities including dirt, folds, tears, brittleness, discoloration, sections joined, texture, and pH. Once these initial assessments were completed, storage options could be considered. In renovating, storage could be more tailored to specific needs; in relocating, storage options were directed by available space.

The condition of the item determined subsequent treatment, which often included photodocumentation; surface cleaning; humidification; flattening; mending; and, in rare cases, deacidification and lining. Humidification allowed brittle pieces of barkcloth to relax and be unfolded. Once unfolded, creases and folds could be flattened and the cloth reshaped under light weight. The surface could then be more thoroughly cleaned if needed. For extremely brittle pieces, a deacidification process was considered to increase the pH, stop further acid deterioration, and extend the life of the cloth. Torn areas were then mended; if necessary, the barkcloth could be offered the additional support of a tissue lining. The condition of the item was reassessed after treatment before being stored.

The literature offered insights regarding the appropriate level of treatment without compromising the historic integrity of these ethnographic items. Perhaps the most valuable succinct words of guidance were those shared by a colleague: “less of you, more of my ancestors.” Because many of the pieces of barkcloth from the Cornell FASD collection were oversized, they would need to be rolled both for final storage

and for transport to and from the digitization studio. This would mean needing the strength to withstand being rolled and unrolled multiple times both during the imaging process and afterward for use in instruction and research.

In addition to this stability concern were other factors that needed consideration—the inherent causes of deterioration rooted in the barkcloth’s history, extending from the time of manufacture and the processes involved, to use and the environmental conditions of previous and present storage.

OVERVIEW AND IMPLEMENTATION OF TREATMENT METHODS

Although the approach and treatment steps were similar, the differences in methods of humidification, cleaning, and tissue repair provide options in conservation treatment. A brief description of methods found in the literature are referenced for each treatment step discussed in this section. The method selected for the Cornell FASD collection follows.

CLEANING

If the condition of the item permitted, surface cleaning prior to humidification was used to remove any surface dirt that would contribute to further deterioration or embed into the fibers when moisture was introduced. The condition of the item dictated the method of cleaning used. These included one or a combination of vacuuming through a screen, the use of a soft brush, or the use of a vulcanized rubber sponge.¹ The use of latex-free cosmetic foam wedges, now commonly used in conservation practices, was not mentioned in the

literature but may provide another option for reducing surface soil from barkcloth collections, being less abrasive than vulcanized rubber sponges.

Previous studies reported that when using a brush, a vacuum should be used in conjunction to remove the dirt as it is loosened with the brush; otherwise, the loosened surface dirt is only spread across the item and further ingrained (Norton 2012). In the presence of mold, the spores can be removed with a dry, soft-bristled natural brush. Although staining will remain, the primary concern is to remove the spores, thus preventing future growth (Bishop Museum 2012).

The barkcloth from the Cornell FSAD collection were not heavily soiled. Some items were very fragile overall, with flaking media, tears, and loose fiber; others contained only brittle areas. In these cases, a sponge or a brush directly in contact with the surface of the item would be too abrasive, risking further damage and loss. For this collection, surface soil was reduced using a Nilfisk HEPA vacuum through a screen (fig. 11).

HUMIDIFICATION

Humidification methods² ranged from localized humidification under dampened blotter to makeshift chambers constructed to accommodate size and quantity, with care taken to monitor relative humidity of the collections. Attention was directed toward the presence of fugitive dyes, consideration of salt-retted and oiled cloths, and the effects of drying. Because humidification introduces moisture to the object, items decorated with dyes were tested in discrete areas to determine dye stability. Those pieces that have been salt retted allow for the possibility of salts being drawn out during humidification, whereas those that have been oiled prevent the use of humidification and water-soluble adhesives in treatment. Ironically, it is the effects of the oils that lead to acidification and embrittlement, and, consequently, the need to humidify, making treatment challenging (Doyal 2001).



Fig. 11. Vacuuming with a Nilfisk HEPA vacuum through a screen allows for the reduction of surface soil, avoiding direct contact with the item.

The goal of humidification among the Cornell FSAD collection was the reduction of deep wrinkles, creases, and folds that have resulted from folded and rolled storage. Each barkcloth was humidified for approximately 20 to 30 minutes between felted Gore-Tex (sprayed with filtered water), allowing a controlled use of water vapor to relax the fibers (fig. 12). Pieces of barkcloth that could not initially be safely unfolded to their full dimension were unfolded slowly during humidification as the needs of the barkcloth directed. The barkcloth pieces were then placed between heavy-weight oversize blotters and allowed to dry under very light weight to maintain the naturally textured quality of the cloth. Frayed and undecorated edges were addressed with local humidification.

The dimensions of most of the barkcloth allowed for overall humidification at one time. However, there were not adequate space or humidification materials to accommodate the largest barkcloth in this way. Instead, this piece was humidified as follows. Half of the item was placed between felted Gore-Tex (sprayed with filtered water), whereas the remaining half was kept rolled on a tube. The humidified half was then dried under light weight. Once dry, the process was repeated for the other half. With both halves initially humidified and flattened, the workbench surface was extended with large Plexiglas sheets and the whole barkcloth was unrolled and laid flat between blotters. Light weight provided even and continued resistance to the reformation of wrinkles and folds.

TISSUE REPAIRS

Tissue mends serve to bridge separated areas, fill losses, and stabilize and strengthen weakened areas. Ideally, mends should be placed on the back and be invisible to the eye. Separated fibers that required additional support and alignment prior to

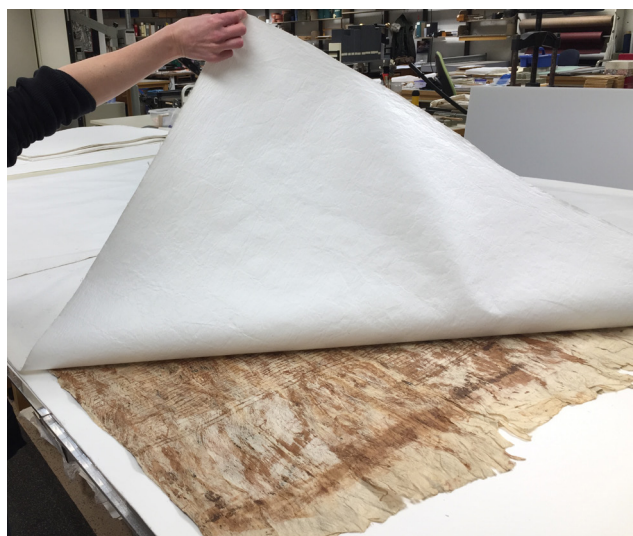


Fig. 12. Each item was humidified between felted Gore-Tex until the fibers were relaxed enough for the item to be fully unfolded and then dried under light weight to restrict the reformation of stubborn folds.

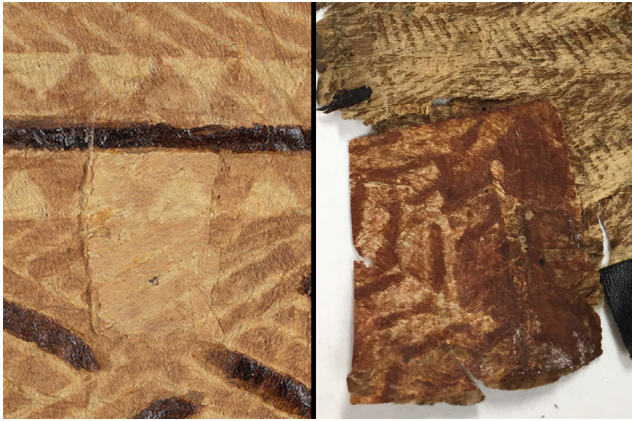


Fig. 13. Previous repairs. Left: Holes that occurred at the time of manufacture during beating were patched with small pieces of barkcloth. Right: Similarly, later repairs were made with recycled pieces of barkcloth. In these instances, the previous repair was of historic value and left in place.

mending were given temporary mends on the front, stabilizing the item so that it could be fully mended on the back (Rose et al. 1988). Losses were filled from the back with toned tissue with a water-torn feathered edge. Care was taken to distinguish between losses due to natural or ethnographic causes rather than deterioration. These ethnographic marks were left untouched, preserving the integrity of the item (fig. 13).

The literature cited testing of potential tissues and adhesives for repair. The Queensland Museum's report discussed a comparison of tissue materials, color matching, and adhesive tests. Four possible materials were chosen for testing: (1) kozo-shi (for being the same fiber as many barkcloths and its proven use in paper mends), (2) barkcloth (for its compositional compatibility), (3) Reemay (for its use in textile repairs and chemical stability, flexibility, and texture), and (4) spun-bonded polypropylene (for its use in ethnographic conservation and availability in neutral colors). Tapioca starch, wheat starch, methyl cellulose, and Klucel G were tested as potential adhesives with each of the sample tissues mentioned earlier. Ultimately, the polyester Reemay used with tapioca starch was chosen for its flexibility with relative humidity, adhering qualities, and visual compatibility (Hill 2001).

The Peabody Museum opted to use a mulberry tissue and aqueous adhesives (not specified) (Holdcraft 2001). Similarly, the Bishop Museum also chose to mend with a variety of Japanese tissues (usumino, sekishu, tengujo, kizukishi). In addition to being among the same fiber source as the barkcloth, the long thin fibers of Japanese tissues adhere well without adding bulk. Rice starch paste was chosen as an adhesive for its good tack, flexibility, water reversibility, and ability to be toned with water-soluble acrylic pigments (Rose et al. 1988).

The author's previous research at the UICB repeated this process—choosing tissues and adhesives based on use

among other collections and determining the most suitable by comparison of testing results. At that time, wheat starch paste and a heavier-weight tengujo proved most compatible. For the Cornell FSAD treatment, tengujo was suitable for stabilizing the torn and frayed undecorated borders, but for large interior tears, areas of brittle cloth, and flaking media, a heavier tissue was needed. For these areas, an assortment of Japanese tissues (kozo, tengujo, and usumino) was used with wheat starch paste. The literature on barkcloth production mentions only the use of adhesives derived from plant-based materials (cassava, arrowroot). Of the adhesives noted in conservation literature, wheat starch and rice starch paste were the most closely related to the adhesives, if any, used in barkcloth manufacture. Wheat starch was chosen for this treatment not only because it was accessible and familiar but also because it has proven outstanding working properties, longevity, and reversibility.

The mending and stabilization needs of the CUL collection varied from fragility imparted by numerous small lateral splits in the barkcloth, areas of loss, and areas of potential loss presenting instability (fig. 14) to a large central vertical tear (figs. 15a, 15b) extending nearly the entire length of the cloth (7 ft. 11 in.). The hand-applied dyes surrounding this latter area were extremely brittle and flaking. Subsequently, the cloth on either side of the tear was also brittle, shredded, and mangled. Temporary reversible bridge mends (Japanese tissue with a thin coat of wheat starch paste) (fig. 15c) were applied on the front to ensure that the design was aligned correctly. The cloth was then rolled, unrolled to have the underside face up, and mended



Fig. 14. Top row: Before treatment, recto and verso. Bottom row: After treatment, recto and verso.



Fig. 15. (a) Central vertical tear extending nearly the full length (7 ft. 11 in.) of the cloth. (b) Close-up of the central vertical tear extending nearly the full length of the cloth. (c) Temporary reversible bridge mends were placed on the recto to hold the cloth in position and ensure proper alignment.

on the verso (fig. 16). Once the mends on the verso were dry, the temporary mends were removed with a light application of filtered water.

LINING

None of the items in this collection needed to be lined; both the literature and colleagues consulted advised that this be

used only as a last resort. More information about the circumstances and procedures of this option can be found in the literature³ (Gottschlich et al. 2015).

STORAGE

In assessing storage options, the realistic often replaces the ideal. Depending on size and condition of the item,



Fig. 16. Each side of each item required multiple shots (12-15 per side) that would then be stitched together using Photoshop (see fig. 17).

the institutions conducting renovations and relocations of their collections had to consider what was most beneficial to the barkcloth while also keeping within allotted limits of budget and available storage space. The preferred and most ideal, although often impractical, is to store the barkcloth flat (Holdcraft 2001) with equal weight distribution (Rose et al. 1988). The least desirable storage is obviously one that facilitates further damage. Folding and stacking cause creases, uneven stretching, breakdown of fibers, and wear along folded edges (Rose et al. 1988). For larger items that must be folded to fit a storage space, folding over a soft support is an option. These items can then be stored individually or in small groups in stackable, lidded boxes (Holdcraft 2001). Rolling is an option for larger items as well, but depending on the fragility of the item, rolling may increase the potential for the flaking of media on delicate or heavily painted pieces (Rose et al. 1988; Murray and Johnson 2001) and add stress to seams and sheets of multilayered cloths (Rose et al. 1988). Although the roll saves space, it also limits accessibility to the researcher, and if used frequently, the rolling and unrolling can potentially lead to further damage (Rose et al. 1988). If rolling is the chosen option, it should be rolled with interleaving to prevent rolling onto itself (Holdcraft 2001; Murray and Johnson 2001). In the presence of mold, interleaving serves

as a barrier between areas contaminated by mold and those that are not. If the ideal storage conditions cannot be met, the main priority is to provide the item with the storage format that best safeguards it from further deterioration and damage.

Among the Cornell FSAD collection, the pieces of barkcloth that fit in folders were stored flat in archival paper folders in flat file map cases. The remaining oversized pieces were rolled on 4.5-in.-wide archival tubes covered with Ethofoam (for cushioning) and a polyester film cover (a barrier between the barkcloth and the Ethofoam). The barkcloth was rolled face up with Hollytex interleaving (spun polyester web). An additional cover of polyester film was rolled around the tube to protect from dust. The tube was labeled with a thumbnail image and catalog information for identification and to limit unnecessary unrolling. The physical collection, now stabilized and more safely stored in a secure climate-controlled environment, is available for research and study alongside the digitized images online.

DIGITIZATION

Published accounts of the digitization of barkcloth collections were not readily found in the literature. The equipment and methods described in the following were those used by the Digital Media Group at CUL. Priority was given to safety in transport and handling, as well as quality of image capture. The Conservation Lab is located on the lower level of Olin Library; the digitization studio is located on the first floor. Limited studio space required each piece of barkcloth to be transported and captured digitally one at a time. Each barkcloth was rolled onto a padded archival tube and hand carried to the digitization studio. Due to oversized dimensions of some of the barkcloth, pieces were imaged on the floor with the camera above on a motorized column from above, capturing one section at a time. A live view on the computer software helped to accurately capture sections so that they could be successfully stitched together in Photoshop. Conservation and digitization staff worked in teams of two in tight quarters during the digitization process to handle the barkcloth. This involved partial unrolling, repositioning under the camera, and rerolling to access the next section. An oversized piece of corrugated plastic board was used as a support and allowed for the cloth to be easily shifted as needed and protected from direct contact with the studio floor. Each barkcloth was imaged recto and verso, with the oversized pieces requiring several images; therefore, digitization could take an hour or more per barkcloth.

A Phase One IQ3 100-megapixel digital back and Digital Transitions DT RCam were used for image capture. This equipment produces an 11,608 x 8708 pixel raw image that can be processed into many different formats. Although the setup for each image required calibration and focus of the camera and time to safely position the barkcloth, image



Fig. 17. Left: After treatment recto. Right: After treatment verso.

capture is quite fast with this method. Four LED lights (Lite panel Astra 1x1) were used for lighting. These panels create an even light (cool and non-UV) with soft boxes and diffusers attached. Calibration with the DT RCam provides an accurate reproduction. The camera is able to capture an area of 40 in. per shot. This meant that the largest items required 12 to 15 shots per side (fig. 16). Each image file is 289 MB. The individual images are then stitched together in Photoshop. The composite image is approximately just over 1 GB in size (Ingall 2017) (fig. 17). The digital images were uploaded to a searchable media management system that supports source files and associated data according to the National Digital Stewardship Alliance's suggested guidelines.

The resultant digital image captures the design, texture, and manufacture characteristics of each cloth in stunning detail. The online collection can be used for instruction and research, facilitating comparison with other collections worldwide.

CONCLUSIONS: THE IMPORTANCE OF CONSERVING BARKCLOTH

Because production of barkcloth has ceased on most of the islands, the methods of production originally used by the ancestors of today's inhabitants are not wholly known. The effects of European influence and missionary initiatives began to heighten during the 18th and 19th centuries. The introduction of synthetic dyes in decoration of the cloths and the replacement of vegetal design tablets used in Tonga, Samoa, and Fiji with carved wooden boards are only two examples.

Primary accounts from the 20th century provide a record of the noticeable change occurring in barkcloth production throughout the Pacific Islands. Writing in 1911, W. T. Brigham notes that "Samoa still continues its rather coarse *siapo* making, but it is mainly for exportation as a curiosity" (Brigham 1911, 3). Arkinstall's research (1966) found the production of *kapa* in Hawaii had ceased by 1890. Dard Hunter, writing of his travels

to the Pacific islands in 1926, confirms this, noting that "in this highly commercialized locality not a vestige of anything relating to this age-old industry remains, and, aside from exhibits in museums, it might never have existed" (Hunter 1943, 30). While barkcloth was still being made at this time in Savaii, British Samoa, and Taviuni of Fiji, Hunter found no production akin to its original practice, and this had been the case for more than 100 years, since the early 1800s. It was not until arriving to the islands of Tonga that he found barkcloth being made in a manner the least pressured by modern influence. As of the mid 1920s, Tonga was the only island that produced barkcloth for native uses and not for the tourist market (Hunter 1943). In 1984, 58 years later, Adrienne Kaeppler of the Smithsonian Institution noted that of the Polynesian Islands, only Tonga, Samoa, and Fiji were still producing barkcloth in some fashion (Pritchard 1984). With few exceptions, the production and high cultural regard of barkcloth has waned, and current manufacture is produced in lesser quality for the tourist market. The indigenous technologies that were once used have been altered and over generations have become lost to unrecorded history and memory.

The available knowledge regarding the ancient production methods of barkcloth is limited. Primary accounts and observations have been provided by sources obtained from Captain Cook's voyages, a few expeditions, and a handful of adventurous scholars (Brigham 1911; Hooker 1896; Wharton 1893). Although these accounts present variations and contain gaps, they are invaluable to the study, preservation, and revival of the craft and culture of the people who practiced it long ago. Because nothing of equal quality is being produced today, conservation efforts to identify the material, environmental, and technological influences responsible for the current condition are necessary to determine appropriate treatments. In preserving these materials, an abundance of cultural, historical, sociological, and artistic information is retained for further research and study of the Pacific Islands and Pacific Island culture. The conservation treatment and digitization of the barkcloth from the Cornell FSAD collection will promote preservation without limiting accessibility and also assist scholars and researchers to use this information to advance knowledge within their field of study.

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NOTES

1. A brush and vacuum were too abrasive for the Manchester Museum collection, disrupting the cloth fibers. A rubber latex sponge proved more suitable. At the Peabody Museum, vacuuming in conjunction with a vulcanized rubber sponge followed by a second vacuuming was used. Other methods included the use of a soft brush, air blower, vacuum, and chemical sponge.

2. Humidification procedures used by each institution:

- *Queensland Museum* (Hill 2001). Using a polyethylene humidification chamber and an ultrasonic humidifier, relative humidity was held at 95% for 24 hours. The barkcloth was unfolded gradually onto two layers of acid-free blotting paper with Plastazote beneath for cushioning. Once fully opened, folds were flattened locally under glass weights lined with acid-free blotter paper for two days, changing the blotter daily.
- *Manchester Museum* (Murray and Johnson 2001). Using a humidity tent and an ultrasonic humidifier and humidistat, the relative humidity was kept at 65% to 70% for 24 to 48 hours. Once fully unfolded, the barkcloth was left for an additional 24 hours. The areas that retained creases and folds were “smoothed” and, when necessary, were placed directly under weight. The flattened and weighted barkcloth was then held for another 6 to 24 hours at 65% to 70%RH. The relative humidity was then reduced to 50% to 55%, allowing the barkcloth to shrink, effectively smoothing out creases or folds. This process was repeated over four to eight weeks, until the item reached a sufficiently flattened state. Large cloths were partially unfolded and flattened, rolled onto acid-free cardboard tube, and unfolded until completely treated.
- *Peabody Museum* (Holdcraft 2001). A local humidification method that weighted a layering of Gore-Tex or Reemay with moistened blotter over the creased areas was used. Once moisture had been introduced, the blotter was removed and the weights remained atop dry blotter.
- *Bishop Museum* (Rose et al. 1988). The barkcloth was placed on fiberglass shelves of an open-frame cabinet enclosed in polyethylene sheeting for 8 to 12 hours. A humidifier was placed on the chamber floor. Once relaxed in the chamber, the tapa was unfolded and flattened on a table covered with acid-free blotter paper. Distilled water was sprayed over, not on, the item. Creases, wrinkles, and

folds were flattened by gently pulling the borders of the cloth and, if necessary, weighting them. The barkcloth was covered with blotter to absorb moisture and facilitate drying. Once multiple pieces of barkcloth had been flattened, the stack was weighted with papermaking felts, providing even weight and continued resistance to the reformation of wrinkles and folds.

3. The Bishop Museum’s collection (Rose et al. 1988) includes some extremely deteriorated pieces that required additional support beyond what the tissue mends could offer. Their report describes a full lining of tengujo applied to the back of the item. This procedure was done after all other repairs had been made. Tengujo was chosen because of its soft, long, thin, and flexible fibers. These qualities add strength without adding bulk. It is strong enough to mend all weights of tapa and can be tinted without obscuring any marking that may be present. Rice starch paste was chosen as the adhesive because it can be diluted and still maintain its strength. The lining procedure used is as follows. The barkcloth was laid face down on blotter paper that had been covered with a release material. The portion of the barkcloth to be lined first was misted with distilled water. This step is imperative. If omitted, the cloth fibers will absorb moisture from the pasted tissue too quickly, causing stress to both the cloth and the tissue, resulting in restrained expansion and possible tears in the tissue lining that is being placed for stability. Due to its extremely thin nature and fragility when wet, the tengujo was pasted up on polyester and then transferred to the back of the cloth. Once placed, the polyester was removed and the tissue pounded to remove any pockets of air that could potentially result in bubbling. The lined barkcloth was then left to air-dry for a short time. Polyester web, blotter, and weighted glass were applied after this partial drying.

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