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The Conservation of Mayan Artifacts

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By

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This paper will examine the conservation methods and techniques used for the preservation of Mayan artifacts. Particular emphasis will be given to the four Mayan Codices known as the Dresden, Paris, Madrid, and Grolier Codices. These four documents are unique in that, not only have they survived until recently in less than ideal conditions for almost five hundred years, but they represent a culture whose written record was almost entirely destroyed by the religious zeal of the early Spanish missionaries. The fact that these codices still exist today is reason enough that special attention should be given to the care and treatment of them. Additional attention will be given to the comparative conservation methods used in treating ancient papyrus paper.

To fully understand the value of the Maya Codices, it is important to realize that at the time of the Spanish conquest in the early 16th century there were literally thousands of "birch-books" in daily use throughout the Mayan civilization. Many of these books had been constructed and in use for centuries before the priests of Spain burned them. The first European to gaze upon a folded birch-bark tome may have been the Spanish cleric, Jeronimo de Aguilar, who had been shipwrecked off the coast of the Yucatan peninsula in the early 16th century. When told by his captors that this was their form of writing, Aguilar – who had learned to speak the Mayan language – may have wondered how anyone could make sense of the strange characters. History does not record whether Aguilar learned to read Mayan script, but perhaps if he had, the secrets of the Mayan hieroglyphics would not have remained a mystery for more than four centuries.

Beginning with Bishop Diego De Landa, who faithfully recorded the Maya calendar and Mayan "alphabet" in his manuscript, *Relacion de las cosas de Yucatan* (1566) – to the ensuing dispute over whether the hieroglyphs were phonetic in nature or ideographs – both archaeologists and linguists struggled for generations to make sense of the enigmatic script. It wasn't until the middle of the 20th century, after a number linguistic dead ends had been reached, that the rich history of the Maya civilization began to be revealed through its writing. The long delay in accurately deciphering Mayan writing can be contributed to a number of factors – one of which was the absolute refractoriness by leading Mayanists – who dominated the field in the late 19th and the first half of the 20th centuries, towards accepting new evidence built upon seemingly previously discredited theories.

However, we can thank Bishop Diego De Landa for two facts concerning the historical preservation – or rather the lack thereof – of the Mayan artifacts. The first is his bungled attempt at hieroglyph decipherment. His belief that the individual glyphs stood for letters and not sounds laid the foundation for the next four centuries of linguistic confusion over Mayan writing. The second is that in 1562, De Landa was directly responsible for starting a book burning campaign that literally destroyed every book, except for four that we know of, which the Maya culture possessed. These four Codices now reside in European museums under ideal conditions with the exception of the Grolier Codex, which is held by the Mexican government where, as Michael Coe (1992) aptly says, "it presently languishes in a México City vault" (p. 229).

How these four books survived has been a matter of speculation, but it is thought that the Dresden Codex had been a gift to the Spanish king, Charles V from Hernán Cortez in 1519 and the Madrid Codex also once belonged to Cortez as well. The other two codices – the Paris and Grolier Codices – may have been snatched from the Inquisition bonfires at lesser known Maya centers. Pre-Columbian Maya books are called codices or screen-folded manuscripts because each book was made of a long strip of *amatl* paper folded like a screen. The paper was made by first stripping the bark from a fig tree, such as the *Ficus cotonifolia* or *Ficus padifolia*, that was then washed. Once the bark was soft, the inner fiber was then "peeled" away from the outer bark, which was then washed again and boiled in limewater, causing the material to be even more pliable. This was then pounded into a pulp to form a kind of felted cloth with stone or wooden mallets called bark beaters (Hunter, 1927, 14). According to colonial observers, the indigenous peoples of Mesoamerica also added "globules of glue between the layers of fiber" to better bind the paper sheet (Von Hagen, 1944, 63). A stucco coating made of fine white calcium carbonate paste, more commonly known as lime, was then applied to both sides of the paper sheets and polished to provide a smooth finish upon which to paint. Using a variety of natural pigments for paint, the codicil pages were generally 10-12 cm wide and 18-30 cm in length and could be as long as forty feet. Painted on both sides of the paper, the codices were read along one side of the paper strip, from left to right, and then turned over to read the other side. Considering the constant daily use by the priests, the heat, the humidity, the torrential rains of the tropics, and the pervasive insect population, experts have estimated that the codices in general had a life span of perhaps 100 – 200 years (Love, 1994, 8).

However, while the production method and composition of the codices is now known, it was not until 1910 that a definitive analysis was performed to determine their organic origin. In a dispute concerning the organic nature of the Dresden codex, chemical analysis conducted by Dr. Rudolph Schwede revealed that the codex was made from the fibers of the *Ficus* tree. He also determined that the paper sizing was a form of vegetable calcium bicarbonate. Schwede also conducted similar analyses on the Madrid and Paris codices and also found them to be of the same composition (Von Hagen, 1944, 61-65).

The most recently discovered codex is the Grolier, so called because it was first displayed at the Grolier Club in New York in 1971. The provenance of the codex, much like the other codices, is a little murky. The codex was "discovered" by a Mexican collector, Dr. José Saenz, in 1965. Saenz, upon hearing of some Mayan artifacts being offered for sale, allowed the seller to fly him in a small plane to a dirt airstrip near the Sierra de Chiapas Mountains, where, along with other relics, he was shown fragments of the codex. The artifacts were said to have come from a nearby dry cave and, after some haggling, Dr. Saenz purchased the codex fragments. These fragments were eventually put on display by Michael Coe at the Grolier Club. Although there has been some bitter dispute as to the authenticity of the codex, radiocarbon dating conducted by Teledyne Isotopes dated the codex A.D. 1230 ± 130. Coe gives a detailed description of the codex in *The Maya Scribe and His World* (1973) and owes its state of preservation to the dry conditions within the cave were the codex was suppose to have come from. Like the other codices, the Grolier Codex is a folding-screen book consisting of eleven pages painted on bark paper that has been coated with stucco. The colors of the codex are confined to a rich hematite red, deep black, blue-green, a brown wash, and a thin red wash, set

Fig. 1. Page 8 also identified as column P, of the Grolier codex shows its remarkable condition. However, a close examination of the lower portion of the page reveals the badly decomposed bark caused by water damage. This page is approximately 12.5 x 18 cm and depicts a Death God similar to those found in the Dresden and Paris Codices

against the strong white background. Where water staining has not altered the surface, the colors still look bright and fresh. However, the bottom part of the codex is poorly preserved, having been eroded through moisture, which has stained the surfaces near the damaged areas. And there are five additional pieces of bark paper, which are not stucco coated, associated with the codex. All are single sheets, brown in color, and somewhat water-stained (Coe, 1973). The codex is currently in the Museum of Anthropology in Mexico City, Mexico, but is not on public display. Scanned photos of the codex however are available on the Internet. Unfortunately the preservation measures undertaken by the museum are not publicly available, and inquiries to the museum by this researcher went unanswered. One can only hope the curators of the Museum of Anthropology have taken the appropriate steps necessary to preserve this valuable piece of Mayan history.

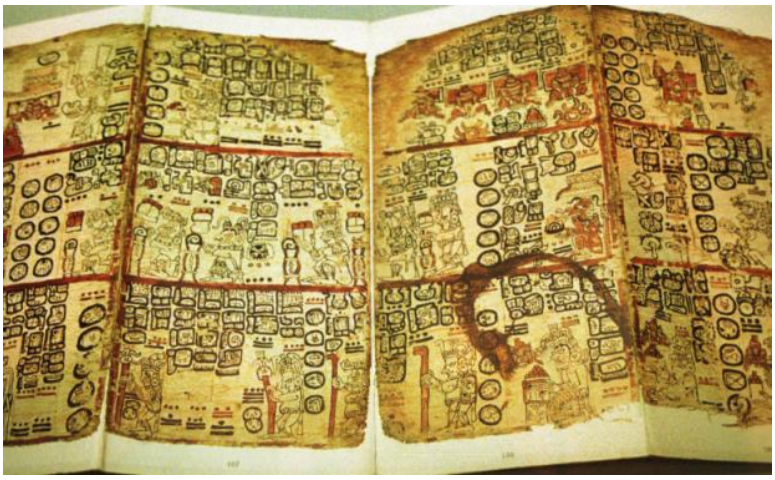

Fig. 2. Pages of the Madrid Codex showing large amounts of flaking pigment on the upper corners of each screen fold.

The other codices have also, in there own way, suffered controversies like the Grolier has. Shortly after the discovery of its existence in 1860, the Madrid codex was separated into two parts. It was the Frenchman Léon de Rosny who realized in 1880 that the two pieces were part of a single codex. Commonly called the "Madrid," and referred to in Europe as the "Tro-Cortesianus," the two parts separately had been called the "Troano" after the first owner, Don Juan Tro y Ortolano, a professor of Spanish palæography and the "Cortesanius." Both parts were finally re-united in 1888, and the codex is now stored at the Museo de América, in Madrid, Spain. The Madrid Codex is the second longest of the existing Maya hieroglyphic manuscripts, and is concerned quite specifically with the activities of daily life such as planting, hunting, and tending one's crops. Made of the traditional *amatl* paper, the codex is 56 pages in length with the detailed glyphs painted over a smooth surface of hardened lime paste. Although no one knows for sure how it arrived in Europe from the New World, some Mayanist scholars

maintain that certain details of the codex, plus the presence of 16th century Spanish paper attached to one page of the codex, suggest evidence of European influence (Vail et al, 2003, 105-112). And that the manuscript may have been written at Tayasal sometime between Cortez' visit in 1525 and the destruction of that city in1618 by the Spanish Captain Urusa. However, the most recent analysis suggests that despite the presence of 16th-century Spanish paper affixed to one page, the iconographic, linguistic, and hieroglyphic evidence strongly point to pre-Spanish contact. The evidence of Spanish paper was determined to be part of a papal bull of the Santa Cruzada that was used to bless the codex at a later date (Chuchiak, 2004, 77).

Fig.3. Page M of the Madrid Codex showing the attached Spanish paper. Note the crumbling edges.

Dra. Paz Cabello, the Director of the Museo de America, however, did advise this writer that a certain amount of restoration work on the codex took place in 1980 in the former Institute of Restoration – today the Institute of Spanish History. And that until a few years ago, the codex remained folded inside an acid-free box stored in one of the Museo de America's vaults (*cámara acorazada*) and was inaccessible for first hand examination. However, the manuscript is now unfolded in a special showcase within the same vault. The case is designed to deflect outside light when someone enters the vault, but allows researchers to study, draw, or photograph the codex. Requests to open the case, handle the codex or to take samples for further study are not considered. Unfortunately, further inquiries as to the details of the 1980 restoration project went unanswered.

León de Rosny, who years later would uncover the Madrid Codex, stumbled across the Paris Codex in 1859 in the Bibliotheque Nationale in Paris. The Bibliotheque Nationale acquired the codex as part of a lot of Mexican manuscripts in1832 from a private collector. Not realizing what they had, the manuscript found its way to the basement where de Rosny discovered the codex in a basket of old papers next to a chimney corner. Covered in dust and wrapped with paper around it with the name Pérez written on it, the curators of the Bibliothèque Nationale were clearly not too

concerned with preservation practices. The codex was first named the Codex Pérez or Peresianus and at one point renamed the Codex Mexicanus after its country of origin. But to prevent confusion with a 19th century compilation of early Colonial Maya writings – which are now lost – that was also called the Codex Pérez, the name was changed to the Paris Codex (Mann, Robin, & Zellner, 2003).

Fig. 4. The extreme damage surrounding the center portion of these 2 pages of the Paris codex is clearly evident.

Only a portion of the original codex survives. But the pages generally measure 12.5 mm horizontally and 23.5 mm vertically. Much of the fine white lime stucco coating has eroded from the edges of the remaining pages causing many of the hieroglyphs and images in these areas to be lost. The codex is painted in black, red, turquoise, tawny, blue, and pink with the outline of the hieroglyphs and images painted in black. The Paris Codex not only contains information on calendrical cycles, history, gods and spirits, weather, and astronomy, but also includes historical information. This makes the codex all the more valuable because so little is known about the history of the Maya. But the codex is in very poor condition. About half of each remaining leaf of the screen fold is missing ink and sizing around the outer margins as a result of past careless handling. Additionally, the screen fold appears to have been folded while closed, causing the ink and sizing of many leaves have to subsequently fallen away along the folds. Today, the Codex is stored in Paris in a sealed wooden case, which hasn't been opened in over a century, for fear of damaging it. However the case is uniquely designed so that two pages – nos. 20 & 23 – are visible through a glass cover (Stuart, 1994, xvii).

The Dresden Codex, perhaps the best known of the surviving Mayan codices, surfaced in 1739. The codex, which was presented to Charles I – the ruler of the Spanish and Hapsburg empires – by Hernándo Cortés as a tribute, was later purchased by *Johann Christian Goetze*, the director of the Royal Library at the court of Saxony, from an unknown private owner. It is the most complete manuscript of its kind. Like the others, it is made from *amatl* paper, folded accordion-

style and written and painted on both sides. Eight different scribes are known to have authored the codex, each with their own distinctive style, type of glyphs and subject matter. Painted in the basic colors of red, black and the so-called Mayan blue, with very fine brush strokes, it totals 74 pages in length. Dated to the same era (A.D. 1200-1250) as the Grolier codex, the Dresden manuscript has been linked to the Yucatec Maya in Chichén Itzá, and was most likely in daily use when the conquistadors arrived.

During World War II, Dresden was severely bombed and the Dresden library suffered serious damage. In correspondence with Dr. Nikolai Grube, who has studied the codex first hand, it was learned that water entered the storage rooms of the library where the codex was kept to protect it from bombing. When Dresden was destroyed in 1945, the entire Elbe River flooded and water entered the storage room, wetting the codex paper. As a result, the paper became inflated like a sponge, which caused the thin layers of paint to be pressed against the protective glass.

Today the stucco with the paint of some pages is still sticking to the glass, and the bark paper has separated from the paint. Museum conservationists and experts decided that the best policy for conserving the ancient manuscript is to leave the codex untouched since lifting the glass would harm the better preserved sections of the manuscript.

Currently, the Dresden Codex is stored in the *Zymeliensammlung* (rare books room) of the University Library of Dresden. The room is entirely dark and the books can only be viewed under low light conditions. The manuscript is kept between the original two glass plates, which date back to before World War II. Unfortunately, to complicate matters further, when the codex was put back on display after the war, some of the pages were erroneously placed in the wrong sequence in the protecting glass cabinet (Sachsische Landesbibiothek, 2001). Interesting enough, in corresponding with Dr. Grube, he noted that while there is much literature concerning the analysis and meaning of the codices content, it is true that very little has been written to date about the current state of the codices.

It is quite remarkable that these four codices are still in existence considering the fact they are all at least 700-to-800 hundred years old; survived crossing the Atlantic Ocean – except for the

Grolier Codex; have been subject to less than ideal storage conditions over the centuries; and have suffered moisture damage to one degree or another. Aside from their extreme age and past careless handling, exposure to water or damp environmental conditions appears to be the main source of deterioration of the codices. To date, there have been no major efforts to restore the codices to their original state. The focus has been merely to stabilize their condition to prevent further deterioration. The Madrid Codex is currently housed in special storage at the Museo de América in Madrid, and the Grolier Codex suffers the same fate in Mexico City. The public display of the Paris Codex at the Bibliothèque Nationale is a facsimile, as is the Dresden Codex. In each instance the codices are kept sealed in climate-controlled cases under appropriate lighting conditions.

These two photographs of Folio 46 and 47 of the Dresden codex illustrate the water damage the codex received from being in storage after the Allied bombings of Dresden in February and March of 1945.

Fig. 5. Folio 46 of the ← Dresden Codex.

Fig. 6. Folio 47 of the Dresden Codex. →

Perhaps one of the only comparable preservation projects that have taken place occurred in the late 1980's. In 1986, the 1531 Huejotzingo codex was brought to the Manuscript Division of the Library of Congress' Conservation Office for examination because of its poor condition. This 79-leaf manuscript, consisting of the proceedings of a lawsuit brought by Hernando Cortés against members of the first *audiencia* (Supreme Court) of Mexico in 1531–32, includes eight Mexican Nahuatl pictographs sewn into the center of the manuscript binding.

When the Library of Congress acquired the manuscript, it consisted of three parts: 1) 74 foliated leaves of Spanish text written in brown ink on antique laid paper-side-stitched together; 2) five loose leaves of the same text that had been silked; and 3) eight fold-out Indian drawings in color on native-made papers sewn into the center of the manuscript. Past handling had soiled, curled, and torn many of the leaves, and some of the iron gall inks used throughout the Spanish text had eaten through the paper extensively. Additionally, the tight sewing structure was actively damaging both the European and Mexican papers and preventing the manuscript from opening easily and lying flat. The Indian papers were very delicate, and repeated unfolding and folding to fit the native paper into the manuscript had caused wearing and fraying along the fold lines. Additionally, the pigments from the drawings were crumbling and brittle along the fold lines as well. Further damage to the Indian drawing papers had been produced by the tension at the sewing points, which had caused tearing of the drawing papers.

While the various antique-laid papers make up the bulk of the text and were identified as Italian linen fiber by using polarized light microscopy, the native paper was made in the traditional Mayan manner of fibrous bark paper. Two distinct different textures were detected in the native papers. Analysis revealed that four of the drawings were made from *amatl* fibers, while the rest were made using the scarcer *maguey* or *metl* (agave) fibers. Both papers were regular and even in texture with the dimensions varying from 19.7 × 48.3 cm to 44.5 × 45.7 cm. The *amatl* paper carries the appearance of a highly worked and refined *tapa* cloth much in the same manner as the four Mayan codices, while the *maguey* paper, which is made from the inside of the leaves of the agave cactus, has a more silvery white color and a thicker, more even texture. It is also a beaten paper, but does not have the corrugated lines normally found in *amatl* paper.

Sewing the drawings into the Spanish text had resulted in mixed benefits for their preservation. One problem was the crumbling pigment in the creases, which had been caused by the repeated folding and unfolding of the drawings. However, in the areas not directly affected by the repeated folding, the pigments were well adhered to the paper as their placement within the manuscript protected them from exposure to light and dust.

Examination with raking light revealed previous folds in the drawing papers, indicating a possible accordion pleat format before they had been sewn into the manuscript. A Fisher Accumet pH meter, model 320, with a flat-head electrode was used to obtain a paper surface pH measurement ranging from 4.0 to 4.2. Despite the tight sewing, exposure to handling, and acidic inks, the drawings had withstood time and survived 500 years of natural aging because of their fine quality. The moderate climate of Mexico City, where the manuscript resided until 1929, also contributed to its survival.

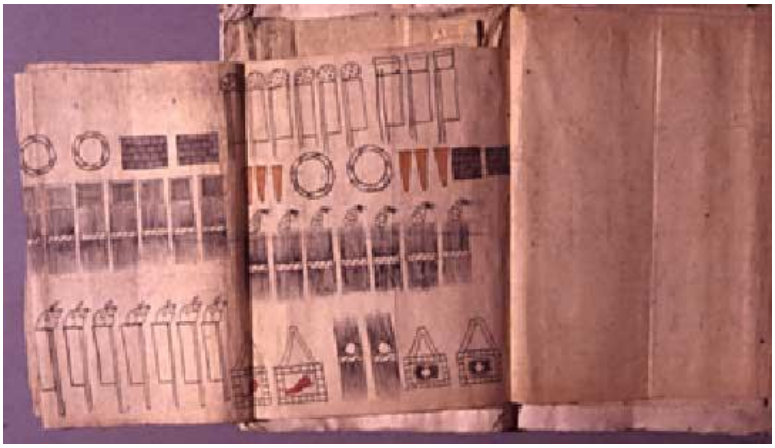

Fig. 7. Nahuatl drawing no. 1 in the manuscript as it appeared before treatment. Paper fiber is *amatl*.

After careful consideration of a variety of conservation and curatorial concerns, the Library of Congress curators approved a proposal for the Huejotzingo Codex that included the removal of the Indian drawings for treatment and separate housing. In general, the *amatl* papers were in poorer condition than the *maguey* papers and had more areas of loss and shredding where they had been folded. But the first step in the conservation process was to relax and flatten the drawings before treatment could begin. To accomplish this each drawing, with the aid of careful moisture control to avoid disturbing the pigments, was humidified in a chamber for three hours before the large wrinkles could be gently pulled out. After humidification the drawings were friction-mounted between *kizukishi* – lightweight Japanese paper – and dried between thick 5/8-inch felts weighted with Plexiglas.

The friction mounting process removed most of the remaining creases, fine wrinkles, and distortions in the papers. The severe wrinkles that remained were treated by local humidification with moist blotters and selective weighting. In areas of serious shredding, local humidification enabled the fibers to be repositioned with tweezers under magnification. This process allowed areas that had warped, as a result of fiber distortion, to be straightened out. Pigment consolidation was accomplished by using a parchment size adhesive that was diluted with isopropyl alcohol and water, and then applied with a fine brush under a microscope. For the actual patching process, the conservators used a modified version of Mexican traditional papermaking to fill the losses in the drawings. The *amate* fibers were cleaned, soaked, and boiled in a mix of fireplace ash and calcium carbonate, then turned into a slurry pulp with a blender. Acrylic color was added to the fiber pulp mixture to match certain areas where the drawing paper differed in color.

To repair the voids, polyester film was used to cover the area to be filled while the drawing was on a light box. Pulp was then added and shaped to correspond with the areas of loss. These formed fills were then dried between blotters without weight to preserve the fiber texture. To place the patch into the drawing, the fill was remoistened with a light mist and tamped into place using a Japanese stippling brush. Adhesive was not required to keep the patch fills in place.

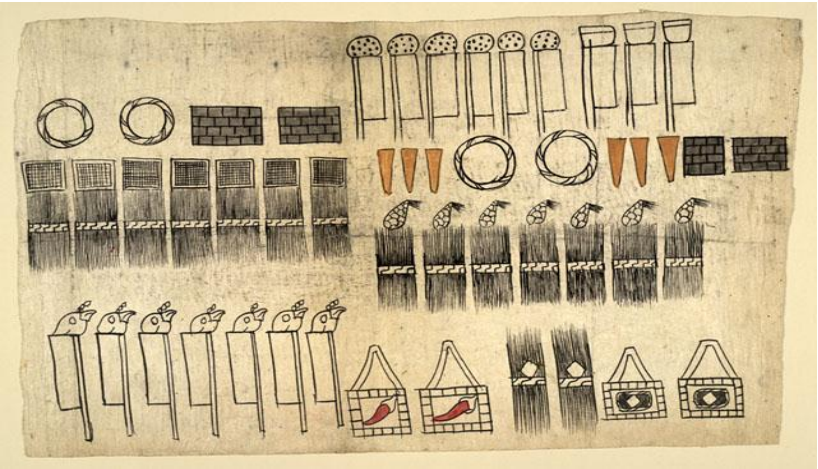

Fig. 8. Nahuatl drawing no. 1 as it appears following treatment.

Albro & Albro (1990) maintained that the use of a stippling brush was successful in blending the long fibers together because “both are of the mulberry family, the fibers seemed to have an affinity for each other” (sec. 10)

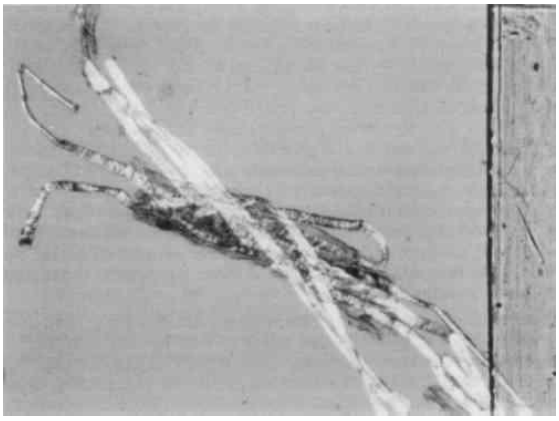

Fig. 9. Photomicrograph of *amatl* paper fiber from drawing no. 1. 250× 25° off cross-polars.

A light application of pastel was used to adjust the color of the fills, which were then reversed by pulling them away with tweezers. To provide additional reinforcement to especially weak or thinned areas, small strips of *tengujo* paper toned with acrylic were tamped into place in the same way, sometimes using a watery wheat-starch paste on the water-cut fiber edges. The local weighting of the areas produced no noticeable difference between the fills and the original. However, examination with ultraviolet light and raking light readily revealed the patches.

The *maguey* papers were treated in the same manner as the *amatl*, but required less filling and mending. After the completed repair, the drawings were hinged with Japanese paper and wheat-starch pasted into mats of a sympathetic color (fawn Museum Mounting Board). A photograph of each drawing was included in each mat to discourage handling of the original in the future. The matted drawings are now housed in a custom-made box that accompanies the boxed and bound manuscript in the Manuscript Division of the Library of Congress (Albro & Albro, 1990, 97-115).

A more recent and highly publicized conservation effort took place with the "lost" gospels of Jesus. In a project sponsored by the National Geographic Society, the papyrus manuscript was treated in a similar manner. The crumbling pages of the manuscript were first subjected to a "humidification" process. This step made the pages temporarily more flexible so that they could be arranged in their original alignment. Tweezers were used for fiber alignment and to place the individual fragments between plates of glass held apart by spacers. This allowed the papyrus to float freely since the fragments were so fragile that even the pressure of the glass resting on them would have caused further damage. For storage purposes, the ancient document is kept at or below a temperature of 68° Fahrenheit (20° Celsius) and can only be viewed under minimal light conditions through ultraviolet glass. Additionally, the plates containing the papyruses must remain horizontal at all times – whether on supports for study or for public display – at its future home in the Coptic Museum in Cairo, Egypt (National Geographic, 2006).

Fig. 10. Piece by piece, conservator Florence Darbre of the Maecenas Foundation reassembles the fragile document.

The techniques for working with papyri are well established simply because of the large volume of materials to work with. To date, some 50,000 Greek and Latin papyri texts have been published, which is only a faction of the unpublished materials still waiting to be deciphered. The large numbers of preserved texts is due to the exceptional dry climatic circumstances of the Near Middle East (Katholieke Universiteit Leuven, 2006).

In addition, consortiums have been established – in the United States and in Europe – with the goal of making all translated papyri text electronically available. The largest is the Advanced Papyrological Information System (APIS), which include the University of California at Berkeley, the University of Michigan, Columbia, Yale, Princeton, and Duke among others in Europe as participating institutions (University of Michigan, 2004). While similar efforts are underway for Mayan hieroglyphs, one major difference exists. (Vail, 2005). The conservation techniques and preservation methods used to preserve papyrus is readily available in print and on the Internet, while the literature for methods of preserving Mayan codices is virtually non-existent. This can be can only be attributed to the fact that while there are literally thousands of papyri fragments, only four pre-Conquest Mayan codices – and some two-dozen post-Conquest manuscripts – are known to exist.

However, a comparison examination of the techniques used for the Huejotzingo Codex, and those used for papyri, reveal similar methods of treatment. Leyla Lau-Lamb, Conservator for the University Library, University of Michigan, has published online its procedures used for the university's conservation program of papyrus. Photo documentation of the entire procedure, the use of humidifier chambers, sable brushes and tweezers, felt blotters, a combination of isopropyl alcohol/ethanol and water solutions, wheat-starch paste, Japanese paper, polyester film, fiber alignment, and the use of glass mounting – or specially made acid free boxes for storage purposes – are all common materials and treatments for both types of documents (Lau-Lamb, 2005).

One technique not discussed by Dr. Lau-Lamb, however, which was employed by the conservators of the manuscript division at the Library of Congress in their treatment of the Huejotzingo Codex, was the use of fiberfills for patching voids. The generally large areas of missing papyri preclude this type of treatment, and leafcasting is considered an inappropriate

treatment due to the mechanical force of the process and the fragile nature of the material. The following illustration is representative of many of the papyri fragments held by custodial institutions.

Fig. 11. A page of Homer's *Iliad* from the archives of Princeton University

But while leafcasting is not considered an appropriate treatment, recent investigations have demonstrated a process called "indirect leafcasting," which can be used successfully in preserving papyri texts. This process involves the cleaning and removal of old backings – which were once generally employed to provide support – by hand. A custom sized sheet of papyrus pulp paper is made in a leafcasting machine and drained to about 15% water content. The original humidified and cleaned papyrus is then coated with a thin layer of starch adhesive on the verso side. The cast paper is then carefully placed on top of the verso side, covered with felt and pressed for a few seconds. The felts are then replaced with blotters and the entire package is subjected to a hot drying cylinder to facilitate a quick dry. The process has several advantages. In addition to strengthening the text, it prevents deformation occurring to the old papyrus from too much moisture; the original texture of the papyri is preserved; and the recto side remains unaltered; but most importantly, the process conforms to the principle of reversibility (El-Meligy & Wahba, 33).

In the event there is writing on the verso side, El-Meligy & Wahba (2002) maintain that two thin layers of papyrus fibers can be placed on each side of the text. However, the illustration provided by the authors demonstrates that the ancient writing, although readable, becomes slightly obscured by the process. But for general leafcasting purposes, this process, which uses papyrus pulp cast to custom specific thicknesses, has not only the advantages outlined above, but can be used to fill in holes and missing pieces caused by mold, insects, fire, water damage, or past careless handling.

Unfortunately, it is highly unlikely a similar process could be applied to native *amatl* paper. There are two main reasons for this. First, because there are so few examples of Mayan or even Aztec codices to experiment on, the custodial institutions would not permit it. Secondly, since the codices have text on the verso side, the application of a similar leafcast backing, even though the process is reversible, would be to obscure the writings.

In the course of this investigation, this researcher was puzzled as to why so many papyri texts have survived so long in poor condition when compared to the Mayan texts, which appear to have greater durability characteristics in retaining their bright colors, their basic form and integrity, less water damage and careless past handling. Certainly one very important reason why so many papyrus fragments are available today is due to the dry environmental conditions, which the papyri have been exposed to over the centuries. And for the Mayan codices, the dearth of available text is certainly the result of the actions of the Spanish missionaries in the New World. However, one consideration that was found lacking in the literature was the absence of any discussion of the chemical properties of either papyrus paper or *amatl* paper. One question that comes to mind is that what are the original natural ph factors of each of the organic materials used to make the papers? The fig, which comes from a variety of the *Ficus* tree, has one of the greatest concentrations of alkaline properties of any foodstuff known to man. These properties undoubtedly are very similar to the alkaline properties of the inner bark of the *Ficus*. With a high natural alkaline, content combined with a sizing of calcium carbonate – which is a natural alkaline substance – the *amatl* paper used for the codices contained the chemical properties necessary for long-term preservation. Despite the moisture damage, the evidence for this can be seen in the excellent condition of the Grolier Codex. On the other hand, papyrus paper, which was used for almost every purpose in the ancient Middle East except for food consumption, is rarely found to be in good condition and invariably requires some measure of conservation work.

The simple answer may be that papyrus paper is, in some cases, 4,000 years older than any known *amatl* paper and has been exposed to degradation far longer than the *amatl* paper. Experiments using Fourier transform infrared spectroscopy (FTIR) could provide clues to this question. FTIR is effective in characterizing organic materials. By radiating a sample in the infrared region of the electromagnetic spectrum, a sample's molecular structure can be identified by comparing the

wavelength spectrum of the absorbed IR light with the spectra of known compounds (Smithsonian Center for Materials Research and Education, 2002). A comparative analysis of the natural ph factors of the identified compounds of both plants would help answer this puzzle. Such experiments, however, are outside the scope and expertise of this writer, but may be worth pursuing by qualified researchers should further Mayan codices be uncovered. Clearly, as our understanding of the chemical composition of the materials our ancestors employed grows, our ability to apply effective conservation treatments will increase, which will allow us to continue preserving the past for future generations.

Illustrations

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