

Sacred Leaves: The Conservation and Exhibition of Early Buddhist Manuscripts on Palm Leaves

ABSTRACT

During the summer of 2007, a collection numbering over a thousand leaves of rare and important Indian paintings on palm leaf and paper were rediscovered during a renovation and storage relocation project within The Metropolitan Museum of Art's Asian Art Department. The first exhibition, in a series of permanent collection rotations, focused on a remarkable select group of forty-five early palm leaves that cite the Buddhist Sutra of *The Perfection of Wisdom in Eight Thousand Lines* (*Ashtasahasrika Prajnaparamita*).

Historic evolution of the structure, the sacred ceremonial functionality and utility of the manuscript traditions, and technical background, material composition, support preparation, painting techniques, pigment analysis, condition assessment, and inherent deterioration mechanisms of both the support and media will be examined and described. Conservation treatment materials and procedures—such as structural stabilization of the aged palm leaf, including ethical considerations in compensation and reintegration of design, mounting, housing, display and storage, and topics pertaining to the care and understanding of these early Indian paintings on palm leaf—will be discussed in detail.

INTRODUCTION

Every art lover knows that many works of art contain a special inner force. It cannot be defined in the usual esthetic terms because it goes beyond the representational, symbolic, and decorative. Some civilizations refer to this force as the so-called magic content or aura. If magic is too strong, we might speak of this indefinable force as the mysteriously enticing power within the object. Let us begin by turning the leaves and allowing the knowledge and the sacred lure of these objects to be understood.

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HISTORICAL BACKGROUND

Illustrated Buddhist manuscripts of South Asia are books that were produced in abundance throughout the eleventh to thirteenth centuries. These illustrated Buddhist books are monastic products transcribing Buddhist sutras, and nearly all of the manuscripts in existence cite the *Ashtasahasrika Prajnaparamita* or *The Perfection of Wisdom in Eight Thousand Lines* (Leidy 2008, 137), one of the most important and earliest Mahayana texts put down in writing as early as the second century B.C.E. This vast body of literature referred to as the *Prajnaparamita* is essentially a compilation of philosophical and metaphysical teachings on the nature of reality and the universe. The basic premise is a radical non-dualism, in which every and any dichotomist way of seeing things is denied, so phenomena are neither existent, nor non-existent, but are marked by *sunyata*, emptiness, and an absence of any essential unchanging nature. The sacred character of the manuscripts is revealed not only in the writing but also through beautifully illustrated representations of important deities to whom the text was dedicated and who were brought to mind while reciting the texts. The illustrations contained in the manuscripts embody the earliest surviving Indian painting in existence and date from the late Pala period (1000–1200 AD) (fig. 1).

The illustrations provide rare glimpses for historians, following the stylistic development of the paintings by comparing them to extant sculptures, with their sinuous and flowing line, as well as to rare and fragmentary paintings that survive in archeological temple and monastic complexes, such as at Ellora and Aganta. They are truly rare keystones and fundamental sources in the understanding of the development of Indian painting. From at least the tenth century, the manuscripts were beautifully illustrated, typically with an expansive pantheon of deities whose spirits were evoked through its recitation and study. Narrative themes such as the scenes from the life of the Buddha occur more rarely (narrative scenes are found more often on the book covers) and the painting style in these earliest surviving manuscripts evolved out of styles developed in Indian temples and monastic mural



Fig. 1. Enshrined Image of Bodhisattva Maitreya. Folio from a manuscript of the *Ashtasahasrika Prajnaparamita* (Perfection of Wisdom). Photograph by Yana van Dyke (all photographs taken by author). Image copyright the Metropolitan Museum of Art (2001.445g)

painting now almost completely lost (Guy 1982, 14–17). The paintings are typically of a linear iconic style; images of deities placed alongside the text are there to increase the spiritual potency and magical power of the book by their sheer presence. The images are not necessarily illustrative, but their auspicious and protective presence alludes to their talismanic power and incites the mind to associate the images with the attributes of enlightened ones (fig. 2).

The *Astasahasrika Prajnaparamita*, or *The Perfection of Wisdom in Eight Thousand Verses*, the most illustrated Buddhist text of the eleventh through thirteenth centuries and one of several texts explaining the development of perfect insight, states that the text itself should be an object of veneration, and valued as much as, if not more than, relics, sculptures, and other icons that also allude to the presence of Buddha.¹ The teaching in the last chapter of the *Prajnaparamita* does not mention much about the philosophical concepts of emptiness but rather emphasizes the importance in the worship of the book. The Buddha instructs:

When through the Tathagata's sustaining power it has been well written, in very distinct letters, in a great book, one should honor, revere, adore, and worship it, with flowers, incense, scents, wreaths, unguents, aromatic powders, strips of cloth, parasols, banners, bells, flag and with rows of lamps all round, and with manifold kinds of worship. This is our admonition to you Ananda. For in this perfection of wisdom the cognition of the all-knowing will be brought to perfection (Conze 2001, 299).

The sacred power of the manuscript also lies in the fact that it is the embodiment of the Buddha, the words spoken by him. Evolving into objects of veneration in their own right in the Pala period, the cultic status of the *Prajnaparamita* (Perfection of Wisdom) manuscripts became so prominent that they became objects of worship, featured among the ritual offerings, evidenced in surviving pedestal sculptures of the period. Devotees of the book cult could direct their devotion to the wise goddess of the same name, *Prajnaparamita*, who represents the personification of the text; one of her principal attributes is a sacred book in hand (Kim 2007).



Fig. 2. Green Tara Bestowing Boons. Folio from a manuscript of the *Ashtasahasrika Prajnaparamita* (Perfection of Wisdom). Image copyright the Metropolitan Museum of Art (detail 2001.445i)



Fig. 3. Bodhisattva Padmapani offering protection. Folio from a manuscript of the *Ashtasahasrika Prajnaparamita* (Perfection of Wisdom). Image copyright the Metropolitan Museum of Art (1986.25.4)

Cults of different kinds have been born out of Buddhist devotees, and the worship and veneration surrounding books of wisdom assumed and still assume an important role in the temple ritual. The public recitation and sanctification of texts, as well as the display of the manuscript itself—the physical vessel of the teaching—still form an important part of Buddhist worship. The emergence of a book-cult was certainly modeled after the *stupa*-cult (the *stupa* serving as a protective container of Buddha relics and often adorned with

flags), and in a parallel way acknowledges the physicality of the book as a physical container of the teaching that is equated with a dharma relic.² Goddesses such as *Prajnaparamita* and *Tara* are symbols of the texts and the advent of the Mahayana female deities, and their bearing on the book cult cannot be underestimated; the idea of a female Bodhisattvas such as *Tara* was being developed during this time (fig. 3).

The Pala Empire was a dynasty in control of the northern and eastern Indian subcontinent, mainly the Bihar and Bengal regions, from the eighth to the twelfth century. The Palas were followers of the Mahayana and Tantric schools of Buddhism. They often intermarried with the Gahadvalas of the Kannauj region. They created many temples and works of art and supported the Universities of Nalanda and Vikramashila. Their proselytism was at the origin of the establishment of Buddhism in Tibet.

Colophons often survive and document the patron who commissioned the manuscript's production, providing dates and monastic place of creation, artisans and monks who made the book and performed rituals around it, and the subsequent footsteps of its provenance, tracing later owners and donors who safeguarded the book. Following its history over hundreds of years and many generations, the book continues to be bequeathed, read and studied, proofread with scrupulous corrections of the writing (text), and repaired time and time again. Because such manuscripts were considered sacred objects and were heavily used both for teaching and as a focus of devotion or meditation, rededications and repairs were common (Leidy 2008, 136).

Small, lightweight, and easily transportable objects of veneration, they have survived through times of danger, persecution, peril, and threat.³ Sometimes, although rarely intact in their protective wooden enclosures, the sacred leaves live to tell the tale. As is often the case of dispersed manuscript folios containing abstruse, mysterious, and impenetrable scripts from diverse cultures—now living in a museum collection or in private hands—text blocks have been discarded along the way and the images themselves taking center stage, often responsible for the survival of the singular leaves. Valued within the art museum setting for their pictorial style, they provide evidence that is reflective of the evolving philosophies of the culture from which they are born and take their place in the evolution and development of structure and style of later Indian miniature painting to follow. Twenty-first-century technology that has rapidly embraced digitization and preservation projects worldwide is enabling researchers and scholars to share previously isolated esoteric information. Transmissions from the powerful tool of the World Wide Web will facilitate the linking together of dispersed fragments, translations of previously impenetrable texts, and a host of other puzzles yet to be solved in relation to these early manuscripts.

LEAF BIOLOGY AND PREPARATION

Substances used for the reception of writing in the ancient world were numerous: wooden tablets, lead tablets, papyrus, bamboo strips, paper birch bark; whatever was most conveniently available could be used for writing (Diringer 1982, 354–62). The inherent instability of these biochemically decaying materials consequently results in an incomplete understanding of the materials used in and the volume of writing produced from the ancient world. Although it is difficult to say exactly when the palm leaf first began to be used for writing, there is ample literary evidence that in both Greece and Rome, the use of leaves for writing was quite familiar. In his *Naturalis Historia*, Gaius Plinius Secundus (23–79 AD), better known as Pliny the Elder, documents the use of palm leaves for writing materials.⁴ The word “leaf” still holds its place in the descriptive lexicon of manuscripts today—as with the term “folio,” from the Medieval Latin *folium*, meaning a leaf—and defines many things related to books, pages, and paper within a book, as do the terms “foliation” and “to foliate.”

Critically important to understanding these manuscripts is the primary substance from which they are built. All elemental and fundamental attributes are linked to the natural structure of the palm leaf itself: the book's unique shape, form, and design layout; orientation of the script, collation and direction; size and placement of images; media interaction and adhesion; binding style; state of preservation; how they have survived; how they have aged; and the conservation challenges they present.

Arecaceae, also known as the palm, is a family of flowering plants belonging to the monocot order, *Arecales*. There are roughly 202 known genera containing an expansive 2600 species of palms. The taxonomic group of the *Corypha* is a genus of six or seven species of palms native to India, Indonesia, and the Philippines. They are the fan palms with leaves containing long petioles terminating in a rounded fan of numerous leaflets. *Corypha umbraculifera* is one of the largest palms in the world with gigantic petioles or stalks measuring from two to five meters in diameter, with thirty to forty leaves per stem each measuring up to fifteen feet in diameter and reaching heights of 20–40 meters. It is cultivated throughout southeast Asia and north towards southern China (Wilson 2000).

Although gymnosperm, dicot, and monocot leaves are all used in a variety of artifact construction, the monocot leaves are the most versatile and heavily utilized. Reasons for this can be attributed to their greater size and durability, but more importantly to their strength, suppleness, and ease of splitting imparted by their long parallel fiber and fibrovascular bundles. From the monocot leaf, the leaf fibers comprise the vascular bundles (xylem, phloem, sclerenchyma fibers) and fiber bundles. They are often referred to as hard fibers, as distinguished from the soft fibers obtained from the inner bark

of herbaceous and woody plants. They may in fact be harder as they tend to be more heavily sclerified and lignified, but they are also mechanically stiffer. As the fibers grow in discrete fiber bundles, leaves are usually processed to extract the whole bundle, which is a compact complex of many cells. The strength, color, and abrasion resistance of monocot leaf fibers vary greatly depending on inherent characteristics and on processing methods. Generally they tend to be smooth fibers with a surface sheen that in book production is often further enhanced and beautified through burnishing. Waxes control water permeability and excessive swelling of surrounding mechanical tissues, such as fibrous sheaths around vascular bundles in palm. Pectin is another important structural component that is protected by cuticular waxes and cutin in leaves (Florian et al. 2001, 112–16).

The leaflets from these fan palms are separated from one another by a thick rib that extends from the hastula along the leaflet, creating a corrugated structure with remarkable mechanical and physical strength. Under magnification key elements of the structure become evident and, like all plant forms, they are abundantly more complex than your naked eye perceives.

Three regions are clear and distinguishable, namely the epidermis, the mesophyll, and the vascular bundles or veins. The outer membrane, known as the epidermis, covers the lower and upper sides of the leaf and protects the internal tissue from injury. Each side is composed of a single layer of closely packed rectangular cells, covered with a cuticle on the outer wall, preventing water loss. There are many stomata, formed by pairs of guard cells, perforating the lower surface (more on the lower than upper epidermis) whose function is to allow for gaseous exchange for photosynthesis and respiration as well as to regulate excess water. The vein system of the leaf consists of branched vascular bundles containing xylem and phloem and surrounded by a bundle sheath. The veins strengthen the lamina, the xylem conducts water and dissolved ions to the mesophyll tissue, and the phloem conducts organic food such as glucose from the mesophyll to other parts of the plant (Kern 1947) (fig. 4). The way in which veins are arranged is known as “venation” of the leaf and can contribute to the species identification of certain genera of palms. Manuscripts have been written on leaves from only a few varieties of palm trees: *Borassus flabellifer* Linn and *Corypha umbraculifera* Linn.⁵

Production processes differ across regions: the palm leaves can be processed by retting, soaking, and softening; boiling in water; smoking; wafting over a charcoal fire; and air, sun, or kiln drying, after which the leaves are then polished and wiped with a cloth of oil. In Indian states, leaves are 1) dried in the shade and rubbed with gingili oil to make them smooth; 2) hung in smoke for several days, then the surface smoke deposit is wiped off, sometimes followed by rubbing with turmeric paste; or 3) dried in the sun, buried in pond mud for ten to fifteen days, cleaned, dried, and rubbed with



Fig. 4. Photomicrograph (20x) of underlying mesophyll and vascular bundles structure



Fig. 5. Bound manuscript of palm leaves. Image copyright the Metropolitan Museum of Art (1953.123)

turmeric paste. In Sri Lanka, fresh, young leaves are boiled in water or lime water for a few hours and dried in the shade. In Thailand, the golden leaf from the Lopburi region is preferred. Leaves are dried in the shade, the midrib is removed, and the blades cut to uniform size. Bundles of leaves are placed in a kiln for twenty-four hours, causing a black oil to exude from the leaf edges. The oil is wiped off, the leaf is held over a fire for a few minutes, and finally polished. The removal of the oil is believed to make the leaves more durable (Agrawal 1984, 27–31).

CONSTRUCTION OF THE MANUSCRIPT

The manuscripts are made of long and narrow leaves of various fan palms, the average size being 22 ½ by 2 ½ inches. The loose leaves are held together between two wooden cover boards, with holes being pierced either through the center, or with two at each end of the leaves and boards. A



Fig. 6. One of a pair of manuscript covers with Buddhist deities. Nepal, Karnata-Malla period, eleventh to twelfth century, distemper on wood. Image copyright the Metropolitan Museum of Art (1983.555.2)

cord or cords are passed through these holes and wrapped around the bundle.⁶ The leaves are read from left to right, top to bottom, and then lifted, turned, and stacked face down one leaf over another (fig. 5). Such openness in the format of the binding structure has certainly made it easier to disperse the text block without initially causing physical damage to singular leaves, although this leads to textblocks found mixed and out of order, making it especially challenging to analyze, contextualize, and collate them.

Additionally, this practice has invariably led to covers being separated from their textblocks and there are many examples of detached and decorated wooden cover boards in the Metropolitan's collection (fig. 6). The manuscripts' cover boards are usually of wood, with finishes that range from simply stained and waxed to elaborately composed narrative painting programs that are highly polished and lacquered. Closed bundles were traditionally wrapped in several layers of cloth and stored in chests. Palm leaves may also be joined by tying at the edges so that they can be folded and unfolded in accordion fashion.

CALLIGRAPHY

Palm leaves have traditionally been written upon in two ways: either the text has been incised into the surface or written on the surface. However, there are no examples of inscribed leaves in the group of early Buddhist manuscripts that were selected for the exhibition.⁷ The other technique of writing on the surface is with a pen, most likely made of reed, utilizing an ink composed of flame carbon with a binder. The smooth, slick, oiled, flat, and dense epidermal layer allows for the reed pen to flow smoothly and distribute the ink fluidly and uniformly on its surface. Unlike other organic writing supports, this ink does not penetrate, embed, or stain a fibrous matrix as in birch bark, paper, or parchment. In general, the writing ink is chemically stable and only inherently susceptible to microscopic instability or losses due to mechanical abrasion in the stack. This also holds true for the paint layers, as the combination of the processed, oiled surface and natural cuticular waxes act as a protective barrier on the surface of the epidermis, inhibiting the penetration and

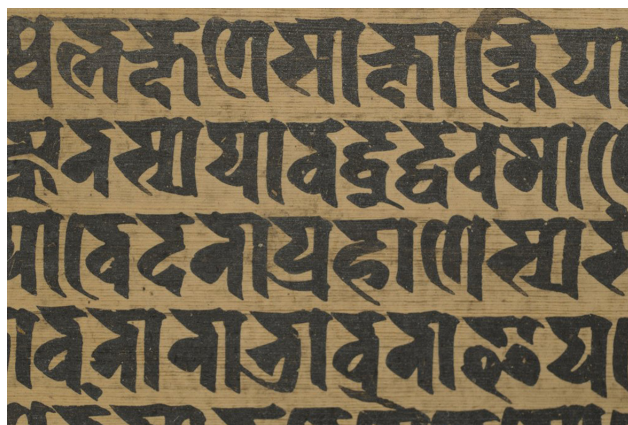


Fig. 7. Detail of calligraphy

saturation or staining by the media, held on by cohesive and chemical forces at the surface.

The text of the Buddhist manuscripts is beautifully written by skillful scribes without any separation between words in a careful and consistent hand; a single folio seems like an overwhelming ocean of letters (fig. 7). Here and there punctuation marks break the *scriptura continua* (writing without separation) with a narrow strip or band of empty space around the binding holes functioning like aeration, not necessarily breaking the sentences into meaningful units, but nonetheless giving visual breaks between many clustered letters. The paintings are usually found centered on the leaf and are placed at the end of each chapter. The paintings also mark points of rest in between the chapters so that during the reading and reciting of the text, they also serve as spiritual signposts by which the essence of the book could be remembered and recalled (Kim 2007, 315–16).

The calligraphy within these Buddhist manuscripts is Sanskrit, a historical Indo-Aryan language, one of the liturgical languages of Hinduism and Buddhism, and one of the twenty-two official languages of India. Classical Sanskrit is the standard register as laid out in the grammar of Panini, around the fourth century. Its position in the cultures of South and Southeast Asia is akin to that of Latin and Greek in Europe and it has significantly influenced modern languages of Nepal and India. The writing is read left to right and top to bottom.⁸

PAINTING

In all examples, the images are built with thickly applied opaque paint applied directly to the palm leaf with no preparation layer or ground. Examination with infrared reflectography revealed no evidence of any underdrawings, although in some cases, examination through the binocular microscope revealed a simple, linear outline underdrawing in pale red or dilute black. Adhesion of the paint layer to the leaf is usually strong and at first glance paintings appear flat and the limited palette is deceiving. On closer inspection, quite a bit of volumetric gradation exists (fig. 8). Forms are created by the application of a broad, overall, base color and built up in stages with an economic linear outline of less thickly applied mixtures.

Illustrations from three different texts were selected for pigment identification and were categorically identified. All pigments within the three selected manuscripts were found to be consistent, as well as customary or expected for this time period. The limited use of exclusively pure pigments, as well as a combination of these pigments in mixtures, varied to some degree from manuscript to manuscript: some exploiting the possibilities of expanding the palette, gradually building up volumetric forms.⁹ Blacks were identified as carbon-based, flame carbon; blue was indigo; yellow was orpiment; red was vermilion; and white was calcium carbonate. Admixtures are prevalent throughout; use indigo and orpiment for green; and white is added to many of the pigments for varying shades. Sinuous and graceful, modeled figurative forms are extremely reflective of Pala sculptures and honor their ancestry of the humanistic naturalistic painting styles of the past.¹⁰

CONDITION AND CONSERVATION

In general, all of the palm leaf supports were very dry and particularly vulnerable to damage around the edges. Fraying, delamination, and splitting of the structure are to be expected around the binding holes and from the edges; tears are much less common. Losses are primarily located around the perimeter of the leaves and planar distortions vary from none to moderately wavy. Separation from their protective covers and exposure to less-than-ideal climatic conditions have certainly contributed to their compromised conditions (fig. 9).

Overall, a conservative conservation strategy addressed the essential and fundamental physical stabilization needs of the leaves, making the objects safe to handle and display while respecting their age and signs of use. Utilizing natural products with good aging properties whenever possible, considerations included how the treatments would ultimately affect the structural, chemical, and mechanical characteristics and long-term stability of the object. Comparatively straightforward conservation procedures were carried out—the difference in this case being the extraordinary level of delicacy



Fig. 8. Detail of volumetric shading. Image copyright the Metropolitan Museum of Art (1986.25.5)



Fig. 9. Before treatment group of desiccated and deformed palm leaves



Fig. 10. Photomicrograph (20x) showing losses within flaking paint layer

involved, especially when treating the support problems. The object's before and after slides will not offer any great dramatic visual response and they do not necessarily present challenges that require new inventions in materials or techniques, but rather adaptations of standard practices with greater necessity of delicacy and sensitivity. These conservation challenges demand patience, and patience on a level that seemed appropriate with regard to their dharmic contents.

MEDIA PROBLEMS

Unstable media in the form of flaking and, less often, friable paint layers, existed in all in the palm leaf illustrations (fig. 10). This instability can be attributed to poor adhesion to the waxy cuticle, desiccation of the binder upon aging, and abrasion and stress caused to the paint layer as the leaves of the book are turned. Aims and considerations in consolidating unstable media are understood: to secure, stabilize, and ensure that no future losses take place without altering the visual character of the paint layers. Desired functional working properties are also important and include strength, flexibility, aging properties, effect on the original, viscosity, surface tension, penetration, and elasticity once applied.

Empirical testing on the manuscript leaves with consolidants and adhesives for either media consolidation or for use of consolidating and adhering delaminating palm leaf structures included: laboratory-grade gelatin at concentrations of 1% and 2%; Dow methyl cellulose 4C; Dow methyl cellulose 4M in 1%, 2%, and 3% concentrations for consolidation and in 5%, 6%, 7% for adhesion; and isinglass at approximately 1%, 2%, and 3% weight/volume for paint film consolidation. Gelatin and methyl celluloses in concentrations that were successful at adhesive bonding proved unacceptable, visually creating tidelines and a glossy surface sheen. Methyl cellulose concentrations at or above 5% have an unfortunate side-effect of leaving crystalline residues that appear as sparkles in reflective light.

Consolidation of the paint layer was carried out with a warm solution of 1% brush-applied isinglass while working under the magnification of a binocular microscope (fig. 11). No visual alteration of any pigments occurred (including orpiment and admixtures thereof).

ISINGLASS: CONSOLIDANT FOR PAINT AND PALM

Empirical testing found that the best consolidant for both the media and the palm leaf support was isinglass. It met all of the criteria discussed for consolidating media and proved effective in the self-mending of delaminating and fraying leaf structures, as well as attaching reinforcement paper in mending breaks and splits. For a complete discussion of this material, consult the article by Tatyana Petukhova and Stephen D. Bonadies, "Sturgeon Glue for Painting Consolidation in



Fig. 11. Consolidating the paint layer with the aid of the binocular microscope



Fig. 12. Isinglass in various forms: (clockwise from upper left) desiccated raw bladder, in solution (*bain-marie*), and dehydrated purified disks

Russia" (1993). Additionally, we have been practicing a useful technique for several years of depositing freshly made isinglass into disks or wafers and allowing them to dehydrate for preservation and storage. In turn, these dehydrated disks of isinglass can easily be brought back into solution as needed, simply reducing the laborious, two-day process of cooking and extracting to once or twice a year (fig. 12).

To make isinglass, follow the basic instructions and techniques provided in Petukhova and Bonadies' article. Specifically, the following guidelines provide the approximate weight of the dried Salianski sturgeon bladder membrane and volume of water to make a large quantity of isinglass (1 L)

that will ultimately be cast into disks, preserved, and stored for future use; one can certainly adjust the weight/volume ratio according to need.¹¹ We normally start the procedure with thirty grams of dried sturgeon bladder, and end up with one liter, or 1000 ml, of extracted collagen liquor to be cast. In practical terms we have found it easier to divide the operation into three portions, especially for working ease of the double boiler system as well as beaker sizes. Additionally, when it is time to cast the liquid into the disks, three people help to distribute all the liquid onto the silicone-release Mylar sheets, making the whole process faster. Break the thirty grams of dried bladder into pieces no bigger than three to five grams each and place approximately ten grams of the dried bladder pieces into three separate beakers and cover with just enough deionized water to top off the bladder. Cover the beaker with a watch glass or Parafilm and let it soak overnight.

Next, pour off the water and gently gather together the swollen bladder mass into an even cluster and add 333.5 ml of deionized water; this will cover the bladder enough to surround and allow the pieces to float. Put this beaker into a larger container of water and make a *bain-marie* or double boiler. Heat the double boiler on low temperature, just enough to release the collagen extract from the fiber of the bladder. Be mindful of the heat; there should be no steam or bubbles released as this will in part denature the protein.¹² The fiber of the bladder will shrink as it releases the collagen. To keep the water from evaporating off, cover with a watch glass. After a few hours, the collagen will be extracted from the fibrous membrane of the bladder. Sieve or decant through cheesecloth (doubled or tripled) or silk. Decant into a clean beaker.

Find a safe and undisturbed area to deposit the liquid into disks; this process will require a fair amount of space in a dust-free environment with enough air to flow and circulate around them during drying. Place several medium-sized sheets of silicone-release Mylar on a flat surface where you intend to carry out dispensing of the disks (fig. 13). Disposable pipettes or eye droppers have been found to be the best tools for distributing the liquid. Deposit and form a circular puddle of the liquid approximately one and a half inches in diameter onto the silicone-release Mylar, spaced out with enough room in between so the disks don't run together. Finding solutions to protect the disks while they dry can be a little tricky to avoid disturbing the liquid as it dries. We make tents of blotters, folded in half so that they span the width of the Mylar, and taped or weighted in place onto the counters to protect the disks as they dry. Once dry the dehydrated disks can be peeled off the Mylar and kept stored in a glass jar.

Dehydrated isinglass disks can now be weighed out and dissolved to make precise concentrations of solutions in small quantities for specific purposes. Casting the disks has proven to be an extremely valuable and time-saving procedure, as the process of extracting the adhesive from the membrane is rather laborious and this step limits that



Fig. 13. Disposal pipettes dispensing the isinglass liquid into disk shapes to be dehydrated and stored for future use

production to once or twice a year. Because of the increasing difficulty and cost of obtaining Russian sturgeon bladder, the flexibility and ease of making smaller quantities are also conservatively advantageous. Isinglass can be refrigerated to postpone mold or bacterial growth and subsequently warmed back into solution in a *bain-marie*.

SUPPORT PROBLEMS AND REHYDRATION

Similar to the demands of papyrus, the aged palm leaf can be very desiccated and brittle, especially around the edges that have been most exposed to oxidation processes. Rehydration of the leaves is considered one of the most important first steps in addressing support problems. Eight-hundred to one-thousand years of hydrolysis and oxidation deterioration mechanisms result in an extremely dehydrated, inflexible, and brittle material with considerable planar distortions. Humidification and rehydration of these desiccated leaves with the use of a Gore-Tex humidification package has many benefits: reducing distortions, relaxing creases, achieving original planarity, increasing suppleness to the leaf, and maintaining planarity between the support and the slightly sensitive media layer while the reintroduction of moisture content takes place. Another advantage of this slow, gentle, and effective vapor humidification procedure is the significant reduction of the all-too-present risk of causing stains and tidelines with direct applications of water or mist. Folds and flaps existed in the corners of many leaves. These folds and creases were relaxed and opened by introducing a localized fine ultrasonic mist humidification, avoiding breakage of any tissue before overall humidification.

The Gore-Tex barrier is a micro-porous membrane of polytetrafluoroethylene laminated to non-woven polyester or polyester felt (Purinton and Filter 1992). Gore-Tex

has been used for some time in the conservation profession and it has become increasingly difficult, if not impossible, to purchase. The membrane transmits water in the form of vapor while preventing the passage of liquid water, thus giving extra protection and control in introducing moisture to sensitive objects. When Gore-Tex is used in the blotter sandwich, two sheets of Gore-Tex are placed dry, one on either side of the object. The smooth membrane side of the Gore-Tex sheet is thus in contact with the object's recto and verso. Moist sheets of blotting paper rest on either side of the felted side of the Gore-Tex, and Mylar sheets are placed on top of the damp blotters to retain moisture levels. Humidification times varied between twenty to forty minutes for complete relaxation of the leaves, after which they were placed into a blotter drying pack between tissue and shuffled over several weeks while drying.¹³

STABILIZATION OF SUPPORT

After the leaves have undergone humidification and drying, they are rehydrated, more supple, flexible, and planar; structural stabilization can now be undertaken with considerably less risk of breakage. Additionally, the humidification process can often lead to improved alignment of sprung tears as well as to invigoration of the natural binding materials within the leaf itself, resulting in an adhesion and reattachment of slightly delaminated areas.

Mending methods chosen should be those least likely to cause permanent alteration of the basic fabric of the object. The choice of method is more immediately dictated by the work of art itself, location of the damage, and condition of the materials. Mending methods should be chosen for the item's intended use, future handling and storage, and compatibility in strength with the work of art so that they are strong enough to give support and physical integrity, yet weak enough to yield under stress before the work of art does. Repairs should be visually subtle yet discernible upon examination and differ from original or historic repairs that cause no harm.

Securing loose and delaminated layers of the leaf requires not only the utmost patience and delicacy but also a fluid form of adhesive that can be delicately applied. A slightly stronger solution of isinglass (approximately 3–4%) was chosen from that which was used to consolidate the media. When consolidating the palm leaf itself, the consolidant liquid needs to penetrate into the tiny crevices and pores in order to make a satisfactory adhesive bond. Increased flow is achieved by keeping the liquid warmed on a coffee cup warmer in a water bath (*bain-marie*) (fig. 14). While working under 10x magnification from the binocular microscope, careful attention was paid to the interior spongy core of the leaf as the brush-applied consolidant was observed to flow and coat the mesophyll and vascular-bundled veins through capillary action, without causing them to expand, swell, or shrink to any discernible degree.



Fig. 14. Consolidation of leaf with 2–3% isinglass while working under binocular magnification

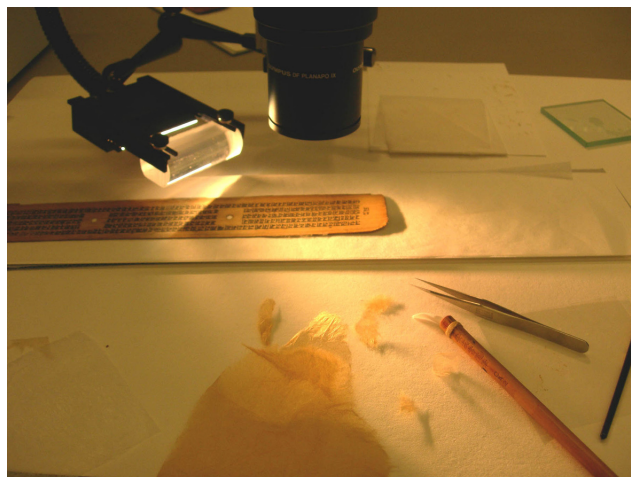


Fig. 15. Toned *tenjugo* reinforcement

As in most instances while consolidating, the conservator can make empirical judgments as to the volume of consolidant that is sufficient and necessary by observing and being sensitive to the object itself.¹⁴

Edges of thick, porous palm leaves are often crushed and frayed, and lead to horizontal breaks along the leaflet. Usually these breaks are too weak or sprung to make a strong, self-mended joint. Therefore it is not only desirable to consolidate and strengthen these ends and breaks but also to provide additional mechanical security through reinforcement strips. A small selection of Japanese handmade *tenjugo* papers were toned with air-brushed acrylic paint in a variety of tones and employed judiciously for reinforced repairs, attached with a 2–3% isinglass (fig. 15).¹⁵ In most cases, leaves being exhibited had a discrete recto and verso, with paintings present on one side only, thus repairs were limited to the verso side of the leaf. The tonality and the thinness of the *tenjugo* made them visually harmonious and they cannot be readily detected with the naked eye.

QUESTIONING INTERVENTION

Knowing the composition and properties of all the materials used in the creation of the manuscripts is essential to understanding their present physical condition and needs, as well as help to predict how the objects will respond to conservation treatment and the museum environment. Correspondingly important is to be sensitive to the object's historic and cultural context in order to acknowledge the intangible properties with which it may have been invested, as well as to recognize alterations that may have taken place through its use and function.

Ethical considerations and principles of conserving sacred objects meshed with curatorial attitudes in regards to loss compensation—all agreed to an approach not to fill losses. From monastic creation to museum display, with few exceptions, most of the leaves are no longer part of a complete manuscript and are appreciated for their visual potency and are safely mounted for two-dimensional display. Objects chosen for the exhibition did not display egregious losses, but even so, all agreed to accept the object with its losses, respect it for its age and wear, and to treat the leaves with physical stabilization as the primary concern. Considerations also included their end use and how infrequently these objects will be handled or originals requested for study. In addition, all the leaves have been captured and digitized in high-resolution image files. In those cases where the loss would promote or exacerbate a further injury, the thin, toned, Japanese paper was left to fill the void and bridge the break (Nichols 2004).

Fraying, especially around the perimeter and binding holes, was minimally addressed to prevent losses but not consolidated to the degree of aligning fractured internal structures. It was respected as the evidence of use damage caused by the binding cords around the holes.

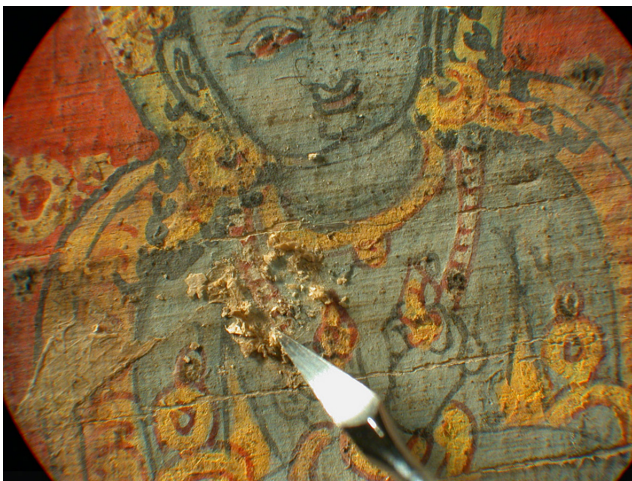


Fig. 16. Micro-surgical tool used to remove accretions

Surface accretions of smoke, dirt, and oils are deposited and absorbed onto the surface of most of these leaves from use and handling, turning, and reading. In addition, the item showed signs of the aforementioned veneration within religious rituals: being anointed, buried, sprinkled with unguents and candles, and incense burned around them. Most surface accretions were left alone and respected as evidence of their use and history. In very few cases, where the surface accretions were particularly disturbing to the overall reading of a deity or the foreign matter was identified as insect deposits, the accretions were removed mechanically under binocular magnification with especially fine surgical tools (fig. 16). In some instances, attachments and accretions covering over images were fragments of offset leaves and these were also delicately removed in order to reveal the painting underneath.

IMAGING AND CATALOGING

The entire collection of palm leaves recently discovered, except a large Indonesian bound book, have been captured with a scan-back camera called the Betterlight on a copy stand set-up. The lights are LED lights made by Scott Geffert, our consultant from CDI (Center for Digital Imaging), for the stand. The images were captured at 600 dpi, resolution set at 100%, with a color profile of ProPhoto RGB. These images are now incorporated into the Metropolitan Museum's Media Bin, the museum's image database, which will eventually be made accessible in the public domain via the World Wide Web. Following the digital image capture, the objects were catalogued into the Museum System (TMS) for museum staff access.

MOUNTING AND DISPLAY

Art museums have a long tradition of displaying dispersed folios from manuscripts out of context in a two-dimensional format. Hinged and matted leaves and bifolios displayed in frames are more common than presenting detached leaves in a book cradle. Valued in the museum setting for their artistic expression and far removed from their original function, these objects required a systematic and thoughtful approach to hinging and mounting.

The uniquely long horizontal format of the leaves creates challenges for exhibition and two-dimensional design display. Although there would have been enough room to display three pages together within the standard-sized mat and frames chosen, the curators believed it best for the viewer's experience to limit the number to two leaves and, thus, two windows per mat. Observing reactions of the leaves after removing them from the drying presses and sensing that with any minor to moderate fluctuations in humidity that these objects will respond as sensitively as parchment, deep-mat windows were considered appropriate for exhibition and safe

housing. The mat board window was composed of a double-step, four-ply window followed by an occasional four-ply lift, for an average total of twelve plies of mat board per window.

Rather than hinge the chosen pairs of palm leaves directly to the four-ply back board of the mat package, leaves were hinged individually to a two-ply museum board (fig. 17). This approach performs several functions: it allows for optimal flexibility in exhibition (arrangements or juxtapositions can be changed in future rotations if desired) and minimizes the need for handling, cutting hinges, removal from the mat, and reattaching new hinges.

Small rectangles measuring approximately 5.0 x 3.0 cm of light-weight *mino-gami* paper (Hiromi HP 04) were attached around the perimeter of each leaf. Because of the potential staining concerns with the wheat starch paste (perhaps due to its large globule size proportionate to the fully dissolved fluid form of isinglass), isinglass was chosen to attach the Japanese

mino-gami paper hinges to the palm leaf. Following hinge attachment the areas were immediately placed under polyester webbing and blotters, under glass squares and lightly weighted until thoroughly dried. Once hinges were attached to the palm leaves, they were in turn V-hinged to a two-ply museum board (Rising Natural 2-ply) with a 2.5cm border all around. When attaching the palm leaf to the secondary, two-ply board, wheat starch paste was used in the typical manner, and in the same method described above except for the additional piece of polyester webbing placed between the hinged object and the secondary support board. Once the hinges were completely dry, the small pieces of polyester were removed with a pair of very fine tweezers. Objects on their two-ply supports were attached into their museum exhibition mats with a pressure-sensitive linen tape (Filmoplast SH). The mats also serve as permanent housings.

EXHIBITION

Following common museum practice, these leaves, like so many other detached and dispersed manuscript folios, were mounted and presented in frames with glazing and hung on the walls of a small, rotating-display gallery devoted to works on paper in the South Asia wing of the museum (fig. 18). They were presented in the low and atmospheric lighting of 3–5 footcandles (30–50 lux). Simple, profiled wooden frames, stained with a walnut color, were outfitted with Optium glazing (a non-glare, anti-static, UV filtering, Plexiglas sheeting), all contributing to a beautifully clean presentation overall.

STORAGE

The folios chosen for exhibition and display were matted in one of a limited number of standard housing and storage sizes: 19 by 14 inches, 20 by 16 inches, and 22 by 28 inches. Once the exhibition rotation came to an end, the objects were taken off view, unframed, interleaved, and stored in a standard-size Solander boxes in the Department of Asian Art's storage facility. There are numerous groups of leaves that are fragments of what was once a complete manuscript not recently or yet chosen for exhibition or display. Inspired by the simple approach to covers that the creators of the manuscripts took, we chose a similar simple solution for their storage and housing within the museum. These dispersed folios are kept together as discrete bundles and are more often than not missing their covers. Folios that have not yet been chosen for exhibition and display are kept together in accessioned numbered sets, stacked and housed between two rectangular boards of acid-free corrugated board with identification labels attached to the top board, wrapped, and tied with cotton twill cordage (fig. 19).

When working out these housing solutions it became clear why for so many reasons two simple boards, tied around the



Fig. 17. Preparing leaves for exhibition: hinging to two-ply board



Fig. 18. *Early Buddhist Manuscripts: the Palm Leaf Tradition*. Gallery installation view. Image copyright the Metropolitan Museum of Art



Fig. 19. Housing and storage solutions

leaves, was ultimately the best approach of protection. Edges, especially the right and left, are particularly susceptible to fraying. Because of their brittle and vulnerable nature, if the leaves are stored in a four-walled or even a drop-spine box, the edges will be abraded, stressed, and potentially at risk for further damage. The damage potential is further increased with challenging access and handling issues. The corrugated boards are cut with a slight overhang on all sides, allowing and accommodating for even slight shifting or uneven stacking, maintaining a force of even pressure from the top and bottom and protecting the textblock leaves from undulations by restricting their movement to slight changes even within the museum environment.

CONCLUSION

The previously described case study only begins to scratch the surface of conserving the rare and important collection of early Buddhist manuscripts in the Metropolitan Museum of Art's collection. Future conservation treatments will continue to be steadfastly approached with unwavering respect for the objects, understood for their sacred and powerful nature and conserved with patience and techniques that do no harm. Stronger and healthier, the *Prajnaparamita*, the Bodhisattvas, and the Buddhas all live to tell their powerful tale, enlightening us now and for future generations.

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NOTES

1. In his seminal essay, *Notes on the Cult of the Book in Mahayana, Indo-Iranian Journal*, Gregory Schopen discusses the emergence of a book-cult modeled after the *stupa*-cult (the *stupa* container of relics), acknowledging the physicality of the book as a physical container of the teaching that is equated with a dharma relic. Goddesses (female Bodhisattvas such as *Tara*) are symbols of the texts and the advent of the Mahayana female deities and their bearing on the book cult were being developed during this time. Buddhist female deities were created in response to the competition with other religious systems such as Brahmanism and other esoteric cult practices (Conze, *Remarks on a Pala manuscript*, 5–12).
2. Buddhist female deities were created in response to the competition with other religious systems such as Brahmanism. For a discussion of the book cult, see Schopen, *Figments and fragments*, 147–181, and Kim, *Unorthodox Practice*, chapter 5.
3. The defeat of the Pala dynasty in the mid-twelfth century by neighboring Sena rulers, and in turn the rapid collapse of the kingdom to Muslim Islamic forces, collapsed the monastic establishments responsible for the production of Buddhist manuscripts. Combination of aggressive Islamic campaigns coupled with expanding populist embrace of Hinduism broke the Buddhist hold on Eastern India, the last stronghold; monks sought refuge in Nepal and Tibet and took their portable sacred texts with them as well as other small relics and accoutrements. The eleventh-century invasions by Islamic Muslims into India is beyond the scope of this paper, but see Paul, *The Early History of Bengal*, 33, for an historical account.
4. Diodorus Siculus relates that judges in ancient times in Syracuse were accustomed to writing exile sentences on the leaves of olive trees (Pliny, *Natural History*, 69).
5. For an in-depth investigation into the types and identification of various palm leaves used in the manufacture of these types of manuscripts see Freeman, *Turning over old leaves*, 99–102.
6. Fibers were collected from a fragment of binding cord clinging to one of the binding holes of a single leaf, TMMMA object 1986.25.4. The sample was dampened with water on a microscope slide to tease apart the fibers and then was examined with a stereobinocular microscope to evaluate the general composition of the fiber. Examined both dampened and after drying and staining with Graff C-stain, the sample was analyzed under 100–400 times magnification and determined to consist of bast fibers, resembling hemp (Graff, *Color atlas*).
7. In Burma and Sinhalese, scribes would employ an iron stylus or some sharp-pointed instrument to scratch the letters. The nature of the material compelled them to avoid long, straight lines because any scratch along the longitudinal fiber (running from stalk to point) would split the leaf. Perhaps this characteristic treatment of writing on this particular plant can be in part responsible for the rise or development of the distinct curvilinear shapes in the Burmese rounded hand script. In order to make the writing or decoration clear and legible in the inscribed leaf, ink prepared from lampblack and oil was rubbed over the surface of the leaf, filling up the finely incised lines to make the writing visible and relatively permanent. Cloth pads were used to smear on

and wipe off the black flame carbon soot mixed with wood oil that fills in the inscribed characters. Fine sand or rice bran is cited to have been used to assist in wiping off the soot and resin from the top surface without disrupting the ink now sitting in the troughs of incised lines.

8. The preclassical form of Sanskrit is known as Vedic Sanskrit, with the language of the Rigveda being the oldest and most archaic stage preserved. Its oldest core dates back to as early as 1500 BCE, qualifying Rigvedic Sanskrit as one of the oldest attestations of any Indo-Iranian language, and one of the earliest attested members of the Indo-European language family (Maurer, *Sanskrit language*).

9. Micro-samples were acquired and analyzed through polarizing light microscopy (PLM) as well as through non-destructive x-ray fluorescence (XRF). XRF spectroscopy was carried out by the author using a Bruker ARTAX open-beam ED-XRF unit, at a kVof 50 and 500 μ A through air, using no filter, with a live time of 100 seconds (Eastaugh et al., *Dictionary and optical microscopy of historic pigments* and *Dictionary of historic pigments*).

10. On the changing nature of the painting styles of India, see Guy, *Palm leaf and paper*, 14–17, and Bhattacharyya, *Notes on the techniques*. Filling in the color is said to make the picture blossom. The painting is compared to an opening flower as the image first burgeons forth as color is being applied to it; and in the likeness of the blossoming painting is also the moment of both shown and not shown, related to the paradoxical manifested state of things as they are in themselves.

11. The Salianski Kremer isinglass glue is made from the fresh air bladder of the sturgeon (species of origin: *Acipenseridae*). It does not include any equine, ruminant, swine, or avian species or their byproducts, and is of German origin. It is a byproduct of sturgeon farming for caviar production. The production, trade, and use of isinglass is not regulated by CITES.

12. Denaturation of proteins involves the disruption and possible destruction of both the secondary and tertiary structures. Since denaturation reactions are not strong enough to break the peptide bonds, the primary structure (sequence of amino acids) remains intact. Denaturation disrupts the normal alpha-helix and beta sheets in a protein and uncoils them into a random shape. Four types of bonding interactions between side chains are possible in tertiary structures: hydrogen bonding, salt bridges, disulfide bonds, and non-polar hydrophobic interactions. The most common observation in the denaturation process is the precipitation or coagulation of the protein. Two procedures in the preparation and use of protein-based consolidants that a conservator should be mindful of are: heat, which can disrupt hydrogen bonds and non-polar hydrophobic interactions; and alcohol, which will disrupt hydrogen bonding between amide groups in the secondary structure and side chains in the tertiary structure, increasing the risk of darkening upon aging. Therefore, use the lowest amount of heat necessary when dissolving solid proteins into solutions, and if alcohol is needed to break surface tensions, apply it before and always separately from the protein being employed in the procedure.

13. Alternative humidification techniques to this procedure could be pursued with a humidification chamber prepared in plastic photo trays with sheets of moistened capillary pads, placed underneath plastic egg crating onto which the object is placed on a piece of smooth polyester

web and covered with a sheet of Plexiglas. This seems like an acceptable means of humidification, but the most suitable is the Gore-Tex package as it keeps the substrate and the media layers from flexing and distorting too much. Finding the balance in the delicate treatment of vulnerable and sensitive objects often requires creativity, especially when dealing with limited resources and materials.

14. Judgments will also be formed from perspectives of timing, when to introduce areas to localized drying and pressing, reassessment, and evaluating the number of campaigns of consolidation necessary to achieve stability without inducing stresses or harm to the original.

15. HM-1 Tengucho from Hiromi Paper Inc is *tengucho* of the finest quality, the kozo fibers cooked with wood ash making the paper optimal for conservation use.

MATERIALS

Salianski Kremer Isinglass Glue

(Product Number 63110)

Kremer Pigments

247 West 29th Street

New York, NY 10001

<http://www.kremerpigments.com>

Tengucho Paper

(Product number HM-1)

Hiromi Paper Inc.

2525 Michigan Ave, Unit G-9

Santa Monica, CA 90404

<http://www.hiromipaper.com>

Surgical tools

Roboz Surgical Instrument Company, Inc.

PO Box 10710

Gaithersburg, MD 20898–0710

Fine Science Tools (USA) Inc.

373-G Vintage Park Drive

Foster City, CA 94404–1139

finescience.com

REFERENCES

- Agrawal, O.P. 1984. *Conservation of manuscripts and paintings of South-east Asia*. Boston: Butterworths and Co. (Publishers) Ltd.
- . 1981. Problems of preservation of palm-leaf manuscripts. *ICOM Committee for Conservation, 6th Triennial Meeting, Ottawa, September 21–25, 1981*, 1–7. Paris: International Council for Museums.
- Barrett, Douglas, and Basil Gray. 1963. *Painting of India*. Geneva: Skira.

- Batton, Susan Sayre. 2000. Separation anxiety: The conservation of a 5th century Buddhist Gandharan manuscript. *WAAS Newsletter* 22 (1): 15–17.
- Beck, Charles. 2005. *An introduction to plant structure and development: Plant anatomy for the twenty-first century*. Cambridge, MA: Cambridge University Press.
- Bhattacharyya, D.C. 1995. Notes on the techniques of Buddhist manuscript painting. In *Indian painting: Essays in honor of Karl J. Khandalavala*, 66–70. New Delhi: Lalit Kala Akademi.
- Chandrasekhar, K.V., and K.V. Rao. 1982. On Indian palm leaf manuscripts. In *Birla Archaeological and Cultural Institute: Contributions to archaeological chemistry*, Research Bulletin 4:1–10. Hyderabad: India.
- Conze, Edward. 2001. *The perfection of wisdom*. San Francisco: Grey Fox Press.
- . 1985. *The Large Sutra on Perfect Wisdom*. Berkeley: University of California Press, Center for South and Southeast Asia Studies.
- Conze, Edward. 1948–9. Remarks on a Pala manuscript in the Bodleian Library. *Oriental Art* 1: 5–12.
- Coomaraswamy, A.K. 1934. *The transformation of nature in art*. Cambridge: Harvard University Press.
- Crawford, John. 1867. On the invention of writing materials in reference to ethnology. *Transactions of the Ethnological Society*, vol. 5, 155–161. London: Royal Anthropological Institute of Great Britain and Ireland.
- Crowley, Alfred. 1969. Repair and conservation of palm-leaf manuscripts. *Restaurator* 1(2): 105–114.
- Das, J.P., and Joanna Williams. 1991. Palm leaf miniatures: The art of Raghunath Prusti of Orissa, India. New Delhi: Abhinav Publications.
- Dean, John F. 1999. Conservation of palm-leaf manuscripts. *Paper Conservation News* 89 (March): 10–11.
- . 1997. The preservation and conservation needs of the upper regions of Southeast Asia. *Libri* 47 (3): 124–138.
- Diringer, David. 1982. *The Book before printing: Ancient, medieval, and Oriental*. New York: Dover Publications, Inc.
- Eastaugh, Nicholas, Valentine Walsh, and Tracey Chaplin. 2008. *Pigment compendium: A dictionary and optical microscopy of historic pigments*. Oxford: Butterworth-Heinemann.
- . 2008. *Pigment compendium: A dictionary of historic pigments*. Oxford: Butterworth-Heinemann.
- Florian, Mary Lou, Dale P. Kronkright, and Ruth E. Norton. 1991. *The conservation of artifacts made from plant materials*. Los Angeles: Getty Trust, Getty Conservation Institute.
- Freeman, Rachel. 2005. Turning over old leaves: Palm leaves used in South Asian manuscripts. *Book and Paper Group Annual* 24: 99–102.
- Gilmartin, Philip M., ed. 2002. *Molecular plant biology*. New York: Oxford University Press.
- Graff, J.H. 1940. *Color atlas for fiber identification*. Appleton, WI: Institute of Paper Chemistry.
- Guy, John. 1982. *Palm leaf and paper: Illustrated manuscripts of India and Southeast Asia*. Melbourne: National Gallery of Victoria.
- Joshi, Binduvasini R. 1989. Preservation of palm-leaf manuscripts. In *Conservation of cultural property in India*, vol. 22, 120–127. New Delhi: Indian Association for the Study of Conservation of Cultural Property.
- Kern, Frank, D. 1947. *The essentials of plant biology*. New York: Harper Brothers.
- Kim, Sinah. 2007. *Unorthodox practice*. Berkeley, CA: University of California, Center for South and Southeast Asia Studies.
- Lawson, Peter. 1987. Palm leaf books and their conservation. *Library Conservation News* 16: 5–7.
- Leidy, Denise Patry. 2008. *The art of Buddhism: An introduction to its history and meaning*. Boston: Shambhala.
- . 1987. Palm leaf books and their conservation, part 2. *Library Conservation News* 17: 3–5.
- Losty, J.P. 1982. *The art of the book in India*. London: British Library Reference Division Publications.
- Maurer, Walter H. 1995. *The Sanskrit language: An introductory grammar and reader*. Richmond, Surrey, England: Curzon Press.
- Nair, M. Velayudhan. 1985. A new method for relaxing brittle palm-leaves. In *Conservation of cultural property in India*, vol. 18–20, 1–4. New Delhi: Indian Association for the Study of Conservation of Cultural Property.
- Nichols, Kimberly. 2004. An alternative approach to loss compensation in palm leaf manuscripts. *The Paper Conservator* 28: 105–9.
- Norstrand, Ove K. 1958. Some notes on procedures used in the Royal Library, Copenhagen, for the preservation of palm-leaf manuscripts. *Studies in Conservation* 3 (3): 135–40.
- Rao, V. Pandit, B. Naga Padma, and M.C. Gandrish. 1992. A study of Indian palm leaf manuscripts. In *Conservation of cultural property in India*, vol. 25, 20–24. New Delhi: Indian Association for the Study of Conservation of Cultural Property.
- Pal, Pratapaditya. *Indian painting*. 1993. Los Angeles: Los Angeles County Museum of Art.
- . 1988. *Buddhist book illuminations*. New York: Ravi Kumar Publishers.
- Paul, Pramode Lal. 1939. *The early history of Bengal: From the earliest times to the Muslim conquest*. Indian Research Institute Publications, Indian History Series, nos. 2–3. Calcutta: Indian Research Institute.
- Petukhova, Tatyana, and Stephen D. Bonadies. 1993. Sturgeon glue for painting consolidation in Russia. *JAIC* 32 (10): 23–31.
- Pliny. 1940. *Natural History*, vol. 3, book 8–11. Loeb Classical Library no. 353. 69. Cambridge: Harvard University Press.

- Purinton, Nancy, and Susan Filter. 1992. Gore-Tex: An introduction to the material and treatments. *Book and Paper Annual* 11: 141–155.
- Sah. Anumpam. 2003. *Indigenous methods and manuscript preservation*. New Delhi: National Mission for Manuscripts.
- . 2002. Palm leaf manuscripts of the world: Material, technology, and conservation. *Reviews in Conservation* 3: 15–24.
- Schopen, Gregory. 2005. *Figments and fragments of Mahayana Buddhism in India: More collected papers*. Honolulu: University of Hawai'i Press.
- Suryawanshi, D.G., P.M. Sinha, and O.P. Agrawal. 1994. Basic studies on the properties of palm leaves. *Restaurator* 15: 66.
- van Gulik, Robert. 2001. *Siddham: An essay on the history of Sanskrit studies in China and Japan*. Repr. New Delhi: Aditya Prakashan, International Academy of Indian Culture written at Nagpur.
- Veidlinger, Daniel. 2006. *Spreading the Dhamma: Writing, orality and textual transmission in Buddhist Northern Thailand*. Honolulu: University of Hawai'i Press.
- Wilson, Karen. 2000. *Monocots: Systematics and evolution*. Sydney: CSIRO Publishing.

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