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Emera Bridger Wilson

Syracuse University, elbridge@syr.edu

Jessica M. Rice

Syracuse University, jmrice@syr.edu

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Palm Leaf Manuscripts in South Asia

Emera Bridger Wilson and Jessica Rice

April 2019

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1. Introduction

In South and Southeast Asia, palm leaves were a popular and important material used for manuscripts and painting before the introduction of paper.^{1,2} A manuscript is often defined as a handwritten document versus one that is printed. The word is derived from the Latin — *manu* meaning by hand and *scriptus* meaning written.³ In this paper, we will discuss the historical and cultural significance of palm leaf manuscripts (PLMs), their physical structure and construction, current preservation challenges and approaches to conservation, and recent attempts to digitize PLMs in the Indian context. While this choice may seem very focused, the historical and cultural boundaries of PLMs are actually quite fluid, thus making our discussion of interest to those outside of South Asian studies as well. These manuscripts not only circulated widely during the time period in which they were created, but the geographic region discussed also encompasses a much wider cultural and geographic area than what we think of as India today.⁴ In terms of a cultural-historical region, “India” may also include areas which now fall in the contemporary nations of Afghanistan, Pakistan, Nepal, Bangladesh, Sri Lanka, and to some extent Tibet and Burma.⁵

¹ Suryawanshi, D. G., M. V. Nair, and P. M. Sinha. "Improving the Flexibility of Palm Leaf." *Restaurator* 13, no. 1 (1992): 37-46.

² Betsy Davids. "From Palm Leaf to Book: A South Asia Quest." *Printing History* 10, no. 10 (2011): 25-37.

³ Jyotshna Sahoo and Basudev Mohanty, "Digitization of Indian Manuscripts Heritage." *IFLA Journal* 41, no. 3 (Oct, 2015): 238.

⁴ Dominik Wujastyk, "Indian Manuscripts," in *Manuscript Cultures: Mapping the Field*, edited by Jorg Quenzer, Dmitry Bondarev, and Jan-Ulrich Sobisch, 159-81. Boston: DeGruyter, 2014.

⁵ Wujastyk, "Indian Manuscripts," 159.

Though there are no known dates for the first use of palm leaves as a writing surface, there is anecdotal evidence that it was quite early and that palm leaves were a common medium in different parts of the world. One of the earliest references to PLMs in South Asia is recorded in an early Pali Buddhist text from the 5th century BCE, which recorded various types of writing materials.⁶ In his treatise, *Naturalis Historia*, Pliny the Elder (23–79 CE) also documented the use of palm leaves for writing materials in Greece and Rome.⁷

The general purpose of the manuscripts was to maintain and spread knowledge, and for this use the palm leaf was a convenient medium. PLMs were “[s]mall, lightweight, and easily transportable objects...”⁸ Important texts were written and then recopied and circulated throughout South Asia, Central Asia, and Southeast Asia. A huge number of historic manuscripts are still extant (some estimates go as high as 30 million), but this constitutes a very small number of the manuscripts which might have once existed.⁹

As a writing medium, the PLMs are actually quite robust. PLMs “can last a millennium or more if treated well.”¹⁰ However, climate and use lead to deterioration. First, due to their organic nature, they are subject to decomposition. In hot, humid areas of South Asia, such as Southern India and Sri Lanka, they have a lifespan of approximately 400-500 years.¹¹ However, in Central Asia, PLMs have been more likely to survive for longer periods because of the low

⁶ Anupam Sah, “Palm Leaf Manuscripts of the World: Material, Technology and Conservation.” *Studies in Conservation* 47, no. Supplement-1 (Jun, 2002): 15-24, 16.

⁷ Yana Van Dyke, “Sacred Leaves: The Conservation and Exhibition of Early Buddhist Manuscripts on Palm Leaves.” *The Book and Paper Group Annual* 28, (2009): 83-97, note 4.

⁸ Van Dyke, “Sacred Leaves,” 85.

⁹ Wujastyk, “Indian Manuscripts,” 160.

¹⁰ Wujastyk, “Indian Manuscripts,” 161.

¹¹ P. Perumal, “The Sanskrit Manuscripts in Tamilnadu.” Chap. 8, in *Aspects of Manuscript Culture in South India*, edited by Saraju Rath, 157-172. Leiden: Brill, 2012, 159.

humidity and cooler temperatures.¹² Some of these texts were heavily used and would have sustained damage over time. These texts would therefore be re-copied, and then the damaged or degraded versions would be disposed of, usually by being burned or submerged in water out of reverence.¹³ Therefore, it is not surprising that the earliest versions of PLMs have been lost.

The use of PLMs peaked in early 19th century. In fact, most extant manuscripts can be dated from the early 19th century. There are more surviving manuscripts from the 1820s and 1830s than from any other time period.¹⁴ This is in part due to the fact that the adoption of paper and printing technologies was relatively slow in India. Handmade paper began to slowly replace palm leaves starting in the 18th century while the printing press, which was introduced in India by the Portuguese in the 16th century CE, did not become widely adopted until the late 19th century.¹⁵

There are still places in India today where people produce PLMs and they have become objects of interest to some Western scholars interested in the book arts.¹⁶ In Orissa, palm leaf manuscripts (primarily containing painted illustrations for sale to tourists) are being made using traditional methods but also using innovations such mechanical or screen printing and new structures such as stitched leaves and double-layered leaves that contain cutouts and flaps.¹⁷

¹² Jan Houben and Saraju Rath, "Manuscript Culture and Its Impact on "India": Contours and Parameters," in *Aspects of Manuscript Culture in South India*, edited by Saraju Rath, 1-53. Boston: Brill, 2012, 2.

¹³ Sah, "Palm Leaf Manuscripts of the World," 16 and John G. Samuel, "Preservation of Palm-Leaf Manuscripts in Tamil." *IFLA Journal* 20, no. 3 (Oct, 1994): 294-305, 296.

¹⁴ Wujastyk, "Indian Manuscripts," 161.

¹⁵ Perumal, "The Sanskrit Manuscripts in Tamilnadu," 161 and Houben and Rath, "Manuscript Culture and Its Impact on "India": Contours and Parameters," 41.

¹⁶ Davids, "From Palm Leaf to Book."

¹⁷ Davids, "From Palm Leaf to Book," 25 and Sah, "Palm Leaf Manuscripts," 17.

Historically, manuscripts were kept by teachers, kings and princes, and religious institutions, such as temples and monasteries.¹⁸ There were also large collections in the homes of Brahmins, members of the priestly caste who inherited these texts from their ancestors.¹⁹ Thus, PLMs have been kept in a diverse set of conditions which has ultimately impacted their survival and condition today. Today, South Asian PLMs can be found in libraries and museums both within the South Asia region and elsewhere, though many manuscripts are still privately kept in personal collections and at temples and monasteries.²⁰ This creates unique conservation, as well as ethical, challenges. As Sah points out, “Despite the fact that the manuscripts are sacred, hundreds if not thousands are lost each year due to the cumulative effects of neglect.”²¹ In the last ten to fifteen years, there has been an effort made by the Indian government to locate, document, and conserve PLMs across the country.²² There are also international efforts, such as the UNESCO Memories of the World project, which hope to preserve both the material culture of the PLMs and the cultural knowledge contained within.²³ For example, one project undertaken by the Endangered Archives Programme of the British Library was necessary because “the manuscripts kept in private repositories are dusty, brittle and are under the daily threat of damage due to lack of knowledge for preservation.”²⁴ In this

¹⁸ Sahoo, Jyotshna and Basudev Mohanty. "Digitization of Indian Manuscripts Heritage." *IFLA Journal* 41, no. 3 (Oct, 2015): 237-250. doi:10.1177/0340035215601447." 237.

¹⁹ Wujastyk, *Indian manuscripts*, 160.

²⁰ Sah, "Palm Leaf Manuscripts," 15.

²¹ Sah, "Palm Leaf Manuscripts," 15.

²² Sahoo and Mohanty, "Digitization of Indian Manuscripts Heritage," 239.

²³ UNESCO, Memory of the World Programme. "Memory of the World Register: Manuscript Holdings of French Research Institutions in Pondicherry. Ref number 2004-29.

²⁴ British Library. Preserving memory II-documentation and digitisation of palm leaf manuscripts from Kerala, India (EAP583).

project, “200,000 pages of palm leaf manuscripts from five districts in Northern Kerala, India” that contained information on “history, the sciences, mathematics, architecture, philosophy and scripture “were carefully cleaned before being archived digitally.”²⁵

2. Cultural Importance of Palm Leaf Manuscripts

Palm leaf manuscripts are an important part of the development of many aspects of South Asian cultural knowledge and religious practice.²⁶ In South Asia, around the first century BCE, there was a shift from passing down cultural knowledge orally to written accounts, first in stone, then on palm leaves, and finally on paper.^{27,28} Thus, for around two millennia, manuscripts, and particularly PLMs, were the main way that knowledge was transmitted.²⁹

The diversity embedded in PLMs is one reason why their preservation is so important. PLMs are composed in many languages and scripts which span the length and breadth of the subcontinent, and they cover a range of disparate topics.³⁰ PLMs were used to record and transmit knowledge of history, medicine, astrology, art, and culture.³¹ They were also used to record administrative information and other official information.³² In addition, some manuscripts were exquisite works of art.³³ However, their most important impact was in

²⁵ British Library, “Preserving memory II.”

²⁶ Sahoo and Mohanty, “Digitization of Indian Manuscripts Heritage.”

²⁷ Houben and Rath, “Manuscript Culture and Its Impact on ‘India’,” 43.

²⁸ Jyotshna Sahoo, Bismita Sahoo, Basudev Mohanty, and Nrusingh Kumar Dash. “Indian Manuscript Heritage and the Role of National Mission for Manuscripts.” *Library Philosophy and Practice (E-Journal)* (June 30, 2013).

²⁹ Houben and Rath, “Manuscript Culture and Its Impact on ‘India’.”

³⁰ Sahoo and Mohanty, “Digitization of Indian Manuscripts Heritage.” 243.

³¹ Perumal, “The Sanskrit Manuscripts in Tamilnadu,” 161-162.

³² Meher, Ramesh. “Tradition of Palm Leaf Manuscripts in Orissa.” *Orissa Review* (January, 2009): 43-46, 45.

³³ Sah, “Palm Leaf Manuscripts,” 15.

terms of the development and spread of the religious texts of three South Asian religious traditions—Hinduism, Jainism, and Buddhism. They were also influential in the spread of Hinduism and Buddhism to Southeast and East Asia as well.³⁴

In all three religious traditions, there was a practice of creating and preserving knowledge through study, teaching, and writing. The texts preserved in PLMs were “written, copied, multiplied and preserved” by priests, monks, and other scholars and kept at religious centers and temples.³⁵ In both Jainism and Buddhism, the written word in the form of manuscripts became ritually important. Therefore, these religious traditions are central to the story of the use of PLMs and their contemporary importance in South Asia.

Manuscripts have played a large role in Jain intellectual, religious, and community life in the Western Indian states of Gujarat and Rajasthan.³⁶ Those texts which were the most important in the daily lives of Jains were copied more often.³⁷ Many of the texts contain teachings of Mahavira, one of the main religious figures in the Jain faith. Commissioning manuscripts was a way of showing religious devotion and “... establishing places for them to be kept were among the duties expected of laity as part of their support for and devotion to the monastic community.”³⁸ Thus, libraries and archives became an important space within Jain communities. *Jnan bhandars*, or knowledge warehouses, were started as early as the 8th

³⁴ Van Dyke, “Sacred Leaves.” also: Gawlowicz, Susan. “Leaves of Gold Using digital imaging techniques, RIT scientists preserve an ancient Hindu text.” *RIT University News (Rochester Institute of Technology)*, May 2, 2007. also: Cort, John E. “The Jain Knowledge Warehouses: Traditional Libraries in India.” *Journal of the American Oriental Society* 115, no. 1 (Jan 1, 1995): 77-87.

³⁵ Perumal, “The Sanskrit Manuscripts in Tamilnadu,” 158.

³⁶ John E. Cort “The Jain Knowledge Warehouses: Traditional Libraries in India.” *Journal of the American Oriental Society* 115, no. 1 (Jan 1, 1995): 77

³⁷ Cort, “The Jain Knowledge Warehouses.”

³⁸ Cort, “The Jain Knowledge Warehouses,” 78.

century CE. These libraries were often in fact more like storage areas, with the manuscripts being stored in “small, dark, unventilated cellars, or in similar chambers above ground.”³⁹

These conditions often protected PLMs from damage because they were cool, dark, dry places.

Within Jainism there was (and continues to be) a widespread veneration of these texts in and of themselves. Once a year on a holiday known as *Jnan Panchami*, Jains go to the libraries “to worship both the knowledge contained in the manuscripts and the physical manuscripts themselves.”⁴⁰

PLMs were also central to the rise and spread of Buddhism, particularly Mahayana Buddhism. This was due in part to the veneration of books and manuscripts by certain communities of Buddhists, especially during the Pala period (8th-12th century CE).⁴¹ The *Aṣṭasāhasrikā Prajñāpāramitā* (the Perfection of Wisdom in 8000 Lines), is “one of the most important and earliest Mahayana texts” that was written down.⁴² During the Pala Empire, the status of the *Aṣṭasāhasrikā Prajñāpāramitā* “became so prominent that [manuscripts of the text] became objects of worship, featured among the ritual offerings.”^{43,44} Nearly all subsequent Mahayana Buddhist manuscripts cite this text, and this vast body of literature, commonly called the *Prajñāpāramitā*, deals with questions of the nature of reality.⁴⁵ Even

³⁹ Cort, “The Jain Knowledge Warehouses,”: 79.

⁴⁰ Cort, “The Jain Knowledge Warehouses,”: 87.

⁴¹ Van Dyke, “Sacred Leaves,” 83.

⁴² Wujastyk, “Indian Manuscripts.”also: Van Dyke, “Sacred Leaves,” 83.

⁴³ Jinah Kim “Emptiness on Palm Leaf: A Twelfth-century Illustrated Manuscript of the “*Aṣṭasāhasrikā Prajñāpāramitā*.” *Bulletin of the Detroit Institute of Arts* 82, no. 1/2 (2008): 76-91.

⁴⁴ Van Dyke, “Sacred Leaves,” 84.

⁴⁵ Van Dyke, “Sacred Leaves,” 83.

today, the public recitation and veneration of texts forms “an important part of Buddhist practice.”⁴⁶

Due to the importance and widespread worship of the *Aṣṭasāhasrikā Prajñāpāramitā*, there are many libraries and museums who hold manuscripts of this text or texts which reference it. The *Aṣṭasāhasrikā Prajñāpāramitā* held by Wellcome Library (London) dates to 1075 CE and is in excellent condition.⁴⁷ There is also a complete manuscript of this text in the Detroit Institute of Arts, which includes “249 folios written on both sides except on the recto of the first folio.”⁴⁸ According to the colophon, the manuscript was prepared around 1160 CE.⁴⁹ The Metropolitan Museum of Art in New York City has a set of PLMs that cite this text, but which also contain some of the earliest illustrations from the Pala period (1000-1200 CE).⁵⁰

Because of the cultural and religious significance of these texts, scholars, librarians, and conservationists have tried to find a way to bring these ancient texts forward into the 21st century, and to make them accessible to a wider audience, both within South Asia and beyond. Therefore, we will discuss the importance of digitization and on-line databases as a means of preserving the heritage contained within the PLMs as well as the material culture of the manuscripts themselves.⁵¹

In addition to technical issues, there are important ethical issues to consider about the conservation of palm leaf manuscripts. First, there is the fact that some PLMs are considered

⁴⁶ Van Dyke, “Sacred Leaves,” 84.

⁴⁷ Wujastyk, “Indian Manuscripts,” 161.

⁴⁸ Kim, “Emptiness on Palm Leaf,” 77.

⁴⁹ Kim, “Emptiness on Palm Leaf,” 77.

⁵⁰ Van Dyke, “Sacred Leaves,”

⁵¹ Van Dyke, “Sacred Leaves,” 85.

sacred items. For example, when professors from the Rochester Institute of Technology assessed and digitized 36 manuscripts at a monastery in India, the monks were the only people allowed to touch the “delicate and sacred leaves.”⁵² Professor Mukund explains that “scholars ... would take one leaf at a time and place it on the table to be photographed.”⁵³ According to Sharma et al., “[i]n some areas of India, it is believed that the palm leaf manuscript itself is the object of worship and the essence of the text is personified in the name of a God or Goddess.”⁵⁴ Florian describes the respect and care that must be taken with artifacts in general because they represent “documents of the aesthetics, beliefs, life styles, and technology of a people.”⁵⁵

Second, many PLMs were taken out of South Asia by colonial powers without permission or input from Hindu, Jain, or Buddhist communities. Many collections of palm leaf manuscripts are located in museums far from their original sources, including some manuscripts here in the United States. Although the concept is certainly controversial, some people would argue that any manuscripts taken under colonial rule should be restored to their owners’ descendants (property rights) or repatriated (cultural rights.)⁵⁶

Even digitization of palm leaf manuscripts, with the obvious benefits of virtual availability and protection of the originals, brings with it various concerns. Mallan and Park cite an essay by Walter Benjamin that argues “removing the work of art from its unique context

⁵² Jeanna Bryner. "Ancient Hindu text digitally preserved." NBC News. 9/19/2006.

⁵³ Bryner, “Ancient Hindu Text.”

⁵⁴ Sharma et al, “Chromatographic Study,” 250.

⁵⁵ Mary-Lou E. Florian, Dale Paul Kronkright, and Ruth E. Norton. *The Conservation of Artifacts made from Plant Materials*. Marian del Rey, Calif.: Getty Conservation Institute, 1990: 196.

⁵⁶ Piotr Bienkowski . "A Critique of Museum Restitution and Repatriation Practices." In *The International Handbooks of Museum Studies*, edited by Sharon Macdonald, and Helen Rees Leahy. Wiley, 2015

destroys its aura.”⁵⁷ Also, any intent to facilitate permanent retention of the original manuscripts certainly differs from a common Indian tradition that old palm leaf manuscripts are either thrown into a river or burnt once their intellectual contents have been copied onto fresh new leaves.⁵⁸ According to the British Library, “[u]ntil recently, consigning manuscripts into the sea or river on auspicious days was considered the best practice to preserve them, for avoiding the sin of witnessing their decay.”⁵⁹ Samuel writes that “[i]f no proper person is available for copying, the manuscripts were allowed to die a natural death.”⁶⁰ Bienkowski points out that in regards to physical objects, “conservation ‘in perpetuity’ is a cultural construct ...it is not a universal value shared by all.”⁶¹

Even further, institutions and persons with the power to select what is digitized can use that choice to “reinforce dominant master narratives of progress, nationalism, ethnic superiority, patriarchy or technological determinism...”⁶² Digitization of manuscripts may even be viewed by some as “a cynical replacement for repatriation, denying the necessity for a real return...”⁶³ Intentionally involving the communities with vested cultural interests may be one way of ameliorating the possible ethical concerns as digitization projects continue.

⁵⁷ Mallan and Park, “Is Digitization Sufficient,” 213, following Benjamin, Walter. 1934/1992. *The work of art in the age of mechanical reproduction*. Illuminations. Repr. London: Facet.

⁵⁸ Kumar et al, “Traditional writing system in Southern India,” 4.

⁵⁹ British Library, “Preserving memory II”

⁶⁰ John G. Samuel, "Preservation of Palm-Leaf Manuscripts in Tamil." *IFLA Journal* 20, no. 3 (Oct, 1994): 301.

⁶¹ Bienkowski, "A Critique of Museum Restitution and Repatriation Practices."

⁶² Mallan and Park, “Is Digitization Sufficient,” 214.

⁶³ Bienkowski, "A Critique of Museum Restitution and Repatriation Practices."

3. The physical structure, design, and construction of palm leaf manuscripts

Of the more than 2,400 species of palms distributed worldwide,⁶⁴ several species have been identified as commonly used in palm leaf manuscripts: *Borassus flabellifer* (palmyra palm), *Corypha umbraculifera* (talipot palm), *Corypha taliera*, and *Corypha utan*.⁶⁵ According to Cornell University Library, the most frequently used manuscript leaves come from the Palmyra and talipot palms⁶⁶ (see table 1). Leaves from the different species vary in color, flexibility, smoothness, strength, reaction to the passage of time, and susceptibility to insect attacks.⁶⁷ These leaf characteristics directly impact the manuscripts constructed with them. As Van Dyke points out,

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.⁶⁸

The palm leaves are usually harvested when young, preferably during the dry season, and require additional processing or "seasoning" before they can be used for manuscripts.⁶⁹ Partially opened younger leaf bundles were preferred as potential writing supports.⁷⁰ The exact

⁶⁴ Wolf L. Eiserhardt, Jens-Christian Svenning, W. Daniel Kissling, and Henrik Balslev. "Geographical Ecology of the Palms (Arecaceae): Determinants of Diversity and Distributions Across Spatial Scales." *Annals of Botany* 108, no. 8 (Dec 1, 2011): 1392.

⁶⁵ Rachel Freeman, "Turning Over Old Leaves: Palm Leaves used in South Asian Manuscripts." *The Book and Paper Group Annual* 24, (2005):99.

⁶⁶ Cornell University Library. "Palm Leaf Manuscripts " Cornell University Library.

⁶⁷ D. Udaya Kumar, , G. V. Sreekumar, and U. A. Athvankar. "Traditional Writing System in Southern India - Palm Leaf Manuscripts." *Design Thoughts* (July, 2009):2.

⁶⁸ Van Dyke, "Sacred Leaves," 85.

⁶⁹ Sah, "Palm Leaf Manuscripts," 17; Davids, "From Palm Leaf," 28.

⁷⁰ Kumar, et al. "Traditional writing system in Southern India," 3

seasoning process used varies according to the leaf type and local custom, but can include: boiling in water, milk, or other liquids, heating in kilns, smoke treatment, air drying, burial in mud, sand or wet rice straw, sanding, rubbing or burnishing, and treating leaves with spices such as turmeric or oils such as sesame seed oil.⁷¹

Table 1. Palm species identified as used in the preparation of manuscripts

Scientific name	Common name(s)	Notes
<i>Borassus flabellifer</i>	Palmyra (Palmyrah) palm ^a ; Toddy palm, Wine palm ^g	Thick, fairly flexible leaves ^d , become brittle with time ^b ; slightly waxy ^e Usually incised writing, does not take surface writing (ink or paint) well ^e Large distribution (sub-tropical, tropical); widely cultivated ^a
<i>Corypha taliera</i>	n/a	Leaves brownish with black spines, thick, not flexible ^d Extinct in the wild; only a tiny number of cultivated specimens remain ^h
<i>Corypha umbraculifera</i>	Talipot palm ^f ; Fan palm ^d Sritala ^l	Light color ^d ; thin, flexible, durable for centuries ^b ; leaves up to 16 feet across ^f ; takes surface writing (ink or paint) well ^e . India, Sri Lanka, introduced in other parts of Southeast Asia ⁱ
<i>Corypha utan</i>	Gebang palm, Buri palm ^c	Takes surface writing (ink or paint) well ^k Southeast Asia, Australia ⁱ

Sources for Table 1: a. Palmweb, “*Borassus*” 28. b. Cornell Univ. Library, “Palm Leaf Manuscripts.” c. CABI, “*Corypha utan*.” d. Kumar et al, 2. e. Sah, 18. f. Columbia Encyclopedia, “palm.” g. CABI, “*Borassus flabellifer*.” h. Johnson, “*Corypha taliera*.” i. Loftus, “*Corypha Utan*.” j. Plants of the World Online, “*Corypha umbraculifera*.” k. Gunawan, “Nipah or Gebang,” 268. l. Perumal, “Sanskrit Manuscripts,” 159.

⁷¹ Sah, “Palm Leaf Manuscripts,” 17; Van Dyke, “Sacred Leaves,” 86.; Schuyler, “Notes on the Making of Palm Leaf Manuscripts,” 282; Perumal, “The Sanskrit Manuscripts,” 160. In various articles, sesame seed oil is referred to as gingili or til oil.

When the leaves are ready after the initial processing, they are cut to size and, if not done previously, the leaf midribs are usually removed.⁷² Sometimes, the central rib is retained, the leaf is folded, and only the outside of the leaf is used to write on.⁷³ While palm leaf manuscripts can vary in length, from just a few inches to as long as 45 inches,⁷⁴ a more typical size might be approximately two feet long by about 3 inches wide.⁷⁵ Usually the manuscripts are rectangular, echoing the shape of the cut leaves, but occasionally palm leaf manuscripts are made into more ornate shapes such as “fish, animals and daggers.”⁷⁶ The trimmed leaves are collected into rolls or flat bundles of just a few to as many as hundreds of leaves,⁷⁷ and may be placed between covers, typically made of wood.⁷⁸ One to three holes are made in the leaves and cover, so cords may pass through and be tied around the manuscript to secure the contents.^{79, 80} Small leaves might have just one hole in the center, but more typical are longer leaves with holes at either end.⁸¹ A less common format is a fan-shaped manuscript, with a pin (sometimes made of metal) securing the leaves at one end.⁸² Perumal noted that “if the [manuscript] has more than ca. 200 leaves, the thread cannot hold the leaves, or it will cause

⁷² Kumar et al., “Traditional Writing,” 3

⁷³ Davis, T. A. and Dennis V. Johnson. "Current Utilization and further Development of the Palmyra Palm (*Borassus Flabellifer* L., *Arecaceae*) in Tamil Nadu State, India." *Economic Botany* 41, no. 2 (April - June, 1987): 250

⁷⁴ "Digitization Project Saves Saiva Agamas." *Hinduism Today*, July 2011, 53-54

⁷⁵ Van Dyke, ""Sacred Leaves," 86

⁷⁶ Sah, "Palm Leaf Manuscripts," 16

⁷⁷ Perumal, "Sanskrit Manuscripts," 161; Sah, "Palm Leaf Manuscripts," 17

⁷⁸ Sah, "Palm Leaf Manuscripts," 15

⁷⁹ Kumar et al, "Traditional Writing system," 3. Sah, "Palm Leaf Manuscript," 18 also notes that sometimes bamboo pins or plugs were used to hold the leaves together.

⁸⁰ Davids, "From Palm Leaf to Book," 26.

⁸¹ W. Norman Brown . "Pennsylvania's "Home of Saravati"." *University of Pennsylvania Library Chronicle* 2, no. 2 (1934): 19

⁸² Davis, "Current Utilization and further Development of the Palmyra Palm," p. 250

damage to the holes in the leaves. In this case a small copper rod or a bamboo strip was pierced into the other hole of the [manuscript]"⁸³ This manuscript arrangement may have be a regional practice as only Perumal described this particular method of fastening the leaves together.

The covers, especially those placed on religious texts used in temples or monasteries, sometimes have elaborate colorful painted illustrations,⁸⁴ and might even be inlaid with ivory or mother-of-pearl.⁸⁵ Once completed, the manuscripts were usually wrapped in cloth, and sometimes also enclosed in protective wooden cases.⁸⁶ The outer cloth wrappings were traditionally red or yellow, colors that were believed to repel worms and insects.⁸⁷ As a side note, manuscripts of other materials that echo the structure of those made from actual palm leaves have also been found in India, although they are beyond the scope of this paper. These alternative "leaves" were made from "gold, silver, or gilded copper," and even ivory plates.⁸⁸

The method of writing and illustrating palm leaf manuscripts depends on the species of palm leaf used as a base. As Van Dyke explains, "[p]alm leaves have traditionally been written upon in two ways: either the text has been incised into the surface or written on the surface."⁸⁹ Talipot leaves, the base material used for the earliest surviving Indian palm leaf manuscripts, usually have ink or paint pigment placed on the surface.^{90, 91} The ink used for the script has various constituents that vary regionally, but most often contains lampblack, water, and a

⁸³ Perumal, "Sanskrit Manuscripts," 161

⁸⁴ Van Dyke, "Sacred Leaves," 83

⁸⁵ Kumar et al., "Traditional Writing System," 3 and Sah, Palm Leaf Manuscripts," 18

⁸⁶ Van Dyke, "Sacred Leaves," 87

⁸⁷ Perumal, "Sanskrit Manuscripts," 161

⁸⁸ Cyril Davenport. *The Book: Its History and Development*. London: Archibald Constable & Co. LTD., 1907:15

⁸⁹ Van Dyke, "Sacred Leaves," 87

⁹⁰ Sah, "Palm Leaf Manuscripts," 18

⁹¹ Kumar et al, "Traditional Writing System," 2

binder such as "...plant-based adhesives like starch paste or wood apple gum..."⁹² Sah mentions that in India, "[c]ommon binders are gum acacia or [sesame] oil."⁹³ Other ink sources include: black thorn apple juice⁹⁴ or bean leaves "mixed with charcoal..., [sesame] oil and turmeric."⁹⁵ Additional oils put into the ink, selected for their insecticidal properties might include: "camphor, citronella, castor, lemongrass, cedarwood, mustard, neem, eucalyptus, clove, and sesame."⁹⁶ The ink would most likely have been applied using a reed pen or brush, with fairly ample and precise spaces left around the binding holes.⁹⁷ Since the edges of the leaves are subject to wear, "[s]cribes...often left large margins, so even after hundreds of years the text area of the manuscript remained intact."⁹⁸ Illustrations were painted or drawn with colorful plant or mineral pigments that Van Dyke and Meher identify as including: black (flame carbon), blue (indigo), yellow (orpiment/turmeric), red (vermillion/cinnabar); and white (calcium carbonate/conch shell powder.)⁹⁹ Tints, shades, and other colors were mixed from this foundational palette.¹⁰⁰

Palmyra (*Borassus flabellifer*) leaves, on the other hand, were incised using a metal stylus and then lampblack or another pigment was rubbed into the grooves formed in the leaf

⁹² Deepakshi Sharma, Manager Rajdeo Singh, and Bhushan Dighe. "Chromatographic Study on Traditional Natural Preservatives used for Palm Leaf Manuscripts in India." *Restaurator. International Journal for the Preservation of Library and Archival Material* 39, no. 4 (Dec 19, 2018): 251

⁹³ Sah, "Palm Leaf Manuscripts," 18

⁹⁴ Sah, "Palm Leaf Manuscripts," 18

⁹⁵ Davids, "From Palm Leaf to Book," 33

⁹⁶ Cornell University Library, "Palm Leaf Manuscripts"

⁹⁷ Van Dyke, "Sacred Leaves," 87

⁹⁸ Wujastyk, "Indian Manuscripts," 161

⁹⁹ Van Dyke, "Sacred Leaves," 88 and Meher, "Tradition of Palm Leaf Manuscripts," 44

¹⁰⁰ Van Dyke, "Sacred Leaves," 88

to make the script visible.¹⁰¹ Styli could also be made of bone or ivory.¹⁰² Leaf scribing requires much manual dexterity and skill to avoid puncturing or tearing the leaves.¹⁰³ The physical characteristics of the leaves also dictated in some part the choice and appearance of the text and illustrations. For example, manuscripts “in Devanagari script, which required horizontal strokes, were usually surface written,” while more rounded scripts could more easily be incised.¹⁰⁴

4. Conservation and preservation of palm leaf manuscripts

The largest collections of palm leaf manuscripts worldwide can hold “tens of thousands of bundles, with each bundle containing hundreds of folios.”¹⁰⁵ However, as Nichols points out, Western collections are typically much smaller, and the manuscripts may be “infrequently requested for exhibition or study. This can impact how routinely their condition is assessed and limit the contact that a conservator may have with the material.”¹⁰⁶ However, as natural organic materials, among the many circumstances that can impact the condition of these manuscripts are “chemical, physical, and biological degradation.”¹⁰⁷ All these issues must be

¹⁰¹ Meher, “Tradition of Palm Leaf Manuscripts,” 44

¹⁰² Perimal, “Sanskrit Manuscripts,” 160

¹⁰³ Meher, “Tradition of Palm Leaf Manuscripts,” 44

¹⁰⁴ Sah, “Palm Leaf Manuscripts,” 17 and Van Dyke, “Sacred Leaves,” 94 (note 7)

¹⁰⁵ Sah, “Palm Leaf Manuscripts,” 15.

¹⁰⁶ Kimberly Nichols, “An Alternative Approach to Loss Compensation in Palm Leaf Manuscripts.” *The Paper Conservator* 28, no. 1 (2004): 105.

¹⁰⁷ Nichols, “An Alternative Approach to loss Compensation,” 105.

considered, according to the American Institute for Conservation, during the examination, preventive conservation, treatment, and documentation of these cultural heritage materials.¹⁰⁸

While digitization of palm leaf manuscripts is one approach to preserving the centuries of accumulated knowledge they contain, international efforts to slow or halt the physical deterioration of manuscripts are a required prerequisite to digitization projects. At several hundred years, the lifespan of a well-treated palm leaf manuscript is potentially much longer than any modern computer format.¹⁰⁹ For example, Van Dyke describes an effort by the Metropolitan Museum of Art to stabilize a collection of illustrated Buddhist manuscripts that “are truly rare keystones and fundamental sources in the understanding of the development of Indian painting.”¹¹⁰ These particular manuscripts happen to be one thousand years old.¹¹¹

Major challenges to longevity of palm leaf manuscripts that have been identified include insect attacks by “*Gastrallus indicus* [Indian bookworm beetle], termites, silverfish, bookworms and cockroaches.”¹¹² Insect larvae can perforate and rapidly destroy manuscripts.¹¹³ Rodents may also damage palm leaf manuscripts.¹¹⁴ Dehydration and brittleness, “especially around the edges that have been most exposed to oxidation processes,”¹¹⁵ as well as repetitive handling may lead to “[f]raying, delamination, and splitting of the structure ...around the binding holes

¹⁰⁸ “Code of Ethics and Guidelines for Practice,” American Institute for Conservation.

¹⁰⁹ Gawlowicz, “Leaves of Gold,” 8. This article describes a digitization project that hopes to eventually etch the contents of a 700 year-old palm leaf manuscript onto fire and waterproof silicon wafers that need only magnification to be read.

¹¹⁰ Van Dyke, “Sacred Leaves,” 83.

¹¹¹ Van Dyke, “Sacred Leaves,” 83.

¹¹² Sah, “Palm Leaf Manuscripts,” 19.

¹¹³ UNESCO, “Memory of the World.”

¹¹⁴ Cornell University Library, “Palm Leaf Manuscripts.”

¹¹⁵ Van Dyke, “Sacred Leaves,” 90.

and from the edges.”¹¹⁶ The parallel venation of palm leaves, along with “[h]ydrolysis and oxidation of cellulose in the plant matrix can contribute to horizontal breaks.”¹¹⁷ Fluctuations in temperature and humidity contribute to deterioration by causing material deformations.¹¹⁸ Other factors that may potentially impact palm leaf manuscripts include fungal attack, photo-degradation of hemicelluloses and lignin, particulate air pollution, ozone, oils or chemicals applied during conservation treatments, fading of inks and paint pigments, and poor storage practices.¹¹⁹

Following sections of this paper will address treatment considerations for just some of these issues. However, in some cases the proper conservation approach may well be to do nothing at all. Norton points out that “[s]ome procedures, such as cleaning, are by nature irreversible, and their application must be fully considered so that irrevocable damage to the artifact and loss of its aesthetic and documentary integrity does not occur.”¹²⁰ For example, the conservators of illustrated palm leaf manuscripts being prepared for an exhibition at the Metropolitan Museum of Art

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...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...Most surface accretions were left alone and respected as evidence of their use and history.¹²¹

¹¹⁶ Van Dyke, “Sacred Leaves,” 88.

¹¹⁷ Nichols, “An Alternative Approach,” 105.

¹¹⁸ Florian et al, “Conservation of artifacts,” 149.

¹¹⁹ Florian et al, “Conservation of artifacts,” 157, 173-174, 176; Sah, “Palm Leaf Manuscripts,” 20; Crowley, “Repair and Conservation,” 105.

¹²⁰ Norton, in Florian et al, “Conservation of artifacts,” 209.

¹²¹ Van Dyke, “Sacred Leaves,” 92.

In addition, some treatments may assist with one problem but simultaneously exacerbate another. A 2014 article about palm leaf manuscripts at Kerala University describes how the staff maintain the collection “with a mixture of lemon-grass oil, isopropane and, in some cases, carbon powder to make the letters visible.”¹²² However, too-frequent application of such oils to palm leaf manuscripts can cause the leaves to stick together in blocks.¹²³ In another case, researchers from the Rochester Institute of Technology found that a 700 hundred year old Hindu text had been damaged when “...a misguided effort to preserve the manuscript with oil ... turned the palm leaves dark brown, obscuring the Sanskrit text...”¹²⁴

While certainly not an exhaustive treatment, the following describes some common concerns and current thinking about the conservation of palm leaf manuscripts. For example, conservators in India and other parts of the world are rediscovering traditional methods of protecting manuscripts, instead of potentially toxic synthetic pesticides, and using innovative materials such as mulberry bark for loss compensation.

Fungal attacks

Mold is a very common issue for palm leaf manuscripts located in warm and humid environments. For example, a recent study of manuscripts in the National Library of Sri Lanka showed that of the 47,250 leaves sampled, more than 75% had evidence (stains) from fungal

¹²² "A Treasure Trove of Palmleaf Manuscripts." *New Indian Express*. Although the specific word in this article reads “isopropane,” it seems possible that the substance is actually isopropanol, which is mentioned in other articles, such as Sah, “Palm leaf manuscripts of the world” as being used in conservation.

¹²³ Bryner, “Ancient Hindu Text.”

¹²⁴ Gawlowicz, Susan. “Leaves of Gold,” 8.

activity.¹²⁵ Even artifacts now held in cooler and more consistent environmental conditions may suffer from previous exposure; a palm leaf manuscript observed in Syracuse University Libraries' conservation lab showed possible signs of a dormant fungal problem, with small light spots along the surface of the leaves. Airborne mold spores are ubiquitous; one study found numerous fungal species in samples "isolated from art objects such as sculptures, wall paintings, manuscripts and other objects of historical importance from museums, palaces, historical sites and various places in India."¹²⁶ Sharma explains that besides "dust, an indirect source of fungus is the adhesive used in the Palm leaf manuscripts."¹²⁷ Paste used in conservation repair may provide a growth medium for fungus, and an article from the 1950s describes adding formalin (formaldehyde and methyl alcohol) to starch paste specifically as a fungicide.¹²⁸

Concerns about the safety, cost, and potential damage to manuscripts from the use of modern fungicidal chemicals has led to a re-examination of traditional methods for protecting palm leaves.¹²⁹ In a study that compared camphor oil to neem, castor, and citronella oils for potential use in the protective coating of Palmyra palm (*Borassus flabellifer*) leaves in various craft products, the authors found that citronella and camphor oils inhibited fungal growth, with

¹²⁵ L.M. Udaya Prasad Cabral, Muthurajah Norman Ravikumar, and Thankavadiivel Ramanan. "Developing a Strategic Program for Safeguarding Palm-Leaf Manuscripts in Sri Lanka." Kuala Lumpur, Malaysia, IFLA WLIC, August 24-30, 2018, 3.

¹²⁶ Cabral, "Developing a Strategic Program," 272.

¹²⁷ Sharma, "Documenting and Preserving the Endangered Archives," 8.

¹²⁸ Nordstrand, "Some Notes on Procedures used in the Royal Library," p. 139, note 13.

¹²⁹ Deepakshi Sharma. "Documenting and Preserving the Endangered Archives: Palm Leaf Manuscripts of Kerala, India." In Proceedings of the Papers Presented at the 2015 CIDOC conference: Documenting Diversity—Collections, Catalogues & Context, Comité International pour la Documentation, International Committee for Documentation, p.1–10. New Delhi, India, 2015:9.

differential effects dependent on fungal species.¹³⁰ Camphor oil may be one of the best essential oils used for the preservation of palm leaves, at least regarding fungus attacks, because the oil shows “significantly higher broad-spectrum of anti-fungal activity... [with the] highest percentage of growth inhibition at the lowest inhibitory concentration.”¹³¹ The “low toxicity for people and environment...and low risk for resistance development by pathogenic microorganisms” found in camphor and other essential oils make them attractive alternatives to synthetic chemicals.¹³²

Turmeric has been applied to palm leaves as part of the seasoning process “since ancient times.”¹³³ Turmeric “is reported to be effective...” against numerous strains of bacteria as well as “pathogenic molds and commonly occurring fungi.”¹³⁴ In an interesting study by Kharbade et al, fungal strains taken from manuscripts and other important historical and art objects in India were cultured and identified. The active ingredient in turmeric, curcumin, was extracted and combined with various metallic salts. Finally, non-staining cloth and paper materials, that could potentially be used to wrap manuscripts, were prepared and tested against the fungi. The authors concluded that curcumin complexes in concentrations higher than 100 ppm “are broadly effective against all 14 commonly occurring fungi in art objects”¹³⁵

¹³⁰ Subajini Mahilrajan, Jeyarani Nandakumar, Robika Kailayalingam, Nilushiny Aloysius Manoharan, and SriThayalan SriVijeindran. "Screening the Antifungal Activity of Essential Oils Against Decay Fungi from Palmyrah Leaf Handicrafts." *Biological Research* 47, no. 1 (2014): 2.

¹³¹ Mahilrajan et al, “Screening the antifungal activity,” 1.

¹³² Mahilrajan et al, “Screening the antifungal activity,” 2-3.

¹³³ B. V. Kharbade, Shirish Rajmalwar, and R.C. Manjunathachari. "The use of turmeric, a traditional Indian material, in the preservation of old manuscripts." Paper presented at the ICOM-CC 15th Triennial Conference in New Delhi, India. 22 to 26 September 2008: 270.

¹³⁴ Kharbade et al, “The use of turmeric,” 270.

¹³⁵ Kharbade et al, “The use of turmeric,” 274.

and that “cloth and paper impregnated with evaluated curcumin complexes may be applied directly to preservation of manuscripts.”¹³⁶

Insect or other animal activity

As previously mentioned, there are a large number of insects and other pests that can cause problems in palm leaf manuscripts. Rodents seem to only occasionally be a problem today, especially in larger institutional collections, although Cort described one researcher’s unfortunate visit to a Jain manuscript library in 1886:

The first thing to catch my eye was a square piece of white cloth extended over the roof exactly above the place where I was to sit. I might have thought it a canopy of honour, had not its real purpose been soon apparent. That part of the roof, and every part of the roof, was covered without an interstice, with bats, hanging down from the rafters, and fastening-so it seemed at least-all their myriad eyes upon me.¹³⁷

Damage from smaller pests such as insects are much more concerning and can be extensive in some collections; a very recent study at the National Library of Sri Lanka showed that almost one third of their palm leaf manuscripts had “holes/insects attacks.”¹³⁸ Indicators of insect attacks include “the presence of neat, pinhead-sized holes, irregularly eaten edges, [or] the presence of larvae which eat the leafy matter...”¹³⁹ The insects can come from the environment surrounding the manuscripts, but “at times the wooden cover boards themselves could be the source of insect infestation.”¹⁴⁰

¹³⁶ Kharbade et al, “The use of turmeric,” 275.

¹³⁷ Cort, “The Jain Knowledge Warehouses,” 80.

¹³⁸ Cabral, “Developing a Strategic Program,” 3.

¹³⁹ Sah, “Palm Leaf Manuscripts of the World. 19.

¹⁴⁰ Sah, “Palm Leaf Manuscripts of the World. 19.

White ants were specifically mentioned by Samuel as being an insect that might infest palm leaf manuscripts, and his article says that chemicals applied in fumigation chambers have been used as a means of treatment.¹⁴¹ Both Sah and Sharma write about *Gastrallus indicus*, a “tiny insect that eats its way through bundles of manuscripts.”¹⁴² Insects such as cockroaches and silverfish may be attracted other materials within palm leaf manuscripts, such as ink binders and even paste used in conservation repairs.¹⁴³ As Nordstrand explained, “[v]arious insects show an interest in paste as in other starch products and moulds ... A strong and permanent insecticide therefore should be admixed in the paste, with proper attention to the fact that certain chemicals (for instance formaldehyde), tend to reduce the adhesive properties of the paste.”¹⁴⁴ Other chemicals mentioned for use in the treatment of palm leaf manuscripts include “phosgene gas, paradichlorobenzene, and naphthalene” as well as “kerosene oil and liberal use of turpentine ... to remove and prevent worms and insects from boring holes into manuscripts.”^{145 146} However, as is the case with potentially toxic fungicides, the use of such insecticides is being reconsidered.¹⁴⁷ As Sah points out, the “indiscriminate use in Asian collections of carbon disulphide (CS₂), gammaxene and DDT – insecticides banned in most countries – must be looked into and taken seriously.”¹⁴⁸

¹⁴¹ Samuel, "Preservation of Palm-Leaf Manuscripts in Tamil," p. 301

¹⁴² Sharma, "Documenting and Preserving the Endangered Archives," 7, and Sah, "Palm Leaf Manuscripts," 19.

¹⁴³ Ove K. Nordstrand . "Some Notes on Procedures used in the Royal Library, Copenhagen, for the Preservation of Palm- Leaf Manuscripts." *Studies in Conservation* 3, no. 3 (1958): 140, note 17.

¹⁴⁴ Nordstrand, Ove K. "Some Notes on Procedures used in the Royal Library," 139.

¹⁴⁵ Sharma et al, "Chromatographic Study on Traditional Natural Preservatives," p. 260.

¹⁴⁶ Sah, "Palm Leaf Manuscripts of the World. 20.

¹⁴⁷ Sharma et al, "Chromatographic Study on Traditional Natural Preservatives," p. 252.

¹⁴⁸ Sah, "Palm Leaf Manuscripts of the World. 20.

In some areas of India, the household's manuscripts were traditionally "stored in kitchen lofts where smoke kept insects away; and the boards between which the folios were stored were often made of a hardwood with insect resistant properties, such as that of the Neem tree."¹⁴⁹ Other traditional methods to prevent insect damage include keeping "a variety of insect repellent oils and herbs with the manuscripts. For example, "The bark, leaves, seeds and wood of Margosa, the Neem tree (*Azadirachta indica*) have been used in India for millennia for their ... insecticidal properties which are attributed to phenolic compounds and to the active ingredient azadirachtin."¹⁵⁰ Somewhat alarmingly from a health standpoint, Cort indicates that "[t]o protect the manuscripts from insects, they were sometimes stored with chips of fragrant wood, and sometimes dusted with red arsenic."¹⁵¹

Sharma et al used chromatography to learn about traditional preservatives used in India to protect palm leaf manuscripts from insects and fungi. They identified a number of materials that were applied for their insecticidal properties, including: oils (camphor, cedar wood, citronella, clove, neem, sandalwood), and herbs or other plants (ajvain, datura, nirgudi, sweet flag/calamus, turmeric). The authors concluded that "plant extracts played an important role in protecting the palm leaf manuscripts under study," but suggest that further research into the effectiveness of the various materials is needed.¹⁵²

¹⁴⁹ Sah, "Palm Leaf Manuscripts of the World," 19.

¹⁵⁰ Sah, "Palm Leaf Manuscripts of the World," 19.

¹⁵¹ Cort., "The Jain Knowledge Warehouses," 80.

¹⁵² Sharma et al, "Chromatographic Study on Traditional Natural Preservatives," p. 260.

Brittleness and Adhesion of Folios

Brittleness and loss of flexibility were mentioned as common problems in palm leaf manuscript, leading to an increased potential for damage when leaves were handled.¹⁵³ As Van Dyke noted, "... aged palm leaf can be very desiccated and brittle, especially around the edges that have been most exposed to oxidation processes."¹⁵⁴ Although in many institutions treatment with various oils such as lemongrass oil is currently done to reduce the brittleness of palm leaves, the application of oil can lead to its own problems.¹⁵⁵ Sharma notes that in a collection in the State Archives, Thiruvanthapuram, Kerala, "frequent use of Citronella or camphor oil on the palm leaf from time to time has resulted in discolouration and accumulation of dust and dirt. It was also found to have a sticky surface due to the frequent use of oil."¹⁵⁶ Another conservation practice had been to brush "glycerine or diethyl glycol ... on leaves to render them flexible but as the glycerine evaporated the leaves reverted to their brittle condition."¹⁵⁷

The Metropolitan Museum of Art in New York used vapor humidification when preparing desiccated palm leaves for exhibition. Van Dyke described the process which involved the use of "a Gore-Tex humidification package" that provided "many benefits: reducing distortions, relaxing creases, achieving original planarity, increasing suppleness to the

¹⁵³ "A Treasure Trove of Palmleaf Manuscripts" is just one example from the sources we looked at. This 2014 newspaper article describes Kerala University's collection of brittle "palm-leaf manuscripts, some of them in very real danger of crumbling at a touch."

¹⁵⁴ Van Dyke, "Sacred Leaves," 90.

¹⁵⁵ "A Treasure Trove of Palmleaf Manuscripts."

¹⁵⁶ Sharma, "Documenting and Preserving the Endangered Archives," 6.

¹⁵⁷ Sah, "Palm Leaf manuscripts of the world," 20.

leaf, and maintaining planarity between the support and the slightly sensitive media layer while the reintroduction of moisture content takes place.”¹⁵⁸

However the director of the Orissa Art Conservation Centre at Bhubaneswar, who trains others in the care of palm leaf manuscripts, stated that he was unsure if it

is necessary to attempt to impart flexibility to the leaves at all. The negative effects of such interventions can do much harm and the introduction of flexibility-inducing agents in weakened plant material is fraught with negative effects with hardly any practical benefit to the folio. The introduction of oils can create gradients between tissues causing structural damage ... ; the introduction of water in the leaves causes swelling and shrinkage leading to failure of the cell walls ...; and PEG [polyethylene glycol] can solubilise lignin ... once it begins to depolymerise.¹⁵⁹

Adhesion of the leaves can also be an issue, such as with a partially stuck together manuscript observed in Syracuse University’s Bird Library conservation lab. As previously mentioned, oil treatments may contribute to leaf fusion, but Sah also mentions that “sometimes whole manuscripts are retrieved as solid blocks due to damage by moisture, insects and neglect.”¹⁶⁰ Possible separation methods, with varying levels of effectiveness and potential negative after effects include: humidification and steam, hot water and glycerin, and hot paraffin followed by an acetone wash.¹⁶¹ Sah adds that sometimes one can merely relieve the pressure on a manuscript and “left undisturbed, often after a month the leaves begin to separate on their own.”¹⁶²

¹⁵⁸ Van Dyke, “Sacred Leaves,” 90.

¹⁵⁹ Sah, “Palm Leaf manuscripts of the world,” 20.

¹⁶⁰ Sah, “Palm Leaf manuscripts of the world,” 22.

¹⁶¹ Sah, “Palm Leaf manuscripts of the world,” 22.

¹⁶² Sah, “Palm Leaf manuscripts of the world,” 22

Storage conditions

As with other organic materials, palm leaves are susceptible to changes in their environment, especially with regards to temperature and humidity. For example, Sharma notes “the presence of longitudinal cracks” in palm leaves in one collection and that “[t]he main cause of the appearance of these cracks on the surface of the leaf is variation in the climatic conditions.”¹⁶³ In addition, Florian et al note that “[c]hanging humidities do more than change materials volumetrically and cause distortions.”¹⁶⁴ The authors discuss changes at the molecular level, such as “a decrease in moisture regain” whereby fewer sites available for hydrogen bonding make for “fewer gel amorphous regions between crystalline areas to allow flexibility, compression, tension, and elasticity.”¹⁶⁵ As is the case with many artifacts, control of temperature and humidity through air conditioning is ideal for storage, extending the useful lifespan of manuscripts. As Perumal notes, “[u]nder ‘normal’ conditions, palm-leaf manuscripts can be preserved for ca. 400 to 500 years. With controlled heat and humidity, we can extend this life-span to more than 1000 years.”¹⁶⁶

The storage condition of the individual manuscripts also plays an important role in their proper conservation. For example, one palm leaf manuscript viewed in Syracuse University Libraries’ Special Collections Department was securely contained in a custom made box to prevent physical damage to the item. However, the conservationists at the Metropolitan Museum of Art, who are responsible for precious paintings on palm leaves, also note that

¹⁶³ Sharma, “Documenting and Preserving the Endangered Archives,” 7.

¹⁶⁴ Florian, “The Conservation of Artifacts made from Plant Materials,” 149.

¹⁶⁵ Florian, “The Conservation of Artifacts made from Plant Materials,” 150.

¹⁶⁶ Perumal, “The Sanskrit Manuscripts in Tamilnadu,” p. 159.

“[b]ecause 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.¹⁶⁷ Instead, the museum’s storage solution was “[i]nspired by the simple approach to covers that the creators of the manuscripts took.”¹⁶⁸ The manuscripts 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.”¹⁶⁹ The 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...”¹⁷⁰

Loss compensation

When lost sections of leaves need to be filled for stability, aesthetic, or other appropriate reasons, infill materials that might be considered include: [t]oned paper, wood veneer, paper and silk laminates, as well as palm leaf.”¹⁷¹ However, after outlining the reasons why each of these materials might potentially be unsuitable, Nichols offers “the inner white bark of the kozo or mulberry plant” as a possible alternative.¹⁷² She notes that kozo bark has comparable rigidity, is visually sympathetic, and yet “is distinguishable from the original palm leaf material upon close visual inspection.”¹⁷³ In her case study, Nichols describes the use of

¹⁶⁷ Van Dyke, “Sacred Leaves,” 94.

¹⁶⁸ Van Dyke, “Sacred Leaves,” 93.

¹⁶⁹ Van Dyke, “Sacred Leaves,” 93.

¹⁷⁰ Van Dyke, “Sacred Leaves,” 94.

¹⁷¹ Nichols, “An Alternative approach,” 105.

¹⁷² Nichols, “An Alternative approach,” 106.

¹⁷³ Nichols, “An Alternative approach,” 106.

Japanese paper, methylcellulose, wheat starch paste, watercolor pigments for toning, and the kozo bark in the conservation of a palm leaf manuscript from 1270.¹⁷⁴

A 2017 article from the British Library's conservation blog outlines another approach to loss compensation in palm leaves which involves "leaf casting."¹⁷⁵ The blog entry explains that a 256-leaf Tamil manuscript needed conservation due to considerable damage and undesirable previous repairs done with string and palm leaf sections attached with fish glue. After testing the ink for stability, toned paper pulp was poured over the leaves and the water was sucked out by the machine. Later, the dried and pressed leaves were trimmed consistent with their original size and shape. Jurkiewicz explains further that

Leaves with less damage were not put through the leaf-caster, but mended by hand. A surgical needle was used to insert toned paper pulp into worm holes, and small missing areas. A piece of blotter paper was placed underneath for absorption of excess water.¹⁷⁶

This technique appeared to give good results in a case where a large number of leaves needed loss compensation. The author noted that besides the visual appearance, the flexibility of the leaves was improved and saved a great deal of time.¹⁷⁷

However, Sah suggests that leaf casting may not be effective due to an overlooked problem:

[C]hannels created by [insect] larvae [may] leave one surface of the palm leaf intact but very thin. For leaf casting to be effective, the fluid should be able to pass through the

¹⁷⁴ Nichols, "An Alternative approach to loss compensation."

¹⁷⁵ Iwona Jurkiewicz. "Magic in Conservation – using leaf-casting on paper and palm leaves." From the British Library Collection Care Blog, October 10, 2017.

¹⁷⁶ Jurkiewicz, "Magic in Conservation."

¹⁷⁷ Jurkiewicz, "Magic in Conservation."

hole and this is prevented by the remaining thin surface. To compound matters, the paper-thin surface often has writing on it and therefore its preservation is necessary.¹⁷⁸

Consolidation

Van Dyke notes that the natural and conditioned surface characteristics of palm leaves may contribute to the problem of crumbling or flaking pigments seen in some palm leaf manuscripts, especially heavily illustrated ones. As he explains, although the inks or paints may be inherently stable, 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 saturation or staining by the media.”¹⁷⁹ Sah mentions that “a 2% solution of soluble nylon” can be used to address flaking of surface materials on palm leaves.¹⁸⁰ Conservators at the Museum of Modern Art tested a number of other consolidation methods for possible use on exhibition materials, with the goal of ensuring “that no future losses take place without altering the visual character of the paint layers.”¹⁸¹ The materials considered included: laboratory-grade gelatin, Dow methyl cellulose 4C, Dow methyl cellulose 4M, and isinglass, which is made from “dried Salianski sturgeon bladder membrane.”¹⁸² The experimental results led to the successful use of “a warm solution of 1% brush-applied isinglass while working under the magnification of a binocular microscope. No visual alteration of any pigments occurred (including orpiment and admixtures thereof).”¹⁸³

¹⁷⁸ Sah, “Palm Leaf manuscripts of the world,” 22.

¹⁷⁹ Van Dyke, “Sacred Leaves,” 87.

¹⁸⁰ Sah, “Palm Leaf manuscripts of the world,” 21.

¹⁸¹ Van Dyke, “Sacred Leaves,” 89.

¹⁸² Van Dyke, “Sacred Leaves,” 89.

¹⁸³ Van Dyke, “Sacred Leaves,” 89

Additional conservation concerns

The conservation of palm leaf manuscripts, similar to that of other culturally important artifacts, must be approached on a case-by-case basis with careful planning and consideration of potential impacts of any treatments. Conservation of palm leaves appears to be an evolving area of practice, with some sense of urgency needed given the rapid rate at which older manuscripts are being lost in India and other places. A 1994 article by Samuels shows that even 25 years ago, the vast scale and rapid pace of the decay and destruction of palm leaf manuscripts was recognized as an important cultural heritage problem.¹⁸⁴ Part of the difficulty is that the sheer number of palm leaf manuscripts in need of conservation is overwhelming the capacity of libraries and archives. Although religious texts written on palm leaves are one subject area of concern to scholars, important cultural information in other domains are also in danger of being lost forever. Samuel notes that an “impressive collection of folk-songs of different kinds, a large percentage of them ballads, have been recorded in palmyra leaves and are languishing uncared for.”¹⁸⁵ His description of the music sheds some light on what might be lost:

The joy of the creative spirit that pervades these songs, their inlaid melody, their astonishing simplicity of style and diction, their subtle blending of the human and the divine, history and myth, natural and supernatural, their complete identity with the soil of their birth, their representativeness of a given community and social clan, their capturing of the here and now of folk life invest them with a unique, compulsive charm of their own, and are a seminal part of the cultural and literary heritage of the Tamils.¹⁸⁶

¹⁸⁴ Samuel, “Preservation of Palm-Leaf Manuscripts in Tamil,” p. 300.

¹⁸⁵ Samuel, “Preservation of Palm-Leaf Manuscripts in Tamil,” p. 297.

¹⁸⁶ Samuel, “Preservation of Palm-Leaf Manuscripts in Tamil,” p. 297-298.

Efforts are now underway, initiated from both within and outside of India, to protect and save palm leaf manuscripts. Improved storage conditions and careful cleaning may be enough to delay the disintegration of high-priority palm leaf manuscripts long enough that digitization or other alternatives may be possible.

5. Digitization

PLMs contain a record of cultural knowledge that is critically important for collective memory and cultural sustainability.¹⁸⁷ With the advent of digital technologies, digitization has become an important tool to preserve PLMs and increase access to them. Digitization is “the process by which analogue content is converted into a sequence of 1s and 0s and put into a binary code to be readable by a computer.”¹⁸⁸ Digitization allows for the creation of surrogate copies of PLMs so that the originals can be conserved and so that the information that these manuscripts contain can be accessed.¹⁸⁹ With the sheer number of manuscripts in South Asia, digitizing all of them is a daunting task. An Indian journalist and professor, Deepti Ganapathy, estimates that at the current rate of digitization, it would take 600 years to digitize all known manuscripts.¹⁹⁰

Across South and Southeast Asia, many manuscripts are being microfilmed or digitized, but the process undertaken differs considerably from place to place.¹⁹¹ The International

¹⁸⁷ Mallan and Park, “Is Digitization Sufficient,” 214.

¹⁸⁸ Hughes 2004, 4 quoted in Mallan and Park, “Is Digitization Sufficient,” 207.

¹⁸⁹ Mallan and Park, “Is Digitization Sufficient,” 202; NMM, “*Guidelines for Digitization of Archival Material.*”

¹⁹⁰ Deepti Ganapathy, “Preserving India’s palm leaf manuscripts.”

¹⁹¹ IFLA Scoping Workshop on Palm Leaf Manuscripts: Preserving Cultural Heritage. IFLA. November 22, 2017: 6.

Federation of Library Associations and Institutions (IFLA) found that although PLMs were kept in similar places across South and Southeast Asia, such as national libraries, museums, temples, shrines, and private collections, there also were significant local variations in collection management. As IFLA notes, “digitization and the subsequent organization of digitized PLMs have often been carried out using different standards or even with no standard at all, particularly with respect to the metadata that is fundamental in the management of digital collections.”¹⁹²

In India, the National Mission for Manuscripts (NMM), founded in 2003, is the lead organization tasked with setting up standards for digitizing manuscripts, including palm leaf manuscripts, and providing technical assistance and funding to organizations such as universities and libraries which have PLM collections.¹⁹³ The National Mission for Manuscripts (www.namami.gov.in) is an autonomous organization created by the Indian government’s Ministry of Tourism and Culture. This group works with three other national level institutions, who are also involved in the preservation of Indian manuscripts: the National Archives of India, the National Library of India, and the Indira Gandhi National Centre for the Arts (IGNCA) with the primary collaborative location at the IGNCA in New Delhi. NMM aims to “locate, document, preserve, and digitize Indian manuscripts and make these accessible in order to connect India’s past with its future.”¹⁹⁴ In addition to these national institutions, NMM works with more than 50 Manuscript Resource Centers, which include large, “well-established institutes, museums, libraries, universities and non-government organisations,” as well as numerous Manuscript

¹⁹² IFLA Scoping Workshop on Palm Leaf Manuscripts, 4.

¹⁹³ Sahoo and Mohanty, “Digitization of Indian Manuscripts Heritage.”

¹⁹⁴ Sahoo and Mohanty, “Digitization of Indian Manuscripts Heritage,” 239.

Conservation Centers and Manuscript Partner Centers, institutions with large holdings of manuscripts, which are required to document and catalog them.¹⁹⁵

The Digitization Process

The National Mission for Manuscripts has created a protocol for digitization which outlines ten steps in the digitization process for manuscripts, including PLMs.¹⁹⁶ We will give an overview of each of the steps, paying particular attention to the selection of equipment for digitization and the importance of metadata in the process of digitization.

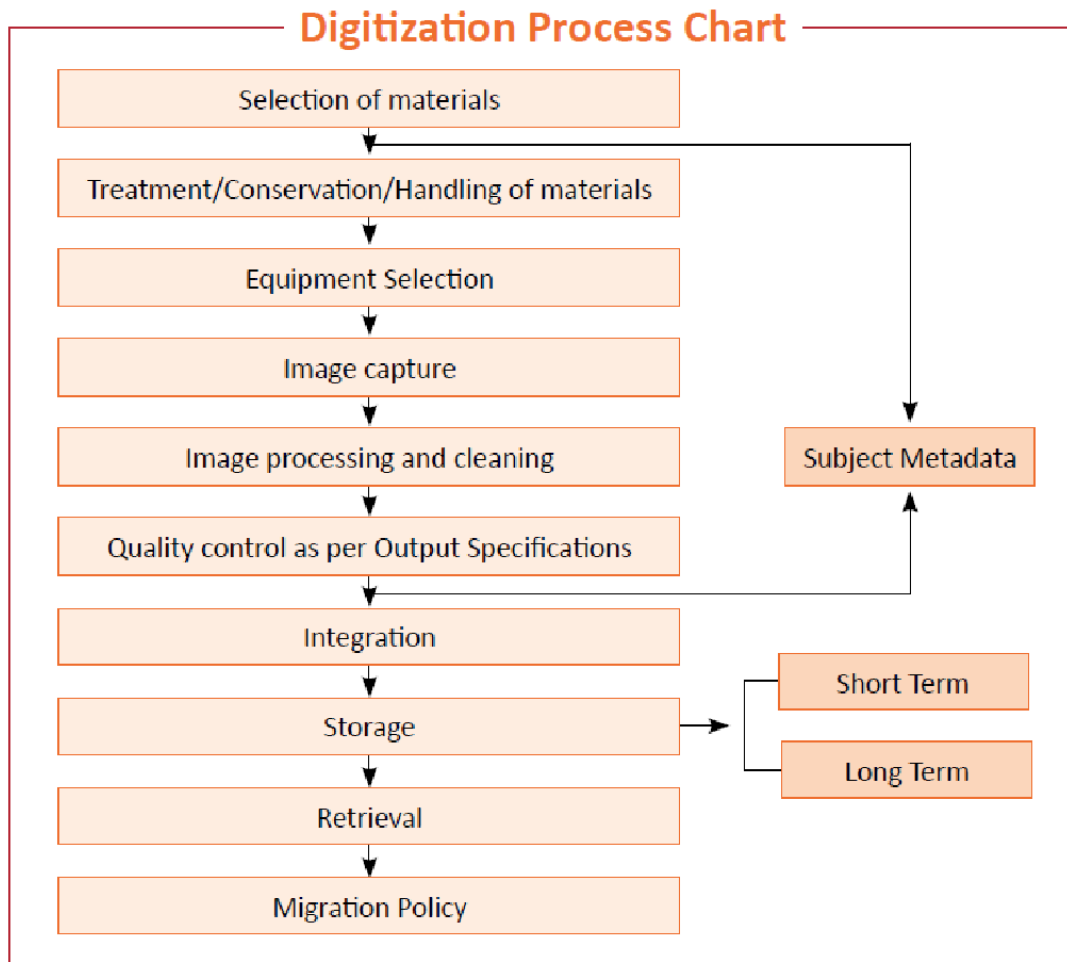
The first decision is to select which manuscripts to digitize. NMM prioritizes manuscripts that meet one or more criteria: “manuscripts that are unique with rare heritage value ..., manuscripts which deal ... with ancient knowledge systems, material where the users are wide-spread geographically and temporally, [and] material where retrieval of information is cumbersome...”¹⁹⁷ The condition of selected manuscripts should then be assessed. Materials that are fragile, damaged or otherwise in poor condition may not be good candidates for digitization unless some basic conservation techniques are used to stabilize them first. NMM recommends cleaning using standard conservation techniques to increase legibility of materials as needed, and in some cases using traditional methods to re-ink the folio if the incised text has become difficult to read.

¹⁹⁵ Ganapathy, Deepti. “Preserving India’s palm leaf manuscripts for the future.”

¹⁹⁶ Sahoo and Mohanty, “Digitization of Indian Manuscripts Heritage,” 246.

¹⁹⁷ Sahoo and Mohanty, “Digitization of Indian Manuscripts Heritage,” 245.

Table 2. The National Mission for Manuscripts Digitization Process Chart¹⁹⁸



The next step is to select the equipment used for the digitization process. Generally speaking, a non-contact device with a cool light should be used to capture images. While flatbed scanners are the most common, inexpensive way to digitize documents, they are not appropriate for PLMs.¹⁹⁹ Digital cameras which can be used without damaging the manuscripts are recommended, under various light regimes.²⁰⁰ While using a digital camera station is more

¹⁹⁸ NMM, "Guidelines for Digitization of Archival Material," 22.

¹⁹⁹ R. Narenthiran, G. Saravanan, and K. Ramanujam. "The Digitization of Palmleaf Manuscripts." *Proceedings of the National Conference on Innovative Library Services in Digital Era*. (January 2012): 457-462.

²⁰⁰ "Digitization Project Saves Saiva Agamas." *Hinduism Today*, Jul, 2011, 53-54

expensive than other options, it also provides the greatest degree of flexibility.²⁰¹ There are other options as well. At the Museum of Modern Art, they have used a digital scanning back from Better Light Inc., which is a trilinear image sensor that moves across the image plane to build an image one color at a time.²⁰² The scanning back was put on a copy scan and used with LED lights.²⁰³

Once the images of the PLMs are captured, a three-step process of cleaning and saving various file versions takes place. First, the original raw images should be saved as a “raw master” image, which would be an uncompressed Tiff.²⁰⁴ Next, the raw image then should be processed “to remove dirt, worm marks, water marks, noise, showdown, scratch marks, etc” [along with] “[a]djustment of brightness and contrast, gamma correction, sharpening and blurring, removing patterns and adjusting colors.”²⁰⁵ This version should be saved as the “clean master,” a compressed Tiff file. Finally, a JPEG/PDF-A image should be created for use in public access to the PLMs.²⁰⁶ Therefore, during the digitization process, three files should be created which are detailed in Table 3 below.

²⁰¹ Narenthiran, et al., “Digitization of Palmleaf Manuscripts.”

²⁰² www.betterlight.com The website explains: “As their name implies, Better Light’s digital scanning backs do not capture an image of the subject in front of the camera all at once, but rather by physically moving a unique, highly-optimized trilinear color image sensor smoothly across the image plane, building up the image one line per color at a time.”

²⁰³ Van Dyke, “Sacred Leaves,” 92.

²⁰⁴ NMM, “*Guidelines for Digitization of Archival Material*,” 27-28.

²⁰⁵ NMM, “*Guidelines for Digitization of Archival Material*,” 27.

²⁰⁶ NMM, “*Guidelines for Digitization of Archival Material*,” 27.

Table 3. Digital Output Specifications²⁰⁷

Material	Raw Master Image	Bit depth	Clean Master Image	Access Image
Manuscripts	Tiff (Uncompressed) 300 dpi (output)	24 bit	Tiff (compressed) 300 dpi (output) Group 6 CCITT Spatial Resolution: 8" X 10" at 300 dpi	JPEG/PDF-A Spatial Resolution: 1024 x 768 pixels

Importance of Metadata

One of the challenges that librarians, museum specialists, and archivists face is digitizing palm leaf manuscripts in a consistent way, using an agreed upon system of metadata.

Metadata, defined as “data about data,” is important in the “development of effective, authoritative, flexible scalable, and robust cultural heritage and information systems.”²⁰⁸ This is particularly true when trying to standardize digitization across national borders. IFLA found that there are five metadata schema for palm leaf manuscripts across South and Southeast Asia, one of which is the National Mission for Manuscripts’ own protocol.²⁰⁹ Without any standard system of recording metadata, it is difficult to develop databases in which records of palm leaf manuscripts can be found easily; different metadata or bibliographic information can contribute to incompatible and inconsistent records.

²⁰⁷ NMM, “Guidelines for Digitization of Archival Material,” 28.

²⁰⁸ Baca 1998, 1 quoted in Mallan and Park, “Is Digitization Sufficient,” 209.

²⁰⁹ IFLA Scoping Workshop on Palm Leaf Manuscripts: Preserving Cultural Heritage and R. Vasanth Kumar Mehta and Nagendra Panini Challa. “Facilitating enhanced user access through Palm-leaf Manuscript Digitization-Challenges and Solutions.” Second International Conference on Electrical, Computer and Communication Technologies, 2017.

According to the NMM guidelines, there are two sets of metadata that should be included with the images—subject metadata of the manuscripts and technical metadata.²¹⁰ The NMM uses a software program, called Manus Granthawali, to generate data records containing metadata based on enhanced Dublin core standards.²¹¹ This software was developed by India’s National Informatics Centre (NIC) and was adopted for use by many members of the NMM.²¹² Subject metadata include 24 items, ranging from title, author and language to material, illustrations, and condition. The technical metadata includes information such as file name, date created, equipment used, image format, color mode, and software. However, for any given manuscript, there may be missing or unclear information in various standard metadata fields.^{213, 214} In addition, because of the nature of palm leaf manuscripts, metadata fields may need to added or modified to account for differences in bundle and leaf-level information, physical attributes, and so on.²¹⁵

Challenges to End User Access

While access to the information contained in the PLMs is one driving reason behind their digitization, this goal has proved difficult to achieve. In 2007, NMM launched

²¹⁰ NMM, “Guidelines for Digitization of Archival Material,” 29 and Sahoo and Mohanty, “Digitization of Indian Manuscripts Heritage.”

²¹¹ NMM, “Guidelines for Digitization of Archival Material,” 32.

²¹² Motebennur, Maltesh. “Digital Preservation of Mahayana Buddhist Manuscripts of Arunachal Pradesh: Strategies, Issues and Challenges.” The Manus Granthawali software may not be currently supported, as it was not found on the NIC’s website.

²¹³ Mehta and Challa, “Facilitating enhanced user access through Palm-leaf Manuscript Digitization-Challenges and Solutions.”

²¹⁴ NMM, “Guidelines for Digitization of Archival Material”

²¹⁵ Mehta and Challa, “Facilitating enhanced user access through Palm-leaf Manuscript Digitization-Challenges and Solutions.”

Kritisampada, a national database that contains information about over a million Indian manuscripts, though not all of these are PLMs.²¹⁶ The primary goal of the online database is not direct access to these manuscripts, but to help scholars to locate manuscripts kept by institutions around the country.²¹⁷ Other institutions in India have used DSpace, an open access software for institutional repositories, as an online database of digitized manuscripts.”²¹⁸

Yet it can be argued that these databases have had limited impact in actually making these documents accessible to a broader public, or even in ways that are useful for scholars. The poor physical condition of many manuscripts may impact the readability of their representations. As Mehta and Challa note, “If the images are not of the desired quality, the digitization itself is futile.”²¹⁹ In addition there is the difficulty of translating texts from numerous ancient languages and scripts into modern Indian languages and also non-Indian languages if applicable.²²⁰ Unfortunately, because the PLMs are hand written in a wide variety of Indic languages, optical character recognition applications have not been particularly effective.²²¹ There is a clear need for better search mechanisms to facilitate the use of digital palm leaf manuscripts.²²²

²¹⁶ Deepti Ganapathy, “Preserving India’s palm leaf manuscripts.”

²¹⁷ NMM website, accessed 4/27/2019 at <https://www.namami.gov.in/database-menu-script> .

²¹⁸ IFLA Scoping Workshop on Palm Leaf Manuscripts: Preserving Cultural Heritage: 6.

²¹⁹ Mehta and Challa, “Facilitating enhanced user access through Palm-leaf Manuscript Digitization-Challenges and Solutions

²²⁰ Sahoo and Mohanty, “Digitization of Indian Manuscripts Heritage,”243.

²²¹ Nagendra Panini Challa and R. Vasanth Kumar Mehta. "Automatic Data Acquisition - A Major Challenge." Coimbatore, India, IEEE, 22-24 Feb. 2017.

²²² Mehta and Challa, “Facilitating enhanced user access through Palm-leaf Manuscript Digitization-Challenges and Solutions.”

6. Conclusion

Palm leaf manuscripts are very important to and within South Asian history, culture and religious traditions. They are one of the oldest media containing ancient texts which are still used today. While they are ubiquitous, with millions of PLMs still surviving around the world, they are also very fragile and the threat of loss of both knowledge and material culture is very real. In this paper, we have discussed some of the historical importance of Indian PLMs as well as significant conservation challenges. Physical means of conserving palm leaf manuscripts will undoubtedly prove important in safeguarding the intellectual treasure of India and the surrounding regions. However, digitization efforts are also a critical part of the overall preservation of PLMs. Surrogate digital copies can reduce handling of delicate PLMs and allow for the information contained within to be accessed worldwide by scholars and others interested in these items.

Important areas of research that remain to be explored further include: how the massive numbers of PLMs remaining in India can best be prioritized for conservation efforts, how to provide equitable access to virtual PLMs where technological resources may not be substantial, necessary advances in computer processing of PLMS including OCR of multiple languages, and even the continuing cultural meaning of palm leaf manuscripts in India today.

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