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Washi: Understanding Japanese Paper as a Material of Culture and Conservation

INTRODUCTION

Washi, Japanese paper, is used ubiquitously for treating books and paper objects on an almost daily basis because of its unique qualities. It is also a material of cultural significance with a rich history that can sometimes be overlooked in the treatment setting. The good aging characteristics of *washi*, particularly *kozo washi*, and the strength and thinness of these papers make it ideal for treating paper objects. However, traditional *washi*-making has experienced significant changes in the past few decades. Sadly, not all changes are for the better—the number of papermakers is dwindling and certain types of *washi* have become extinct due to closure of studios responding to various pressures. The accelerated changes in the industry, compounded by potential language barriers for conservators who are not fluent in Japanese, make it difficult for conservators to be certain of how these changes might be affecting *washi* used in treatment. Attending the Hiromi Paper Inc. *2017 Washi Tour* and the *Identification of East Asian Papers for Conservation Workshop* lead by Nancy Jacobi and Megumi Mizumura in 2016 at the American Institute for Conservation's 44th Annual Meeting inspired the author to share the insights gained through these experiences.

Seminal research on Japanese papermaking has been published in the conservation field covering the history of *washi*, and the conservation quality of handmade and machine-made *washi*. There are references that are the first to be consulted by conservators, such as Barrett's 1983 publication, *Japanese Papermaking: Traditional Tools and Techniques,* or *The Book and Paper Group Annual* articles, "A Study of the Quality of Japanese Papers Used in Conservation" by Beauman and Rempel in 1985, and "Machine Made Oriental Papers in Western Paper Conservation," by Nicholson and Page in 1988. At first, it may seem that there are limited resources on the subject; however, a broader search will reveal that a number of publications have been consistently published on the manufacturing and quality of *washi.* Many publications are in conference proceedings or European journals that may be more difficult for North American conservators to access. While much of the literature is quite dated, new and exciting research has been published in the last four years. Older publications, especially those discussing the traditional methods and history of *washi* are still relevant and valuable. However, the findings in resources related to *washi* permanence for use in conservation may not be reliable for the papers available today, although they do serve as records that may assist future researchers in how *washi* quality may have changed over time. Publications on *washi* can be separated into three categories:

***Washi* Manufacturing**—literature describing the papermaking procedures and its cultural context (Hunter 1943; Hughes 1978; Barrett 1983; Masuda 1985; Turner 1998; Mizumura, Kubo, and Moriki 2015; Colbourne and Hori 2015; Mizumura and Moriki 2017).

Examination and Identification–literature that establishes characteristics differentiating *washi* from other kinds of paper or other kinds of *washi* (Collings and Milner 1978; Nicholson and Page 1988; Koestler, Indictor, and Fiske 1992).

Quality Assessment–literature investigating the quality and aging characteristics of *washi* and the implication for conservation uses (Murphy and Rempel 1985; Inaba and Sugisita 1988; Uyeda et al. 1999; Inaba et al. 2002; El-Esseily and Inaba 2004; Calvini, Gorassini, and Chiggiato 2006).

Even with the more recently published articles on the subject, there is still limited information that would help conservators assess *washi* quality from a conservation standpoint without use of costly and sometimes inaccessible advanced technical analysis. The aim of this paper is to review traditional papermaking processes and the cultural importance of *washi*. Methods for examining *washi* will also be discussed to guide selection of high quality *washi* for treatment relying on touch, sound, and transmitted and raking light.

TRADITIONAL PAPERMAKING METHODS—A REVIEW

As would be expected, the traditional methods of making *washi* remain the same for papermakers dedicated to the

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tradition, albeit with a few modifications that will be discussed later. The process begins with cultivating and harvesting the raw materials. There are three main traditional paper fibers used in Japan: *kozo* (*Broussonetia kazinoki Sieb*), *mitsumata* (*Edgeworthia papyrifera Sieb. Et Zucc*), and *gampi* (*Wikstroemia sikokiana Fanche et Sav*). All of these fibers are bast fibers, meaning they are extracted from the inner layer of the bark.

Kozo and *mitsumata* can be domesticated while *gampi* must be harvested in the wild. *Kozo* is harvested every year, *mitsumata* every 3 years, and *gampi* every 5 to 7 years (Barrett 1983). Harvesting *kozo* and *mitsumata* occurs between November and January after the leaves have fallen (Hughes 1978; Barrett 1983; Mizumura, Kubo, and Moriki 2015). *Gampi* must be harvested in the spring between March and April because the fibers are ideal for papermaking at this time, and the bark is easily stripped from the branch by hand as it cannot be steamed (Hughes 1978). The stalks of the shrubs are carefully cut with enough of the stem left at the base of the plant to allow for new growth in the spring (fig. 1). Some people make their living by cultivating the raw materials for papermaking. It is also common for papermakers to cultivate and harvest their own raw materials. This paper will focus on the processing of *kozo,* as this is the main fiber in papers used for conservation.

Fig. 1. A harvested stump of *kozo* or *mitsumata* with stalks remaining to allow for new growth in the next season.

Just like grapes cultivated for wine, many factors in the cultivation of *kozo* related to the growing environment will influence the physical and chemical characteristics of the fibers. There are two main types of *kozo* fibers grown and used in Japan and recognized for their quality and unique properties: *nasu kozo* and *tosa kozo*. *Nasu kozo* is grown in more northern prefectures of northeastern Tochigi and southern Fukushima (fig. 2) (Masuda 1985). The climate is cooler and the growing season is shorter—yielding soft, tender, and shorter *kozo* fibers. *Tosa kozo* is grown in the south in Kochi prefecture, where the growing period is longer and produces longer, stronger fibers (fig. 2).

Kozo may be cultivated in other parts of the world with similar climates to Japan. Thai *kozo* is a recent introduction to the papermaking industry. It grows very fast and can be harvested twice in a growing season (Mizumura, Kubo, and Moriki 2015; Jacobi and Mizumura 2016). As a result, Thai *kozo* is much less expensive than Japanese *kozo,* creating competition for Japanese raw material suppliers that is too difficult to overcome (Jacobi and Mizumura 2016). The faster growing season also means that the Thai *kozo* fibers contain more oils and plant impurities that are very difficult to remove. These fibers require caustic soda, a more aggressive cooking agent, to remove the impurities. Even after cooking with stronger alkalis, the impurities can remain in the fibers and leach out, forming oily stains in the finished sheets (Jacobi and Mizumura 2016).

Fig. 2. *Nasu kozo* is grown in northeastern Tochigi and southern Fukushima Prefectures and *tosa kozo* is grown in Kochi Prefecture in the south.

China is another producer of *kozo* and it is believed to be of good quality (Mizumura, Kubo, and Moriki 2015).

The harvested *kozo* is immediately steamed and the bark peeled by hand from the wooden core in one piece. The bark has three layers (fig. 3): the *shirokawa* or white inner layer composed mainly of cellulose; the *nazekawa* or the middle green layer, which is composed mainly of hemicellulose; and the *kurokawa*, or the outer black bark (Hughes 1978; Barrett 1983; Masuda 1985; Mizumura, Kubo, and Moriki 2015). Different layers may be retained based on the type of paper to be made. The unwanted bark layers are scraped away after steaming (fig. 4). The desired part of the bark is then placed in the river to rinse out soluble impurities. The rinsed bark can be dried and stored until needed for papermaking.

If traditional methods are followed, the fibers will brighten slightly from natural light bleaching. There are three methods for light bleaching: in the river while rinsing, *kawa-zarashi*; on the ground in the sun, *tempi-zarashi*; or laid out in the snow and sun, *yuki-zarashi* (Hughes 1978). In some paper studios, chemical bleaching of fibers may be conducted as an additional step after cooking the fibers. Sodium hypochlorite (NaOCl) is the bleach that is most commonly used (Koestler, Indicator, and Fiske 1992; Mizumura, Kubo, and Moriki 2015). Less processing of the raw material occurs when chemical bleaching is involved in papermaking because all three layers of the bark can be cooked and then bleached to render everything the same color: bright white. Chemical bleaching produces poor quality *washi* that ages poorly because the fibers are less purified, chemically damaged, and have chlorine residues if chlorine-based bleaches are used (Uyeda et al. 1999; Koestler, Indictor, and Fiske 1992).

When papermaking is to begin, the dried bark is soaked anywhere from several hours to a couple of days (Hughes 1978; Barrett 1983). The steamed, scraped, and rinsed fibers are cooked with an alkaline agent for approximately two hours (fig. 5). The cooking time will vary depending on the strength of the cooking agent and the studio practices. Wood

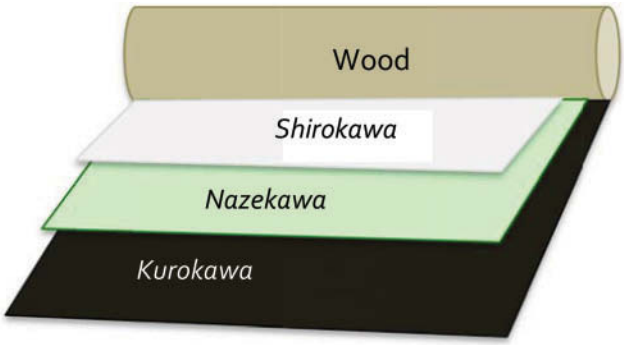

Fig. 3. Three layers of the *kozo* bark: the inner white layer called *shirokawa*, the middle green layer called *nazekawa*, and the outer black layer called *kurokawa*.

Fig. 4. Scraping unwanted layers of outer bark with a knife. Sekishu Kubota Studio, Shimane Prefecture. Credit: Jacinta Johnson.

ash (potassium carbonate, K_2CO_3), also called potash, was the traditional alkali collected from burned wood or burned buckwheat husks (Barrett 1983). Slaked lime (calcium hydroxide, CaOH) has also been used. Two other alkalis that have been introduced to the *washi* industry are soda ash (sodium carbonate, $NaCO_3$) and caustic soda (sodium hydroxide, NaOH). These alkalis are stronger, reduce the cooking time, and are more soluble in water, allowing easier removal of residues when rinsing the cooked fibers. However, stronger alkalis will cause more chemical damage to the fibers and will also make the fibers whiter. After cooking, the bark is rinsed to remove any remaining alkali and soluble impurities. The fibers are carefully examined and any pieces of black bark, called *chiri,* are removed by hand in a process called *chiritori* (fig. 6).

The cooked bark is then beaten to separate the individual fibers. Traditionally, the fibers are beaten by hand with wooden mallets (fig. 7) or with a foot stamper. More automated methods are now being used to increase production rates, including mechanical beaters (fig. 8), *naginata* beaters—similar to a

Fig. 5. Mr. Fukunishi removing cooked bark from the cauldron. Fukunishi Studio, Nara Prefecture. Credit: Jacinta Johnson.

Fig. 6. Mrs. Kubota removing blemishes from cooked bark in the chiritori process. Sekishu Kubota Studio, Shimane Prefecture.

Hollander beater but with curved blades causing less physical damage to the fiber (Barrett 1983), and the Hollander beater. The modern mechanical beaters cause more physical damage to the fibers, producing shorter, weaker fibers.

The beaten fibers are mixed with water and a formation aid, called *neri*, in preparation for sheet formation. *Neri*, a plant mucilage extracted from *tororo-aoi* (*Hibiscus Manihot*), has a stringy, slippery consistency similar to mucus (fig. 9). The mucilage is key to Japanese papermaking as it helps to disperse fibers in the vat, slows sedimentation of fibers, and controls water drainage from the mold. *Neri* also helps with sheet separation after the post is pressed. It is not an adhesive or internal sizing agent. If additives are used, they may include *gofun*, calcined oyster shell powder, clays, and calcium hydroxide in the form of lime (figs. 10 and 11). Sizing agents are not commonly used in *washi* but some may include *dosa* (an animal glue and alum mix), *konyaku*, a plant starch from the *konyaku* (*Amorphophalus konjac K. Koch)* root, and rice starch. Sizing agents are often applied to the sheet instead of in the vat.

Fig. 7. Mrs. Fukunishi demonstrating how cooked fibers are beaten by hand. Fukunishi Studio, Nara Prefecture. Credit: Jacinta Johnson.

Fig. 8. A mechanical beater used in place of hand beating paper fibers. In some studios hand-beaten fibers are then further beaten using the mechanical beater. Fukunishi Studio, Nara Prefecture.

Once the pulp is mixed into the vat, the papermaker begins the Japanese sheet formation method called *nagashizuki.* Sheet formation involves repeated charging of the mold from the vat, complex shaking, and discharging excess pulp until the desired thickness is achieved. In Western papermaking, the mold is only dipped once, shaken gently and quickly, and allowed to drain. The Japanese papermaking studio setup is also quite different from a Western studio. The mold is called the *keta,* with the frame and the deckle hinged together. The screen is a separate part of the mold. It is called the *su* and is a flexible, laid screen made from stiff, organic materials like bamboo or kaya, a type of grass that will be discussed in more detail later. When referring to the Japanese mold and the screen together, it is called the *suketa*. This differs from the Western papermaking mold, which is a laid screen made from wires secured to the mold frame. The *suketa* is hooked onto wires attached to bamboo struts that extend over the vat above the papermaker's head. The struts help support the weight of the mold and flex with the movement of the screen during sheet formation. This system also allows for handles to be attached to the *keta* shoulder width apart and allows much larger *suketas* to be used.

Fig. 9. *Neri* dispersion agent extracted from the *torroro-aoi* root by crushing and soaking in water. *Neri* is scooped from the bucket and passed through a strainer before it is added to the vat.

Once a sheet is formed, the *su* is removed from the *keta,* lifted overhead, and couched on the post stationed on a table directly behind the papermaker. There are wooden guides

Fig. 10. Powdered oyster shells are sometimes added to papers as a filler.

Fig. 11. Kaolin is another type of filler that might be added to paper. Fukunishi Studio, Nara Prefecture. Credit: Jacinta Johnson.

that help align the *su* as the fresh sheet is couched. Instead of interleaving the sheets with felts, the fresh sheet is couched directly on top of the last couched sheet. A string, ribbon, or fishing line is often laid along the edge of the post closest to the papermaker to aid in sheet separation. The studio setup is very efficient and allows one person to do all the sheet formation steps and operate a much larger mold that would otherwise be too heavy to manage. In Western papermaking studios, this process requires at least two workers. Figure 12 shows Mr. Fukunishi making *udagami* and illustrates the tools and studio design unique to the *nagashizuki* method.

A completed post is pressed overnight in a screw press or hydraulic press. This is a slight alteration to the traditional lever press. The next day, the sheets are separated and applied

Fig. 12. Mr. Fukunishi making *udagami* with the *nagashizuki* method. The organization of the studio and the tools used in the step depicted here include the vat; the bamboo struts over the vat; the hinged frame and deckle called the *keta*; the removable, flexible screen called the *su*; the post behind the papermaker with the wooden guides; and fishing wire placed along the edge closest to the papermaker to assist in sheet separation. Fukunishi Studio, Nara Prefecture. Credit: Jacinta Johnson.

Fig. 13. Mrs. Hamada separates sheets of paper from the post. She is holding the brush used to apply the sheet to the drying surface, which is a rotating, heated stainless steel drum behind her. Hamada Washi, Kochi Prefecture. Credit: Jacinta Johnson.

to drying supports (fig. 13). Traditionally, these supports are made from wooden boards. The boards with the attached papers are then placed in the sun to dry. There are three types of wood commonly used: horse chestnut, ginko (fig. 14), and

Fig. 14. Examples of ginko drying boards. Fukunishi Studio, Nara Prefecture. Credit: Jacinta Johnson.

Fig. 15. Papermakers greatly value their drying boards as is evident by the repairs made with metal staples and *kozo* patches to secure splits and cracks. These boards used at the Fukunishi Studio in Nara Prefecture are 300-year-old pine heirloom drying boards. Fukunishi Studio, Nara Prefecture.

pine. Today, drying supports may include wooden boards placed in the open air to dry, wooden boards placed into heated chambers to accelerate drying and eliminating the change of poor drying weather, or heated stainless steel plates or drums that reduces drying times to a matter of minutes.

Wooden drying boards are very precious to papermakers because they have been passed down through generations. It is also difficult to get wooden planks of the same size and quality today. As a result, papermakers take good care of the boards, repairing splits and cracks as much as possible (fig. 15). These drying boards are the first things to be bought from another studio that is closing.

Once dried, sheets are removed from the boards (fig. 16), examined, and categorized by weight and quality. Weight is measured by hand in *monme*, reflecting the slight variances in handmade sheets. Any sheets that do not pass inspection are reprocessed into fibers. Figure 17 summarizes the steps in making *washi* and the reader may refer to Appendix A for a glossary of terms and Appendix B for a chart summarizing the effects of materials and methods on *washi* quality. The papermaking process is incredibly labor intensive. According to the Tosa Washi Museum in Kochi Prefecture, only 4% of the raw materials are represented in the final product.

CHARACTERISTICS AND HISTORY OF *WASHI* COMMONLY USED IN PAPER CONSERVATION

Conservators approach *washi* with treatment in mind. The types used for treatment have been carefully selected for their physical and chemical properties that align with the goals of the conservator. However, what is exciting and interesting is that there is a long history attached to *washi.* Each type of *washi* was carefully engineered for specific uses long before it was used for Western conservation. Understanding the history of the papers used in conservation can also help inform conservators of the characteristics each paper has that may be

Fig. 16. Mrs. Fukunishi removing dried *udagami* sheets from wooden drying boards. Fukunishi Studio, Nara Prefecture.

helpful in treatment. It is important to note that, as of 2014, three types of *washi* were registered as UNESCO Intangible Cultural Heritage of Humanity: *sekishu-banshi*, *hosokawa-shi*, and *hon-minoshi*. *Sekishu-banshi* and *hon-minoshi* will be discussed in more detail below. *Hosokawa-shi* is made in Saitama Prefecture (fig. 18)—this paper celebrates a long history and was and is prized for its quality. Below is a summary of the history of four types of *washi* most commonly used in conservation: *tengujo*, *sekishu-banshi*, *usumino*, and *udagami*.

TENGUJO

The first mention of *tengujo* can be traced back to the 15th century (Masuda 1985). Traditionally, *tengujo* was used as

1.	Harvesting Raw Materials
2.	Bark Preparation
3.	Cooking Bark
4.	Rinsing, Chiritori
If nontraditional methods are followed, Chemical Bleaching	
5.	Beating Fibers
6.	Sheet Formation
7.	Pressing & Drying
8.	Inspection

Fig. 17. The procession of the steps involved in making *washi*.

filter paper, for cleaning lenses, and wrapping precious objects. Later, it was in high demand for uses related to typewriters and mimeographs (Hughes 1978). *Tengujo* as we know it today is made in Ino-cho in Kochi Prefecture (fig. 18) using only the *shirokawa* (white) layer of *tosa kozo* (Masuda

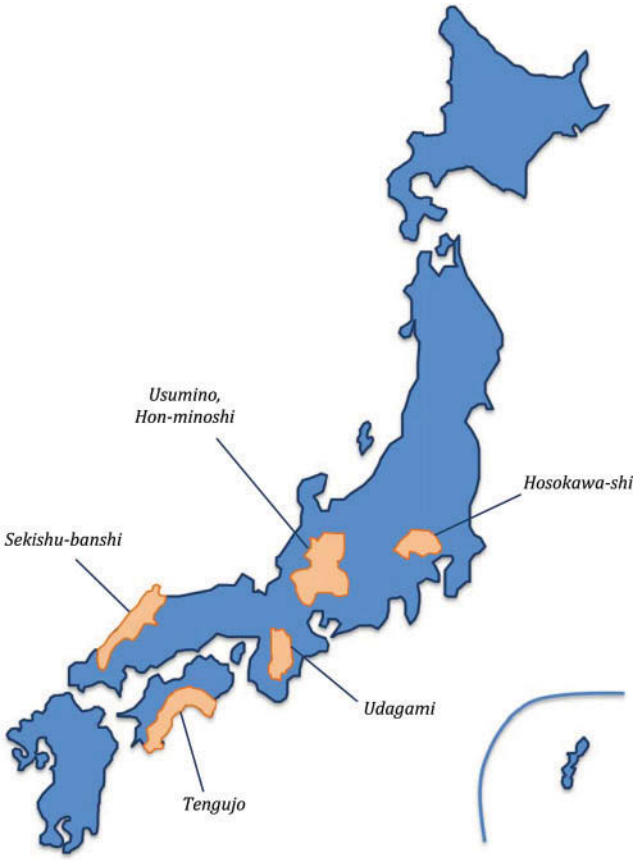

Fig. 18. Map showing the location of four types of papers commonly used in conservation. *Tengucho* is made on Shikoku Island in the south in Kochi Prefecture. *Sekishu-banshi* is made in Shimane Prefecture on the west coast off of the Sea of Japan. *Usumino* is made in the Mino area (bottom half) of today's Gifu Prefecture. *Udagami* is made in Yoshino in the middle of Nara Prefecture. In addition to *sekishu-banshi*, the other two UNESCO papers are also shown: *hanminoshi* made in Gifu Prefecture, and *hosokawa-shi* made in Saitima Prefecture.

1985). Kochi papermakers incorporate a second fiber-rinsing step conducted after the beating step. The fibers are placed in a basket called *koburi* (fig. 19) while rinsing to further remove hemicellulose and other plant impurities (Barrett 1983; Masuda 1985). The additional rinsing step is unique to Kochi Prefecture and produces paper that is softer, with more "give." According to Hidaka Washi Co., Ltd. (2017), Kochi *tengujo* is the thinnest handmade paper in the world with a thickness of 0.03 μm, and the thinnest machine-made paper with a thickness of 0.02 μm.

SEKISHU-BANSHI

Sekishu-banshi is made in Shimane prefecture (fig. 18) and is one of the oldest types of 100% *kozo* papers with records mentioning it in the 8th century (Masuda 1985). *Sekishu* was known for its strength and was used for account books, windows and sliding doors, and *karibari* boards (Hughes 1978). *Banshi* or *hanshi* means "half sheet" and refers to the size 9.8 × 13.8 in. (24.9 × 35 cm) and is only used in reference to 100% *kozo* papers of this particular size (Hughes 1978). Today there are two other sheet dimensions for *sekishu-banshi*: 19.6 × 27.5 in. (49.7 × 69.8 cm) and 23.98 × 35.7 in. (60.9 × 90.6 cm) (Masuda 1985). *Sekishu* is made with the *nazekawa* (green) and *shirokawa* (white) layers of locally grown *kozo* bark (fig. 20). The green layer is composed mostly of hemicellulose, which helps fibers bond together. The incorporation of the green layer in *sekishu-banshi* produces a stronger paper with a distinct rattle and slightly warmer color than other *kozo washi*. This paper is traditionally made with a kaya screen, although bamboo screens are also used.

It is important to note that there are two types of *sekishu* available to conservators today: *sekishu-mare* and *sekishu-tsuru*. These names are an indication of paper quality. *Sekishu-mare* has been made strictly following the traditional methods. *Sekishu-tsuru* has been made with the incorporation of more modern techniques to decrease production times and includes the use of caustic soda, machine beating, and heated steel drying plates. The difference in production methods is also reflected in the retail price for each type of *sekishu*.

Fig. 19. A *koburi* basket on display at the *Tosa Wahi Musuem* in Kochi Prefecture. The basket is used for the additional rinsing of fibers after they are beaten. This step is unique to papermaking in Kochi.

Fig. 20. Papermakers retain the green *nazekawa* layer of the *kozo* bark when making *sekishu-banshi*. This layer is composed mainly of hemicellulose and imparts unique characteristics of the paper. Sekishu Kubota Studio, Shimane Prefecture. Credit: Jacinta Johnson.

USUMINO

Usumino is made in the Mino area of Gifu Prefecture (fig. 18) and is also one of the oldest papermaking areas. There are references to Mino *washi* dating from the 8th century (Masuda 1985). This type of *washi* is recognized for its extremely fine quality. This is because of the quality of *kozo* used, its excellent fiber distribution, and even sheet formation. Only the *shirokawa* (inner white) layer of *nasu kozo* is used to make *usumino* (Masuda 1985). Papermakers in the Gifu Prefecture use mallets that are unique to this area for beating fibers. The mallets have grooves cut in a starburst pattern on the beating face of the mallets (Hughes 1978). Historically, heavier weight *washi* made in the Mino area was used for the windows of the guest room called the *shoin* because its fine quality allowed an even, diffused light into the room, uninterrupted by slubs (Hughes 1978; Masuda 1985). This type of paper is called *shoin-shi*. *Usumino* is selected by scroll mounters for the first lining of artworks made for hanging scrolls because the artworks are on fairly thin, translucent supports (Masuda 1985). The flawlessness of *usumino* does not disrupt the appearance of the artwork.

UDAGAMI

While *udagami* is not ubiquitously used for treating Western paper objects, it is used for scroll mounting. *Udagami* is made in Yoshino in Nara Prefecture (fig. 18). Paper made in this

area of Japan is referenced as early as the 15th century and was recognized for its thinness and quality (Masuda 1985). *Udagami* is used as the final lining in scroll mounting because of its stiffness, resistance to insects and heat, and minimal reactiveness to moisture.

The *shirokawa* (white) layer of locally grown *kozo* is used to make *udagami*. Kaolin filler is added to the pulp before the formation aid and is what imparts the unique characteristics to this type of *washi*. The amount of clay added to the vat is determined by the thickness of the paper to be made. A different formation aid called *nori-utsugi* is used in Yoshino instead of *neri* and is a mucilage extracted from the bark of a locally grown shrub (*Hydrangea paniculata Sieb.)*. Another distinctive characteristic of *udagami* is that it is made on a long and narrow mold approximately 12.5 × 57.2 in. long, fitted with a kaya screen (fig. 12). This size is a more recent introduction to the making of *udagami* (Masuda 1985).

EXAMINATION OF *WASHI*

Knowing what kind of *washi* is being used in treatment is important for ethical practice and for maintaining respect for cultural heritage. There are challenges to understanding *washi*. It may be difficult to follow the many variations on spellings of *washi* names or deciphering specific names of papers versus more general names of categories of papers. Additionally, language barriers for those who are not fluent in Japanese or immersed in the *washi* culture can lead to misunderstandings. To further complicate matters, names that once stood for quality *washi* no longer can be used as a guide when ordering conservation quality papers (Jacobi and Mizumura 2016). Finally, manufacturers' details can be difficult to obtain, making it harder to ensure that quality papers are selected. Thankfully, *washi* suppliers are aware of this and provide as much information as they can for the papers that they offer.

There are certain features of *washi* that will indicate manufacturing methods and fiber furnish. These characteristics will inform the conservator of the quality of papers selected and their behavior during and after treatment, such as strength, reactivity to moisture, and long-term stability. These features are also unique markers related to the historical and cultural importance of this material. Knowing what these characteristics and markers are will help conservators select quality papers for specific treatment uses as well as help respect the beautiful cultural heritage of *washi*. This will allow more detailed information about materials to be incorporated into treatment records for future reference. In this section, the following markers and characteristics that influence *washi* quality will be discussed: fiber furnish, cooking and bleaching agents, fiber processing and distribution, screen impressions left in the papers, machine-made or handmade papers, and drying methods.

FIBER FURNISH

Identifying the fiber furnish of *washi* will help discern traits like flexibility, reactivity to moisture, and predict how the paper will age as each fiber type has different quantities of lignin and hemicellulose. Also, a specific type of *washi* may be desirable in treatment with a specific type of fiber furnish. For example, a fill might be necessary in a more modern work of art that has been made on a paper with *kozo* and sulfite wood pulp fiber mixture. This section will focus on observations made using visuals, sound, and touch, and will not discuss technical analytical methods.

The three traditional fibers for *washi* are *gampi*, *mitsumata*, and *kozo*. However, papers made with *kozo* are the most common in conservation, making logical deduction easier in this challenge. Today, some *washi* marketed as traditional papers have pulp mixtures of one of the three traditional fibers with hemp and/or sulfite wood pulp. *Gampi* has the shortest and weakest fibers and is the most reactive to moisture. A sheet of *gampi* has a warmer color with a high luster, very smooth surface, and exhibits a significant degree of translucency at lighter weights. Another distinctive characteristic of *gampi washi* is a very loud rattle when shaken.

Mitsumata looks similar to *kozo* and it can be difficult to differentiate between the two. The fibers are shorter than *kozo* and the paper is slightly weaker and more opaque than *kozo* papers when viewed through transmitted light. *Mitsumata* is more lustrous and softer than *kozo* papers, which is why it is historically described as a feminine fiber.

Kozo fibers are the longest and strongest of the traditional fibers and the *shirokawa* (white) layer has the least amount of lignin and hemicellulose content in comparison with the other two bast fibers. *Kozo* paper has more of a rattle when shaken than *mitsumata* papers and has some luster. *Kozo* papers are also slightly more translucent than *mitsumata*. Thai *kozo* can be harder to differentiate when comparing two types of *kozo* papers. However, the fibers are shorter and are less supple and lustrous than Japanese *kozo*. Papers made with Thai *kozo* are often whiter because they have been cooked with stronger alkalis and are regularly chemically bleached as well.

Kozo and sulfite wood pulp fiber or *kozo* and hemp fiber mixes produce duller papers that are more opaque in transmitted light. These papers are not as resilient when flexed and do not have as crisp of a rattle when shaken compared to pure *kozo* papers. Additionally, the rough side is fuzzier and feels courser because of the short wood fibers. Like Thai *kozo* papers, *kozo* and wood pulp mixes are cooked with caustic soda and chemically bleached.

COOKING AGENTS AND CHEMICAL BLEACHING

Differentiating between types of cooking agents when examining papers without any context can be challenging.

However, some qualities can help guide the conservator in the right direction. Papers made strictly following traditional methods will have warmer yellow-cream tones, with good flexibility, and will feel "healthier." Stronger cooking agents, particularly caustic soda, produce lighter colored, less supple, and weaker papers. Bleached fibers will have similar characteristics as papers cooked with caustic soda but they will also be unnaturally bright white. Papers made with fibers cooked with strong alkali agents and/or chemically bleached will be stiff and coarse to the touch and will be weaker. Both types of papers will not age well because these processes have chemically damaged the fibers. It is important to note that when chemical bleaching is used in the manufacturing of *washi*, there is no need to carefully process the bark by removing the different layers, which is done when making good quality paper. Instead, all components of the bark are processed and a very poor quality paper is produced. To make things more complicated, some bleached papers are redyed to make them look like the warmer, traditionally made *washi*.

FIBER PROCESSING AND DISTRIBUTION

If fibers are not beaten thoroughly, slubs (clumps of fibers) will be present in the *washi* and are more visible in transmitted light. More slubs may indicate less care taken in processing fiber; however, the presence of a few slubs can be a good indication that the paper is handmade. Three examples of papers with varying degrees of fiber processing viewed in transmitted light are shown in Figure 21.

Even distribution of fibers in a sheet may also be determined using transmitted light. Less transparent areas in a sheet indicate a denser area of fibers. Significant variances in transparency, or a mottled appearance in transmitted light, is a sign of uneven, poorly distributed fibers. This happens during sheet formation or when an incorrect amount of dispersion agent (*neri* or *nori-utsugi*) is added to the pulp (Barrett 1983). Figure 21 also shows a range in fiber distribution quality in different quality sheets.

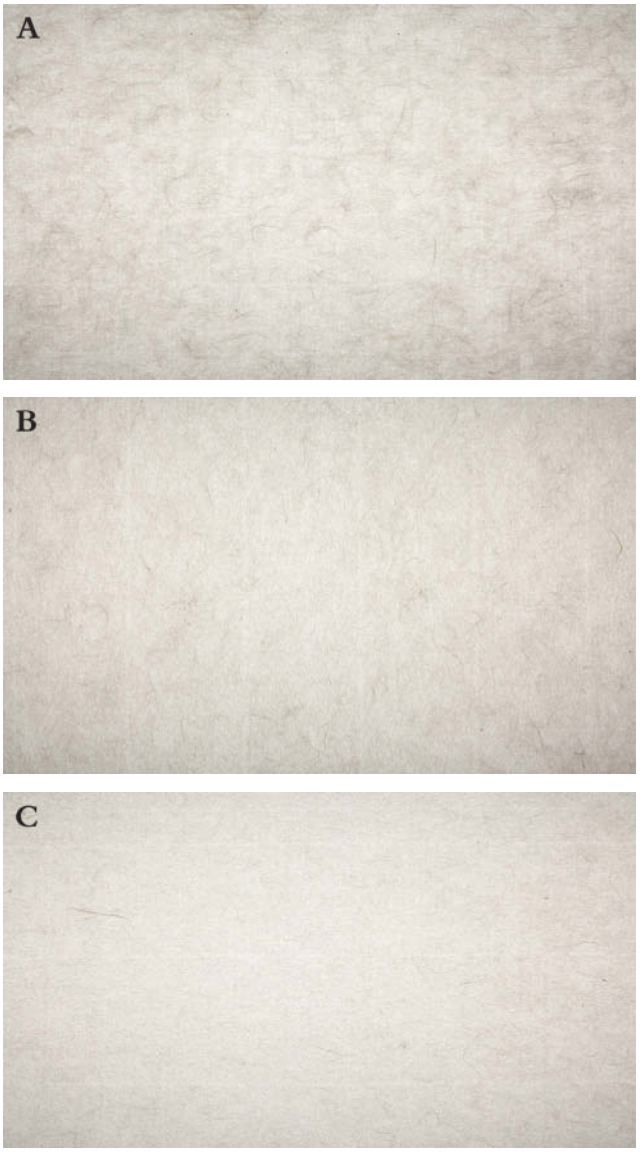

Fig. 21. Three different papers in transmitted light arranged from poor quality to excellent quality (a–c). The first image depicts poorly processed fibers and poor fiber distribution in the sheet. The last image depicts good fiber processing and excellent fiber distribution. Credit: Matthew Hamilton.

SCREEN IMPRESSIONS

If there are chain and laid lines impressed in the *washi*, there are two kinds of *su* (screens) that may have been used. As mentioned earlier, the *su* is a flexible mat made with bamboo or kaya as the laid supports and silk woven around the laid supports to form the chain lines. It is possible to differentiate between the two types of screens by looking at the chain and laid line relief patterns in the paper. The unique pattern of each type of screen is related to the construction of that screen.

Bamboo screens are constructed by cutting bamboo splints to the desired diameter. Then half the diameter of the splints is cut away at either end. The splints are lap joined to create one continuous laid line support across the width of the screen (fig. 22a). The joins are aligned at the same point for each laid support in the screen. The laid supports are secured by stitching silk chain lines at even intervals. A double chain line will be woven where the lap joins are in order to secure this weak point in the screen structure (fig. 22b). When looking at paper in transmitted light, those made with a bamboo screens will have narrower distances between chain lines, sets of narrow double chain lines at intervals, and the laid lines are much finer (fig. 22c). According to papermakers, *washi* made

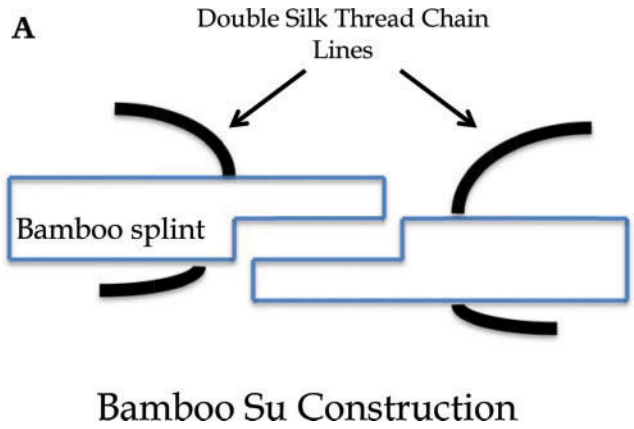

Fig. 22a. Construction of a bamboo screen.

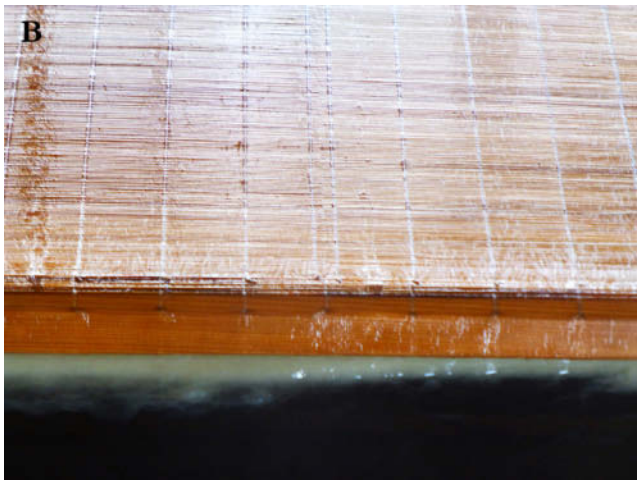

Fig. 22b. Bamboo screen.

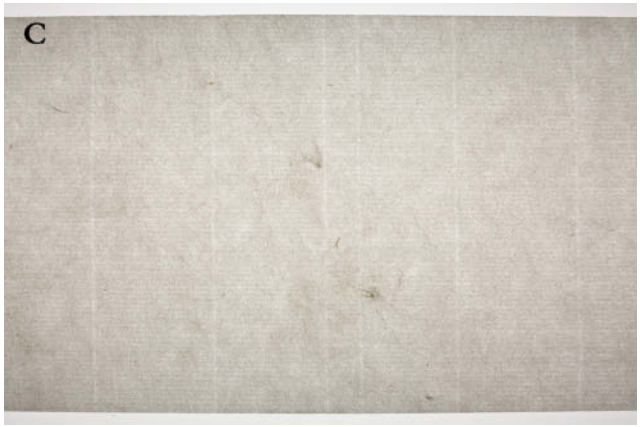

Fig. 22c. Detail of a paper made with a bamboo screen in transmitted light. The narrower chain lines, double chain lines, and finer laid lines are visible. Credit: Matthew Hamilton.

on a bamboo *su* are crisper. This may be because the laid supports are closer together and more uniform in diameter, affecting the way the fibers lay on the screen during sheet formation.

Kaya screens are made using the hollow kaya (*Miscanthus sinensis*) grass. The harvested grass is sorted by diameter. The grass is aligned end to end and joined by placing a thin bamboo splint inside the hollow grass to secure the butt join (fig. 23a). The single chain lines are sewn to secure the kaya laid supports regardless of where the joins are placed (fig. 23b). The kaya *su* has wider distances between chain lines than bamboo screens. The diameters of the kaya supports are also slightly larger, more pronounced, and more irregular when viewing the chain and laid patterns with transmitted light (fig 23c). Also, the papers made from kaya *su* are softer. The patterns of chain and laid lines will help indicate the type of *washi* in question as specific types of *washi* are traditionally made with a bamboo or kaya screen. For example, *sekishu-banshi* and *uda-gami* are traditionally made with a kaya screen.

The lack of chain and laid lines may indicate that the *washi* was made with a silk *sha* placed over the *su*. A *sha* is a silk cloth made with the leno, or gauze weave, an open but strong weaving technique. The *sha* is often placed onto a *su* when making thinner papers to catch the fibers. This masks the chain and laid lines of the *su* and will make a paper with a wove screen pattern. The lack of chain and laid lines may also indicate that the *washi* is machine-made.

MACHINE-MADE OR HANDMADE

When determining if a paper is handmade or machine-made, size is often the most helpful indicator. Machine-made *washi* can come in any length and the width is larger than the width of most handmade *washi* molds. The presence of deckled edges may also help determine if it is machine-made or handmade. Machine-made paper will have two deckled edges with the exception of *tengujo*. Handmade paper can have three (when the sheet is cut in half) or four deckled edges unless all edges have been trimmed, as is often the case with *tengujo*. Finally, grain direction of a paper is also helpful in identifying a machine-made paper. The grain direction of machine-made *washi* is stronger in the machine direction. Handmade *washi* grain direction will be slightly less distinctive, with the grain being stronger in the chain line direction because this is the dominant direction of movement during *nagashizuki* sheet formation.

DRYING METHODS

The drying method used in making *washi* can be determined by examining the surface texture of both sides of the sheet. Handmade *washi* will have a rough side, the side of the paper that the brush was passed over when attaching it to the drying board. Brush marks on the rough side are often visible in raking light (fig. 24). The smooth side of *washi* has been in contact with the drying support. If it is very smooth, the paper was dried on a heated metal plate. If it is moderately smooth, the paper has

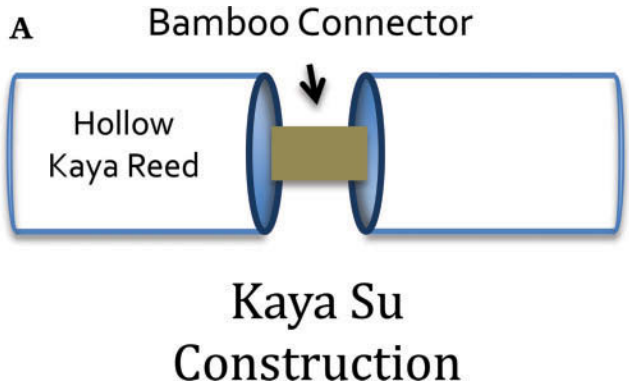

Fig. 23a. Construction of a kaya screen showing the double chain line.

Fig. 23b. Detail of a kaya screen showing the random placement of laid support joins.

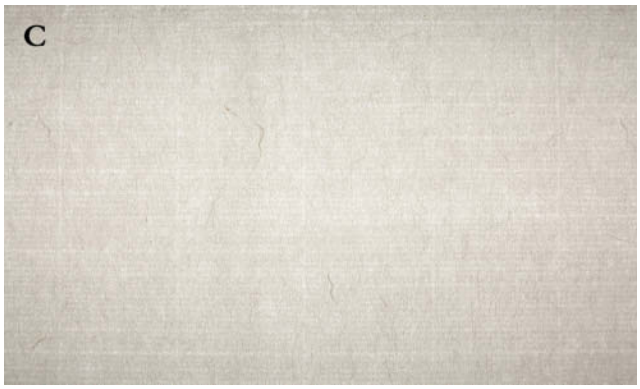

Fig. 23c. Detail of a paper made with a kaya screen in transmitted light. The wider chain lines and inconsistent, pronounced laid lines are visible. Credit: Matthew Hamilton.

been dried on a wooden board. Looking for these traits in a paper will help determine how severely it will react to moisture: papers dried on wooden boards will expand and contract less than papers dried on heated metal plates (Nicholson and Page 1988). This is because the heated metal plates dry the papers very quickly. Papers dried this way have more moisture removed from the fibers, causing shrinking and creating a lot of stress in the paper, making it highly reactive to moisture.

Fig. 24. The brush marks visible in racking light on the rough side of a sheet of *washi*. The marks are imbedded on the paper as it is brushed onto the drying support.

Identifying these characteristics of *washi* will give a sense of how the *washi* will react during treatment. Even fiber processing and distribution will mean that the *washi* will behave uniformly across the sheet. It is also an indication of quality and care in making the *washi*. Drying methods will greatly influence the dimensional changes of the paper when introduced to moisture and may inform the conservator's use of that paper in treatment (for example, prewetting papers dried on heated steel plate prior to lining). Identifying machine-made versus handmade may help select higher quality papers necessary for certain tasks or treatments. While there are good quality machine-made papers for use in conservation, a good quality handmade *washi* following traditional methods with Japanese cultivated *kozo* will be of higher quality because less physical and chemical damaging of the fibers has occurred, and the locally grown *kozo* is of better quality than Thai *kozo*.

THE FUTURE OF *WASHI*

Handmade *washi* is on the decline as it becomes more and more difficult to get the raw materials needed to make quality papers. The traditional process is very labor intensive with little profit, pushing younger generations toward more appealing careers. Consequently, many species of *washi* are vanishing as papermakers end their careers. In 2013, the Japanese government recorded only 170 papermakers still working (Megumi and Moriki 2017). A similar decline is observed in the tool-making trade associated with the papermaking trade—making it more difficult for papermakers to get the tools they need (figs. 25 and 26). While the situation seems dire, there is some hope. Many of the papermakers

Fig. 25. Mr. Ichibei Iwano, National Living Treasure and maker of *hosho washi*. Echizen, Fukui Prefecture. Credit: Jacinta Johnson.

Fig. 26. Mr. Yamamoto, the last *su* maker. Kochi Prefecture. Credit: Jacinta Johnson.

Fig. 27. So Kubota making sekishu. *Sekishu* Kubota Studio, Shimane Prefecture. Credit: Jacinta Johnson.

Fig. 28. Osamu Hamada, papermaker. Hamada Washi Studio, Kochi Prefecture.

visited on the Hiromi Paper Inc. *2017 Washi Tour* had a younger generation family member who was interested in learning the trade (figs. 27 and 28).

CONCLUSION

Washi holds a very important role in book and paper conservation because of its unique qualities and good aging characteristics. However, the *washi* industry has undergone many changes that have been largely unaccounted for in conservation literature. In response to differences in quality of some *washi* caused by these changes in the industry, conservators can assess a paper's quality by understanding how traditional papers are made and look for certain characteristics and marks formerly discussed that can help indicate paper quality. This practice will also help to keep the cultural importance of *washi* in mind.

Much more work is needed to update what the profession understands about *washi*. The composition and aging properties of *washi* used in conservation should be reexamined. Efforts to create a relevant reference would be invaluable, with standardized descriptive terminology used to communicate *washi* characteristics, and ensuring that what is understood is based on reliable translations of the Japanese language and *washi* culture. Finally, with the awareness of the fragility of the *washi* industry, conservators should investigate how to help sustain this industry it relies so heavily upon.

ACKNOWLEDGMENTS

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techniques and for helping me to build my foundation in understanding *washi.* I would like to extend a final, special acknowledgment to all the papermakers who are dedicated to carrying on the trade of making traditional *washi* and to whom book and paper conservators are indebted to for their quality product.

APPENDIX A

GLOSSARY

Banshi or hanshi: A term that means "half sheet" and refers to a paper size that was popular in the middle ages: 9.8 × 13.8 in. (24.8 × 35.0 cm) used in reference to 100% *kozo* papers of this particular size.

Dosa: A mixture of animal glue and alum sometimes used as an external sizing agent.

Kaya: A hollow grass, *Miscanthus sinensis*, used to make screen supports. Kaya screens are often used for making certain types of papers like *udagami* and *sekishu-banshi*.

Keta: The deckle and mold frame of the Japanese paper mold that is hinged together.

Koburi: The special type of basket used to rinse fibers used for the additional rinsing step unique to papermaking in Kochi Prefecture.

Kurokawa: The outer black layer of the *kozo* bark.

Nagashizuki: The Japanese sheet formation technique.

Nazekawa: The middle green layer of bark composed mainly of hemicellulose.

Neri: A plant mucilage extracted from *tororo-aoi* (*Hibiscus Manihot*) that has a stringy, slippery consistency similar to mucus. The mucilage is added to pulp as a fiber dispersion agent.

Nori-utsgi: A different formation aid used in Yoshino instead of *neri.* It is also a mucilage extracted from the *Hydrangea paniculata Sieb.* shrub.

Sha: A silk cloth made using the leno, or gauze weave, an open but strong weaving technique. The *sha* is placed over the *su* in a paper mold to create wove patterned paper and is often used when making very thin papers.

Shirokawa: The inner white layer of bark where the quality bast fibers are located in *kozo* bark.

Su: The flexible, removable laid support that forms the screen in the paper mold. It is made from organic materials such as bamboo or kaya instead of metal wire.

Suketa: The name of the Japanese paper mold used when referring to both the screen and the hinged deckle and mold frame.

APPENDIX B: Methods of manufacturing *washi* and how it affects paper quality

Quality	Kozo Source	Cooking Agents	Bleaching	Beating Methods	Drying Methods
Excellent Quality	Japanese *Kozo* i.e., *Nasu* or *Tosa Kozo*	Wood Ash/Pot Ash, Potassium Carbonate, K_2CO_3	Natural Bleaching, Light	Hand Beating with Wooden Mallets	Wooden Boards, Outdoors
		Slaked Lime, Calcium Carbonate, $Ca(OH)_2$		Foot-Powered Stamper Mechanical Beater	Wooden Boards, Heated Chambers
	Thai Kozo	Soda Ash, Sodium Carbonate, $NaCO_3$		*Naginata* Beater	
Poor Quality	Thai Kozo/Fiber Mix (Hemp, Sulphite Wood Pulp)	Caustic Soda, Sodium Hydroxide, NaOH	Chemical Bleaching, Sodium Hypochlorite, NaClO	Hollander Beater	Heated Stainless Steel Plate or Drum

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