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Japanese paper: History, development and use in Western paper conservation

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Japanese paper in the UK

1 History

The earliest known paper fragments were discovered in north-west China, dating back to the Western Han Dynasty (206 BC–AD 8). These fragments were made of coarsely pounded and unmacerated fibres of hemp (*Cannabis sativa*) and ramie (*Boehmeria nivea*).[1] A Chinese court official Cai Lun (AD 50–121) of the Eastern Han Dynasty (AD 25–220) is associated with the invention of papermaking, usually given as AD 105. The use of plant fibres and evolvement of the papermaking process enabled paper to replace bamboo, wooden strips and silk as a support for writing.[2]

The papermaking technique using hemp and ramie was transmitted to Japan via Korea. It is assumed that paper was introduced at an earlier date, but it is in *Nishon Shoki* (Chronicles of Japan, AD 720) that the manufacture of paper was first mentioned. *Nishon Shoki* says that a Korean Buddhist priest, Dam Jing, who knew how to produce colourants, paper and ink, was sent to Japan in AD 610.[3] The Japanese Imperial Court encouraged the development of papermaking, and abundantly available *kōzo* (楮, *Broussonetia kazinoki x B. papyrifera*) became the main raw material. It was during the Heian period (AD 794–1185) that wild-grown *gampi* (雁皮, *Wilstroemia sikokiana*) was introduced to papermaking. It is considered that *mitsumata* (三椏, *Edgeworthia chrysantha*) was originally brought from China in the later Muromachi period (1337–1573), and it was not until the late eighteenth century (the Edo period, 1603–1868) that paper was made from *mitsumata*.[4]

In 1543, Francis Xavier, a Basque Roman Catholic missionary, was sent to Japan by the Society of Jesus, and many other missionaries followed. They brought Western paper and wrote reports for their members in India and Europe. When their terms of services were extended, they started using local *gampi*-based paper, especially *torinoko* (鳥の子, meaning 'bird's child' from its glossy, eggshell-like surface), which has smooth texture and appropriate hardness on which to write with a pen and ink.[5]

The Tokugawa shogunate (the last feudal military government) enacted the isolation policy from most foreign countries in 1639 to eliminate any religious and colonial influence. During the seclusion in the Edo period, the Dutch were the only Europeans permitted to trade. George Biörklund mentioned, during his examination of the Dutch East India Company's records, finding two records in the mid-seventeenth century that named Japanese paper among their exported goods.[6]

During the Edo period, a wide variety of paper was manufactured in Japan. Although the majority was *kōzo*-based paper, such as *hosho* paper (奉書紙, named as the paper for official government documents), *sugihara* paper (杉原紙, thinner than *hosho*, used for official documents by samurai, warrior nobilities), and *mino* paper (美濃紙, used for the high quality *shoji* paper door and documents), the West was more interested in *gampi*-based paper.[7] *Nippo Jisho* (Japanese–Portuguese Dictionary), published by missionaries in

1 Yasuo Kume, *Zoushi no Genryu* [Origin of papermaking] (Tokyo, Japan: Yushodo, 1995), 33.

2 Bunsho Jugaku, *Nihon no kami* [Japanese paper] (Tokyo, Japan: Yoshikawa Kobunkan, 1967), 35.

3 Ibid., 1.

4 Ibid., 25.

5 Yasuo Kume, *Washi—tasai na you to bi* [Japanese paper—various uses and beauty] (Tokyo, Japan: Tamagawa University Press, 1998), 13–14.

6 Biörklund, *Rembrandt's Etchings, True and False* (Stockholm, 1955). The first document (1 October 1643) is an invoice of the ship De Swaen for two casks of Japanese paper and the second document (6 November 1644) mentions 'merchandise (3,000 sheets of Japanese paper) to be delivered by the Japanese both for the Netherlands and for India'; Kume, *Washi—tasai na you to bi*, 17–18; Sho Kida, *Rembrandt to washi* [Rembrandt and Japanese paper] (Tokyo, Japan: Yasaka Shobo, 2005), 107–8.

7 Kida, *Rembrandt to washi*, 131.

1603, described some Japanese papers and half of them were *gampi*-based.[8] It is well known that Rembrandt executed many of his prints on papers of Oriental origin, especially *gampi* paper, from the late 1640s.[9]

The seventeenth-century English writer and diarist John Evelyn wrote about Japanese paper in his diary of 22 June 1664.[10] He met a merchant in London, who showed him a collection of rarities sent from the Jesuit missionaries in Japan and shipped by the East India Company. Among the collection there were some papers, which he described as:

> a sort of paper very broad, thin, and fine, like abortive parchment, and exquisitely polished, of an amber yellow, exceedingly glorious and pretty to look on, and seeming to be like that which my Lord Verulam (Francis Bacon) describes in his *Nova Atlantis*.[11]

About 200 years later, when the first Great Exhibition was held in London in 1851, only a small number of Japanese goods were displayed in the Chinese section. However, when the period of isolation ended in 1853, information and artefacts began to flow out of Japan towards Europe.[12]

In 1859 Sir Rutherford Alcock was appointed as British Consul-General in Japan. When he climbed Mount Fuji as the first non-Japanese in the following year, he visited a *gampi* papermaking mill in Atami (current Shizuoka Prefecture) on the way back to Edo. He conducted a survey on Japanese paper and sent the report and papers to the British government. Those papers were displayed in the Japanese section at the 1862 International Exhibition in London, and had a great influence on the British in terms of their aesthetic appeal.[13] *The Times* of 29 March 1862 reported, 'China and Japan will both be splendidly represented in all their varied branches of arts and art-manufactures . . . There will also be a fine collection of arms and armour, scent bottles, exquisite ivory carvings, Japanese metal work, with paper, silk, crape and cotton tapestry'.[14]

Sir Harry Smith Parkes was appointed as Alcock's successor. At Prime Minister William E. Gladstone's request, he and his staff conducted thorough surveys and published a government report in 1871 on the manufacture of Japanese paper, with 412 paper samples. The Victoria and Albert Museum currently houses the Alcock, and a part of the Parkes, collection; with the rest at the Royal Botanic Garden, Kew.[15] Their stories show a strong connection with Japanese paper between Japan and Britain.

A hundred years after the International Exhibition in London, the Arno River in Florence flooded in 1966. The heart of the city disappeared under 3 m of water, which damaged millions of masterpieces of art and rare books. Experienced and skilled conservators around the world gathered and developed conservation methods and materials. Japanese paper and tissue were used to repair books and to remove fuel oil from fresco paintings. It is said to be the first occasion Japanese paper was widely used in Western paper conservation.[16]

2 Japanese paper trades in modern times

Moriki Paper Company was established in 1925 in Yokohama (currently located in Tokyo) by Yasumi Moriki, grand-uncle of the current president Takao. They supplied Tosa *tengujo* paper (土佐典具帖紙, thin *kōzo* tissue, its manufacture started in Tosa in 1880) and other Japanese papers, especially for overseas markets. Previously the family had been papermakers in Tosa (current Kochi Prefecture).

After the Second World War, the company was exporting Tosa *tengujo* for typewriting and *gampi* paper for mimeograph via major Japanese trading companies. During the presidency of Takao's father, Shinji, the company started exporting paper directly to North America in 1979, distributed via

8 Kida, *Rembrandt to washi*, 133.

9 Ibid., 136–7.

10 Kume, *Washi—tasai na you to bi*, 18.

11 John Evelyn, *The Diary of John Evelyn*, vol.1, ed. William Bray (London: M. Walter Dunne, 1901), 373–4.

12 University of Oxford, 'Made in Japan, Japanese things owned by Pitt-Rivers', Pitt Rivers Museum, http://web.prm.ox.ac.uk/rpr/index.php/article-index/12-articles/266-japanese-artefacts/ (accessed 17 July 2017).

13 Kume, *Washi—tasai na you to bi*, 28–31; Kida, *Rembrandt to washi*, 29–30; Seishi Machida, *Washi no michishirube—sono rekishi to kagaku* [Handbook of Japanese paper—its history and chemistry] (Kyoto, Japan: Tanko-sha, 2000), 53–4.

14 The Amateur Casual, 'The International Exhibiton of 1862', *The Victorianist*, 30 November 2010, http://thevictorianist.blogspot.co.uk/2010/11/international-exhibition-of-1862.html (accessed 17 July 2017).

15 Kume, *Washi—tasai na you to bi*, 31–2; Kida, *Rembrandt to washi*, 28.

16 Scott W. Devine, 'The Florence flood of 1966: A report on the current state of preservation at the libraries and archives of Florence', *The Paper Conservator* 29 (2005): 15, 20.

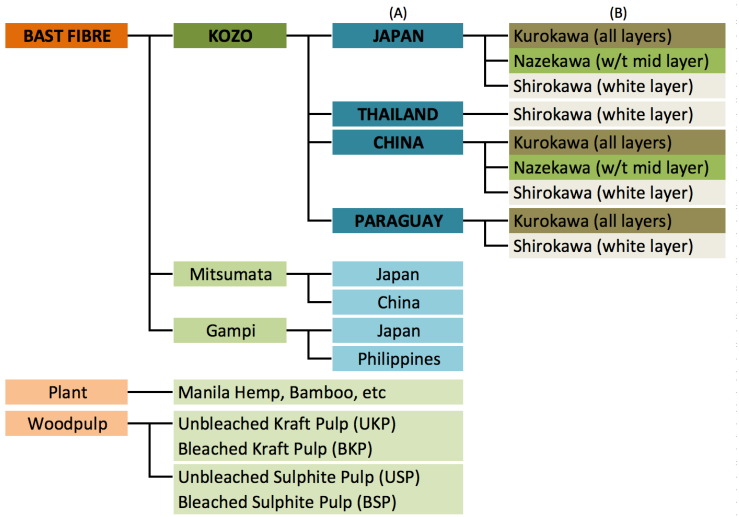

Fig. 1 Raw materials in the current Japanese papermaking: (A) shows origins of bast fibres and (B) shows fibre preparation of *kōzo* fibres.

Andrews / Nelson / Whitehead of New York.[17] As of 2015, most of their papers from various areas of Japan are being distributed over North America via the Japanese Paper Place in Canada.

Japanese papers, such as Tosa *tengujo* and *mino*, were exported to Europe, including England, via the British trading company Berrick Brothers Ltd, who had branches in Yokohama and London, until 1983. Since then their papers have been supplied by a few German distributors (e.g. Römerturm Feinstpapier GmbH & Co. KG, near Cologne) and, in the UK, paper for conservation has been sold at John Purcell Paper and Shepherds (inc. Falkiner Fine Papers). One of the company's international projects was the conservation of the Duchess Anna Amalia Library in Weimar, Germany, after a fire in 2004. They supplied a machine-made Japanese tissue, manufactured by Kashiki Seishi, who uses only Japanese domestic grown *kōzo* fibre.

17 Judith Walsh, 'The Japan Paper Company', *Hand Papermaking* 16, no. 1 (2001).

The current Japanese papermaking procedures

1 What is *washi*?

Paper made from bast fibres such as *kōzo*, *mitsumata* and *gampi* was generally called *kami* (紙, meaning paper), or by its paper name, such as *torinoko*. With the introduction of Western machine-made papermaking in the Meiji period (1868–1912), the term *washi* (和紙, meaning Japanese paper) was created for the traditional methods, and *youshi* (洋紙, meaning Western paper) for machine-made wood-pulp paper. Currently, the papermaking procedure has become more complicated in Japan and *washi* is applied both to handmade and machine-made Japanese paper.

Traditionally, bast fibres have been the main raw materials for handmade Japanese paper (Fig. 1). Imports of bast fibres from other countries began in 1950 and they have become an important source. Nowadays, *kōzo* is exported from Thailand, China and Paraguay, *mitsumata* from China, and *gampi* from the Philippines, in addition to those grown domestically in Japan. Plant fibres, such as Manila hemp, bamboo and rice straw, are also used for some papers. Around 1894, wood pulp became a raw material for papermaking and has been used for both handmade and machine-made Japanese paper. Therefore, it is more difficult to define the term *washi* since its usage is not limited to handmade Japanese paper with bast fibres.

Table 1 A variety of *kōzo.*

Botanical Name	Common Name (Japanese/English/Chinese/Korean)	Species
Broussonetia kazinoki x B. papyrifera	**Kozo** (楮) E: Kozo K: Kku-ji-dang-na-mu (꾸지닥나무)	**AKASO** （赤楮）
		AOSO（青楮）
Broussonetia kazinoki Siebold	**Hime Kozo** (姫楮) E: Japanese Paper Mulberry C: Chu (楮) K: Dak-na-mu (닥나무)	
Broussonetia papyrifera (L.) L'Her. ex Vent.	**Kajinoki** (構の木) E: Paper Mulberry C: Gou Shu (构树) K: Kku-ji-na-mu (꾸지나무)	**TAORI** （手折）
		KUROKAJI （黒構）
		TAKAKAJI （高構）
Broussonetia kaempferi Siebold	**Tsuru Kozo** (蔓楮) E: Climbing Kozo C: Teng Gou (藤构) K: Dak-na-mu (닥나무)	

2 *Kōzo* cultivation

In Japan, there are *kōzo* (楮, *Broussonetia kazinoki x B. papyrifera*), *hime kōzo* (姫楮, *Broussonetia kazinoki* Sieb.), *kajinoki* (構の木, *Broussonetia papyrifera* (L.) L'Her. ex Vent.) and *tsuru kōzo* (蔓楮, *Broussonetia kaempferi* Sieb.) (Table 1). *Kōzo* is a hybrid of *hime kōzo* and *kajinoki*. *Kōzo* and *kajinoki* are commonly used in Japanese papermaking, both of which have various species. Harvesting and fibre preparation vary, depending on species and fibre qualities. *Taori* (手折) of *kajinoki* grows quickly and is easy to cultivate. *Akaso* (赤楮) of *kōzo* tends to be affected by damage, but grows better in the warm weather, yield rate is excellent and fibre grade is high. Differentiating fibre quality depending on species is not easy. For instance, the fibre quality of the middle part of *taori* bark would be better than the top part of *akaso*. In the past, *kōzo* barks were sold by parts, such as top, middle and bottom of the stem, but these days they are mixed. Well-known areas for *kōzo* cultivation are Ibakaraki and Kochi Prefectures, and their *kōzo* are sold as Nasu *kōzo* (那須楮) and Tosa *kōzo* (土佐楮) respectively, but species are not specified.[18] Some papermakers grow their own *kōzo*, while many others purchase prepared *kōzo* barks from the raw materials suppliers.

18 Bunkacho [Japanese Agency for Cultural Affairs], *Tesuki Washi—Echizen-hosho, Sekishu-banshi, Hon-Minoshi* [Handmade Japanese paper] (Tokyo, Japan: Daiichi Hoki Shuppan, 1971), 140–64.

Fig. 2 *Kōzo* in the summer. Image copyright T. Kubo.

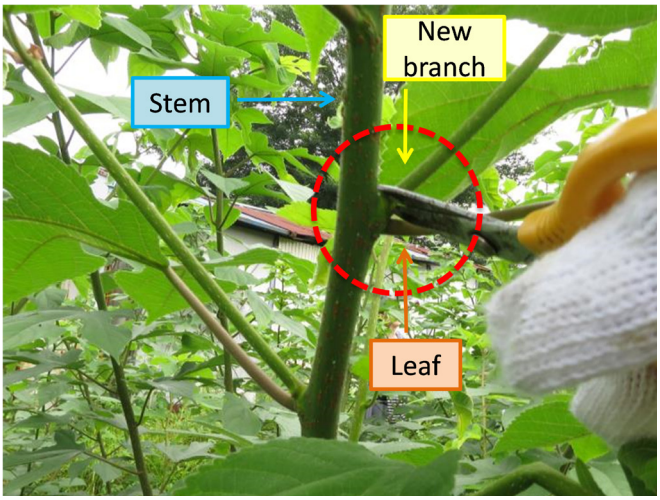

Fig. 3 Pruning a new branch. Image copyright M. Mizumura.

In spring, new shoots sprout from old *kōzo* stumps and the stems quickly grow as a bush throughout spring. In summer, stems reach more than 1 m in height (Fig. 2). New branches grown above leaves have to be pruned regularly, leaving only leaves on stems (Fig. 3). In winter, when leaves have fallen, a well-maintained *kōzo* tree has straight stems only. Without pruning, side-branches would result in scars and knots on the main stems and require removal during fibre preparation. *Kōzo* can grow to a height of 2 m to 3 m in a year, and all stems are harvested between December and January. In Niigata, where they have heavy snowfalls, harvesting is done in November before the snow arrives. In the following spring, new shoots sprout again from an old stump.

All the stems harvested are cut to 1 m length and bundled to fit into a steamer (Fig. 4). The traditional way of steaming is in a cauldron of hot water, covered with a wooden barrel. A modern method uses a stainless steel cabinet with steam coming from a boiler instead, but the theory is still the same. After two hours of steaming, the outer bark would be shrunken, exposing the inner stem. Separating the bark is carried out immediately by

Fig. 4 Trimming *kōzo* branches after harvesting (at Ogawa Washi Experience Study Centre, Saitama). Image copyright M. Mizumura.

Fig. 5 Stripping off the bark after steaming (at Oguni Washi Production Association, Niigata). Image copyright Martina Issler.

hand, since its removal would be difficult when it becomes cold. The bottom of a stem is picked with the left hand and the bark is twisted with the right hand, creating a split. The right hand pulls outwards, holding and stripping the bark, while the left hand holds the stem (Fig. 5). The left index finger could be placed between the bark and the stem, sliding down while pulling the bark. If there were a lot of knots on the stem, separating the bark in one piece would be difficult. That would make separating the outer dark layer at the later stage more time-consuming. Thus, the maintenance of pruning new branches throughout the summer is important. After stripping off, the barks are dried and stored for later use, but the inner stems have no use in papermaking and are used as fuel.

3 Fibre preparation

The dried barks are pre-soaked in water for a day or longer before fibre preparation, during which unwanted layers are removed from the bark by hand with help of knife. The knife shape and the way it is used vary from place to place.

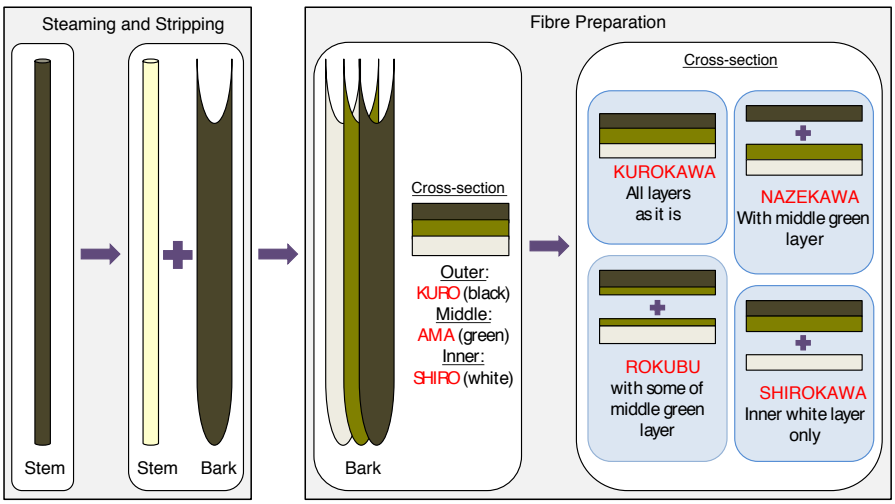

Fig. 6 *Kōzo* fibre preparation.

Fig. 7 *Kōzo*: *shirokawa*, *nazekawa* and *kurokawa*. Image copyright M. Mizumura.

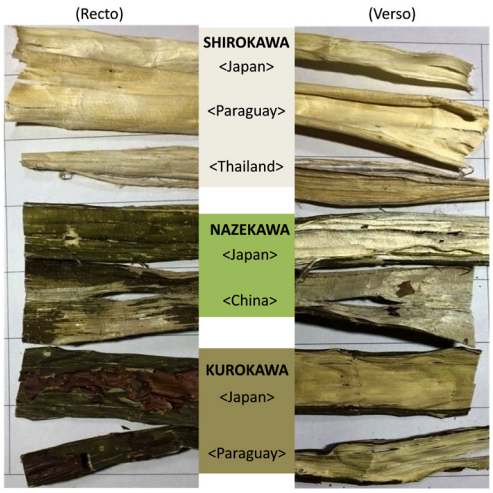

Fig. 8 Various origins of *kōzo*. Image copyright T. Kubo.

Kōzo bark consists of the outermost layer *kurokawa* (黒皮, meaning black bark), the middle layer *amakawa* (甘皮, meaning epidermis), which is greenish colour, and the inner layer *shirokawa* (白皮, meaning white bark) (Figs. 6 and 7). The barks are prepared in the following categories, depending on the type and quality of paper to be made:

1. *Kurokawa* (黒皮) is leaving all three layers.
2. *Nazekwa* (なぜ皮) is removing the outer black layer and leaving the middle greenish and white layers.
3. *Rokubu* (6分), meaning 60%, is removing the outer black layer and a part of the middle greenish layer, and leaving a part of the middle greenish layer with white layer, but is not commonly mentioned.
4. *Shirokawa* (白皮) is leaving the inner white layer only.

For the best quality paper, only the inner white layer is used, meaning less fibre is produced from the bark. The prepared barks are dried again and stored for later use.

4 Origins of *kōzo*

The *kōzo* from different origins are prepared differently and the qualities also vary (Fig. 8). Japanese *kōzo* has all three types: *kurokawa*, *nazekawa* and *shirokawa*. Only *shirokawa* is exported from Thailand, since the preparation is easier and there is more market demand for it. Chinese *kōzo* has all three types, providing an alternative to Japanese *kōzo*, and traded more than Paraguayan *kōzo*, but the quality is not constant. The quality of Paraguayan *kōzo* is similar to Japanese *kōzo*, but the amount available is small, thus they only produce *kurokawa* and *shirokawa*, which requires a shorter preparation time. In addition, the distance between Japan and Paraguay adds to the cost.[19]

Imported *kōzo* has become an important source in Japan, but there are a few problems due to the quality caused by the differences in the climate and soil. The trade of Thai *kōzo* (*Broussonetia papyrifera*) was started in 1950, but recently the origin of Thai *kōzo* has shifted mainly to Lao PDR. Once the bark is in Thailand, it is sorted out into four grades: SA, A, B and C. The highest quality is exported to Japan, while lower grades are either exported to Korea or used for domestic Thai paper.[20] Often the bark of Thai *kōzo* contains resinous substances, which are difficult to dissolve in mild alkali, and can end up as oily brownish or colourless spots in the final paper. When the paper is dyed, these spots would be resistant and remain undyed. Thus, Thai *kōzo* requires a stronger alkali, caustic soda.

19 Since the time of writing, the importation of *kōzo* from Paraguay has ceased due to lack of supply.

20 Maria Miguel Riberiro and Ika Darnhofer, *Understanding the Supply-chain of paper mulberry bark in Lao PDR using causal mapping*, Project report., part of the research project 'Spatial trade-off analyses for site-sensitive development interventions in upland systems of South-east Asia', (Vienna: Institute of Agricultural and Forestry Economics, 2007), 10–13. The report can be downloaded from: http://www.wiso.boku.ac .at/laos.html.

Table 2 Alkalis used in Japanese papermaking.

Substances	Description	Period
Wood Ash (Lye/Potash) (木灰 Kibai) Potassium Carbonate K_2CO_3	• Weak. • 60-100% of the raw material required. • Least damage to fibre. • Long cooking and fibre cleaning time. • Produce soft fibre and high quality paper.	From about 1060 years ago. Commonly used until Taisho Period (1912-1926).
Slaked Lime (消石灰 Shosekkai) Calcium Hydroxide $Ca(OH)_2$	• Mild. • 30-50% of the raw material required. • Less damage to fibre. • Less cooking and fibre cleaning time. • Insoluble mineral salts adhere to fibre, which require through rinsing.	Used from Edo Period (1603-1868). Used in Shikoku (e.g. Kochi). Paper often described as 'HAI-NI (Ash cooked)'.
Soda Ash (ソーダ灰 Soda Ash) Sodium Carbonate $NaCo_3$	• Mild. • 13-18% of the raw material required. • Less damage to fibre. • Less cooking and fibre cleaning time. • Commonly used for cooking *shirokawa*.	From 1882/1883 (Early Meiji Period).
Caustic Soda (苛性ソーダ Kasei Soda) Sodium Hydroxide NaOH	• Strongest. • 13-14% (for *kurokawa*) and 10% (for *shirokawa*). • Most damage to fibre. • Short cooking and fibre cleaning time. • Used for cooking *kurokawa* and Thai *kozo*.	Around 1890 (Mid Meiji Period).

5 Alkaline cooking

Dried barks are soaked in water for a few days before alkaline cooking, removing any water-soluble impurities in the fibre, such as tannin, starch, protein and fat.[21] During the alkaline cooking many non-cellulose components, such as hemi-cellulose, lignin, pectin, glucose and minerals are liquefied by hydrolysis.[22] After a few hours, the bark will be softened and easily separated into fibres.

The strength of alkalis varies from weak to strong (Table 2). Wood ash (lye/potash, potassium carbonate, K_2CO_3) produces the weakest alkali, and was commonly used until the early twentieth century. It is the least damaging and produces high-quality fibre, but requires long cooking and fibre-cleaning times. Slaked lime (calcium hydroxide, $Ca(OH)_2$) is a mild alkali, used mainly in Shikoku where it can be obtained locally. Along with soda ash (sodium carbonate, $NaCo_3$), slaked lime takes less cooking and cleaning time than wood ash. They are commonly used for cooking *shirokawa*. Soda ash and caustic soda (sodium hydroxide, NaOH) have been in use from the late nineteenth century. Caustic soda is the strongest and most damaging alkali. The short cooking and preparation time means it is cheaper to produce and is used for fibre prepared as *kurokawa* for machine-made or lower-grade paper and Thai *kōzo*.[23]

Paper made from fibres cooked with slaked lime are sometimes labelled as *haini* (灰煮). In Japanese, wood ash is called as *kibai* (木灰) and slaked lime as *shosekkai* (消石灰). Both use the same Chinese character '灰' at the end, meaning ash, which can be also read as *hai* in Japanese. Thus, the paper made from lime-cooked fibre is sometimes labelled as *haini*. They are often translated literally as 'ash cooked' or 'cooked with wood ash' in English by suppliers, letting people assume they were cooked with wood ash. However, wood ash is potassium carbonate and weak alkali, while slaked lime is calcium hydroxide and mild alkali, and they should not be confused.

21 Imakichi Nakajima, *Saikin washi tesuki-ho* [The latest Japanese hand-papermaking techniques] (Tokyo, Japan: Maruzen Shuppan, 1946), 149.

22 Machida, *Washi no michishirube*, 132.

23 Machida, *Washi no michishirube*, 132–40; Nakajima, *Saikin washi tesuki-ho*, 152–63; Haruji Kato, *Washi* [Japanese paper] (Tokyo, Japan: Sangyo Tosho Publishing, 1958), 67–78.

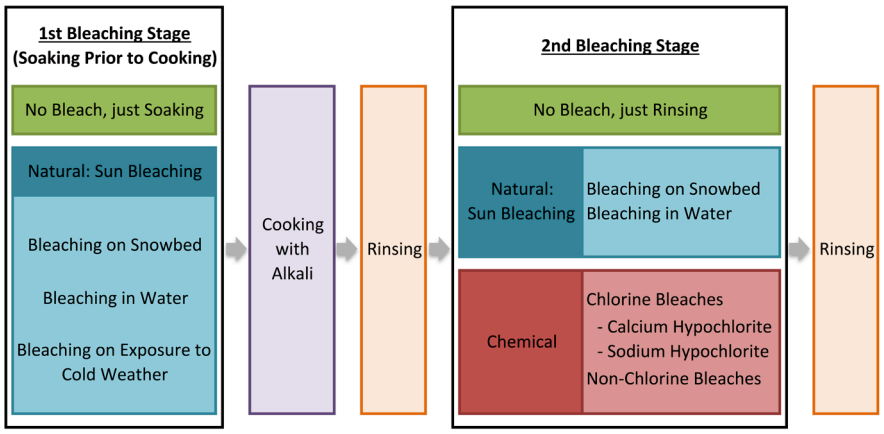

Fig. 9 Possible bleaching stages.

6 Is bleaching used in Japanese papermaking?

During pre-soaking, before alkaline cooking, barks are either soaked in water or go through natural bleaching by exposure to sunlight. After alkaline cooking and rinsing, some go through the natural bleaching again and some go through chemical bleaching, such as with chlorine bleach or non-chlorine bleach (Fig. 9).[24]

At the second bleaching stage (Fig. 10), if the barks do not go through bleaching, they simply go through either quick or thorough rinsing only. Quick rinsing may leave impurities in the fibre and produces light greenish or brownish paper, but the paper is strong. Paper like *hosokawa* paper (細川紙, *kōzo* paper used for accounting books and folding *kimono* paper-cases) and *sekishu* paper (石州紙, *kōzo* paper used for *shoji* paper doors, under-layers of folding screen, and calligraphy) fall into this category. With thorough rinsing, less impurity would remain in the fibre. Extra rinsing is carried out after beating for some papers, such as *hosho* paper for woodblock prints, to obtain pure cellulose.

The barks that go through the second natural bleaching produce paper with greater whiteness, but that does not necessarily mean it produces pure cellulose. For instance, if the *rokubu*-prepared bark goes through natural bleaching, it could be whiter than one which goes through thorough rinsing, but would contain more impurities such as hemi-cellulose. Chemical bleaches are used for lower quality and machine-made paper for economic reasons, and also Thai *kōzo*.

24 Machida, *Washi no michishirube*, 140–1; Nakajima, *Saikin washi tesuki-ho*, 165–83; Kato, *Washi*, 78–84.

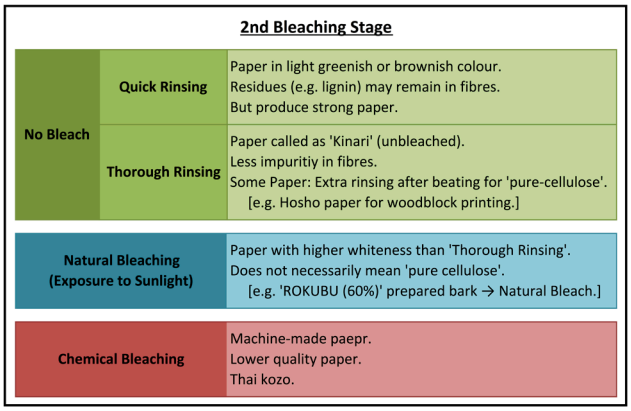

Fig. 10 Effects of second bleaching stage.

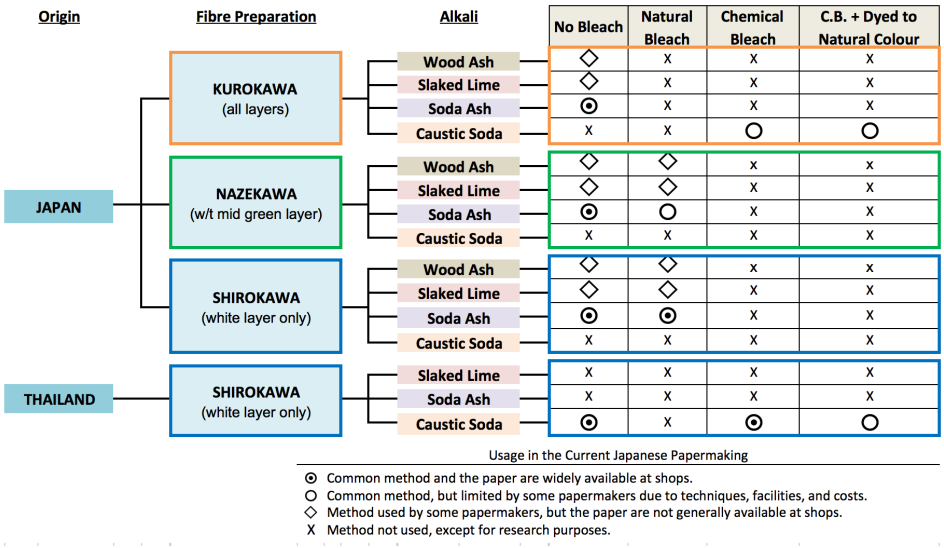

Fig. 11 Combinations of fibre condition, alkaline cooking and bleaching.

7 Various combinations of fibre preparation, cooking and bleaching

Figure 11 shows various combinations of fibre preparation, alkaline cooking and bleaching for Japanese *kōzo* and Thai *kōzo*. The boxes with cross marks are not the common combinations used. Thai *kōzo shirokawa* is cooked with caustic soda and then either not bleached, chemically bleached or chemically bleached and dyed to natural tone. For Japanese *shirokawa* and *nazekawa*, soda ash is commonly used, while use of wood ash and slaked lime is limited to some papermakers, as the former is used for special papers and the latter is mainly used in Shikoku. Those barks go through either no bleaching or natural bleaching. As for Japanese *kurokawa*, soda ash is commonly used and it is not bleached. The fibre is often used for wrapping paper, containing bark fragments as decoration, which does not require a high level of fibre cleaning. When cooked with caustic soda, it is often chemically bleached, or chemically bleached and dyed to natural tone.

Figure 12 shows Japanese *kōzo*. The first was prepared as *shirokawa*, the second and the third as *nazekawa*. The first and the second were cooked with soda ash and the third with wood ash. None of them were bleached (Table 3). The first and the second show differences in colour between the fibre preparation of *shirokawa* and *nazekawa*, and the second and the third show

Fig. 12 Comparison of fibre preparation and alkaline cooking. Image copyright T. Kubo.

Table 3 Comparison of fibre preparation and alkali cooking as in Fig.12.

No	(1)	(2)	(3)
Origin	Japan	Japan	Japan
Fibre Preparation	Shirokawa (white)	Nazekawa (w/t green)	Nazekawa (w/t green)
Alkaline Cooking	Soda Ash	Soda Ash	Wood Ash
Bleach	No Bleach	No Bleach	No Bleach

differences in colour between the alkaline cooking with soda ash and wood ash. This information aids an understanding of the effect of each procedure during papermaking.

8 Rinsing/cleaning and beating/separation

After alkaline cooking, the bark is rinsed in water. If bleached, further rinsing follows to remove bleaching residues. After rinsing, any impurities which would show in the paper are removed by hand.[25] Therefore, a papermaker like Iwano Ichibee IX, making handmade *hosho* paper, and papermakers at Kashiki Paper, who produce machine-made *kōzo* rolls, repeat the process, spending days cleaning fibres by hand.

The cleaned bark is beaten into fibres, traditionally with wooden sticks by hand for a few hours (Fig. 13). After continuous beating, bonds between fibres would loosen and easily separate (Fig. 14). Automated stampers introduced in the early twentieth century as a substitute for hand beating would take about 30 minutes to complete the beating process.

The beaten fibres would be separated in the water. Traditionally, they would be mixed in the vat using wooden equipment called *maguwa* (馬鍬), which looks like a large comb (Fig. 15, left-hand side), or a bamboo stick. Nowadays a Hollander or *naginata* (長刀) beater would be used beforehand to tease the fibres apart in the water. *Naginata* was developed in the mid-twentieth century. The blades are blunt, simply used to separate remaining fibre bundles, and the process takes about 5 minutes.[26]

9 Formation aid (*neri*)

When the fibre is ready for sheet formation, a formation aid, called *neri* (ネリ) in Japanese, is mixed in water. *Neri* is commonly made from the roots of *tororo aoi* (トロロアオイ, *Abelmoschus manihot*), which is annually grown and harvested in the autumn. The roots are crushed and soaked in water to extract the slimy solution. Synthetic thickener is used for most machine-made Japanese paper.[27] Papermakers judge the amount of *neri* to be added, depending on the weather, season and the type of paper to be made, based on their experience (Fig. 15).

25 Kato, *Washi*, 84–7.

26 Machida, *Washi no michishirube*, 143; Nakajima, *Saikin washi tesuki-ho*, 207–10; Kato, *Washi*, 87–93.

27 Machida, *Washi no michishirube*, 176–83.

Fig. 13 Traditional beating *kōzo* with wooden sticks. Image copyright T. Kubo.

Fig. 14 *Kōzo* fibres after beating. Image copyright T. Kubo.

Fig. 15 Adding *tororo aoi* to the pulp solution in the vat (T. Kubo). Image copyright M. Mizumura.

Fig. 16 Sheet formation (*nagashizuki*) (T. Kubo). Image copyright M. Mizumura.

Functions of *neri* are: it does not adhere the fibres together; it makes for even fibre dispersion and prevents fibre precipitation in water; it enables water to drain slowly and fibre to disperse evenly and intertwine on the screen. The resulting effects in the paper are: beautiful fibre alignment and strong fibre-fibre bonding; increase in paper strength; thin and strong paper. Traditionally, papermaking was done during the cold winter months, since the strength of the formation aid weakens in higher temperatures.[28]

28 Machida, *Washi no michishirube*, 195–6; Nakajima, *Saikin washi tesuki-ho*, 280–3.

10 Sheet formation

In Japanese papermaking the bamboo screen is called *su* (簀) and the wooden frame is called *keta* (桁). The *keta* frames holds the *su* screen between them and altogether they are called as *sugeta* (簀桁). The majority of Japanese paper is made in the flowing method, called *nagashizuki* (流し漉き) (Fig. 16). There are three steps during the sheet formation procedure. The first, *kesho-mizu* (化粧水), creates the surface layer. The pulp solution is scooped towards the papermaker with *sugeta* and the excess solution is drained out from the opposite side of *sugeta* immediately, letting the pulp solution run over the screen surface and creating the surface layer. The second, *choshi* (調子), builds up the thickness. The pulp solution is scooped again and the *sugeta* is shaken back and forward and left and right to disperse the fibre evenly and intertwine on the screen, while water drains through the screen. Excess solution is drained out from the opposite side of *sugeta*. The *choshi* step is repeated until the desired thickness is obtained, depending on the paper manufactured. The third, *sute-mizu* (捨て水), creates the finishing layer. Excess solution is tossed out from the opposite side of *sugeta* slowly, with care, to create the finishing layer.[29]

29 Machida, *Washi no michishirube*, 196; Nakajima, *Saikin washi tesuki-ho*, 213–21.

The papermaker takes off the flexible *su* screen, with a newly formed sheet of paper, from the *keta* frame and turns back while turning the screen upside-down in the air, facing the paper post behind him. Placing the screen on the post, the paper is couched without an interleaving felt, unlike Western handmade paper. The formation aid added in the pulp solution means fibres are intertwined with each other within a sheet. Therefore, even when the sheet is couched directly on to another, it remains as a separate sheet.[30]

30 Nakajima, *Saikin washi tesuki-ho*, 221–6.

11 Drying

The paper post is left overnight for water to drain gradually, and the following morning the excess moisture is removed under the press.[31] The pressed papers, which still contain about 70% moisture, are carefully removed one by one from the post, and brushed onto a wooden board, which is placed

31 Nakajima, *Saikin washi tesuki-ho*, 225–8; Kato, *Washi*, 100–3.

Fig. 17 Drying: the wooden boards (left) and stainless steel wall (right). Image copyright T. Kubo.

outside to dry (Fig. 17). On a sunny day, it would take 1–3 hours. The paper would be soft but strong, due to restrained hydrogen bonds among fibres caused by gentle expression and compression of the board and paper during drying. Ginkgo tree boards are used for smoother paper, but boards of p ine tree, Japanese cypress and horse chestnut are also used, depending on the paper type. Nowadays, a heated stainless steel wall is used for drying most paper. This takes about 2–5 minutes and the paper can feel rather crispier, due to excess loss of moisture by rapid drying with high heat. In addition, only the paper tends to shrink on the stainless steel, which may damage the fibre structure and prevent enough hydrogen bonding, resulting in weaker paper.[32]

People often wonder which the front side of paper is. During drying, the side adhered to a drying board would be smoother, and is regarded as the front. It depends on papermakers and types of paper whether the *su* screen side or the finishing side is placed on the board. After drying, the finished paper is checked for quality and stacked into a pile as the final stage of production.[33]

32 Nakajima, *Saikin washi tesuki-ho*, 233–41, 368; Kato, *Washi*, 103–7.

33 Machida, *Washi no michishirube*, 196; Nakajima, *Saikin washi tesuki-ho*, 359; '*Washi*—Iwano Ichibee *shi*' [Japanese paper—Mr Ichibee Iwano]', in ed. S.B.B. *Shokunin—tsutaetai nihon no 'Tamashii'* [Craftsmen—stories of the Japanese soul] (Tokyo, Japan: Sanko-sha, 2001), 163; Zenkoku Tesuki Washi Rengoukai [All Japan Handmade Washi Association] 'Echizen no washi—sono shurui to gihou' [Echizen Washi—its variety and techniques], *Kikan Washi* 15 (June, 1998): 19.

Japanese paper used for conservation

In an ideal trade system, all papermakers would produce conservation quality paper and conservators would buy them directly through Japanese and UK suppliers. But in reality there are many types of Japanese paper, both handmade and machine-made, for different use. Suppliers deal with paper for all markets, not just conservation. So what kinds of paper have been used for conservation?

Table 4 Common Japanese paper used in Western paper conservation.

Name of paper	Description
Arakaji natural	Handmade, *kōzo* and sulphite wood pulp.
Atsukuchi	Handmade, 70% *kōzo* and 30% sulphite wood pulp.
Gampi	Machine-made or handmade, 100% Japanese *gampi*, neutral pH.
Kawanaka	Handmade, laid, 80% *kōzo* 20% sulphite wood pulp, neutral pH.
Kitakata natural	Machine-made, 90% Philippino *gampi* and 10% wood pulp, neutral pH.
Kozu-shi	Handmade, 70% *kōzo* and 30% sulphite wood pulp, neutral pH.
Maruishi	Machine-made, 100% Manila hemp, neutral pH.
Shoji	Machine-made, 30% *kōzo* and 70% wood pulp.
Tengujo	Machine-made, *kōzo* (cooked in soda ash)
Tonosawa	European name for *Kitakata* natural (USA name).
Tosa-*shoji*	Machine-made or handmade, 50% *kōzo* and 50% sulphite wood pulp, pH 7.5
Tosa-*washi*	Machine-made, *kōzo* and sulphite wood pulp, neutral pH.
Usumino	Handmade, 100% *kōzo* (cooked with soda ash).

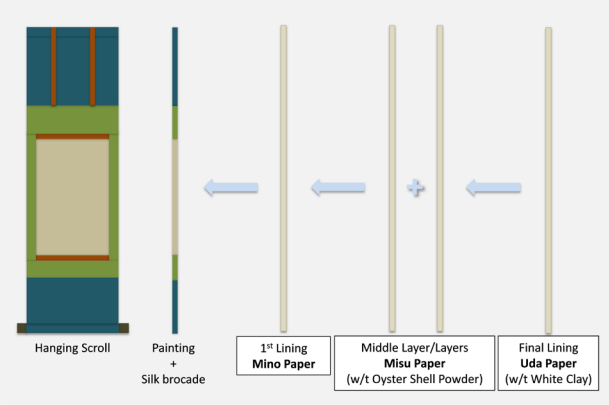

Fig. 18 Japanese paper commonly used for Japanese hanging scrolls.

Table 4 is the list of Japanese papers which many conservation studios in the UK have stocked for the last 30 years. Two-thirds of the papers contain 10% to 70% wood pulp. The problem is the detailed information about each paper is often lost and people only know the names of paper. *Arakaji* natural and *kitakata* natural contain wood pulp, and the fibres are chemically bleached and dyed to look like a natural colour. *Tonosawa* is the name for European market and is the same paper as *kitakata*. *Kozu-shi* is correctly called as *kōzo-shi* (楮紙) in Japan. One may think it is 100% *kōzo*, but it is not. If it were, it would be called *jun kōzo-shi* (純楮紙), meaning 'pure *kōzo* paper'. *Shoji* is a Japanese sliding paper door. *Shoji* paper (障子紙) used to be 100% *kōzo*, but, after changes to a more Western style of living, *shoji* doors and *tatami* straw mat floors have become less common in Japanese households. Nowadays, most *shoji* paper is made from a blend of *kōzo* and wood pulp.

Japanese paper introduced in Western paper conservation was often related to scroll mounting. A Japanese hanging scroll is composed of a painting and silk brocade. *Mino* paper is used as the first lining, then *misu* paper (美栖紙, which contains *gofun*—powdered seashell) as middle layers, and *uda* paper (宇陀紙, which contains locally obtained white clay as filler) as the final backing (Fig. 18). *Kōzo*-based papers, like *hosokawa* and *sekishu*, are used for hinges and under-layers of a folding screen. For the conservation of Japanese cultural properties, there are rules dictating the Japanese paper used: firstly, it is made from the fibres grown in Japan and, secondly, it is made by traditional handmade methods, using mild alkali and no chemical bleaches. This ensures long-term preservation.[34] Their paper trade is an

34 Masaaki Ariyoshi, 'Tesuki washi no genjyou ni tsuite—Kochi-ken wo reini' [Current situation of handmade washi in Kochi] (paper presented at *Les Savoir-Faire du Papier en France et au Japon—Connaissance, Usages et Conservation*, 2ème Rencontre Internationale, Tokyo, 6 September 2012).

Table 5 Descriptions of various '*sekishu*' papers.

Name	Area	Description
SEKISHU-BANSHI (or Sekishu-Hanshi)	Shimane	Handmade, 100% Kozo (Nazekawa), Alkali: Wood Ash or Soda Ash, No Chemical Bleach, Natural Formation Aid (Neri).

Currently Available Paper with Name 'SEKISHU'

Name	Area	Handmade/ Machine-made	Fibres
Sekishu-Hanshi Mare	Shimane	Handmade	**100% Japanese Kozo** (rokubu) (hand-beaten)
Sekishu-Hanshi Tsuru	Shimane	Handmade	**100% Japanese Kozo** (rokubu) (machine-beaten)
Sekishu-shi	-	Handmade	90% Kozo and 10% Wood Pulp
Sekishu: Natural/White	-	Handmade	70% Thai Kozo and 30% Sulphite Wood Pulp
Sekishu Roll	Kochi	Machine-made	**100% Japanese Kozo** (kurokawa)
Kodai Sekishu	Kochi	Machine-made	80% Kozo and 20% Wood Pulp
Sekishu-shi	-	Machine-made	50% Thai Kozo and 50% Wood Pulp
Sekishu-shi Roll	Tottori	Machine-made	30% Thai Kozo and 70% Wood Pulp

Table 6 Descriptions of various '*tengujo*' type papers.

Name	Area	Description	Weight
TENGUJO-SHI	Kochi	Tosa Kozo (Shirokawa), Alkali: Slaked Lime, Natural Bleaching, 3 Rinsing Stages, Natural Formation Aid (Nerl).	11gsm

Handmade/Machine-made TENGUJO-type Paper

Name	Area	HM/MM	Fibres	Weight
Tengujo-shi	Kochi	Machine-made	Tosa Kozo	2.5-6.0gsm
Hai-ni Roll [RKOO, RKO]	-	Machine-made	Toso Kozo	3.5-5.0gsm
Sekishu Extra Thin	Kochi	Machine-made	Tosa Kozo	10gsm
Tengucho	Tokushima	Hand-made	Japanese Kozo (Shikoku)	9.0gsm
Tengu (Tengucho)	Kochi	Machine-made	Japanese Kozo	2.0-9.0gsm
Fuji Kozo Roll	Tokushima	Machine-made	Japanese Kozo	3.0-10gsm
Tengujo-shi	Kochi	Machine-made	Tosa Kozo and Manila Hemp	7.0-10gsm
(Mino) Tengujo	-	Machine-made	Manila Hemp	9.0gsm
Tengu (Tengucho)	Kochi	Machine-made	Thai Kozo	2.0-9.0gsm
Tengucho	Tokushima	Machine-made	90% Thai Kozo and 10% SP WP	9.0gsm

ideal system, and conservators who deal with Japanese national cultural properties know who makes the paper and how. Will it be possible to create the same system in Western conservation? As with other materials adapted for Western paper conservation, it is more likely that most conservators prefer to select a paper suitable for their needs within their budget.

Is it possible to be sure about what a paper is by name alone? For instance, the original definition of *sekishu* paper is handmade with *nazekawa*-prepared 100% *kōzo*, cooked with wood ash or soda ash, no chemical bleach and sheet formed with natural *neri* (Table 5).[35] Papers currently available with the name *sekishu* are made from either 100% Japanese *kōzo* or a mixture of *kōzo* and wood pulp, both handmade and machine-made. When it says just *kōzo*, it is more likely to be imported Thai *kōzo*, which requires strong alkali. Another case is the paper produced by Sajio Hamada, who is well known for handmade *tengujo*, made from 100% Tosa *kōzo*. These days, various thinner machine-made *kōzo* or hemp papers are sold as *tengujo*-type paper. The fibres used and manufacturing procedures vary (Table 6).[36] Is the name of the paper, the proportion of fibres, or information, such as handmade or machine-made, enough to reassure the conservator that the paper is suitable for conservation treatments?

When choosing Japanese paper, firstly, use and requirements are to be considered. Then, various factors in the papermaking process, which affect the paper quality, might be helpful (Fig. 19). The origin of fibre is related to the following procedures of fibre preparation, alkaline cooking and bleaching methods. During the sheet formation, wood pulp would

35 Bunkacho, *Tesuki Washi*, 165–223; Makoto Yanagibashi, *Washi—fudo, rekishi, giho* [Japanese paper—climate, history, techniques] (Tokyo, Japan: Kodansha, 1981), 22–4.

36 Kenichi Miyazaki, et al., 'Hamada Sajio', *Shukan Ningen Kokuhou* 63 [Weekly Living National Treasures] (2007): 20–24.

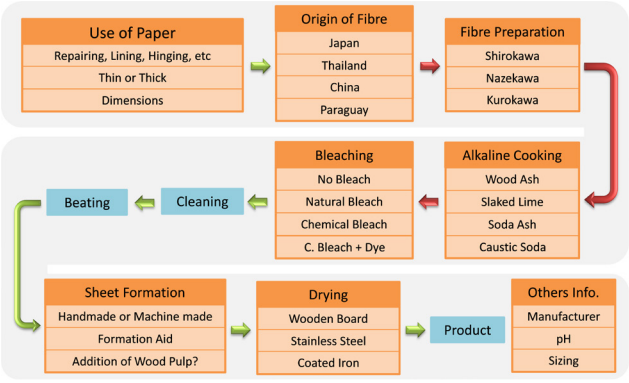

Fig. 19 Factors to consider for choosing Japanese paper.

Table 7 Proposal — *washi* standards for Western paper conservation.

Classification	Fibre content	Production method
Museum/Cultural Heritage Level for valued original works on paper	Made with 100% domestically grown Japanese bast fibres by the traditional method. Bast fibre preparation: *shirokara* or *nazekawa.*	Handmade by the traditional method. Alkalis: wood ash, soda ash or lime. No chemical bleach. Natural formation aid. Drying: wooden drying boards.
Conservation Level (I) for original works on paper	Made with 100% domestically grown Japanese bast fibres by close to the traditional method. Bast fibre preparation: *shirokara* or *nazekawa.*	Handmade or machine-made. Alkalis: soda ash or lime. No chemical bleach. Undyed or dyed with natural or synthetic dyes. Natural or synthetic formation aid. Drying: wooden drying boards or stainless steel wall.
Conservation Level (II) for original works on paper	Made with imported bast fibres or a mixture of Japanese and imported bast fibres. Bast fibre preparation: *shirokara* or *nazekawa*.	Handmade or machine-made. Alkalis: soda ash, lime or caustic soda. No chemical bleach or (chlorine-free) chemical bleach. Undyed or dyed with synthetic dyes. Natural or synthetic formation aid. Drying: wooden drying boards or stainless steel wall.
Conservation Level (III) for original works on paper	Made with a mixture of bast fibres and a high quality chemically purified wood pulp (high alpha-cellulose content). Bast fibre preparation: *shirokara* or *nazekawa*.	Handmade or machine-made. Alkalis: soda ash, lime or caustic soda. No chemical bleach or (chlorine-free) chemical bleach. Undyed or dyed with synthetic dyes. Natural or synthetic formation aid. Drying: wooden drying boards or stainless steel wall.
Standard Level not recommended for conservation	Made with a mixture of bast fibres and unpurified wood pulp or other synthetic materials.	Handmade or machine-made. Alkalis: caustic soda. Chemical bleach. Undyed or dyed with synthetic dyes. Synthetic formation aid. Drying: stainless steel wall.

be added for certain papers. As described above, many papers with wood pulp have been used in conservation, but often unknowingly. In the West, conservation-grade acid-free paper is made from 100% chemically bleached wood pulp and used as interleaving or wrapping. Thus, Japanese paper with wood pulp could be used for certain purposes. But conservators should choose them with knowledge and understanding.

Conclusion

It is important that conservators let suppliers know their requirements for paper. At the Icon Adapt & Evolve conference in London in April 2015, we proposed a grade system for Japanese paper, created by the Japanese Paper Place in Canada for artists, adjusted for conservators. Would it be beneficial to have a system for categorizing Japanese paper for European paper conservators?

In the UK, the Fine Art Trade Guild set the standards for mountboard and other boards used in framing in 2004.[37] It has provided benefits in the industry, and the standards continue to be amended. The paper for the standards describes the details of materials and qualities required for various purposes, which include the quality of pulp, alkaline reserves, sizing and dyes/pigments used as well as pH. Therefore, for the publication of this paper, the proposal for a grade system for Japanese paper is adjusted as in Table 7, influenced by the standards for mountboard. Description of fibre

37 Fine Art Trade Guild, *The Fine Art Trade Guild standards for mountboard (mat board) and other boards used in framing* (London, Fine Art Trade Guild: 2004).

contents for Japanese paper is rather obscure, even in Japan. For instance, if wood pulp is used for Japanese paper, it is simply mentioned as 'pulp', or occasionally 'sulphite pulp'. Thus, the content of the proposal might not be familiar to papermakers and paper suppliers in Japan. There are many factors to be considered, including the views of papermakers, paper suppliers and paper conservators, in order to agree the standards.

The aim of this paper is to provide a brief insight into Japanese papermaking and to open a forum for informal discussion among conservators to learn more about these diverse and useful papers.

Abstract

Japanese papers are popular in fine art and paper conservation, but the range of different paper types is extremely broad, even among papers made from *kōzo* fibre. This paper outlines the development of Japanese paper and its use in Western paper conservation, including its export to the West. The details of Japanese traditional papermaking procedures focus on the factors which affect paper quality, the preparation of raw materials, cooking with alkali, bleaching and drying. It also covers the history of machine papermaking and the use of wood pulp and *kōzo* fibres from outside Japan, as well as modern technology that has been introduced into hand-papermaking. The paper concludes with the considerations conservators should keep in mind when selecting Japanese papers for their specific objects and applications. It provides a multi-angled view of the topics involved, from the perspectives of a papermaker, a paper supplier and a paper conservator.

Biographies

Megumi Mizumura is a paper conservator in the Western Pictorial Art section at the Department of Conservation and Scientific Research at the British Museum. After receiving her BA from Camberwell College of Art and MA from Northumbria University, she worked in Asian painting conservation and completed Samuel H. Kress and Andrew W. Melon Fellowships in paper conservation in the USA. She has worked on Western, Asian and Middle Eastern objects using her knowledge and skills in both Western and Asian paper conservation. During her twenty-year career, she has carried out research on papermaking in China, Japan and the Middle East, given talks and conducted tours to papermaking mills in Japan and China.

Takamasa Kubo is the fifth-generation papermaker based in Kubo Seishi papermaking mill, established in 1913 in Saitama prefecture. Takamasa has been involved in papermaking since his graduation from Dokkyo University in 2003. His father, Haruo Kubo, is a member of Hosokawa-shi Preservation Society, which was designated as an Important Intangible Cultural Property of Japan in 1978 and added to UNESCO's Intangible Cultural Heritage list as one of Japanese papermaking techniques in November 2014. Hosokawa paper dates back to the Edo Period (1603–1867) when it was used for account books and registries. He is one of the young generation papermakers who, apart from making paper, carry out literature research on Japanese papermaking and take a scientific approach to current 'traditional' Japanese papermaking.

Takao Moriki is the third-generation president of Moriki Paper Company, Ltd., based in Tokyo. The company was established in 1925 in Yokohama as a supplier of Tosa *tengujo* paper and other Japanese papers, especially for overseas markets, by his granduncle, Yasumi Moriki, whose family had been papermakers in Kochi prefecture. The company started exporting Japanese paper directly to the USA in 1979 and to the UK and West Germany in 1983 during the presidency of his father, Shinji Moriki, and has a long history of providing a wide selection of Japanese paper internationally. Takao has been working closely with local papermakers across Japan to support the industry as well as to meet the needs of overseas customers.

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