WHAT IS SILK?

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Silk is one of the oldest known textiles and has been prized over thousands of years for its luxurious feel, lustrous appearance, and excellent draping qualities. Silk is an organic fibre produced by silkworms which are the caterpillars of the silk moth species *Bombyx mori*.

China is credited with the discovery and development of silk cultivation. This is currently called sericulture in the West, from the Greek term *seres* which was used both for silk and for Chinese people. The term 'sericulture' thus merges silk's country of origin, silkworm cultivation, and the woven fabric itself. Here we use sericulture to refer to silkworm farming and the creation of silk filaments.

Archaeological evidence proves that silk appeared in China as early as 8,500 years ago, with silk fragments and bone carvings of silkworms having been found from the Neolithic period.[1] There are many myths about the discovery of silk. Naturally, such legends, like the powerful Confucian narrative involving the virtue of women, come after its invention (based on artefacts), and point to the intriguing history of female labour: on the one hand their contribution is recognised as complimentary and equal to that of the men, while on the other hand these narratives firmly contain their labour within the traditional framework of female duties within the household unit.[2]

The role of women is paramount in Chinese sericulture, ranging from the highest-ranking female in the Middle Kingdom to the producers. It is the empress who opens the season and inaugurates the process of hatching silkworms and gathering mulberry leaves. For instance, according to the *Book of Rites,* or the *Book of History*, women took care of silk reeling and spinning as part of their household duties and carried out weaving and embroidery in workshops or at home.[3] The best-known legend concerning Chinese sericulture's origins focuses on the Empress Leizu, wife of the mythical Yellow Emperor. The story recounts that a cocoon fell into her tea and the steam unravelled the thread. Through careful observation, Leizu perceived the full potential of this wondrous fibre. She subsequently domesticated silkworms and is also credited with the invention of the silk reel and the loom. The narrative captures quite well the crucial process of unreeling the filaments from the cocoons while also illustrating sericulture's ancestral and divine-like status in China.

THE PROCESS OF SILK HARVESTING

Silk is harvested from the cocoons that the silkworms wind around themselves as a protective coating. Since the silkworms are voracious feeders of mulberry leaves, the cultivation of mulberry trees (preferably white) is fundamental to the breeding of silkworms. Once they have eaten large quantities of these leaves and matured in size, they spin cocoons made of silk filaments, which can be up to 900 meters long. The caterpillars' solidified protein secretion is what creates a fine, resistant strand. To retrieve the silk fibres, one must carefully unravel the cocoons, often with the help of heat or steam to loosen the sericin, a natural gum that holds the fibres together.

Various species of wild silk moths can be found in different countries. The *Bombyx mori* comes from the family *Bombycidae*, which descends from a wild species native to the regions in northern India and China, Korea, Japan and far eastern Russia. In ancient China, the creation of the domesticated species, *Bombyx mori*, must have emerged through a long process of experimentation. The Chinese discovered that when fed solely on white mulberry leaves, this moth produced a thread with smoother, finer, and rounder filaments, all in a pure white colour. From this domestication process, the *Bombyx mori* evolved into the specialised silk producer it is today.

The domesticated variety is a blind, flightless moth, now only capable of mating and producing eggs. A female moth lays hundreds of eggs over six days or so and dies soon after. The eggs are usually attached to mulberry leaves, their traditional food source. To hatch, the eggs must be kept in a warm environment for around 10 to 14 days.

There are four stages in the silkworm life cycle: egg, silkworm, pupa and moth. As worms they go through several moulting stages, shedding their skin and changing colour as they grow larger (Figs. 1-5). Numbers are fascinating when it comes to silk. The initial eggs are only a couple of millimetres in diameter and are extremely light (0.00078g in average). However, the worm that hatches will consume up to 500g of mulberry leaves (about 30,000 times its weight) before changing into a pupa. The newly hatched silkworm thus multiplies its weight 10,000 times within a month (Fig. 6). Apparently, a roomful of munching worms sounds like heavy rain falling on the roof.

The silkworms secrete filaments of a liquid protein (fibroin) through two tiny openings called spinnerets (tiny glands near their mouths). The fibroin solidifies upon contact with air, forming a single thread that the silkworm spins around itself to form a cocoon (Fig. 7). The cocoon serves as a protective covering for the silkworm during its metamorphosis into a pupa.

Fig. 1
Silkworms Lay their Eggs
China, 1795-1800
Water and gouache on paper
H. 59.7 cm x L. 52.7 cm
Chris Hall Collection

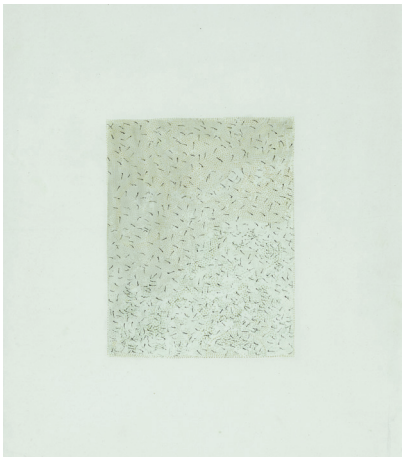

Fig. 2
Newly-Hatched Silkworms
China, 1795-1800
Water and gouache on paper
H. 59.7 cm x L. 52.7 cm
Chris Hall Collection

Fig. 3
First Moulting of the Silkworms
China, 1795-1800
Water and gouache on paper
H. 59.7 cm x L. 52.7 cm
Chris Hall Collection

Fig. 4
Second Moulting of the Silkworms
China, 1795-1800
Water and gouache on paper
H. 59.7 cm x L. 52.7 cm
Chris Hall Collection

Fig. 5
Third Moulting of the Silkworms
China, 1795-1800
Water and gouache on paper
H. 59.7 cm x L. 52.7 cm
Chris Hall Collection

Fig. 6
Fourth Moulting of the Silkworms
China, 1795-1800
Water and gouache on paper
H. 59.7 cm x L. 52.7 cm
Chris Hall Collection

Fig. 7
Silkworms Spin Cocoons on Wood Frames
China, 1795-1800
Water and gouache on paper
H. 59.7 cm x L 52.7 cm
Chris Hall Collection

Fig. 8
Pupae Hatch from the Cocoons
China, 1795-1800
Water and gouache on paper
H. 59.7 cm x L. 52.7 cm
Chris Hall Collection

To retain the silk threads intact, the cocoons are harvested before the pupa can emerge as an adult moth (a growth that takes two weeks) which would otherwise break the threads (Fig. 8). The cocoons are sorted according to size, colour, shape and texture, as these attributes affect the quality of the silk filaments; they are then boiled to kill the pupae and to soften the silk fibres by removing the sericin proteins in a process called degumming.

After softening the fibre via several hot and cold baths, the unwinding of a single continuous filament can begin. This filament extraction is called the unravelling process. Multiple silk fibres are unwound simultaneously to create a single, stronger thread. Each cocoon can produce between 600 and 900 meters of silk thread. The unwound silk filaments are then reeled onto a device called a reel or a swift and twisted together for the first time to form a continuous thread, wound onto a reel or a spool.

These threads can then be spun and twisted together even further, if desired, to produce silk yarn of various widths, called raw silk. The raw filaments can be left white or dyed at this point and are then ready to be woven into a fabric using handlooms or mechanised weaving techniques. The woven fabric may also undergo additional processes, including dyeing, printing, and finishing to achieve the desired colour, pattern, and texture. The finished fabric is often enriched through various weaving and embroidery techniques.

The silk fibres are extremely fine and smooth, with a triangular prism-like structure that reflects the light, giving it a natural sheen and a beautiful lustre. It is also highly breathable, moisture-wicking, and has good insulation properties, keeping the wearer cool in warm weather and warm in cold weather. Despite being a lightweight fabric, silk is known for its strength and durability. It is resistant to wrinkles and has a natural elasticity that allows it to recover its shape after being stretched. In addition, silk is hypoallergenic and less likely to irritate the skin than synthetic fibres.

A versatile textile, silk can be used for a great variety of products, such as dresses, blouses, ties, scarves, and accessories. Besides clothing, silk is a favourite material for home décor like high-end home furnishings, upholstery, and draperies. Its multi-faceted qualities have also made silk valuable to the sciences, where it is used in medical surgical suture, for instance. In industry, silk was the material for parachutes made before the Second World War and more recently has been included in bicycle tubular tyres to increase their flexibility.

While mechanisation has enhanced the efficiency of silk production, the fundamental methods developed in ancient China have remained the same. Sericulture still relies on silkworms to spin natural silk, whose essential diet remains mulberry leaves. Even some ancient tools like the silk reel, spinning wheel, and loom continue to play vital roles (Fig. 9). And though silk cultivation and production has developed in many other countries, China remains the largest producer.

TECHNIQUES

Like all weaving, that of silk involves the simple interlacing of the warp (the vertical thread) and the weft (the horizontal one) on a loom. The stages of weaving involve: the design and pattern preparation; the warp and loom setup; the repeated insertion of the shuttle with the weft (followed by shedding and beating); the finishing processes.

The development of weaving techniques in China followed that of the silk industry itself. As early as the Shang (c. 1600-1100 BCE) and Zhou (c. 1100-256 BCE) dynasties, the variety of fabrics produced already included tabby weave, gauze, polychrome woven silk and embroidery. The Qin (221-207 BCE) and Han (c. 202 BCE-220 CE) dynasties established the foundations for an organised system of silk production. The industry grew continuously from the Spring and Autumn Period (770-476 BCE) to the middle period of the Tang dynasty (around 755 CE). Great leaps in technology and production took place as trade thrived along the silk roads, most notably under the Tang and Song dynasties. The Ming (1368-1644 CE) and Qing dynasties (1644-1911 CE) saw more specialised production, resulting in a remarkable array of innovative weave structures and vividly coloured patterns.

Fig. 9
Spinning Wheel
China, late Qing dynasty (1644-1911)
Wood
H. 23 cm x L. 75 cm x W. 21.5 cm
Chris Hall Collection

Fig. 12
Cheng Qi (mid to late 13th century)
Women Weaving, from *Silk Weaving* (after Lou Shou)
Mid to late 13th century
Ink and colour on paper
Smithsonian National Museum of Asian Art
Freer Art Collection
Purchase--Charles Lang Freer Endowment
F1954.20 (det.)

The first and simplest weaving technique to appear was tabby. Based on a unit of two warps and two wefts interlacing in an unvarying alternation, it is already present in China in Neolithic times (Fig. 10). Twill weave developed out of tabby, where the weft passes over two or more warps and then under two or more, creating a herringbone-type pattern (Fig. 11). Gauze, an open weave made by twisting adjacent warps together, appears during the Shang dynasty, developing in complexity under the Tang (618-907 CE). With the invention of the drawloom and pattern tower during the Han dynasty, weavers could produce figured textiles with complicated designs. The principles of this machine are still in use today. The weaver organises the warps ahead of time into sequential clusters based on the drawn pattern; at the required moment the person in the elevated tower raises the group required for that colour (this was usually done by a child because of their small size) (Fig. 12).

New weaving techniques also emerged under the Tang, such as slit tapestry weave (*kesi)*, which then became extremely popular under the Song (960-1279 CE). Slit tapestry is a highly pictorial weave that allows great flexibility in creating polychrome motifs over areas of solid colours; the weaver inserts discontinuous wefts of different colours over the undyed warps only at the point where that colour is required (Fig. 13).

Brocade was another way to introduce colourful patterns, using polychrome or gold supplementary wefts interlaced into the foundation weave. And damask, a reversible patterned fabric of silk with

contrasting designs, also came to prominence under the Tang (here done in monochrome purple Fig. 14). Despite its name, damask was most likely a Chinese invention, which Western merchants subsequently named after its trading source, the Syrian city of Damascus.

Under the Southern Song (1127-1279 CE), the production of silk was officially recognised as one of the two pillars of the Chinese economy (the other being rice), reflected in the poetic manual *Pictures of Tilling and Weaving* by Lou Shou (1090-1162). The accompanying illustrations are lost but inspired a new genre of painting in that name (as in Fig. 12).[4] The poems describe the entire process of agriculture and sericulture, from the breeding of silkworms to silk weaving.

During the Song and Yuan (1271-1368 CE) dynasties, golden textiles (called *nasij*) became extremely fashionable, especially under the Yuan, reflecting the influence of their nomadic culture, an example of which can be seen in Fig. 13, p. 27. New weaves emerged during the Yuan dynasty, such as satin—a simple 'float' weave allowing the fibre's natural lustre to appear—and satin damask, which remained a staple of silk production both in China and Europe, as shown in this lavish 18th-century French satin (Fig. 15).

Under the Ming and Qing, centres of production became more specialised, allowing regional varieties to flourish. Thus, slit tapestry (*kesi*) became an art associated with the region of Suzhou, while the four main schools of Chinese embroidery developed their distinctive styles: Suzhou embroidery (Su Xiu), Hunan embroidery (Xiang Xiu), Guangdong embroidery (Yue Xiu) and Sichuan embroidery (Shu Xiu). Today all of them are considered part of Chinese Intangible Cultural Heritage.

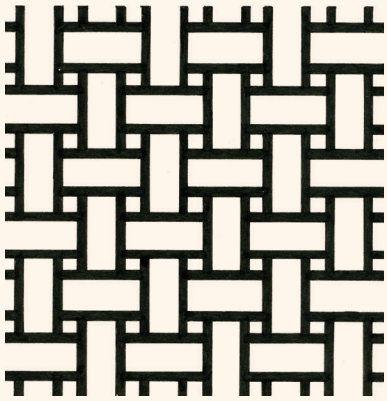

Fig. 10
Tabby Weave
From *The Artful Fabric of Collecting*

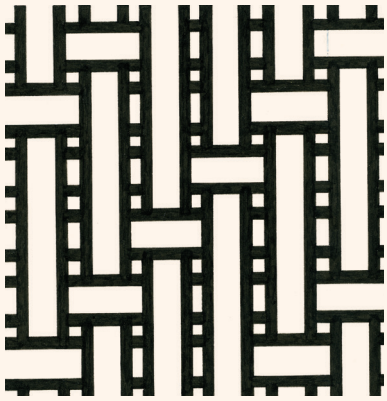

Fig. 11
Twill Weave
From *The Artful Fabric of Collecting*

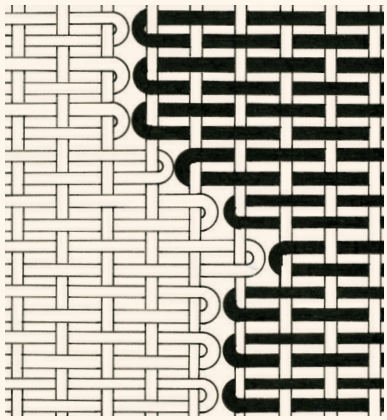

Fig. 13
Slit Tapestry Weave (*kesi*)
From *The Artful Fabric of Collecting*

[1] www.chinasilkmuseum.com/info_180.aspx?itemid=27699, accessed February 10, 2024

[2] N. Harry Rothschild, 'Three First Ladies of Sericulture: Wu Zhao and Leizu', in *Emperor Wu Zhao and the Pantheon of Devis, Divinities, and Dynastic Mothers* (New York: Columbia University Press, 2015), pp. 60-74.

[3] Francesca Bray, 'Textile Production and Gender Roles in China, 1000-1700', *Chinese Science* 12 (1995), 115-134.

[4] Roslyn Lee Hammers, *Pictures of Tilling and Weaving: Art, Labor, and Technology in Song and Yuan China* (Hong Kong: Hong Kong University Press, 2011).

Fig.14
Damask Weave Silk Cloth (detail)
Purple Silk Pantaloons
Central Asia, c. 5th century
Chris Hall Collection

Fig.15
Wall Hanging with Doves (detail)
By Philippe de Lasalle for Empress Catherine II of Russia
France, Lyon, c. 1773
Raspberry satin lampas, embroidered polychrome silk
L. 273 cm x W. 60 cm
Villa Rosemaine Collection