

Eleanor Morgan

Spinning with spiders' silk

In the autumn of 2009 a piece of golden coloured fabric went on display at the American Museum of Natural History in New York. It stretches 11 feet by 4 feet and is created entirely from the silk of the golden orb spider of Madagascar. Over four years, under the guidance of art historian Simon Peers, a group of local Madagascan people collected approximately 3000 spiders each day from trees and telegraph poles. The spiders were then handled by a group of women weavers, who extracted the silk from the creatures' spinnerets onto a spool from which it was woven on a loom. It is the largest known spiders' silk fabric in existence. Yet it is not the first attempt to harvest silk from spiders. Throughout history people have experimented with spiders' silk to create fabrics and clothing. Most of these items have disappeared, and are perhaps still waiting to be found in various museums and attics. Simon Peers himself was inspired by the story of a 19th century French missionary, Jacob Paul Camboué, who had woven the silk of the Madagascan golden orb spider into bed hangings. These were to be exhibited at the 1900 Paris Exposition, but there is no record of them in the exhibition catalogue. As perhaps befits such a magical material, the history of people weaving with spiders' silk is intertwined with myths and vague accounts. Having researched the notes, letters and sketches of some of these individuals, I would like to present a short history of some spiders' silk collectors, the machines they created and the spiders they worked with. The prints accompanying this story are my own, created from historical written descriptions or drawings.

Fear of spiders is a common phobia, out of all proportion to their actual threat to us. Yet they also hold a particular mythical attraction. The Greek story of Arachne is one of many spider tales, in which the mortal Arachne's pride in her weaving ability leads to her being turned into a spider for all eternity by the goddess Athene. Another example is the spider Ananse, a trickster figure in West African and Caribbean tales, who was responsible for introducing stories and wisdom into the world. The enchanting, mythical potential of spiders lies in the fact that they produce what is perhaps *the* magical material: spiders' silk – held in popular regard as being stronger than steel. It is also magnetic, water resistant and has 'shape memory', in that it can be stretched and return to its original size without any loss of tension. Such properties have made spiders' silk

a versatile material for human uses. A naturalist in the 19th Century records seeing women in Bermuda using spiders' silk for sewing; Australian aboriginal communities used it to make fishing nets and lines; and since the time of the Ancient Greeks, spider webs have been used to help heal wounds – a possibility still being explored today with artificial silk in biomedical research. More recently, strands of spiders' silk were used as crosshairs in gun sights and telescopes. There is also a story of the 17th Century Mughal Emperor Aurengzebe, who reproved his daughter for “the indelicacy of her costume, although she wore as many as seven thicknesses of spider cloth”.¹ Examples of the practical uses of spiders' silk cannot entirely avoid this sense of the fantastical and enchanting. Most of the collectors in this story recount being spellbound by the shimmering appearance of spiders' silk. Yet unlike silkworms, spiders have resisted all attempts at large-scale human harvesting. Even recent research into artificial silk has been unable to replicate the mysterious transformation of liquid protein to solid silk that takes place in the body of the spider. In this sense, the story of spiders' silk collectors can be considered as an example of the many enchantments and obstacles that occur in our encounters with animals.

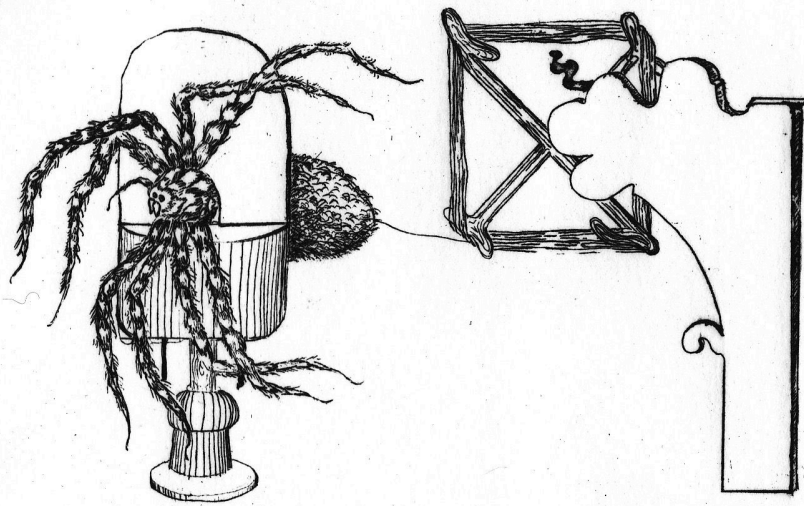
The first recorded attempt to turn spider silk collecting into a commercially profitable activity was made by in 1709 by Monsieur Le Bon, President of the court of accounts in Montpellier. He collected spider's nests, which he boiled in water and gum arabic - a technique similar to those used for collecting silk from silk worms. Indeed, the interest in the commercial possibilities of spiders' silk was partly in response to the desire for domestic European silk production, which would not rely on Asian imports, or on the delicate demands of the silk worm unsuited to the European climate and agricultural traditions. After boiling the cocoons, Le Bon dried and spun the silk into three pairs of spider silk stockings, two of which he presented to the Royal Academy of Sciences in Paris and the third to Sir Hans Sloane at the Royal Society in London.² In response to Le Bon's research, the Royal Academy commissioned the prolific scientist René Antoine de Réaumur to investigate the commercial possibilities of spiders' silk.

Using Le Bon's technique of boiling spider's nests, Reaumur concluded that spiders' silk could not be of any commercial value. He listed three limiting factors. The first was the difficulty of collecting and housing the spiders – particularly the problem of trying to prevent the spiders from eating each other. The second was supplying the animals with

fresh prey, and the last was the inferior quality and yield of spider's silk compared to that of the silk worm. However, in reference to this final problem Reaumur had been studying the silk of spider's nests, a very fine material that most closely resembled that of silk worms. It was not until 1762 that a Spanish Jesuit priest discovered that the strongest silk came not from a spider's nests, but directly from her body.³

Abbé Ramon de Termeyer was a missionary and amateur naturalist. His wide and varied research included experiments on electric eels, a proposal for an antidote to viper venom and a short paper on how to keep eggs fresh during long journeys. But his main passion was spiders. His house in Milan was filled with thousands of them. They were suspended from separate canes all around the house, and were fed by a steady supply of flies that bred in the piles of rotten meat that Termeyer had put out for them.

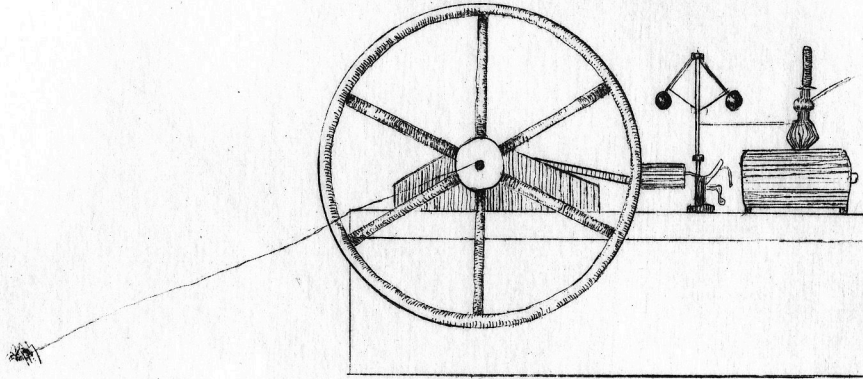
Termeyer noticed that if he gave a fly to one of these spiders, it would quickly envelope it with silk from its abdomen. He went about devising a machine that could collect this silk directly from the spider's body. He came up with this contraption:



The spider was held between two plates, while her silk was collected onto a spool. Termeyer described the silk he collected as appearing like a mirror, or polished metal. He was convinced of its commercial possibility. He had solved the problems that Reaumur had listed – he kept his spiders on separate canes so they could not eat each other; they had a steady supply of food which was easy to provide and he had discovered that the silk they produced on his machine was stronger and more vibrant than that of the silk worm. He was now faced with the problem of how to spin the silk. It was too thin in its original form, so the strands had to be twisted together. Yet this led to the silk losing its lustre, looking more like white cotton than silk. In the end, he reverted to the tried and tested technique of boiling up the spiders' nests. He then spun the silk into pairs of stockings. Over the next 20 years, Termeyer sent these spiders' silk stockings to various monarchs, including Charles III of Spain, Catherine the Great and Archduke Ferdinand. He also sent some stockings to Napoleon and Josephine, in spite of the fact that his own house had been blown to pieces during the Napoleonic invasion of 1796.⁴ Unfortunately, I have yet to find any record of what happened to these various pairs of silk stockings.

Termeyer recorded his spider research in a small pamphlet, of which only one copy exists. It remained largely forgotten in a library in New York until 1866 when it was discovered by a US army surgeon.

But first, a quick stop somewhere closer to home – at 21 Friday street, Cheapside, London, where in the autumn of 1829 Daniel Bransdon Rolt was struck by the beauty of the light on the spiders' webs in his garden.⁵ He began to pull the silk from a spider, and was able to collect a few yards before the spider broke the thread with her legs. He proceeded to collect 100 of these garden spiders, and kept them in separate boxes in his room to prevent any cannibalism. Underneath the boxes was a large drawer containing rotten meat. This attracted flies, some of which would fly through tiny holes into the spider's dens above. He was thereby able to keep a large number of spiders alive while he devised a way of collecting their silk. In the end, he attached the spider to a steam engine, which he had borrowed from the factory in which he worked.



She was attached to a reel, which he turned at a rate of 150 foot per minute. Every 10 minutes he would change the spider for another. Over the course of two hours, he was able to collect 7,200 feet of silk. Rather than tying the spider down, as with Termeyer's machine, he simply let her crawl along the floor, or over his hands. Perhaps the rhythm and speed of the machine was such that the spider could not cut the thread with her legs.

Rolt submitted his findings, along with a scrap of silk and one of his spider houses, to the Royal Society of Arts, where he was presented with a silver medal in manufacturing, and praised for the novelty and ingenuity of his experiments.

I return now to the US Army Surgeon, who found Abbé Termeyer's forgotten manuscript at the end of the American Civil war. His name was Dr Burt Green Wilder. In 1863 Wilder joined the 55th Massachusetts regiment and was stationed on a marshy sand bar just south of Charleston, named Folly Island. To pass the time on Folly, he would explore its desolate terrain, and it was on one of these walks that he discovered a huge spider sitting in the centre of a golden coloured web, a web that stretched 10 feet

between the trees. He collected the spider in his hat and carried it back to his tent.

Here, he describes the scene:

‘The insect was very quiet, and did not attempt to escape; but presently, after crawling slowly along my sleeve, she let herself down to the floor, taking first the precaution, after the prudent fashion of most spiders, to attach to the point she left a silken line, which, as she descended, came from her body. Rather than seize the insect itself, I caught the thread and pulled. The spider was not moved, but the line readily drew out, and, being wound upon my hands, seemed so strong that I attached the end to a little quill, and, having placed the spider upon the side of the tent, lay down on my couch and turned the quill between my fingers. ‘⁶

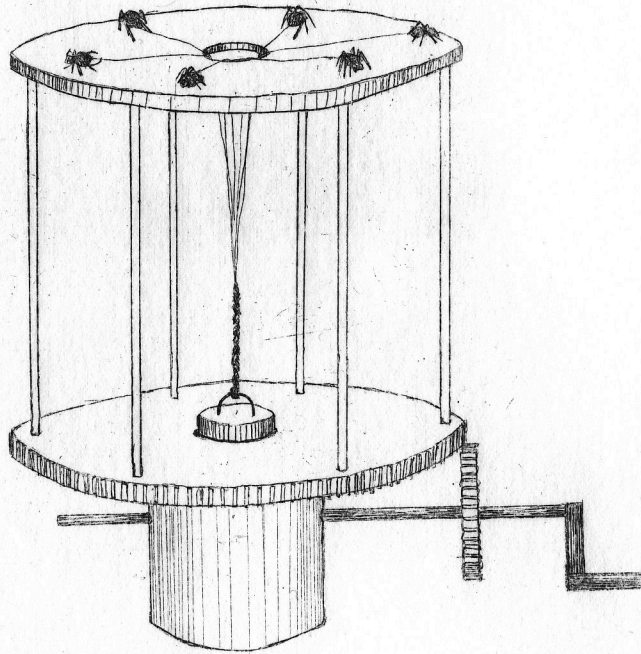
He continued at this for an hour and a half, after which time he had collected over one hundred and fifty yards of “the most brilliant and beautiful golden silk I had ever seen”.

The spider that Wilder had found was the *Nephila*, or golden orb spider. Wilder was not the only soldier on Folly Island to have discovered this spider. Sigourney Wales, a lieutenant in the same regiment, had been passing the long hours on lookout duty by carving trinkets and mementoes, which he sold to the other men. He came across the *Nephila*, and like Wilder, realised that he could pull silk directly from the spider’s spinnerets. He attached the thread to a spool and wound the yellow silk onto rubber rings, which apparently he was able to sell as real gold jewellery.

Wilder and Wales discussed their use of the spider, which led to Wilder’s creation of a spider silk spinning machine, similar to that of Termeyer. The spider was held in place upside down, which gave easier access to the spinnerets and was apparently more comfortable for the spider. In the autumn of 1864, while the union bombardment of Charleston was at its height, Wilder was able to wind almost two miles of golden silk on this machine.

After the end of the war, Sigourney Wales became a salesman in New York, while Burt Wilder became professor of zoology at Cornell University where he continued his

investigations into spiders. He was interested not only in the biology of the spider, but also in the commercial potential of its silk. The thread was too thin to spin like cotton, so he tried various ways of twisting the threads together to make a thicker strand. In one of his attempts, he secured spiders to the top of a disk, and attached their silk to a stationary disk underneath.



As the top disk turned, the silk was wound together. Using this process he was able to make a small strip of spider's silk ribbon. In 1867, encouraged in his belief in the commercial potential of spiders' silk, he submitted a patent claim for his spider silk spinning machine.

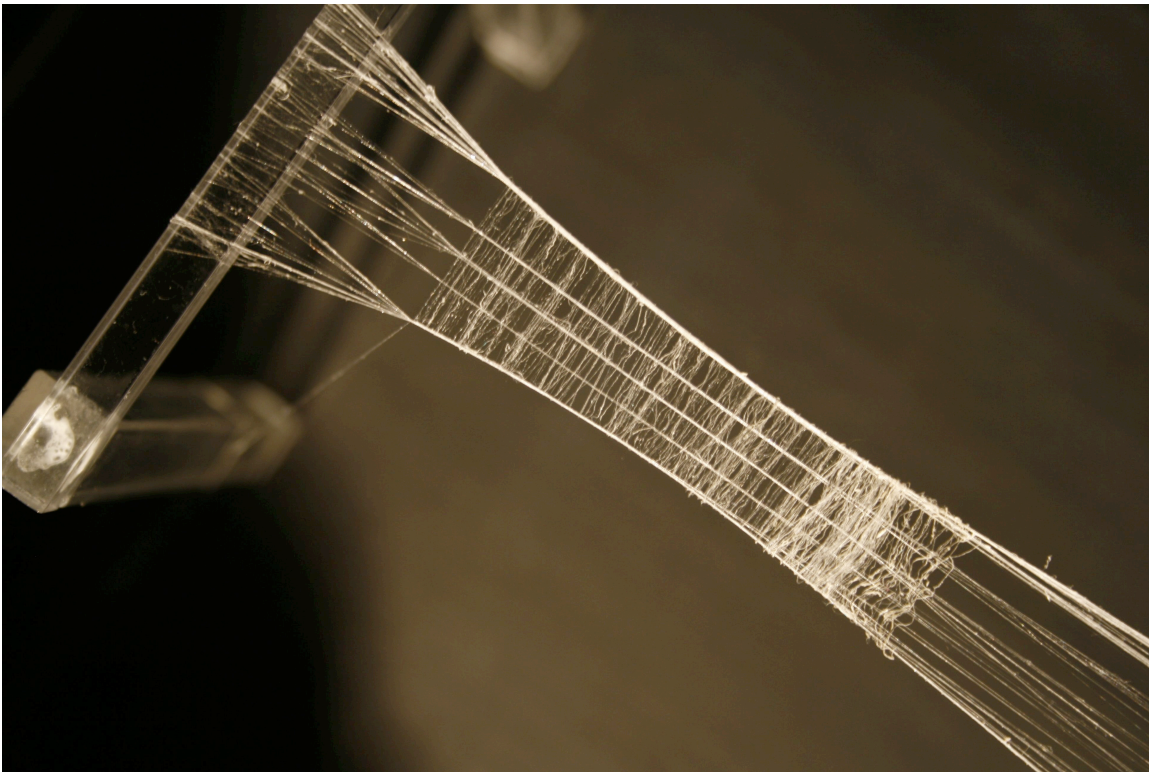
I found Wilder's patent a few years ago while looking through old copies of Scientific American. I was already a silk spinner myself, but I did not know that there had been others. I collect silk from the European garden spider, which I weave into drawings or sculptures. It began in my studio, while I was staring at the many spider webs catching the dust and light in the corners of the room. I wanted to see what a sculpture made from spiders' silk would actually look like – could the strands of silk retain their magical

glow when woven together? There were practical decisions to be made: How would I collect the silk? And once I had collected it, how would I weave such a fine material, better suited to spiders' legs than to clumsy human fingers? To begin, I constructed small wooden frames, which I placed behind the webs and pulled towards me, so that the strands of silk stuck to the frame. I then returned to my studio and tweezed apart the individual strands of silk. It was a slow and inefficient process, as I had to extract the dry, strong threads and discard the rest. I soon discovered a much better method. I found a huge web attached to the branches of a tree, with a European garden spider sitting in the centre. As before, I put my wooden frame behind the web and drew it towards me. The spider ran top right, off the web and onto a leaf. I turned the wooden frame, and the spider was still attached to the web with silk coming from her spinnerets. As I rotated the frame, I realised that I was extracting silk directly from her abdomen. I was able to collect at least two metres of silk before she cut the thread with her back legs.



It was unsettling to realise that I was extracting silk from a spider and could feel the bodily resistance of another animal through my hand. It is a moment that is described with amazement by many of the silk collectors. For me, the oddest experience is when I

am weaving the silk on a loom (fig. 4). I stare at the silk for hours, and I can only see the threads clearly by using a strong spot light, so that when I close my eyes I can still see them as lines of light. At first I tried to work with tweezers, but the silk is more attracted to skin. So I hold and weave the silk between my hands. Often I cannot see it, so I seem to be gesturing at nothing, simply waving my hands in the air. I weave during early autumn, when spiders are at their largest. These are the 'gossamer' days, a name that originates from this time of year when all the bushes and trees seem to be covered in webs. After a day of weaving, I sometimes dream of the silk, the feel of it on my hands and the look of the strands on the loom. Perhaps these dreams are as close as we can get to the life of spiders.



¹ Henry Christopher McCook, *American Spiders and Their Spinningwork: A Natural History of the Orbweaving Spiders of the United States, with Special Regard to Their Industry and Habits* (Philadelphia: H. C. McCook, 1889), 84.

² Marquis de Bon, 'Translation of a letter from Marquis de Bon to Hans Sloane', 1739, EL/B3/41, GB 117 The Royal Society.

³ Raimondo Maria de Termeyer, *Researches and Experiments Upon Silk from Spiders, and Upon Their Reproduction. Translated and Revised by B. G. Wilder. Communicated to the Essex Institute. Extracted from the Proceedings, Vol. 5* (Salem, Massachusetts, 1866), p. 8.

⁴ M. de Asúa, 'The experiments of Ramón M. Termeyer SJ on the electric eel in the River Plate region (c. 1760) and other early accounts of *Electrophorus electricus*.', *J Hist Neurosci*, 17 (2008), 160-74.

⁵ Daniel B Rolt, 'Letter from Mr D Bransdon Rolt to the Royal Society of Arts, 29th November 1830', Manuscript Transactions Vol 121 (1829-31) part 4 of 5, The Royal Society of Arts.

⁶ Burt G. Wilder, 'How my new acquaintances spin', *The Atlantic Monthly*, 18 (1866): 132.