I’ve always loved fashion. As a child, I was fascinated by all the colors and textures of fabric available to me. I would go to the store with my mother and touch every article of clothing, every scrap of fabric, every blanket or pillow case on display. I loved busy patterns and bright colors, I was constantly dazzled by the beauty of fabric.

As I grew up, that fascination extended to style. I loved learning what clothes could convey. I started to understand the role fabric plays in society. I started to understand fashion. From there, my love only grew, I loved modern fashion, and was excited for future fashion. I watched runway shows, attended fashion clubs after school, learned to sew to make my own clothes. I spent my free time on the bus designing clothes in my notebook, imagining a future in which I could be the next Vera Wang, Versace, Gucci, Chanel.

Then, I was taught about climate change in Social Studies. Looking back now, it feels absurd, I feel as though I have always known about the clock being set for the human race. At the time, I was horrified. In the mock-debates we held, I would passionately propose solutions, filled with anger towards my government and fear for the planet and her people. I was told that I couldn’t fix it, and that the people who could weren’t going to.

I retreated in the past, too scared to look at the future for too long. I was sure I was going to be dead by 20, that doom. I loved the fashions of the past just as ardently as I had loved those of...
the present. I spent hours looking at drawings, diagrams, pictures of recreations, reading archeological research on the most recent textile finds. I was in love.

I loved, most of all, hanfu, wafuku, and hanbok, the traditional fashions of the Han Chinese, Japanese, and Korean peoples, respectively. The patterns, the texture, the colors. I was obsessed with silk.

**A HISTORY OF SILK**

To understand the history of silk, it’s important to know where it comes from. No, not where it's produced, but what produces it: Silkworms! These little creatures have been a valuable resource for thousands of years.

In fact, even before we domesticated them, we would harvest wild silk. This wild silk has been around for even longer than the industrially produced kind, which began production 6,000 years ago in China. This silk was a commodity, and a huge source of trade income for the Xia Dynasty, and has continued to be important even into the modern day.

The semi–mythical inventor of Silk, the Empress Leizu, wife of the Yellow Emperor, is said to have discovered the fiber when a silkworm cocoon fell into her tea, causing the the pod to unravel. Interested in the fiber, she spun and wove it, creating the first silk. While this story is almost certainly not true, it speaks to the great importance of silk; only someone as important as the Empress of China could have discovered it.

The process of actually making silk is fairly simple. Silk-producing species of Lepidoptera, the order of insects to which butterflies and moths belong, particularly of the genus Bombyx, are fed a diet of mulberry leaves as caterpillars. They then pupate, creating a cocoon of fibroin, the protein that makes up silk. The cocoon is then boiled, the fiber unraveled and spun into a thread. The thread is then woven into silk.
There is also the option of “Peace Silk”, though it is less popular than traditional silk because the resulting thread is shorter, making for a weaker end result in the silk. This is because the cocoons are not boiled, and instead allowed to hatch, so that the silkworms aren’t killed in the process of making silk.

This process wasn’t always easy to access, however. For the centuries between the invention of silk and the 550s BCE, it was a well kept secret. Only China, India, and Japan had access to silkworms; it was illegal under penalty of death to export the worms. Trade between these countries and Europe happened along a trade corridor referred to as the “Silk Road” due to the importance of silk trade, which took precedence over the equally lucrative and widespread trade of spices, and overshadowing other agricultural goods traded in this corridor.

That all changed when the Byzantine emperor Justinian paid two monks to smuggle silkworms out of China, hidden in their canes. This semi-mythical exchange began Mediterranean silk production. Italy and France began producing their own silk shortly thereafter,

After outside production began, markets shifted, dropping the price of silk in Europe significantly, with both cheap and expensive luxury silks being produced far closer than the previous seven-to-nine thousand miles away. Until the mid-1700s, silk was a major export of Italy and France. Not long after, cotton superseded silk as the major textile product of most nations in Europe, because of its low production cost. However, silk production retained its power in Asia, with China and India holding strong at
the top of the industry. The existence of synthetic alternatives to silk have lessened its importance in the modern day, as silk can still be quite expensive compared to nylon, polyester, or acrylic.

**SILK AND SUSTAINABILITY**

This cost difference is down to several things. The first, and perhaps most important, is the difference in labor requirements between synthetic textiles and natural silk. After this, the next biggest difference is in time. It takes far longer to produce silk than synthetic fibers. Then, there is sustainability.

Silk production, as is the case for many trades that come from pre-industrial times, did not struggle with sustainability until the industrial revolution shifted production preferences, favoring speed and profit over quality. Silk is a biodegradable, renewable, low-impact material, as it uses few environmentally harmful chemicals. This perceived green-ness is a factor in setting the price for silk. Corporations will charge more for sustainable products, because having a moral standing will drive many consumers to choose a more expensive option, even if it doesn’t actually have to cost more.

Feeding silkworms requires a significant amount of mulberry leaves, and this is the juncture at which most of *sericulture*, or silk production, gets its sustainability issues. Mulberry trees can become a problem due to their shallow root systems, which persist even after the trees are felled, meaning that they will regrow from stumps. If there is too much wind they’ll fall easily, as they lack the deep root systems that better anchor other trees, like oaks, to the ground. The biggest issue, however, is pesticide use in farming mulberry leaves.

Nonorganic silk also uses chemical treatments, producing industrial chemical waste, usually some sort of soap, which is used to “degum” the fibers. Degumming is the process of separating the fibers from each other to
prepare them for the spinning process that makes the fibers into thread. These chemical treatments pollute water sources, making this method of degumming less than ideal from a sustainability perspective.

The primary way that silk pollutes is actually through its dyeing process. Globally, textiles are one of the most polluting industries, almost entirely from the dyeing process. Harsh synthetic chemical dyes are dumped outside factories, polluting water sources, and poisoning wildlife, sometimes even people, with the refuse. There are dozens of natural dyes that do not pollute to this degree, some that don’t even pollute to any significant degree at all, but they’re not used because they are more expensive to produce, generally less vivid (though by no means are they dull), and don't last as long in fiber.

Organic and recycling methods of silk textile production do exist, and these methods present a fairly environmentally-clean way of producing silk. These methods are the ones that show the greatest promise with regards to a sustainable future for textiles, as there are ways to change the color of silk without dye, including changing the diet of the silkworms.

This method in particular seems promising for a more sustainable approach to fabric dyeing.

Outside of ecological concerns, there is resistance to using silk due to it usually requiring killing the silkworm before it can hatch. Vegan and animal rights activists have argued that it is unethical to kill silkworms in the massive quantities required to produce silk. Between 2 and 3 thousand cocoons are needed to make a pound of silk. However, I feel that while insect lives are valuable, the pay-off is worth it, especially considering the fact that B. mori moths usually live for only a few days, and are unable to eat during that time. This ethical concern is what encouraged the development of “peace silk”, which allows for the hatching of silkworms at the cost of the resulting thread having lower strength.
**OTHER USES FOR SILK**

Silk fibroin has uses outside of textile production, as well. Fibroins, which are the insoluble proteins at the core of silk thread, have been used in a number of innovative and creative ways that may be very useful for making more STEM fields, such as medicine, electronics, and agricultural science, more sustainable. I have three non-textile uses that I find the most promising and intriguing that I hope increase your understanding of the usefulness of silk.

In the case of biomaterials, a term used to describe a vast array of materials that are used medically to interact with biological systems, a greater variety of species are used for silk, including members of the insect Orders Hymenoptera, which contains bees, wasps, and ants, and Neuroptera, which contains lacewings. The different capabilities of the silk fibers of each type of silk-producing insect allow for a great flexibility in use, and expand the world of artificial tissue exponentially.

Silk can also be used as a conductive material for wiring and energy storage. The effectiveness of conductive silk materials has been improved through a variety of methods over the years, and may be made cheaper by innovations in diet manipulation, as changing silkworm’s diets has a great effect on the silk they produce.

Silk can also be used as a coating to keep perishables for longer when suspended in a solution and used as a coating to prohibit gas exchange, or in simpler terms, it can be used to seal fruits and vegetables, much like wax is often used at present.

**BIGGER THAN SILK**

Using silk is part of a larger conversation in sustainability: The conversation about Insects. It has been observed by entomologists, ecologists, ornithologists, and biologists during the past few decades that insect populations and biodiversity are in rapid decline. These extremely concerning issues have few, if any, good solutions. The best we can do, as individuals, is valuing insects. Loving them. As Heedra on Tumblr said, in a popular post about learning to love insects: “It’s especially about trying to uncouple the value we find in them
from how ‘convenient’ they are to us; to face head on the part of us that wants to assign moral evil to another organism who just happens to live life in a way that is not harmonious with ours. You can love insects in this way and still recognize your own health and safety needs. We are animals living side by side within a biosphere. This is how it is, sometimes.” She continues, saying: “I think this is important to cultivate because, if you are alive at all, you are coming into conflict with countless other people and things that don’t owe you an apology for their existence and needs. If you are alive at all, you are encountering countless other people and things that harmful bias and personal discomfort have made repulsive to you. This is about bugs, but it's also about way more than bugs.”

We all need to learn to love the other, to value what we do not understand, or what we do but hold with disgust. We have to do what we can to save insects, to keep them and their skills alive, for them and for us.
REFERENCES


This article discusses the potential use of silk fibers as an electric conductor, through the modification of *Bombyx mori* diets with different chemical components. Graphite, MoS2, TiO2 nanotubes, and a mixture of KMnO4/MnCl2 were all tested, with the last being the most effective improver of conductivity, particularly with the addition of a glassy carbon substrate. Silk is naturally conductive, and already has use in sustainable and/or flexible electronics, and has been chemically modified for better performance, but the method of diet modification offers a promising alternative to expensive post-production modification of silk fibroins.


This article is the opening matter to an issue of *Insects* with the same title, and summarizes in broad strokes the research presented. It explains the needs of sericulture (silk production), which gives context for the industries reliance on moriculture (mulberry production). This is providing a succinct and manageable overview of current research in sericulture.


Gaviria, A., et al. “Silk wastes and autoclaved degumming as an alternative for a sustainable silk process.” *Scientific Reports*, vol. 13, no. 1, 2023, [https://doi.org/10.1038/s41598-023-41762-6](https://doi.org/10.1038/s41598-023-41762-6)

This article discusses the potential benefits of using silk wastes, such as defective cocoons and fibrous wastes, to produce textiles. The sustainability aspect is emphasized, as these products are, as the name implies, otherwise wasted in their entirety. I feel it is sound and of a good intention.

This is a text post on the internet blogging site *Tumblr*, which I have singled out for use in my paper as a source of inspiration for my broader ideas about insects, as well as the application of some of user Heedra’s elegant prose on the matter of respecting insects as part of earth’s biodiversity.


This article overviews the usefulness of different production methods of silk, and goes into great detail as to the various methods one can use, the different species (or synthetic proteins) which can be used to produce raw silk, and the processing of said raw material. It is effective and informative.


This section of The Textile Institute Book Series “Sustainable Fibres and Textiles” covers the particular topic of the ethics and sustainability of silk production, and presents areas for improvement. It covers the types of silk used commercially, and the production process, pointing out the advantages and disadvantages of different approaches, while evaluating the sustainability of sericulture more broadly.


In use to confirm that Confucius did not write about Leizu inventing silk.

Lee, Boyoung, et al. “Species identification of silks by protein mass spectrometry reveals evidence of wild silk use in antiquity.” *Scientific Reports*, vol. 12, no. 1, 2022, [https://doi.org/10.1038/s41598-022-08167-3](https://doi.org/10.1038/s41598-022-08167-3)

This article covers the evidence of the method used for silk production in antiquity, looking specifically at samples from the city of Palmyra. The researchers developed a method to identify silks by species of production, then applied this method to archeological samples, coming to the conclusion that Palmyra’s silks were likely primarily derived from the Indian subcontinent’s
Tasar silkworm (*A. mylitta*), rather than the now nearly-ubiquitous Mulberry silkworm (*B. mori*).

Marelli, B., et al. “Silk fibroin as edible coating for perishable food preservation.” *Scientific Reports*, vol. 6, no. 1, 2016, https://doi.org/10.1038/srep25263

This article goes over the usage of silk fibroin (one of the components of silk) suspended in a solution as a food preservative. The solution allows for the dipping of perishables, and the subsequent coating conserves gas exchange, keeping perishables fresh for longer periods of time. Additionally, this coating is entirely biodegradable and edible, presenting a promising method of food preservation, which demonstrates the myriad usages of silk.


A basic overview of the history of silk, for use in my explanation of its history and present.

**IMAGE BIBLIOGRAPHY**


