Rearing Silkworms at Home

"Patience is power; with time and patience the mulberry leaf becomes a silk gown."
-- Chinese Proverb

Sericulture (the cultivation and production of silk) has been shrouded in mystery since the Chinese first began cultivating silk around 2700 B.C. Sericulture eventually migrated west to Europe, with Italy becoming an especially strong silk producing nation. Silk production methods had not changed significantly from the techniques developed by the Chinese almost four thousand years prior. Empires have since risen and fallen on the strength of this luxurious fabric. The key component in the entire process – then, as today – is the tiny silkworm.

This article will outline simple and mostly period methods of raising silkworms and silkmoths in your own home. The initial set up costs are minimal, with the greatest investment being the time you spend in caring for your new houseguests. If you want to make your own silk for spinning or weaving, or if like me, you just have a fondness for bugs, raising your own silkworms can be an extremely satisfying endeavor.

Preparation

The first step is securing a reliable food source for your silkworms. Mulberry leaves are the food of choice for silkworms because it results in the whitest, strongest, and shiniest silk. The Chinese favored the white mulberry (Morus alba), however, any variety of mulberry will work. If you do not have access to a mulberry tree or bush yourself, ask around; most people that have them in their yards will be more than happy to let you prune this rapidly growing and tenacious plant. Mulberry trees are also prevalent in church yards, parks, and cemeteries. Check with the landowners before picking any leaves! How many leaves you need to harvest depends on how many silkworms you are feeding. I suggest starting with 25 eggs, for which you’ll need one medium to large mulberry tree (at least 10 feet tall) or two good-sized mulberry bushes.

If you absolutely cannot locate a mulberry tree, silkworms will eat other varieties of leaves, including nettle, oak, rose, and elm. They will also eat certain weed species and vegetable plants leaves, but the quality and color of the silk produced is far from ideal. There are also commercially available artificial diets, but the silk produced from them can be very poor, and sometimes silkworms fed this diet will not spin cocoons at all, so I cannot recommend it.

Equipment

All measurements of the containers listed below are approximations and you will need larger containers (or a greater number of them) if you are undertaking a large-scale silk production project. The containers can be made of just about any material, but if using wood avoid cedar due to its insecticide characteristics. Assuming you’re starting with 25 eggs, you will need:
Hatching box
If you order eggs from a commercial source they will arrive attached to a piece of paper and will already be in a container suitable for hatching.

Small rearing box immature silkworms
A container at least six inches square, lined with paper. It doesn’t need to have a lid.

Large rearing box for mature worms
A container at least 12x24 inches and also lined with paper. It can also be a basket with a woven bottom, which I recommend. The bottom of the basket should be loosely woven so that the bodily waste of the silkworms (called “frass”) can fall through. The weave should be no larger than that which would allow a large pearl to pass through. If the bottom of the container is solid, the frass must be cleaned away every day, which is time consuming.

Spinning chamber
This container should also be 12x24 inches or larger, but with a lid. I recommend clear plastic or glass so that you can observe the spinning process. The lid must be vented in some fashion, preferably with screening to provide airflow and prevent silkworm escape. Place several cardboard egg cartons on the bottom, which the silkworms will use to spin their cocoons.

Breeding chamber
A container at least 12x24 inches, lined with absorbent paper. Must have a lid, which should also be vented to allow airflow.

Egg laying chamber
A container at least 12x12 inches that is lined with leaves or fabric. It need not have a lid.

Eggs and Hatching
Once you have your equipment you will need silkworms eggs. Eggs of the common silkmoth (*Bombyx mori*) are available online from a number of sources (Web sites and other sources can be found at the end of this article). They are usually only available in late spring through fall, which is when your mulberry trees will have leaves, although some companies sell artificial diet and will therefore ship year round. For less than $20 you can have 25 eggs sent to your door in a container suitable for hatching. You can also obtain eggs from someone else that is raising silkworms. In period, eggs were either obtained from specialized silkworm egg brokers or by saving eggs from the previous year’s silkworm crop.
Healthy eggs are grayish-blue in color, a little larger than poppy seeds and have a slight dimple in the middle. Squeezing one between your fingernails should result in a pop. In period, eggs would often be floated in a glass of wine to determine their quality.  

The most important step in hatching your eggs is to warm them uniformly so that all the eggs develop at the same rate and hatch about the same time. This will make the future care of the worms much easier. If you purchase commercial eggs, they will already have begun to develop during shipping. When they arrive, try to keep them at approximately 80° F/26° C. This is easily achieved by placing your rearing boxes in a room with a space heater, or in a large container covered by a heating pad set on low. It’s important to use a thermometer and check the temperature often as not to overheat the eggs (which will cause them to dry out and die). In period the eggs were placed in a small pouch and carried close to the body so that the heat of the body warmed the eggs or the eggs were placed in a small box and warmed by pillows, blankets, or cushions heated near a fire.  

Depending on the temperature, the eggs will hatch within seven to 14 days. The warmer the temperature, the faster the eggs will develop and the sooner they will hatch. Examine the eggs carefully every day. They will be ready to hatch when they appear clear in the center with a dark ring around the outside. When the eggs are ready to hatch, shred tender young mulberry leaves and place them in the hatching container. It isn’t always easy to tell when the eggs are about to hatch, so if you’re in doubt place fresh leaves on the eggs every day until they do hatch. The newly hatched worms will be extremely small (about 1/4 inch or 5 mm) and will need food immediately. These leaves should be replaced two or three times daily, or as they dry out. The silkworms do not need to be provided with water, as they get all the moisture they need from the leaves. 

**Feeding and Tree Care**
When feeding the worms, care should be taken to feed the young worms the tender young leaves of the mulberry. Period sources explain this by saying that the worms would be fed leaves that are their same age. The tender leaves are easier for the young worms to eat and digest. The leaves should be shredded, since most of the time worms eat from the edges of the leaves, and shredding gives them a greater surface. As the worms mature, they can be fed more mature leaves, and eventually can be fed whole leaves. Fresh leaves should be fed to the worms three to four times daily, making sure that the leaves are clean, dry, and that your hands are free of any odors that may be offensive to the worms. Make certain that the trees have not been sprayed with pesticides, as they could kill your worms. To safeguard against this, you should wash the leaves with a mild soap, rinsing thoroughly, and dry them prior to feeding. Only feed as many leaves as the worms can finish between feedings. Supplying more leaves will only create dried leaf waste that must be cleaned away. It also wastes the leaves, which are a precious resource. Never pick more than 25% of the leaves of any one tree, as this can damage the tree and result in poor leaves the following year or even death. Most period sources contain in-depth sections on care of the mulberry trees.

**Immature Silkworms**

Once the worms hatch they can be moved from the hatching container to the small rearing box. They will be black and covered with short stiff hairs. When transporting the silkworms you should move the leaves that the worms are attached to instead of trying to move the worms themselves. At this stage they are very small and fragile, and picking them up is very difficult. You can house all the young worms together in one box. They will not crawl away from the food source, so a lid is not needed as long as you provide a constant supply of fresh leaves. In period, all of the worms that hatched in a six hour period were kept in separate batches, but that is only necessary when rearing thousands of worms at a time.

The worms will molt for the first time at five to seven days after hatching. A silkworm will go through four molts during it’s worm (or larval) stage. Before the first molt, the worm is known as a 1st instar. After the first molt it is a 2nd instar and so on. The worms will grow inside their skin, and eventually need to molt the old smaller skin in order to grow larger. Also, a hard covering called the head capsule protects their heads, and as they grow larger the head capsule begins to interfere with their mouth parts, making it impossible for them to eat. When the worms are ready to molt, they will stop eating and raise the front part of their bodies in the air, sometimes weaving back and forth. In period this was referred to as the worms “sickness.” The worms must pop the head capsule off and wiggle out of the old skin in order to continue feeding and growing. This is a very strenuous process for the worms, and they should be left alone as much as possible. Worms that are bothered by cleaning or transferring to another container could actually become sick and die if they are in the middle of a molt, since they might have to stop eating for as much as two days in order to complete the molt. Having all the worms in one batch molt at the same time becomes very convenient for the silkworm farmer, because there may be whole groups of worms that need less food and care while they molt.
After the worms have hatched the main objective is to have the worms reach the spinning stage as soon as possible. Period sources indicate that the sooner the worms spin, the more silk will be produced. There are three important things that must be accomplished to have healthy, rapidly growing worms, which produce the most silk. First, the worms must have the proper and best quality food available. Second, the worms must be kept clean. Third, the environment must be comfortable and idea for the worms.

The rearing container must be kept very clean. Excessive buildup of frass can cause mold and infection that can sicken or kill the worms. The 1st and even 2nd instar worms produce a very small dried frass, which does not need to be cleared away. However, as the worms get to the 3rd instar stage, their frass becomes larger and has a higher water content. This frass is likely to mold and smell badly. In period, worms were kept in drawers or shelves with woven or slatted bottoms which allowed the frass and dried leaf pieces to fall away without having to transfer the worms to another clean container (See Figure 1). It also kept the worm farmer from having to clean around the worms when they were molting. Sickness can be caused be a viral or bacterial infection, and the affected worms will not eat, turn brown or black, and die. This sickness should not be confused with the molting “sickness.” Any worms that are seriously ill should be killed in the freezer and discarded as quickly as possible.

Figure 1
Shelving unit used to house the worms. From The Perfect vse of Silk-wormes by Olivier de Serres, 1607
Controlling the environment of the worms was the most challenging part of the process for the medieval silk farmer. However, with modern technology such as space heaters, it is easy to keep the temperature constant. In period, structures were built specifically to house the silkworms. These structures had windows or doors that could be opened to allow light and cool air into the building, or closed to keep the heat in. Widely fluctuating temperatures are injurious to the worms. A constant temperature of between 75˚ F/23˚ C and 85˚ F/29˚ C is optimal for worm development.

**Mature Silkworms**

After the first molt, the worms will turn a very light whitish-green color, and will molt every five to six days. When the worms have reached the 5th instar sage, they will eat voraciously. At this point they are filling up their silk glands in preparation for spinning the cocoon, and will be around 3 inches (75mm) long. They should be fed the greenest, largest, sturdiest leaves at this time. After 10 days or so they will begin to slow their eating and will start to wander, crawling upwards in search of a suitable place to spin. The worms will turn yellowish, look a bit transparent and be bloated and turgid. At this point they can be moved to the spinning chamber or other structure which facilitates spinning. When you move the worms (at any stage of their development) great care must be taken as it’s possible to tear off their legs if you pick them roughly off their leaves, and it is hard for them to spin good cocoons with missing legs.
Food should be provided in the spinning chamber, because occasionally the worms will decide to eat a bit more before actually spinning, even though they show all the signs of being ready to spin. In period structures were made for the worms to spin on which included lattice work or arbors of twigs. (See Figure 2)

Figure 2. Shelves with arbors to aide the silkworms in spinning their cocoons. From The Perfect Use of Silk-wormes by Olivier de Serres, 1607

Spinning

It is important to not crowd the worms in the spinning chamber, as two worms may spin inside one cocoon, or spin cocoons that touch each other. This tangles the silk threads and makes the silk difficult to reel.

The worms will take two or three days to complete a cocoon. Spinning worms should not be disturbed once they start weaving their cocoon, because they may stop spinning and finish their development without creating a complete cocoon. Inside the cocoon the worm will molt for the fifth and last time. It will then turn into a pupa, which is the intermediate stage between the larval worm state and adult moth. Harvest the cocoons from the spinning chamber no sooner than five days after the worm begins to spin to insure that the worm inside has completed the spinning process.
Once the cocoons are collected, they should be sorted by quality. The whitest, firmest, most complete cocoons should be separated and the silkmoth allowed to emerge and breed for next year’s crop. The rest can be set aside for silk harvesting. Save approximately 2% of the cocoons for breeding if you want the same number of worms the next year, or save proportionally larger numbers for larger crops. In any case, never save less than 20 cocoons in insure that you have a significant number of males and females.

Breeding

The breeding cocoons should be separated into equal numbers of males and females. The female cocoons are larger with blunted ends. The male cocoons are smaller, have more pointed ends, and can have a peanut or hourglass shape. It is not an exact science, so the more cocoons you set aside for breeding the better your chances of getting the numbers of males and females you want. Place all the cocoons in the breeding container with the lid fastened. Make sure to line the box with absorbent paper, as when the moths emerge from the cocoons they secrete a brown liquid that is very messy. In period the tops of the cocoons would be threaded with string and hung on a wall on top of a piece of fabric. There the moths would be allowed to emerge, mate, and lay eggs (See Figure 3).

Figure 3. Adult moths breeding and laying eggs on cloth. From *The Perfect vse of Silk-wormes* by Olivier de Serres, 1607
It’s a misconception that silkworms chew their way out of cocoons. In reality, the moths secrete an enzyme that softens the glue (called sericin) that holds the silk threads together. Once the end of the cocoon is softened they push their way out of the end, creating a hole.

It is not necessary to provide food or water for the silkworms as they do not have functioning mouth parts, making feeding impossible. At this stage of their life they only live long enough to breed, then die.

The male moths will immediately begin searching for the females. Violently beating and fluttering their useless wings, they crawl around until they find a mate. The moths are flightless, having been domesticated by the Chinese centuries ago, so they are not likely to escape a deep container. However, as the males flutter their wings they shed thousands of wing scales. These scales are an allergen and a lung irritant, so it is prudent to have a lid for the breeding chamber to help contain these scales. When the males find their mates, the moths press the ends of their abdomens together and the sperm from the male is transferred to the female. The moths can stay coupled for up to 24 hours.

When they separate, the males usually die quickly, although some attempt to mate again. You should prevent this from happening, as the male’s second mating will result in a great number of unfertilized eggs. Carefully place the coupled moths in a separate container from those that have yet to pair up, then remove the males once the pair separates. If you don’t want to disturb the mating pair by moving them, you can mark their backs with a felt-tipped pen to distinguish them from those who have not mated. The females will swell noticeably after mating.

The female moth will begin laying eggs about 24 hours after separating from the male. She should be moved to a specially prepared laying chamber so that she can lay her eggs on leaves. Any broad leaf will do, even mulberry leaves if they are large enough to line a box. She should not be allowed to lay on paper or fabric, since the eggs will stick securely to these materials and you won’t be able to remove them without damaging the eggs. She will lay between 300 and 600 yellow eggs, and then she will die. The eggs will turn a bluish-gray in a few hours, and then they are ready to be harvested. The eggs can be gently rubbed off of the leaves and stored in a glass or ceramic container with a tight fitting lid to prevent the eggs from drying out. Eggs that stay white or yellow are not fertile and can be discarded. The eggs must go through at least three months in a cold environment before they will hatch, so it is convenient to store them in a refrigerator at about 40° F/4° C over winter. Be aware that there are some species of silkworms that do not need require overwintering as the *Bombyx mori* silkworm does. Any unwanted eggs can be killed by freezing. Eggs are usually viable for three years in the refrigerator. After three years a fresh supply of eggs should be obtained to increase both viability and genetic variability.

**Harvesting the Silk**
In order to harvest the silk from the cocoons, you must kill the pupa to prevent it from turning into a moth and emerging from the cocoon (which weakens the silk and makes the threads around the hole unreelable). There are several period methods that work very effectively, although they are not the most humane methods. The easiest is to steam the cocoon. Simply boil a pot of water and suspend the cocoons over the pot in a basket or colander (See Figure 4). They should steam for about an hour. The cocoons should then be allowed to dry in the sun or on a rack to prevent mold growth. The cocoons can also be put in an oven to kill them with dry heat in an oven "which has just baked a loaf of bread. Set the oven to a low temperature, around 200° F/93° C, and put the cocoons in the oven on a cookie sheet or pan for about an hour. Check to make sure the silk is not scorching or turning brown, and turn down the over if necessary. A slower but period method would be to place the cocoons in a black container or sack and leave them in the sun for three days. I only recommend this method if you leave in an especially hot and arid climate to ensure that the pupa has been killed and a moth will not emerge.

Figure 4 - Steaming the cocoons to kill the pupa inside. From Summary of the Principal Chinese Treatises upon the Culture of the Mulberry and the Rearing of Silkworms by Stanislas Julien (translator), 1838
The most humane method, and the one that I would recommend, is freezing the cocoons. Simply put them in a plastic bag in your freezer for a few days, or up to a few months. The pupae inside will die with little or no pain in a few hours.

Once the pupa has been killed, the cocoons are ready to be reeled, stretched into hankies or mawatta, or combed for spinning. Silk from stained cocoons can still be used by dyeing it a darker color than the stain.

**Conclusion**

While at first glance it may seems to be a daunting task, the rearing of silkworms and silkmoths in your own home is a fairly straightforward and highly rewarding project.

**Sources for Silkworm Eggs and Materials**

Carolina Biological Supply Company  
Phone: (800) 334-5551.  
Email: carolina@carolina.com  
http://www.carolina.com/  
25 eggs - Item #WW-14-3962 - $10  
100 eggs - Item #WW-14-3964 - $34

Mulberry Farms  
Box 174  
Bonsall, CA  92003  
Phone: (760) 731-6088  
FAX: (760) 728-3089  
Email: info@mulberryfarms.com  
http://www.mulberryfarms.com/

Niles Biological  
9298 Elder Creek Road  
Sacramento, CA 95829  
Phone: (916) 386-2665  
FAX: (916) 381-4006  
email: ted@nilesbio.com  
http://www.nilesbio.com/

Sericulum Co.  
Post Office Box 1854  
Sebastopol, CA 95473-1854  
FAX: (707) 829-1248  
Email: info@sericulum.com  
www.sericulum.com

For great information on silkworms and links to silkworm sites visit -
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*Il Vermicello dalla Seta (The Little Silkworm)*
Italy
1581

Fessenden, Thomas Green
*The New American Gardener : Containing Practical Directions on the Culture of Fruits and Vegetables : Including Landscape and Ornamental Gardening, Grape-vines, Silk, Strawberries, &c. &c.*
Boston : Carter, Hendee, & Babcock
1831

Geis, Frances & Joseph
*Cathedral, Forge, and Waterwheel : Technology and Invention in the Middle Ages*
New York : Harperperennial
1995

Hartlib, Samuel
*A rare and new discovery of a speedy way and easie means, found out by a young lady in England, she having made full proofe thereof in May, anno 1652, for the feeding of silk-worms in the woods, on the mulberry-tree-leaves in Virginia*
London : Printed for Richard Wodenothe
1652

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Washington: Peter Force
1838
Original version from China, dating back to 2205 BC or earlier

Kenrick, William: 1844
The New American Orchardist; Or, An Account of the Most Valuable Varieties of Fruit, of All Climates, Adapted to Cultivation in the United States; With Their History, Modes of Culture, Management, Uses, &c. With an Appendix on Vegetables, Ornamental Trees, Shrubs, and Flowers, the Agricultural Resources of America, and on Silk, &c.
Boston : Otis, Broaders, & Co.
1844

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The Lever of Riches : Technological Creativity and Economic Progress
New York : Oxford University Press
1990

Mola, Luca
The Silk Industry of Renaissance Venice
Baltimore : Johns Hopkins University Press
2000

Pullein, Samuel
The Culture of Silk, or, An Essay on its Rational Practice and Improvement
London : A. Millar
1758

Serres, Olivier de
The Perfect vse of Silk-wormes
Amsterdam, Theatrum Orbis Terrarum; 1607
New York, Da Capo Press, 1971

Stallenge, William
Instructions for the increasing of mulberie trees : and the breeding of silke-worms, for the making of silke in this kingdome : whereunto is annexed His Maiesties letters to the lords liefetaneants of the seuerall shieres of England, tending to that purpose
London : Printed by E.A. for Eleazar Edgar, and are to be solde at his shop
1609

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A series of engravings entitled Vermis Sericus
Netherlands
1580
Vida, Marco Girolamo

*De Bombycis mori* (On the Silk Moth)

Italy, 1527

Translated into English verse by Samuel Pullien

*The Silkworm: A Poem in Two Books.*

Dublin: S. Powell, 1750

**Endnotes**

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*Summary of the Principal Chinese Treatises upon the Culture of the Mulberry and the Rearing of Silkworms*

Washington: Peter Force, 1838

Original version from China, dating back to 2205 BC or earlier

2 - Serres, Olivier de

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New York, Da Capo Press, 1971

3 - ibid

4 - Pullein, Samuel

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While this work is not within period, the author translated a number of in-period works about silkworms and wrote essays on sericulture. In a personal conversation with Dr. Claudio Zanier, known currently as a world expert in medieval sericulture at the University of Pisa in Italy, he asserted that sericulture methods did not change significantly between medieval times and 1758 when this work was published.

5 - ibid

6 - ibid

7 - Julien

8 - Serres

9 - ibid

10 - ibid
11 - Pullein
12 - ibid
13 - Julien
14 - Serres
15 - Julien
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17 - ibid
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