

AMONG THE SILK-WORMS AND VELVET LOOMS.



COCOON MARKET IN NOVI.

IN Italy, where the production of silk is one of the principal sources of national wealth, the art of rearing silk-worms has been so developed and improved by culture and experiment that it is now considered as having reached a point of scientific, if not of practical, perfection. This branch of rural economy, in view of the inconsiderable expenditure of time, capital, and skill required, is doubtless one of the most profitable, where the climate is propitious, to which the agriculturist can devote his attention. The time from the hatching of the eggs to the marketing of the cocoons ordinarily occupies from five to six weeks. The labor is light, and may be performed for the most part by women and children, while a vacant room or two in a dwelling or outhouse will answer temporarily the purposes of a well-appointed cocoonery. To these is to be added the consideration that the mulberry-trees, being carefully pollarded, and usually stripped of their leaves during the month of June and a part of July, interfere but very little with the cultivation of other crops at the same time.

In the silk-producing districts of Italy, beside the large cocooneries, almost every peasant sets apart, during the season, every square foot of unoccupied space in his little cottage for the rearing of silk-worms, while Italian ladies of wealth and position not unfrequently raise a hundred thousand or so for pastime and pin-money.

The silk-worm, though delicate and very sensitive to sudden changes of temperature, is capable of adapting itself to differences of climate, within certain limits; while the white mulberry, which is the most approved variety for feeding it, though a native of China, has been naturalized in various parts of Central and Southern Europe, and will grow in the United States between the thirty-second and forty-third parallels of latitude. The red mulberry, which may, in the feeding of silk-worms, be substituted for the white, is a native of America, and there can be but little doubt that the climate of various portions of the United States, particularly that of California, is admirably adapted to the successful culture of silk.



Magnified.

HATCHING THE EGGS.

Natural Size.



FIRST PERIOD.

These considerations, taken in connection with the fact that the attention of agriculturists, particularly upon the Pacific coast, is being more recently directed to this subject, have suggested the idea that perhaps some account of its history and development, its introduction into Europe, and especially into Italy, together with the most approved methods of Italian culture, may not prove untimely, and possibly may be the means of stimulating a most interesting and profitable branch of rural industry.

The silk-worm, or *Bombyx mori* of naturalists, is generally supposed to be a native of China. According to Chinese annals the discovery of the art of utilizing its products is attributed to Si-ling-shi, wife of the emperor Hoang-ti, more than twenty centuries before the Christian era. The empress, it appears, not only instructed the ladies of the court in the culture of the silk-worm, but also in the spinning and weaving of silk, the knowledge of which industry, thus ennobled by royal example, gradually diffused itself throughout the Chinese empire. Upon this point, however, writers disagree. In the introduction to the History of Hindostan, or rather of the Mohammedan Dynasties, by Mohammed Cassim, it is stated that in the year 3870 B.C. an Indian king sent various silk stuffs as a present to the king of Persia, a statement that is rendered the less improbable from the fact that at the present day silk-worms are found in many of the provinces of India in their native state, where they pass through their various transformations and spin the cocoons upon the mulberry-trees in the open air.

But, whether originating in China or India, it is certain that this industry was introduced into Persia and other portions of Asia at a very early period. The Phœnicians were the first who imported silk stuffs from India to the various ports of Syria, by whom they were sold to the Greek and Roman merchants, and thus introduced into Europe. Silks were first imported into Rome about the time of the down-

fall of the republic, when they sold, it is said, for their weight in gold, and the fact that Helio-gabalus had a garment made wholly of silk is cited as a most striking instance of his wanton extravagance.

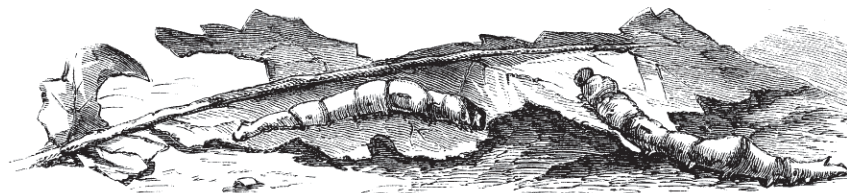
It is related by Muratori, in his "Annali d'Italia," that during the war between Justinian and the Persians the emperor prohibited the importation of silks from Persia, because at that time such merchandise, being very costly, carried out of the empire vast sums of gold, to the great profit of the Persians, who imported it from India and sold it to European merchants at enormous prices. This edict was the occasion of some monks, just returned from India, proposing to introduce the culture of the silk-worm into Europe. They described the process to the emperor, who manifested much surprise, and encouraged them with promises of great reward to undertake the difficult enterprise. These monks, having concealed the eggs in hollow canes so as to elude the vigilance of the Asiatics against exportation, returned from India to Constantinople with their precious booty, and undertook the propagation of the silk-worm. The experiment was so successful in the vicinity of Constantinople and throughout Greece, where the existence of the black and white mulberry rendered its acclimation comparatively easy, that toward the middle of the eighth century the importation of silks from India ceased altogether.

The seed was first introduced into Sicily during the time of the Crusades, in the early part of the twelfth century. From thence it spread into Italy, first into Bologna, Modena, and Lombardy, and then throughout the other Italian provinces, where it was cultivated with such diligence and success that, as early as the sixteenth century, it became, as it is now, one of the principal staples of a large portion of the peninsula.

It appears that the first silk-worms were introduced into France from Southern Calabria



SECOND PERIOD.



THIRD PERIOD.

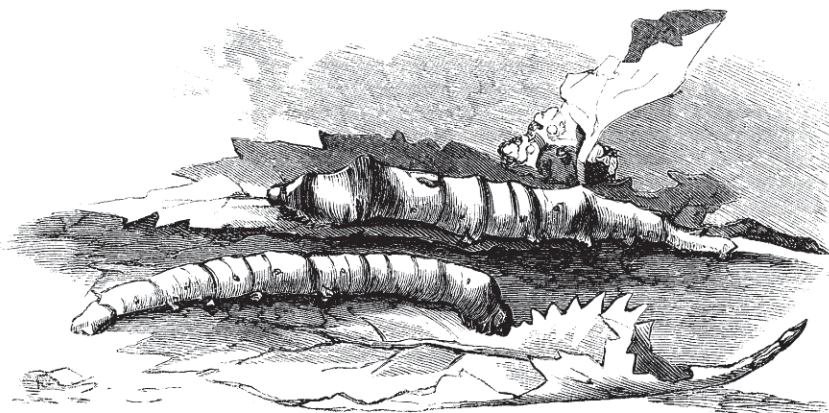
toward the close of the fifteenth century. Though considerable attention was paid to their culture, especially during the reign of Louis XI., it was attended with only moderate success. Fruitless attempts were made to introduce it into Holland, England, and the Low Countries, on account of the unpropitious character of the climate; nor more fortunate were those made in Germany, Saxony, Switzerland, Denmark, and Poland. The Arabs are entitled to the credit of introducing it into Spain, where, the climate being more favorable, it soon became a not unimportant branch of industry and commerce.

From this it will appear that the silk-worm, transported from its native country, where it propagates itself, as already intimated, upon the mulberry-trees in the fields and forests, found the climate of Italy the best adapted to its successful culture; the soil being more favorable than elsewhere to the growth of the mulberry—its leaves in southern latitudes containing a less proportion of water and more of the silk-producing substance—while the regular procession of the seasons, the gradual elevation of temperature in the spring, the favorable topography of the country, the patronage of the nobility, and the fostering care of the government, in connection with the observations and experiments of scientific men, were among the principal causes that produced in Italy such favorable results.

Like other species of the same genus, the silk-worm is oviparous, and exists in three different states—the larva or caterpillar state, the

pupa or chrysalis, and the moth or butterfly state. These metamorphoses take place at stated intervals, and result not only in the transformation of certain organs, but in the substitution of others that are entirely new. During the larva or caterpillar state the ordinary variety undergoes four mutations (*mutæ*), and two in the pupa or chrysalis state while dormant in the cocoon. These mutations, or moults, are considered by entomologists as so many stages in its development, and though it is more liable to disease at such periods than at any other, they are not to be regarded as indicative of disease, but simply as a natural phenomenon that is necessary to its growth and maturity.

The common larva at birth is about four lines or one-third of an inch in length. At the expiration of the fifth period it sometimes reaches forty lines. Its color for the first ten days is generally a bluish black, afterward a bluish white, and when ready to spin a semi-transparent yellow, resembling the color of a perfectly ripe white grape. It is composed of a succession of rings, covered with scattering hairs, with a little fleshy horn or tubercle on the upper part of the last ring. The time occupied during the larva state with its several mutations may be embraced within a period of thirty days, or may extend to forty-five, by simply varying the temperature of the cocoonery ten degrees Réaumur or twenty-one Fahrenheit. Taking the former limit as the standard, the first period (*età*) embraces five days, and then commences the first moult (*mutæ*),



FOURTH PERIOD.

which continues one day. The second period occupies three days, followed by the second moult, which continues a little longer than the first. The third period, including its moult, occupies five days, and the fourth seven. When they approach the dormant state (*muta*) the indications are easily noted. The larva generally remains fixed and motionless, with the head, which appears swollen, and a portion of the body raised aloft, becomes semi-transparent, eats nothing, and finally ends by casting its skin. On the fifth day of the fifth and last period they reach their maximum growth, then commence to diminish in length, weight, and the amounts of food consumed, until about the eighth day, when they reach their maturity, eat no longer, fast for thirty-six hours, and are then ready to commence spinning the cocoons, or to go, as the Italians express it, "*al bosco*."

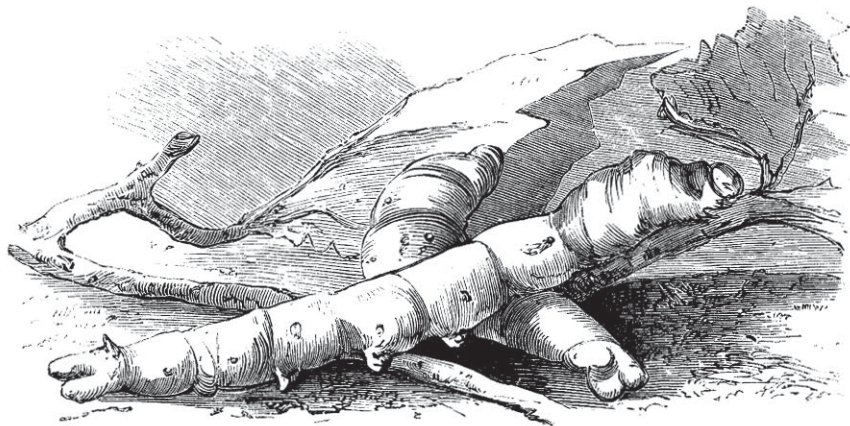
When ready to spin, they raise their heads and a portion of their bodies, moving them about as if in search of something, until they find a favorable place for the construction of the cocoon. This they form by attaching the slender silk filament at various points; and then, by a rotary motion of the head and upper part of the body, spinning the silky, gossamer-like thread around them until they gradually disappear from view. The length of this thread, according to Count Dandolo, a celebrated *bacologist*, is sometimes six hundred and twenty-five yards. The silk-producing substance is contained in cylindrical sacks, many times the length of the worm, and is in the form of a fluid resembling Venetian varnish.

In two or three days the cocoon will be completed, and the insect will have undergone its first metamorphosis, and entered the nymph or chrysalis state. In eight days the cocoons may be gathered, and, after the destruction of the chrysalis by the application of heat, are ready for market. The chrysalis, when not destroyed, requires a period of from fifteen to twenty days before undergoing the second

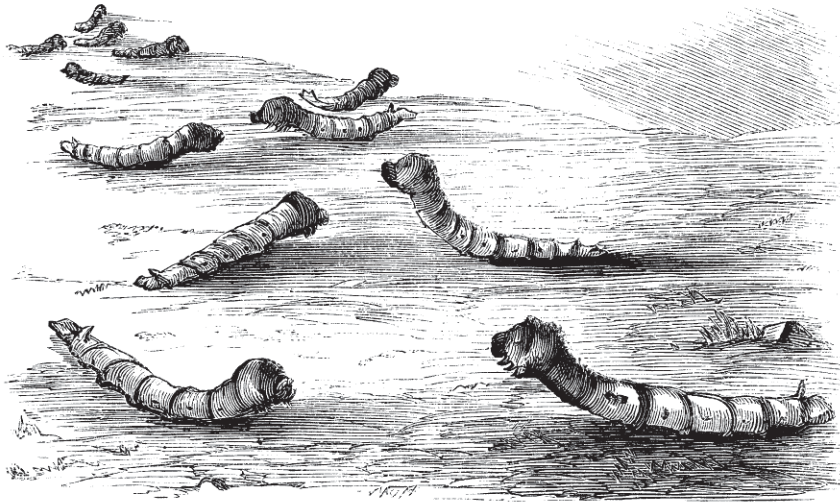
metamorphosis, when the moth makes its appearance, forcing its way through the cocoon, breaking the slender filaments of silk, thus diminishing, if not destroying, its value for commerce. The males first appear, and are readily recognized; they are smaller than the females, move about more briskly, keeping their wings in a continual flutter without flying, at least in northern latitudes. The moths eat nothing, live but a few days, during which time the female deposits her eggs to the number of four or five hundred, which are usually attached, in the artificial culture, to a fine cotton or linen cloth by means of a glutinous substance, and are thus preserved in a cool place until ready to be hatched in the following spring.

Professor Moretti states that the difference in culture, influence of climate, and food results in modifications of color, number of mutations, and power of reproduction—*i. e.*, once or several times a year. The white variety, which has the advantage of producing cocoons that do not require any preparatory process before coloring, has been introduced into Brescia, Brianza Novi, and elsewhere in Lombardy with flattering success. Those held in the highest esteem are the white cocoons commonly called *sinesi*, which are characterized by great fineness, whiteness, and brilliancy. They are admirably adapted to the manufacture of certain fabrics requiring a degree of whiteness which can only be obtained from silk that is white by nature. Though not so productive as the common variety, it commands a higher price in the market, which more than compensates for this apparent disadvantage.

There is another variety characterized by only three mutations in the larva state. Some of the advantages of this variety are, that being shorter lived by about four days they are exposed to fewer dangers, consume less, and require several days less of manual labor, while the cocoons being better constructed, and consequently unwinding more readily and completely, the silk-spinner obtains a relatively



END OF FIFTH PERIOD.



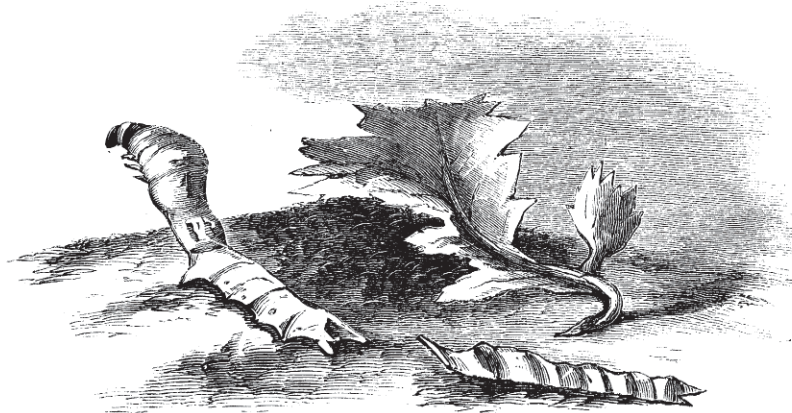
DORMANT STATE OF THE SEVERAL PERIODS.

greater quantity of silk. On the other hand it produces less silk, though of a finer quality, and has a tendency to degenerate into the ordinary variety of four mutations. For these and other reasons it is held in less estimation now than formerly.

In the construction of a cocoonery* dryness and a good ventilation are considered as absolutely indispensable. It should be erected in a dry and healthy locality, that should be rendered so if necessary by drainage, and the removal of every thing from the sides of the house calculated to collect or retain moisture, and remote from foul or putrid exhalations, occasioned by the fermentation or decomposition of vegetable or animal matter, as the silk-worm is peculiarly sensitive to all such influences. It should have large windows at least upon two sides—a north and south exposure being preferable—and these should be protected from the

direct rays of the sun by awnings rather than window-blinds.

The tables or platforms, upon which the worms are reared, are generally so arranged as to admit of a free passage around them. They are constructed by means of upright posts, to which are attached longitudinally a series of transverse pieces about a foot and a half between each series, upon which the platforms are arranged. These sometimes consist of canes, somewhat resembling the Chinese sugarcane, placed side by side, and woven together by means of cord or twine, sometimes of a fine net-work of pack-thread, iron or brass wire, or else very coarse open canvas, so as to allow, in any case, a free passage of the air from below, which is considered very necessary. Every room of a cocoonery should be furnished with a fire-place, which will serve the double purpose of supplying warmth and ventilation.



SILK-WORM CASTING ITS SKIN.



FORMING THE COCOON.

It need hardly be stated that in the rearing of silk-worms very much depends upon the selection of the seed. Since the appearance of the disease which has committed such ravages among the silk-worms in Italy, that have become so extremely delicate from many generations of oven-breeding, large quantities of seed are annually imported from Japan, with the most favorable results. But notwithstanding the strictest precautions and the most stringent regulations of the government, a spurious article is not unfrequently introduced into the market upon the old Japanese cards as Japanese seed. Though an expert may judge somewhat of the quality from the size, color, weight, and uniformity of the eggs, yet as there is no certain criterion, Italian silk-growers (*baconomi*), after the first year, find it safer to raise their own seed. For this purpose they select the largest and strongest silk-worms and place them by themselves for spinning; when the cocoons are completed, those are preferred that are of a fine texture, firm, smooth, and compact, and such as are rather small, pale in color, hard at the extremities, with the chrysalis movable and not adherent. An equal number of

male and female cocoons are selected, which are readily distinguished. Those inclosing the male are rather small, somewhat acute at one or both ends, and straighter in the middle. The larger ones and those more spherical at the extremities contain the female. As each female moth will lay on an average four hundred eggs, one hundred female cocoons will produce an ounce of seed, that, with skillful management, ought to yield forty thousand worms. The eggs, after being deposited, which will require two or three days, are carefully preserved in a dry, cool, and well-ventilated place, where the thermometer does not indicate a temperature above 55° Fahrenheit. A temperature below the freezing-point does not injure them, if kept perfectly dry. Some silk cultivators steep the eggs repeatedly in wine or other spirituous liquors, while others suspend them over wine in a state of fermentation, under the impression that the carbonic acid renders them more hardy; but this practice, together with that of detaching the seed from the cloth, is condemned by the most judicious *bacologists*.

In the spring, when the mulberry has put forth its leaves sufficiently to afford the neces-



COCOONS COMPLETED.



1. FEMALE MOTH.—2. MALE MOTH.—3. MOTH ISSUING FROM COCOON.—4. CHRYSALIS.

sary nourishment, the hatching process begins. This requires from ten to twelve days, and is generally effected by means of artificial heat, which is furnished by means of a portable stove specially constructed for the purpose, or by the heat of the human body. It is said that the peasant women of Piedmont and Lombardy go through the process of incubation by placing the eggs in their beds, or carrying them in their bosoms. The temperature to be observed during this period should be from seventy to seventy-five degrees Fahrenheit, though Beauvais places it somewhat higher. After the hatching process is completed the young silk-worms are retained upon the card or cloth until they attain some size, when they are separated from time to time upon the tables, as their growth and development may require. In feeding, the mulberry leaves are simply strewn upon the platforms over the silk-worms, that soon gather upon and quickly consume them. They should be fed frequently and abundantly; the leaves should be fresh, though free from moisture; while the bed, which will be formed from time to time by the accumulation of the stems and offal, should be frequently removed to prevent fermentation, and to allow the free circulation of the air from underneath.

After thirty or forty days, varying according to the temperature, they will be ready to spin the cocoons. The "*bosco*" is constructed principally of light brush or dead twigs, with dried leaves, light shavings, stems of salad, French turnip, Italian senna, rape, wormwood, mugwort, dog-grass, and other things of a similar character, all clean and well dried. It is most convenient to construct it in the middle of each table, forming a kind of hedge its entire width, extending in height to the platform above, and branching out in the form of a fan or the branches of a tree. It should be open, so as to admit a free passage of the air, as good ventila-

tion, at other times so desirable, is, during the process of spinning the cocoons, absolutely indispensable.

Count Dandolo estimates that the silk-worms from an ounce of seed (40,000) require eight hundred and eighteen kilograms, or about eight hundred pounds, of leaves for their consumption. Other *bacologists* place it as high as nine hundred and seventy-five kilograms. Of this amount they will consume less than the $\frac{1}{2}$ part in the first period, and about $\frac{7}{5}$ in the fifth or last period. Forty thousand silk-worms, with skillful culture, should produce ninety kilograms, or about two hundred pounds of cocoons. The average price of cocoons of all qualities throughout Italy for 1868, as taken from the official statistics, was seven francs and twenty-eight centimes a kilogram, or sixty-six cents per pound. From this it will appear that the silk-worms arising from an ounce of seed, costing from twenty-five to thirty francs an ounce, and consuming something less than two thousand pounds of mulberry leaves, will produce about two hundred pounds of cocoons, worth in Italy, on an average, six hundred and seventy-five francs, or one hundred and thirty-five dollars in gold, and, judging from the relative cost of silks, worth two or three times that amount in the United States.

The production of silk in Italy, though still one of the principal branches of Italian industry, has of late years, owing to the disease of the silk-work, considerably diminished. It is estimated that Lombardy alone has fallen off during the last eight years to the amount of four hundred millions of francs. In Piedmont, which may, perhaps, be taken as a fair sample of the rest of Italy, the production of cocoons, which in 1861 amounted to 3,934,010 kilograms, had gradually fallen off until 1865, when it produced only 1,157,470 kilograms. In 1868, however, the production rose to 3,036,220 kilo-



THE "BOSCO"—COCOONS DURING SPINNING PROCESS.

grams. And yet the quantity of silk produced in Italy is not only greater than all the rest of Europe together, but is more prized as to quality, on account of its beauty, color, brilliancy, and softness.

Kolb, in his "Handbuch der Vergleichenden Statistik," estimates the whole European production for 1862 at four hundred and fifteen millions, while that of Italy alone was two hundred and eighty-five millions.

The history of sericulture in America, though antedating the Revolutionary war in its origin, may be summed up in a very few words.

"The culture of the mulberry-tree in Virginia was encouraged by James I., and the coronation robe of Charles II. was spun from Virginia silk. Silk husbandry was introduced at an early day into Louisiana, and a state robe was made from Georgia silk in 1735 for Queen Caroline. In 1749 the export of cocoons was 1000 pounds, and in 1766 it had reached 20,000 pounds. Afterward a decline resulted from the withdrawal of the government bounty.

"Pennsylvania and New Jersey about this time became interested in the business, and Dr.

Franklin, in 1770, sent seeds, mulberry cuttings, and silk-worms' eggs for distribution. A silk manufactory was established in Philadelphia in 1771, which received cocoons for several years. A court dress of silk from cocoons of Lancaster County was acknowledged with a present of lands. New Jersey planted mulberry groves extensively, and New York made similar experiments. Connecticut and Massachusetts led this interest in the Eastern States. The Revolutionary war put an end to all these enterprises.

"In the revival of industry at the commencement of this century renewed efforts to establish the silk business are observed. In 1819 five tons of raw material were produced in Mansfield, Connecticut. In 1842 the New York State prison at Auburn produced \$13,000 worth of sewing-silk. In 1840 the total domestic product of silk was 60,000 pounds, valued at \$250,000; in 1844 400,000 pounds, worth \$1,500,000; and in 1850 only 14,673 pounds. In 1860 Connecticut, New Jersey, Mas-

sachusetts, Pennsylvania, and New York produced \$5,000,000 worth of sewing-silk, some silk stuffs, ladies' trimmings, and other goods. Philadelphia and New York manufacture about \$2,300,000 of these articles annually. The business, in all its branches, has greatly increased since 1860."*

Mr. Prevost, one of our most successful silk growers, expresses the opinion that California, owing to the mildness and dryness of its climate, is better adapted to the culture of the silk-worm than any other country in the world. This opinion is strengthened by the fact that the cocoons of California were among the finest exhibited at the French Exposition. Utah Territory, he thinks, is also admirably adapted to silk culture, and mentions the fact that Brigham Young, with his usual sagacity, has already planted out one hundred and sixty acres in mulberry-trees.

From these observations, and from the fact that recent experiments seem to indicate that the osage orange may be substituted success-

* Report of Commissioner of Agriculture for 1867.



STORING THE COCOONS.

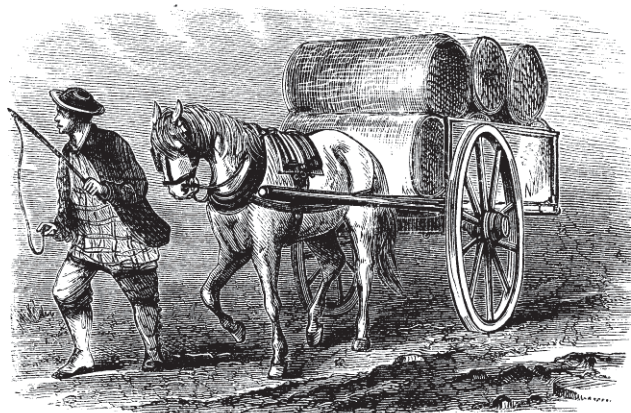
fully for the mulberry, it is sincerely to be hoped that, while sericulture, owing to the disease among the silk-worms, is declining in Europe, it may so enlist the services of our scientific as well as practical men as to become at no distant day one of the most profitable branches of our agricultural industry.

In the manufacture of silk the cocoons are first separated from the floss, and then thrown into basins or boilers of hot water, which, dissolving the glutinous substance by which the cocoons are rendered so compact, greatly facilitates the process of reeling. The ends of the silk thread are now readily disengaged by stirring them with a wisp of broom straw, several of them being united together and passed through perforations in a cross-bar, and from thence on to the reel. In many of the factories of Italy these reels are still turned by hand, in which case great skill and delicacy of touch are necessary in order to avoid breaking continually the slender and almost invisible filaments. Steam, however, is now being introduced into the larger factories, thereby insuring greater delicacy, precision, and uniformity of movement. In

one of these factories which we visited in Lombardy we noticed that little girls were principally employed in performing this delicate work; and it was something wonderful to observe the careless skill they exhibited in joining the broken threads as they sang cheerily, in the harsh Lombard dialect, their simple improvised songs.

When reeled the silk is twisted or thrown, one or more threads being twisted more or less tightly, according as it is intended for the warp or woof of the various kinds of silk fabrics. The thrown silk, after being boiled in soap-suds for several hours and rinsed in clean water, becomes soft and glossy, and is now ready for the weaver, by whom it is manufactured into a variety of tissues or fabrics. These, though differing greatly in name, quality of the material, and thickness of the tissue—such as brocade, damask, crape, gauze, satin, and velvet—yet do not differ materially in their mode of manufacture.

If Lombardy is justly celebrated for its silk, Genoa is pre-eminently the city of velvets. As late as the seventeenth century she supplied Eu-



MARKETING THE COCOONS.

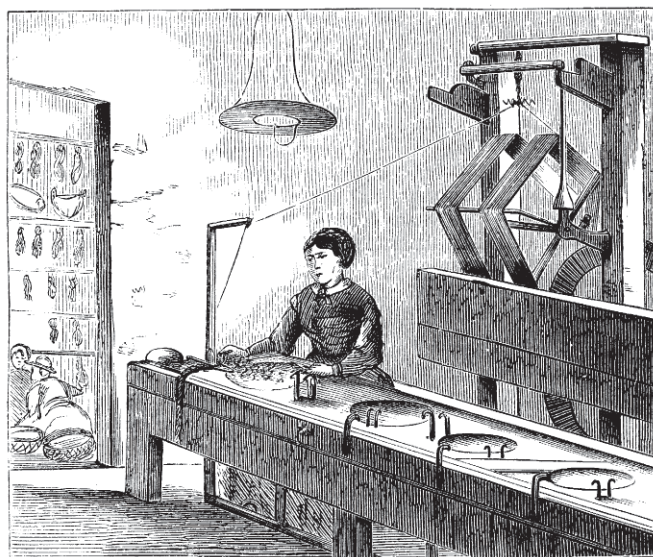
rope with her damasks, while the costly products of her cunning looms were celebrated before the times of Shakspeare. In damasks the French have imitated and finally surpassed her, but in velvets she fairly maintains her old supremacy.

In Italy, in the manufacture of velvets as well as many other fabrics, the operatives are not collected together in large factories, but remain at their several homes, where they receive the raw material and work it up into the required article. This system, in a country where labor is cheap, has its obvious advantages. Among others, it avoids the congregating of large numbers of operatives in the same building, as well as the investment of a large amount of capital in buildings and machinery. For example, in the manufacture of straw hats in the straw-plaiting districts, of which Pisa, Pistoja, Leghorn, and Florence are the principal centres, in every town and village peasant women may be seen, sitting in the doorways, in the fields, along the road-side, about the railroad stations, every where, busily plying their vocation as they sport with their children or gossip with their neighbors. So in the silk and velvet manufacture. The looms are to be found in the homes of the respective weavers. The Messrs. De Ferrari Brothers, among the most extensive as well as successful manufacturers of velvet in Genoa — the senior

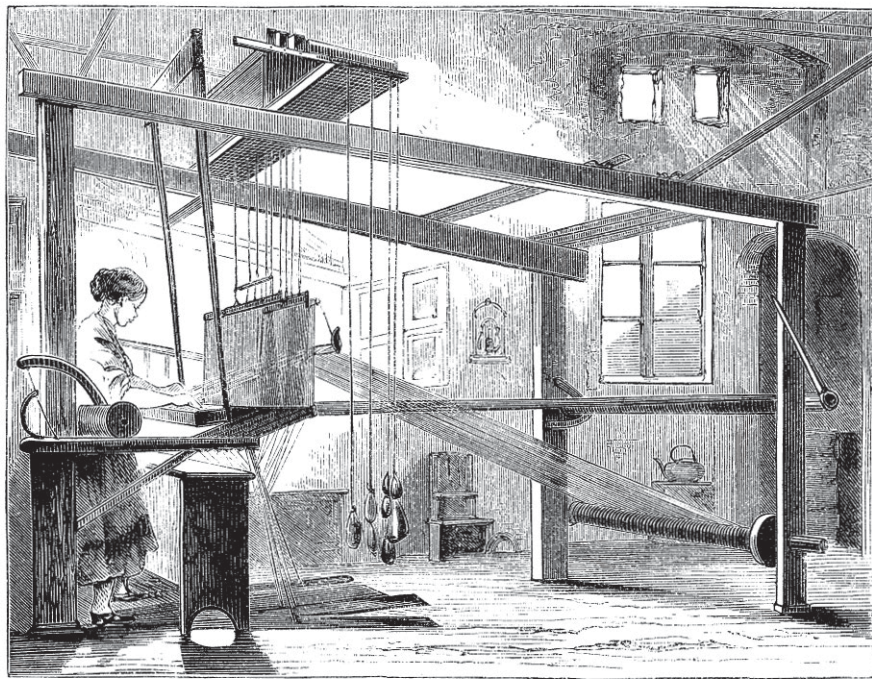
member of the firm having recently been decorated with the cross of the Crown of Italy for their enterprise and skill — thus employ about four hundred looms, distributed throughout the city and adjoining country. The weavers are furnished with the raw material, which is weighed, as is also the velvet when completed, from two to three per cent. being deducted and allowed for loss in working it up. The looms are of the most primitive construction, and do not differ materi-

ally from those that are used in the ordinary processes of weaving. In addition, however, to the warp usually employed in the manufacture of plain goods, and which is generally divided into two equal parts, there is a third and similar series of fine silk threads that plays, by means of pedals, above and below the ordinary warp, over small brass wires inserted under it at short intervals, thus raising it into a series of ridges similar in appearance to cording. These, being cut from time to time by drawing a sharp steel instrument along the upper edge of each ridge, constitute the nap or pile, which, on being cut, liberates the wires, and standing upright upon the surface, entirely conceals the warp and woof, which is usually styled the back of the velvet.

Satin differs from other silk fabrics in that the weaver, instead of raising alternately each half of the warp, only raises the fifth or the



REELING THE SILK.



A VELVET LOOM.

eighth part at a time, thus concealing the woof and keeping a large proportion of the warp visible, thereby presenting a smooth surface, which is capable of reflecting the rays of light more equally, and which, after being dressed on heated metallic rollers, gives it its peculiar lustre.

We have indicated in merest outline whatever relates to the manufacture of silk, not because it is a subject devoid of interest to the casual observer or general reader, but because it would have been inconsistent with the gener-

al scope of this article, which, in view of the recent impulse given to silk husbandry in the United States, was to give some account, such as we might in so limited a space, of the history and development of sericulture in Italy, as well as to call attention to the most approved methods of Italian silk growers, that, in connection with her favorable climate, has rendered Italy, as it regards both quantity and quality, the first silk-producing nation not only of Europe, but perhaps of the world.