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An Essay on the Culture and Manufacture of Silk

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APPENDIX No. 10.

SILK.

An Essay on the Culture and Manufacture of Silk, by H. P. BYRAM, *Brandenburg, Meade county, Kentucky.*

Experience of past ages has fully proved that the climate of the United States is as well adapted to the nature and habits of the silk-worm and the production of silk, as that of any other country. Several varieties of the mulberry being indigenous in our soil, and those generally used in the native country of the silk-worm succeed equally well in our own soil and climate. Hence, from the nature and habits of the American people, we must soon become the greatest silk-growing nation on the earth.

The first step towards the production of silk, is to secure a supply of suitable food for the silk-worm.

Having tried all the varieties introduced into our country, I find the morus multicaulis and the Canton varieties, all things considered, most suitable for that purpose.

Propagation of the Mulberry.—Although the experience of some years past has rendered this subject familiar to many, yet those now most likely to engage in the *legitimate* business of silk-growing may be less acquainted with the propagation of the tree. I shall give some brief direction on the subject.

Almost any soil that is high and dry, and that will mature Indian corn, is suitable for the mulberry. That, however, which is inclined to be light or sandy is the best.

The morus multicaulis may be propagated by cuttings or layers, (or a good variety may be raised from the seed.) Cuttings may be of one or more buds, planted perpendicularly, in a light, mellow bed of good soil. They should be planted when the spring has fully opened, or about the usual time of planting corn. They may be planted in the rows, about twelve inches apart, and the rows at a sufficient distance to admit of a thorough cultivation with a plough or cultivator. The ground should be kept mellow until past mid-summer.

Select a suitable piece of ground for a permanent orchard. It would be well if broken up in the fall, and again ploughed in the spring, and, if followed with the subsoil plough, it would be advantageous. After a thorough harrowing it should be laid off in rows each way *eight* feet by *four*, with the plough. The trees at one year old from the nursery should be taken up, the tops cut off near the root, and one planted in each of the squares or hills.

Having tried various methods of planting and different distances, I prefer these here given. This will admit the free use of the plough and cultivator *both ways*.

In latitudes north of 38° or 40°, where land is dear, they may be planted much nearer. If a sufficient quantity of cuttings from old trees cannot at once be procured, the trees from the nursery should be taken up in the fall,

and burried in a cellar, or upon the *north side* of a bank or hill, in alternate layers of trees and earth, and the whole protected by a shed from the rains of winter, as the plants seldom sufficiently mature the first season from the cuttings, to withstand the winters of a northern climate, particularly that portion above the ground. South of 38° of latitude these precautions may not be necessary.

The Canton mulberry is a more hardy kind, resembling in some degree, the varieties known as the common Italian, producing a large full thick leaf. This variety is propagated from seed and from layers, but does not readily strike root from cuttings.

In 1838, I procured a quantity of this seed from Canton, which produced a *variety* of plants. Those producing the greatest quantity of fruit yield an inferior leaf.

They are now propagating this variety very extensively at the silk-grow ing establishment at Economy, Pennsylvania, which, in connection with the morus multicaulis, constitute the principal food used at this establish ment.

The fruit should be gathered when fully ripe, and the seed washed out and dried. If south of the thirty-ninth parallel of latitude, they may be planted the same season. North of this, they should be planted in the following spring, in a bed of rich earth prepared as for beets or onions, and planted in drills about *eighteen inches* apart. The young plants should be thinned to the distance of from *one* to *three* inches from each other. They should be well cultivated, when they will attain the height of three or four feet the first season. In the fall, in a northern climate, the young trees should be taken up and protected during the winter, as directed for the morus multicaulis.

In the following spring the branches may be taken off *near* the main stem, the top shortened, and the whole tree planted, completely covering the roots and the main stem from one to two inches deep. In this way two or more trees may be produced from each plant. If a full supply can be procured, the *roots* of the young plants may at once be removed to the orchard. They may be allowed to stand much nearer than the multicaulis, leaving only sufficient room for cultivation.

When seed is required it would be well to plant out a portion from the seed bed at once, as standards for this purpose, always selecting those bearing *full heart-shaped* leaves.

The leaves of the white Italian produce a good heavy cocoon, and should always be used in the last age of the worms when *other larger leaved* varie ties cannot be obtained.

Cultivation.—The mulberry orchard should be *annually* cultivated. The ground kept mellow and free from weeds until the middle of July.

The fields should be divided into *three* equal parts, and after the second season from planting, *one-third each year* should be cut down near the ground. This will cause a more vigorous growth, and an abundant crop of foliage.

Feeding Apartments.—Various plans have been proposed and adopted for cocooneries or feeding-sheds for the silk-worm; none of which, I think are without objection, except a perfect laboratory, so constructed as to be able to fully control the atmosphere and temperature within. These, however, would be too expensive, and require too much skill and judgment for general adoption.

Open or shed-feeding has been employed with some success of late years, and for general use may be the most successful for family establishments. This, however, confines the whole business particularly in the northern states, to one or two crops in the season. South of Ohio, more can be successfully fed.

These sheds may be cheaply made, by setting some durable posts in the ground, say from six to eight feet high, with a roof of shingles or boards. The roof should project two feet over the sides. There should be some temporary protection to the ends and sides of the shed, perhaps the best and cheapest can be made of strong cotton cloth, (osnaburg;) three or four widths should be sewed together, with small rods across the bottom which will answer as weights, and also as rollers, which, by the aid of a pulley may be rolled up or let down at pleasure.

The width of the sheds must be governed by the size of the hurdles or feeding trays used. The width that I have adopted is from eighteen to twenty feet. The length according to the extent of the feeding contemplated.

Where it is designed to carry on an extensive business, a building should be constructed expressly for the purpose. It should be on an elevated situation, convenient to the mulberry orchard. There should be a cellar under the building. Any material commonly used for building may be employed. If of wood, weather-boarded and plastered. It would be well to fill up the space between the two with tan bark or unburnt brick, or something of the kind, which will render the temperature more uniform. The width of the building should be twenty or twenty-eight feet. The former admitting of *two*, and the latter of *three double ranges* of hurdles or trays of suitable size. The length suited to the extent of the business designed. It should be two stories high, and so constructed as to be thoroughly ventilated. There should be two double doors in each end, with doors, windows, and ventilators in the sides. The windows should extend to near the top of the rooms. There should be sliding ventilators near the floor. The windows may be filled with oiled paper or cloth, which will admit the light and exclude the sun. It would also be important to have under each tier of hurdles, through the floor, two planks of ten inches width each, hung with hinges that they may be raised at pleasure by a pulley. Also an upright ventilator on the roof, fitted with blinds, through which a constant draft may be kept up.

In one end of the building in *each* of the two doors there should be a ventilating wheel made of thin boards, (plank,) much after the form of the wheels applied to the stern of our steam propellers. These wheels should be about two feet in diameter. They should be put in motion for a few minutes every hour, or oftener in still weather. Both may be made to turn by one crank, connecting each by bands and whirls to the main shaft.

An air furnace, such as is now employed in heating churches and other buildings, should be constructed in the cellar, and so arranged as to draw directly from the feeding-rooms all the air necessary to supply the furnace. The air, when heated in the chamber, should be conveyed through the whole length of the rooms, in a square pipe with openings at short distances from each other, which should increase in size as they recede from the furnace. These openings may be so connected as to be all closed at once, or a valve applied at the air-chamber may be used to cut off the communication of heated air when the temperature is sufficiently high in the room.

suffering the hot air to escape outside of the building. In the last ages of the worms the furnace will be found of great benefit, even when the heat is not required in the rooms, for the purpose of drawing off and consuming the impure air of the cocoonery.

At Economy, they not only make use of air-furnaces, but in an adjoining building they have a large air-pump constantly in operation, connected with the cocoonery by a pipe with small openings through the length of the building. This pump is kept in motion by a steam engine.

With good eggs, when proper means have been employed for their preservation and the feeding apartments thoroughly ventilated, I do not know of a single instance where the worms have proved unhealthy.

From the conviction that proper regard had not generally been paid to the ventilation of cocooneries, in the summer of 1842 I commenced a series of experiments by which I ascertained that the silk worm, during its last age, consumed *nearly* its *own weight* of *leaves daily;* and that the amount of exhalations or *imperceptible perspiration* given off in *proportion* to the quantity of food consumed, was about equal to that ascertained to escape from a healthy man.

I found, from the most carefully conducted experiments, that the weight of one hundred thousand silk worms, about five days before their time of winding, was four hundred and fifty-eight pounds, and that they would consume daily three hundred and seventy-two pounds of leaves,* and that their *increased weight* in *twenty-four hours* from the food consumed was *forty-six pounds;* and that the enormous amount of *two hundred and six pounds* was given off in the same time, in the form of *exhalations* or *imperceptible perspiration* alone. This, then, I think, fully explains the cause of disease complained of by many, and establishes the importance of ventilation in every possible form.

In one corner of the building there should be a hatching room, with which the furnace below should be connected, so as to receive a greater or less degree of heat, as may be required, without reference to the temperature of the feeding rooms.

Fixtures.—In fitting up the hurdles or feeding-shelves for a building of *twenty feet* wide; it will require a double range of posts two and a half or three inches square, on each side of the centre of the room, running lengthwise, and the length of the shelves apart, in the ranges, and each two corresponding posts, crosswise of the ranges, about the width of the two shelves apart. On each double range across the posts are nailed strips, one inch or more in width and about *fifteen* inches apart, on which the trays or hurdles rest, which may be drawn out or slid in as may be found necessary in feeding. The aisles or passages of a building of the above width will be four feet each, allowing two feet for the width of each *single* hurdle.

The hurdles that I have used for many years are of twine net-work. A frame is first made five feet long and two feet wide, of boards seven-eighths of an inch thick, and one and a half inches wide. There should be two braces across the frame at equal distances of five-eighths by seven-eighths of an inch square. On a line about *half an inch* from the inner edge of the frame are driven tacks *nearly* down to their heads, at such distances as will

* Had these worms been fed in the ordinary manner they would have consumed many more leaves in the same time. But to preserve the greatest possible accuracy, through the whole experiment, they were fed rather sparingly.

make the meshes of the net about three-quarters of an inch square. Good hemp or flax twine is passed around these tacks, forming a net by passing the filling *double* over and under the warp, or that part of the twine that runs lengthwise. This twine should be somewhat smaller than that running lengthwise. On a damp day the twine becomes tight; I then give the netting two good coats of shellac varnish. This cements the whole together and renders it firm and durable.

The varnish is made by dissolving a quantity of gum shellac in alcohol in a tin-covered vessel, and placed near the fire. It should be reduced, when used, to the consistence of paint.

Another set of frames are made in the same way and of the same size, and covered with strong cotton or tow cloth; this is secured with small tacks. Upon these the net frames rest, which serve to catch the litter that falls through from the worms.

Hurdles made and supported in this manner admit of a more free circulation of air, and the litter is less liable to mould or ferment, and can be removed and cleaned at pleasure.

With this kind of hurdle and screen, I make use of winding frames, constructed in the following manner: A light frame is made of boards one and a half inches wide, and the length of the hurdles, and *two feet* and *four inches* wide; this is filled crosswise with thin laths about one inch apart in the clear. The manner of using these will be hereafter explained. They answer the two-fold purpose of winding frames and mounting ladders.

The care and expense required in fitting up a house on this plan may prevent its *general* adoption.

The most common method that has been heretofore employed is permanent shelves, but the labor required to keep the worms properly cleaned renders this plan objectionable.

At Economy, Pennsylvania, the rearing of the silk worm is now carried on to a great extent and more successfully than in any other part of the United States, or perhaps the world. Their houses are two stories high. The worms are fed on small trays about eighteen or twenty inches wide, and about three feet long. They are supported in the same manner as the hurdles above described, and are about six inches apart. When the worms are about ready to wind, they are transferred to the upper story, to permanent shelves, about sixteen inches apart, where they form their cocoons in bunches of straw placed upright between the shelves. The worms are cleaned at least once after every moulting, and after the last, every day. For this purpose they have nets wove or knit, of cotton twine, something larger than the size of the trays, with meshes of various sizes suited to the age of the worms. For the last age they are about three-quarters of an inch square. These are used without frames. When it is required to remove the worms from their litter, the nets are laid lightly over them, and then plentifully fed. When the worms have arisen upon the fresh leaves, they are removed by two persons taking hold of the four corners of the net and transferring them to clean trays, held and carried off by a third person. One hundred thousand are changed in this manner in two hours.

Description of the Silk Worm.—It will be necessary for the inexperienced culturist to have some knowledge of the forms, changes, and appearances of the silk worm before he enters upon the duties of his interesting charge.

The silk worm is a species of caterpillar, whose life is one continual suc-

cession of changes, which, in due time, becomes a moth or winged insect, like others of the genus.

The time occupied in going through its different forms of existence varies in different countries—governed by climate, temperature, and the quality and quantity of the food upon which it is fed, and the nature of the particular variety of the insect.

The worm changes or casts its skin (of the common varieties) four times before it attains its full growth. These changes are called moultings, and the periods intervening between the several moultings are termed ages. When it is first hatched it is of a blackish color, which afterwards becomes lighter, varying almost daily to different shades, and in different varieties through every age, to the close of the last, or near the time of spinning, when it assumes a grayish yellow semi-transparent appearance.

Having tried all the varieties that have been introduced into the United States, those I consider the best are known as the *Chinese imperial*, producing a large salmon colored peanut shaped cocoon; and a kind called the peanut, producing a mixture of white and salmon-colored cocoons. This variety produces a larger and more firm cocoon than any of that name that I have seen.

Time of Hatching—Rearing.—When the leaves of the mulberry have put forth, to the size of about an inch in diameter, it may be generally inferred that the proper time for hatching the worm has arrived.

The papers or cloths containing the eggs should then be brought out and placed in the hatching room, upon a table or trays made for the purpose. When artificial means are employed, the temperature should be *gradually* raised until the time of hatching, which will be in about ten days, to 75° or 80° of Fahrenheit's thermometer. But few worms will make their appearance on the first day, but on the second and third the most will come out; should there be a few remaining unhatched on the fourth day they may be thrown away, as they do not always produce strong and healthy worms. When the worms begin to make their appearance, young mulberry leaves cut into narrow strips should be laid over them, to which they will readily attach themselves; these should be carefully removed and placed *compactly* upon a cloth screen or tray, prepared for them, and other leaves placed upon the eggs, for the worms that still remain, which should be passed off as before. A singular fact will be observed, that all the worms will hatch between sunrise and before noon of each day. Care should be taken to keep the worms of each day's hatching by themselves, as it is of the greatest importance to have the moultings and changes of all the worms as simultaneous as possible. It is also important that the worms that have been transferred to the trays should *not* be fed until the hatching for the day is completed, so that all may be fed equally. Young and tender leaves should be selected to feed the worms with; these should be cut with a sharp knife into pieces not exceeding a quarter of an inch square, and evenly sifted over them. They should be fed in this way *six* or *eight* times in *twenty-four* hours, as near as possible at regular and stated periods.

It will be impossible to lay down any definite rules for the quantity of leaves necessary for a given number of worms for each succeeding day, through every age. After a little acquaintance with their nature and habits, the intelligence and judgment of the attendant will be the best guide; they should, however, have as much as they will eat, but after a few days, care should be taken not to give them more than they will generally consume,

as this will increase the accumulation of litter, which will endanger the health of the worms. In the last age they eat voraciously, when they should be well supplied. A quantity of leaves should always be on hand in case of wet weather.

When the average range of the thermometer is between 70° and 80°, the several moultings will take place near the fifth, ninth, fifteenth, and twenty-second days after hatching. It may be known when the worms are about to cast their skins, as they cease to eat and remain stationary, with their heads raised and occasionally shaking them. This operation will be more distinctly observed as they increase in size, through their succeeding ages.

Assuming the above temperature as the standard, the quantity of leaves for the three first days of this (the first) age must be gradually increased at each feeding, after which they will require less at each succeeding meal until the time of moulting arrives, when, for about twenty-four hours, they eat nothing. But as it is seldom the case that all cast their skins at one and the same time, some will still be disposed to eat, when a few leaves must be *cut fine*, and *sparingly* scattered over them, so that those that remain torpid may be disturbed as little as possible. They must now be carefully fed in this way until it is discovered that *some* have moulted, when the feeding must *cease altogether* until the *most* of them have recovered. This rule must be *particularly* regarded through all the succeeding moultings, otherwise some of the worms will be far in advance of others; and this want of uniformity will *increase* throughout each succeeding age, and to the period of winding, which will not only result in great inconvenience in gathering the cocoons, but will materially injure the worms, and consequently lessen the crop of silk.

When the *greatest portion* of the worms have moulted and appear active, leaves a little wilted are laid over them, by which they are passed to clean trays. If any still remain that *have moulted*, they must be transferred in the same manner, by laying more leaves upon them. The remnant of worms that *have not* changed their skins, should be left upon the litter, and added to those of the next day's moulting. By closely regarding these rules throughout the several ages, the worms will generally all commence the formation of the cocoons about the same period.

After having gone through and furnished all the worms with a quantity of leaves, it is well to go over a second time and add more where they seem to require it.

Very young and tender leaves must be given to the worms in the first age; after which older ones can be given, as they advance in age, until after the last moulting, when they should be fed upon sound full-grown leaves.

After the second moulting, the leaves, where large crops are fed, may be cut by running them twice through a common *rotary* hay or straw-cutter of Hovey's, or one of a similar make.

The worms will frequently heap together and become too thick, as they increase in size; when they are fed, the leaves must be spread and the space enlarged, or they may be removed by leaves or twigs of the mulberry to places unoccupied. If they are permitted to be crowded, disease is apt to follow, and the whole crop endangered.

It will sometimes be observed, when the light falls more directly on one side of the hurdle than the other, that the worms will incline to leave that side and become crowded on the opposite, when the hurdle should be turned around.

Up to the last moulting it is best to feed the worms entirely upon the

leaves of the multicaulis; after which the Canton or white Italian should be used, if a full supply can be obtained—the former being consumed with greater avidity, and the accumulation of litter is consequently less. The Canton and Italian produce the heaviest cocoon, while the multicaulis yields a finer and stronger fibre. In pursuing this course, the advantages of both are in some degree secured.

The worms should be removed from their litter immediately after each moulting, and in their fourth age the hurdles should be cleaned a second time, and after the last moulting they should be removed at *least* every *second day*.

Where nets are not used, in the last ages the worms are changed, by laying over them the small branches of the mulberry.

Recently branch feeding, as it is termed, has been introduced with some success and with great economy of time; in the last ages of the worms, care should be taken to lay the branches as evenly as possible, especially where it is designed to use twine hurdles, otherwise it will be difficult for the worms to ascend through the netting.

When the worms are about to spin, they present something of a yellowish appearance; they refuse to eat and wander about in pursuit of a hiding place, and throw out fibres of silk upon the leaves. The hurdles should now be thoroughly cleaned for the last time, and something prepared for them to form their cocoons in. Various plans have been proposed for this purpose. The lath frames, before described, I prefer. They are used by resting the back edge of the frame upon the hurdle, where the two meet in the double range, and raising the front edge up to the under side of the hurdle above, which is held to its place by two small wire hooks attached to the edge of the hurdle, showing an end view thus:

A covering of paper or cloth should be applied to the lath frames. In using the hurdles and screens, I remove the screen from under the hurdle, turning the other side up, and letting it down directly upon the winding frame. This affords double the room for the worms to wind in. Lath frames of this description have advantages that no other fixtures for winding possess that I have ever seen tried. The frame resting upon the back side of each hurdle renders this side more dark, which places the worms instinctively seek, when they meet with the ends of the laths and immediately ascend to convenient places for the formation of their cocoons. From these frames the cocoons are gathered with great facility, and free from litter and dirt, and when they are required they are put up with great expedition.

Where branch feeding has been adopted by some, no other accommodation has been provided for the winding of the worms than that afforded them by the branches from which they have fed. This is decidedly objectionable, as the worms are always disposed to rise until their course is obstructed above. When this is not the case, they wander about for hours upon the tops of the branches, and only descend after their strength becomes exhausted, and the result is, the production of a crop of loose inferior cocoons. Next to lath frames, small bunches of straw afford the best accommodation for this purpose. Rye straw is preferred. Take a small bunch about the size of the little finger, and with some strong twine tie it firmly about half an inch from the butt of the straw; cut the bunch off about half an inch longer than the distance between the hurdles. They are thus placed upright with their butt ends downwards, with their tops spreading out, interlacing

each other, and pressing against the hurdles above. They should be thickly set in *double rows* about sixteen inches apart, across the hurdles. These may be preserved for a number of years.

After the most of the worms have arisen, the few remaining may be removed to hurdles by themselves. In three or four days the cocoons may be gathered. While gathering, those designed for eggs should be selected. Those of firm and fine texture with round hard ends are the best. The smaller cocoons most generally produce the male, and those larger and more full at the ends, the female insect. Each healthy female moth will lay from four hundred to six hundred eggs. But it is not always safe to calculate on one half of the cocoons to produce female moths. Therefore it is well to save an extra number to insure a supply of eggs.

The cocoons intended for eggs should be stripped of their floss or loose tow, which consists of irregular fibres, by which the worm attaches its work to whatever place it is about to form its cocoon. These should be placed on hurdles, in a thin layer, and in about two weeks the moths will come out; always in the forepart of the day, and generally before the sun is two hours high. If laid upon a net hurdle (which is best) they will immediately fall through the meshes and remain suspended on the under side, where they are not liable to become entangled in the cocoons. As soon as the male finds the female they become united. They should be taken carefully by the wings, in pairs, and placed upon sheets of paper, to remain until *near* night, when the female will be anxious to lay her eggs. Then take each gently by the wings and separate them, placing the females at regular distances, about two inches from each other, upon sheets of paper or fine cotton or linen cloth; these should hang over a line, or be tacked to the side of the house. In two or three nights the moths will complete their laying, when they should be removed from the papers or cloths. Frequently the males appear first in the greatest numbers, some of which should be reserved each day, in case there should afterwards be an excess of females. They should be shut out from the light, otherwise they are liable to injure themselves by a constant fluttering of their wings. The female is largest, and seldom moves or flutters.

Killing the Chrysalides.—After the cocoons have been gathered, those that are intended for sale, or for future reeling, must be submitted to some process by which the moths will be killed, otherwise they will perforate and spoil the cocoons. This is done by various methods. The most simple and convenient is to spread them thinly on boards, and expose them to the direct rays of the sun. In a hot day many of them will be killed in a few hours, but they must be stirred occasionally, or some will be liable to escape the heat, and afterwards come out. At Economy they place them in an *air-tight* box containing about ten bushels, (the box should always be full, or if not, a partition is fitted down to the cocoons,) sprinkling *evenly through* the *whole*, beginning at the bottom, about three ounces of camphor, slightly moistened with alcohol, and finely pulverised. The box is then closed, and the seams of the top covered by pasting strips of paper over them. They remain in this way about three or four days. They are then spread out thinly in an upper loft to cure, where they should be occasionally stirred. It will require some weeks to thoroughly cure them. Before camphoring, the dead and bad cocoons must be taken out, otherwise they will spoil the good ones.

When it is convenient, it is best to reel as many of the cocoons as possible

immediately after they are gathered, as they reel much more freely, before they are exposed to the sun or dried.

Succession of Crops.—Preservation of Eggs.—Repeated attempts have been made to feed a succession of crops of worms throughout the entire season from the same stock of eggs. In most instances success has failed to attend these efforts. When proper means are employed and due care observed, the eggs may be preserved and worms successfully raised until the feed is destroyed by the frost. In many years' experience I have never failed in this respect.

In the spring of 1840 I communicated to Miss Rapp, of Economy, my method of preserving eggs, which she immediately adopted, and has pursued it until the present time with perfect success, feeding from eighteen to twenty-five crops each year. The following is an extract of a letter from the post-master at Economy, dated January 19th, 1843.

"Between May and September, we raised near *two millions* of worms, in eighteen sets, of near equal numbers, about a week apart, producing three hundred and seventy-one bushels of cocoons. The last crop hatched the 9th of September and spun the 10th of October. We found no difference in the health of the different sorts. We are of the opinion that the late keeping of the eggs does not bring disease on the worms, if they are kept right, and gradually brought forward as they ought to be."

It may be remarked that the qualities of the mulberry leaf are such in the latter part of the season that as heavy cocoons will not be produced as in the first. A bushel of the first crop raised at Economy, in the season refered to, produced twenty-three and a quarter ounces of reeled silk, and the last crop, wound in October, but nineteen ounces. About one month of the best part of that season of feeding was lost by the severe frost that occurred on the 5th of May, which entirely killed the young leaves, and must have materially injured the whole crop of the season.

My method of preserving eggs is to place them in the ice house in February, or early in March or sooner if the weather is warm. For this purpose a box or square trunk is made, extending from within *one foot* of the *bottom* of the ice to the top. This may be made in joints, so that as the ice settles the upper joints may be removed. The eggs should be placed in a tin box, and this enclosed in a wood one, and suspended in the trunk near the ice. The communication of warm air should be cut off by filling the opening with a bundle of straw or hay. The eggs should be aired for a few minutes, as often as once in one or two weeks, always choosing a cool dry morning; when selections for succeeding crops may be made, these should be placed in another box and gradually raised in the trunk for several days, avoiding a too sudden transition from the ice to the temperature of the hatching-room.

Their ice-house at Economy is connected with the cellar, the bottom of the former being eighteen inches below that of the latter. A long wooden box extending into the ice-house, level with the bottom of the cellar floor, contains all the smaller boxes of eggs. The door of the box, opening in the cellar, is kept well closed to prevent the admission of warm air. They employ another ice-house, sunk deep in the cellar, with shelves gradually rising from the ice up to the top of the ground, upon which the eggs of succeeding crops are placed, and raised one shelf higher every day, until they are taken into the hatching room. The past season they have hatched about *five ounces* of eggs, or one hundred thousand worms every four days.

Diseases of the Silk Worm.—The silk worm, like every other animal or

each other, and pressing against the hurdles above. They should be thickly set in *double rows* about sixteen inches apart, across the hurdles. These may be preserved for a number of years.

After the most of the worms have arisen, the few remaining may be removed to hurdles by themselves. In three or four days the cocoons may be gathered. While gathering, those designed for eggs should be selected. Those of firm and fine texture with round hard ends are the best. The smaller cocoons most generally produce the male, and those larger and more full at the ends, the female insect. Each healthy female moth will lay from four hundred to six hundred eggs. But it is not always safe to calculate on one half of the cocoons to produce female moths. Therefore it is well to save an extra number to insure a supply of eggs.

The cocoons intended for eggs should be stripped of their floss or loose tow, which consists of irregular fibres, by which the worm attaches its work to whatever place it is about to form its cocoon. These should be placed on hurdles, in a thin layer, and in about two weeks the moths will come out; always in the forepart of the day, and generally before the sun is two hours high. If laid upon a net hurdle (which is best) they will immediately fall through the meshes and remain suspended on the under side, where they are not liable to become entangled in the cocoons. As soon as the male finds the female they become united. They should be taken carefully by the wings, in pairs, and placed upon sheets of paper, to remain until *near* night, when the female will be anxious to lay her eggs. Then take each gently by the wings and separate them, placing the females at regular distances, about two inches from each other, upon sheets of paper or fine cotton or linen cloth; these should hang over a line, or be tacked to the side of the house. In two or three nights the moths will complete their laying, when they should be removed from the papers or cloths. Frequently the males appear first in the greatest numbers, some of which should be reserved each day, in case there should afterwards be an excess of females. They should be shut out from the light, otherwise they are liable to injure themselves by a constant fluttering of their wings. The female is largest, and seldom moves or flutters.

Killing the Chrysalides.—After the cocoons have been gathered, those that are intended for sale, or for future reeling, must be submitted to some process by which the moths will be killed, otherwise they will perforate and spoil the cocoons. This is done by various methods. The most simple and convenient is to spread them thinly on boards, and expose them to the direct rays of the sun. In a hot day many of them will be killed in a few hours, but they must be stirred occasionally, or some will be liable to escape the heat, and afterwards come out. At Economy they place them in an *air-tight* box containing about ten bushels, (the box should always be full, or if not, a partition is fitted down to the cocoons,) sprinkling *evenly through* the *whole*, beginning at the bottom, about three ounces of camphor, slightly moistened with alcohol, and finely pulverised. The box is then closed, and the seams of the top covered by pasting strips of paper over them. They remain in this way about three or four days. They are then spread out thinly in an upper loft to cure, where they should be occasionally stirred. It will require some weeks to thoroughly cure them. Before camphoring, the dead and bad cocoons must be taken out, otherwise they will spoil the good ones.

When it is convenient, it is best to reel as many of the cocoons as possible

insect is liable to disease and premature death. European writers have enumerated and described six particular diseases to which it is subject. But in our more congenial climate nothing is wanting to insure a healthy stock of silk worms, and a profitable return from their labors, but to give them *sufficient room, a regular and full supply of suitable food, a strict regard to cleanliness, and a proper ventilation of their apartments.*

In excessively hot, damp, or sultry weather, in the last age, the disease known as the *yellows* sometimes occurs. Where open feeding is adopted some fine *air-slacked lime* may be sifted on the worms once or twice a day, *before feeding*, and the diseased and dead worms picked out and thrown away. In a regular cocoonery, properly ventilated and supplied with an air furnace, dry air should be made to circulate freely. But if the temperature is above eighty or eighty-five degrees, the ventilating apparatus should be constantly employed until a change of weather occurs, or the disease disappears.

A feeding house should be so arranged as to cut off all communication of rats and mice from the worms and the cocoons.

Reeling.—We have now arrived at another branch of the silk business, which more properly comes under the head of manufacturing. Every farmer who engages in the silk culture, in order to avail himself of an additional profit, should provide his family with a suitable reel, by the use of which, after a little experience, he will be enabled to offer his silk in market, in a form that will greatly enhance its value, and much reduce the trouble and expense of transportation. Reels can now be procured in almost any of the principal cities at a small cost, or they can be made by any ingenious farmer or carpenter. The reel now uniformly used is that known as the Piedmontese.

All attempts to improve this reel in its general principles, I believe, have failed. At Economy, however, they have made an addition which may be found useful. It consists of *two pair* of whirls, made of wire, in the form of an aspel to a reel, about *four* inches long and two and a half inches across at the ends, the wires being bent in the middle, leaving them about one and a half inches across from arm to arm, making the circumference about six inches. These whirls are set in an iron frame, and run *each* upon two points or centres. Each pair is set equidistant, on a direct line, about eight inches apart, between the first guides and those on the traverse bar, instead of making the usual number of turns around each thread, as they pass between the guides on the reel. With this arrangement, each thread is taken from the basin and passed through the first guides, then carried *over and around* the two whirls, and where they *pass* each other *on the top*, the *turns* are made necessary to give firmness to the thread, then passing directly through the guides in the traverse bar to the arms of the reel, making each thread in reeling independent of the other. This enables the reeler, when a remnant of cocoons are to be finished on leaving the work, to unite both threads into one, retaining the necessary size; whereas both would be too fine if continued on the reel in the ordinary manner.

Directions for reeling.—In family establishments, a common clay or iron furnace should be procured, to which should be fitted a sheet-iron top, about twelve inches high, with a door on one side, and a small pipe on the opposite side to convey off the smoke; this top should retain the same bevel or flare as the furnace, so as to be about twenty inches in diameter at the top. The pan should be twenty inches square and six inches deep, divided

into four apartments, two of which should be one inch larger one way than the others. They should all communicate with each other at the bottom.

In large filiatures, a small steam engine to propel the reels, &c., and to heat the water for reeling would be necessary.

Before the operation of reeling is commenced, the cocoons must be stripped of their floss, and assorted into three separate parcels, according to quality, or of different degrees of firmness. The double cocoons or those formed by two or more worms spinning together, the fibres crossing each other and rendering them difficult to reel; these should be laid aside to be manufactured in a different manner.

After the cocoons have been assorted as above directed, the operation of reeling may be commenced. The basin should be nearly filled with the *softest* water, and kept to a proper heat by burning charcoal, or some other convenient method of keeping up a regular heat. The precise temperature cannot be ascertained until the reeling is commenced, owing to the different qualities of cocoons; those of the best quality will require a greater degree of heat than those of a more loose and open texture; hence the importance of assisting them. Cocoons also require less heat, and reel much better, when done before the chrysalides are killed, and the cocoons become dried.

The heat of the water may be raised to *near* the boiling point, (it should never be allowed to boil,) when two or three handfuls of cocoons may be thrown into one of the large apartments of the basin, which must be gently pressed under water for a few minutes, with a little brush, made of broom corn, with the ends shortened. The heat of the water will soon soften the gum of the silk, and thereby loosen the ends of the filaments; the reeler should then gently stir the cocoons with the brush, until the loose fibres adhere to it; they are then separated from the brush, holding the filaments in the left hand, while the cocoons are carefully combed down between the fingers of the right hand, as they are raised out of the water. This is continued until the floss or false ends are all drawn off, and the fine silk begins to appear; the fibres are then broken off and laid over the edge of the basin. The floss is then cleared from the brush and laid aside as refuse silk, and the operation continued until most of the ends are thus collected.

If the silk is designed for sewings, about twenty-five fibres should compose a thread; if intended for other fabrics, from eight to fifteen should be reeled together. The finer silk should always be reeled from the best cocoons. The cocoons composing the threads are taken up in a small tin skimmer, made for the purpose, and passed from the large apartment of the basin to those directly under the guides. As the ends become broken they are passed back into the spare apartment, where they are again collected to be returned to the reel. The requisite number of fibres thus collected for *two* threads are passed, each, through the lower guides. They are then wound around each other two or three times, and each carried through the two guides in the traverse bar, and then attached to the arms of the reel. The turning should now be commenced with a slow and steady motion, until the threads run freely. While the reel is turning, the person attending the cocoons must continually be adding fresh ends, as they may be required, not waiting until the number she began with is reduced, because the internal fibres are much finer than those composing the external layers. In adding new ends, the reeler must attach them, by gently pressing them, with a little turn between the thumb and finger, to the threads as they are running. As the silk is reeled off, the chrysalides should be taken out of

asin, otherwise they obscure and thicken the water and injure the color ustre of the silk. When the water becomes discolored it should always anged.

in reeling, the silk leaves the cocoon in burs or bunches, it is evident ater is too hot; or when the ends cannot be easily collected with the , or, when found, do not run freely, the water is too cold.

pail of cold water should always be at hand, to be added to the basin may be required. When the cocoons yield their fibres freely, the reel ɔe turned with a quicker motion. The quicker the motion, the smoother ıetter will be the silk. When from four to six ounces have been reeled, spel may be taken off, that the silk may dry. The end should be fas- so as to be readily found. Squeeze the silk together and loosen it the bars; then on the opposite side tie it with a band of refuse silk or then slide it off the reel, double, and again tie it near each extremity.

.e *quality* of the silk depends much upon the art and skilful manage- of the reeler. All that is required to render one perfect in the art of ıg, is a little *practice*, accompanied at the beginning with a degree of *nce*, and the exercise of *judgment* in keeping up the proper tempera- ɔf water, and the threads of a uniform size.

ınufacture of perforated cocoons.—The perforated and double cocoons ɔe manufactured into various fabrics, such as stockings, gloves, under- ı, and the like. Before the cocoons can be spun, they must be put ı clean bag, made of some open cloth, and placed in a pot or kettle, *covered* with soft water, with soap (hard or soft) added, sufficient to ı a strong suds, and boiled for about three or four hours. If they are red to be very nice and white, the water may be changed, and a l quantity more of soap added, and again boiled for a few minutes. they are boiled, they may be hung up and drained; they should then nsed while in the bag, in fair water, and hung out to dry, without dis- ng them in the bag. When completely dry, they may be spun on the non flax wheel, by first taking the cocoon in the fingers, and *slightly* ming the fibres that become flattened down by boiling, and then spin- off from the *pierced end.* The silk will run entirely off, leaving the bare.

ıe double cocoons may be spun in the same manner, but should be d separately.

MANAGEMENT OF A COCOONERY.

'MACKSHILL COCOONERY, near Reading,
Hamilton Co., Ohio, Nov. 17, 1845.

. HOOPER,

ear Sir: Agreeably to your request, I will give my mode of silk grow- I have been feeding, for the last six years, with varied success. I ı tried a number of plans and find the more simple the plan the better. e Morris' Burlington frame, and think it decidedly the best I have seen ied. First—have good eggs, well kept, and do not let them hatch till n' weather has fairly set in—say from tenth to twenty-fifth of May, as season may be. As soon as they are hatched, lay on leaves and move ı on to clean papers by lifting the leaves. Be careful not to get them thick, or you cannot feed them enougn without covering them too deep