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THE
CALIFORNIA
SILK GROWERS'
INSTRUCTOR.

✓
BY MRS. T. H. HITTELL.

PUBLISHED BY THE

CALIFORNIA SILK CULTURE ASSOCIATION.

MRS. E. B. BARKER, President, - - - - - 14 Stanley Place.

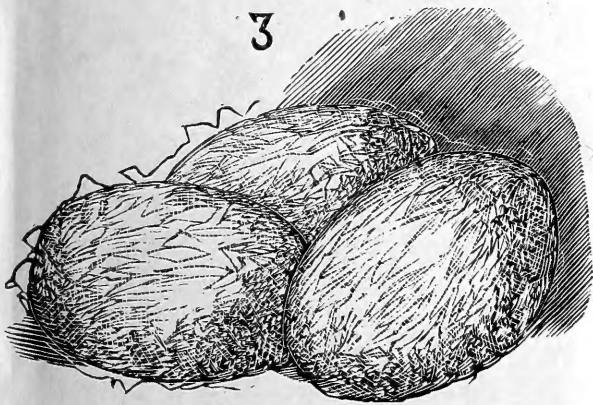
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SAN FRANCISCO,
1881.

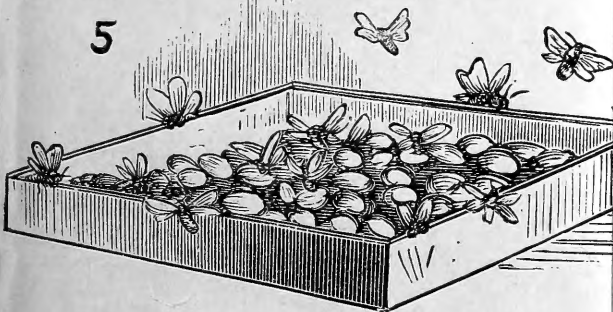
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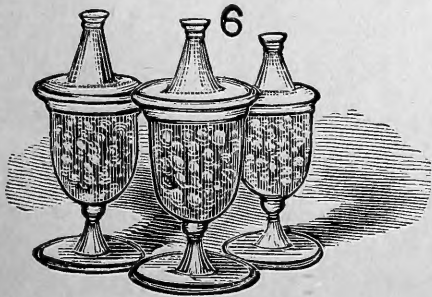
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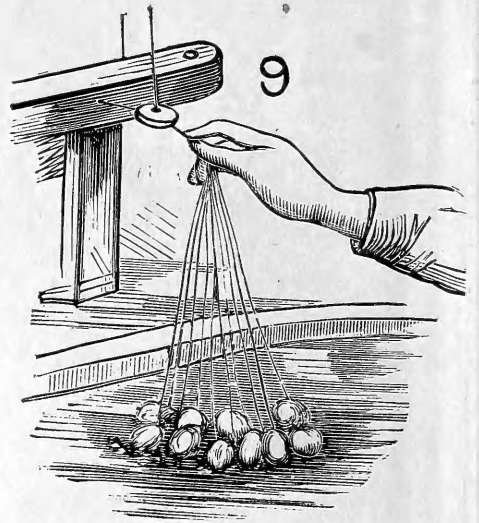
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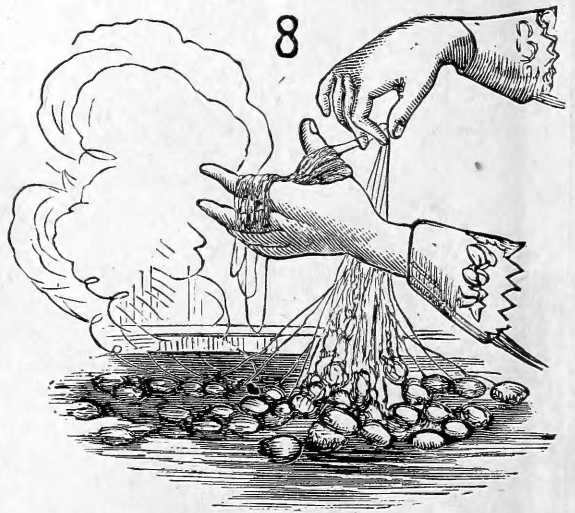
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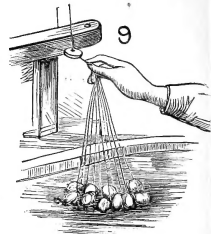
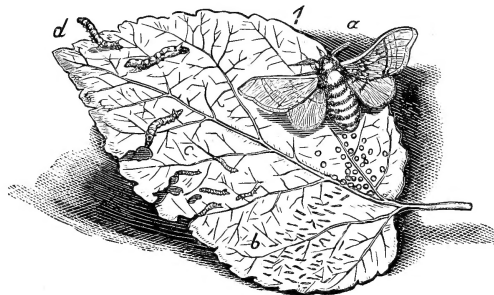
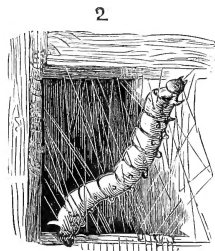
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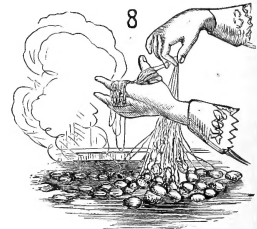
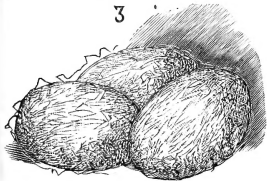
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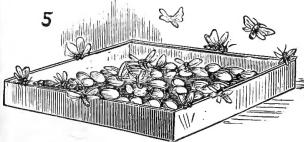
old—life size. **c**—Silkworm—
 thilk worm—life size—spinning a
 co—Moths emerging from cocoons.
6 **8**—Removing the outer fibre.
9 ng Machine, ready for work.



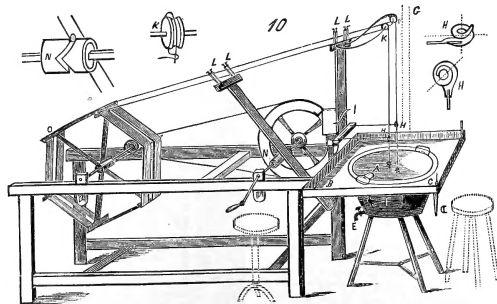
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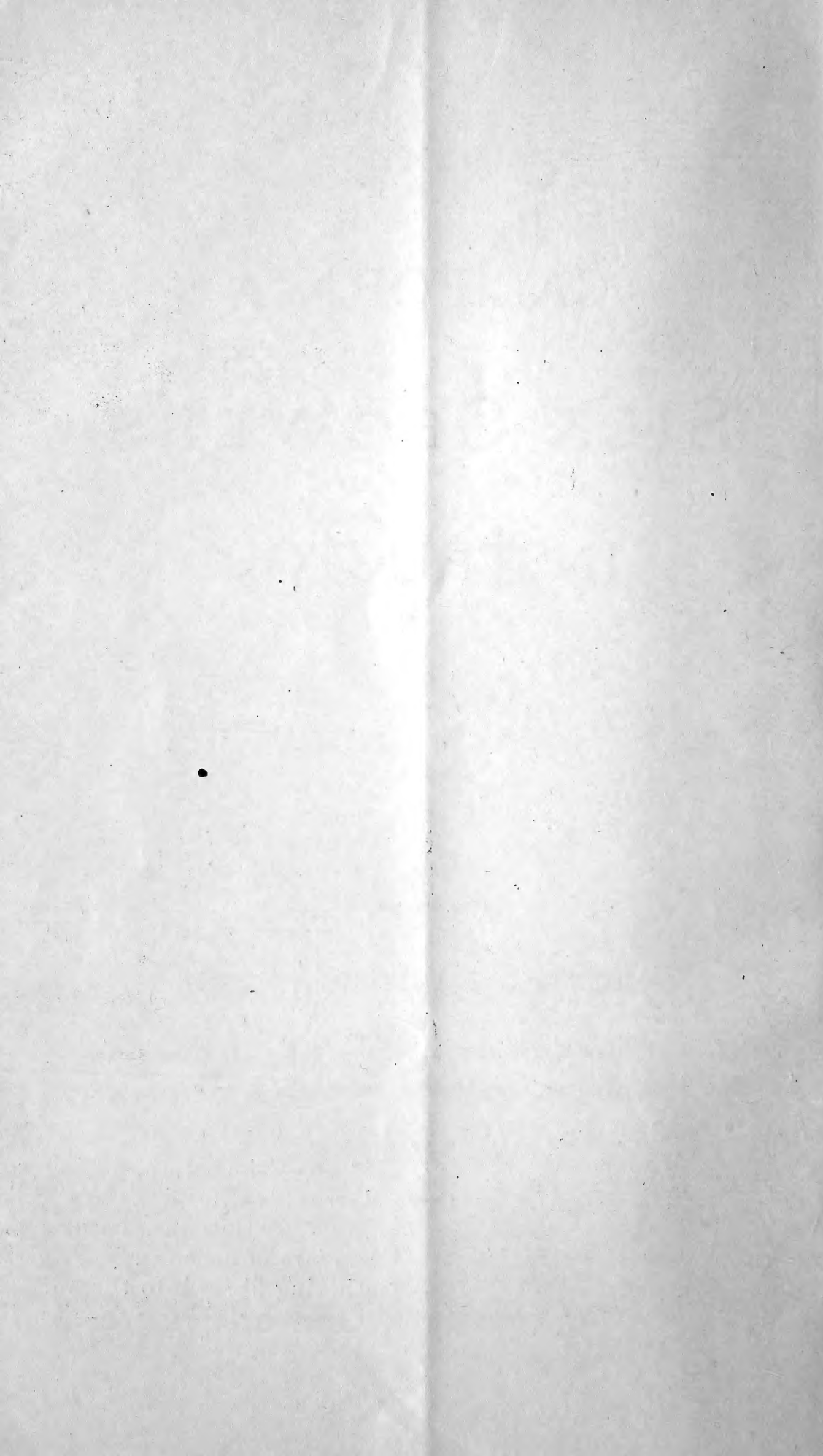
EXPLANATION:

1 a—The Moth, laying eggs—life size. b—Silk Worm, one day old—life size. c—Silkworm—three days old—life size. d—Silkworm, seven days old—life size. 2—Silk worm—life size—spinning a cocoon. 3—Cocoons, natural size. 4—Chrysalis, natural size. 5—Moths emerging from cocoons. 6—Glass jars of cocoons. 7—Loosening the outer fibre of the cocoons. 8—Removing the outer fibre. 9—Gathering fibres into thread.

Center Figure—An illustration of the improved Lombard Reeling Machine, ready for work.



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BY MRS. T. H. HITTELL.

Hittell, Mrs. Elise C. (Wiche)

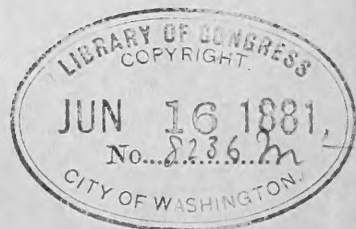
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SAN FRANCISCO,
1881.



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PREFATORY NOTE.

This short treatise has been prepared for the purpose of encouraging Home Silk Culture in California. Success requires intelligence on the part of those who engage in it. One of the reasons why former attempts have failed, was insufficient knowledge on the part of the workers; but failure in the past is no good reason for discouragement.

The production of wine in California was, for many years, a failure. Hundreds of thousands of dollars were sunk in the business before it became a success. There were many failures in wheat crops, chicken ranches, orange orchards, and other industries that have now become profitable. Success in these enterprises gives assurance for success in Silk Culture. The work must be prosecuted intelligently, faithfully and patiently. There must be a willingness to wait a reasonable time for results, just as we do for other products. With perseverance, all obstacles will be overcome. The time is near when, with proper and intelligent action, Silk Culture will rank among the most important industries in California. *Labor vincit omnia.*

The proof is abundant that California can produce the finest silk. This, in fact, has already been done, on a small scale. The superiority of the climate and soil of this State for the growth of the mulberry and the development of the silkworm are attested by many witnesses, and proved by actual results. Mrs. Sellers, of Antioch, has 3,000 mulberry trees. The late Louis Provost gives abundant testimony in proof of success for Silk Culture in California, in the manual which he has left behind him. Prof. Muller and Mr. Gillett, of Nevada City, Mrs. Keeney, of San Rafael, Mr. Warren, of the "California Farmer," Mr. J. Neuman and many others, who have given attention to the subject, testify to the same facts.

The California Silk Culture Association has determined to foster this great industry in the homes of the people. All who wish well to the State, in proportion to their means, should assist in the great work, not solely for the sake of immediate personal profit, but rather for a wider and lasting blessing to the State. Success can be achieved, and we believe it will be. It will eventually prove a great boon to California, and a rich blessing to all her people.

The author acknowledges her indebtedness to the Rev. Dr. C. A. Buckbee for literary aid and advice in the preparation of the work. The manuscript has been carefully revised and prepared by him for the press. The authorities for the facts stated have been submitted to him, and the statements verified. The classification and arrangement of the details of the work, are due to his careful analysis. For this and similar aid in the preparation of our Plea for Home Silk Culture in California, Dr. Buckbee has placed the author and the California Silk Culture Association under many and great obligations.

E. HITTELL.

808 TURK STREET:

SAN FRANCISCO, April 13, 1881.

INTRODUCTION

Silk manufacture has become an established industry in the United States. Its success is also certain in California. The cultivation of raw silk can be prosecuted, especially in California, and its advantages to the people are many and great. It will furnish pleasing and profitable employment to men, women and children; it will increase the home comforts of the people; it will add many millions annually to the wealth of the State.

In Europe many millions of people are supported by raising raw silk and fitting it for the use of the manufacturer. The most favored nations of the East have wisely fostered this industry among their people until now it is the main occupation of vast multitudes. In France, for example, mothers train their children to it. It is, in fact, a part of the education of young ladies. Schools, convents and academies receive small quantities of silk-worm eggs, and instruct their pupils in all the details of the production of raw silk. It is a refreshing change in the studies of the young to pass from the class-room to the cocoonery, from books to trees, to feed the worms, watch their growth, and behold the marvelous production of silk in its raw condition. Educators in the United States are turning their attention to the subject.

While our children are being instructed in botany and zoology, is it not equally important that in our schools there should be taught an industry like that of silk culture "to our girls," *an Industry* which promises such boundless weal and wealth for home and country?

Silk culture is peculiarly adapted to women and girls. Woman and her work is one of the great questions of the hour. With the increase of population it becomes important that women should take their share in every appropriate industry that bears upon social life and the stability of our homes. Largely as the result of her labor our country is now producing annually six hundred millions of pounds of butter worth \$200,000,000. We have fifty millions of people in the United States largely engaged in agricultural pursuits. But not one in ten expects to live without work. Appropriate work is honorable. The necessity is imperative for mothers, educators, and patriotic men to provide suitable kinds of labor, and to interest our boys and girls in its performance. Such considerations as these induce us to

contribute our share to that education, in the department of home silk culture. The cultivation of the mulberry, the care of the silk worm, the treatment of the cocoon, and the reeling of the precious fibre constitute an employment so light, cleanly and healthful that women and children will gladly betake themselves to it when once they are properly instructed. A more suitable or remunerative employment is likely never to present itself. Its reward is a sure support for the industrious, and its severest labor is little more than an agreeable pastime, for it taxes neither body nor mind so as to be hurtful.

Hon. James Pollock, of Philadelphia, ex-Governor of Pennsylvania, says: "I am pleased to see that ladies of San Francisco and elsewhere on the Pacific Coast are becoming interested in this important branch of American industries. California, by soil and climate, is peculiarly fitted for the cultivation of the *morus multicaulus*, or mulberry, so necessary in feeding the silk worm. I would not be surprised if California, with her many advantages, and with the determination and energy that characterize her people, would ere long become one of the great silk producing and manufacturing countries of the world. We are doing much and well in Pennsylvania and New Jersey in silk raising, and with the ladies of California heading the line success is assured."

SOIL AND CLIMATE.

The selection of soil is important. The mulberry will grow in almost any part of California, but success requires a rich, light, loamy soil. On such soil one acre will produce as much food as two acres from other soils. The ground must be plowed deep and rendered loose and friable, so as to retain moisture, and allow the roots to permeate the soil, where it is damp and cool.

The ground selected should have a sunny exposure; that opening to the southeast is the best. The sunny slopes of the foothills of the Sierra Nevada and the Coast Range mountains, as well as the alluvial flats and valleys in all parts of California, afford excellent sites for planting the mulberry.

MULBERRY TREES.

The leaves of the mulberry are the proper food for the silk worm.

The mulberry or *morus* of the botanists is a genus comprising many species. Its origin has been assigned to China, but several species have been found growing in a wild state in America.

Its berry is of a roundish and oblong form, its color varying from white to red and black; its pulp envelopes numerous small seeds.

Most varieties are esteemed as a dessert fruit. When ripe they are agreeable to the taste, very wholesome and nourishing. The syrup is useful in mitigating inflammation of the heart. The wood of the mulberry is compact, elastic and hard, and susceptible of a fine polish; it is therefore sought after by the upholsterer, the carver, and the turner. The strength of the timber renders it valuable to the joiner, and also for building boats; its power of resisting the action of water has been compared to that of the oak.

One of the original or parent trees of all the white mulberry trees of France, which the followers of Charles VIII had brought from Italy on his invasion of that country in 1794, Mr. Lachaux has caused to be encompassed by a wall to evince his respect and veneration for a tree so inestimable.

MORUS ALBA.—In setting out a plantation the largest number should be the white mulberry or *Morus Alba*. This produces the best silk, and its leaves should be fed to the worms after they are pretty well grown. This tree is one of the most useful in the world if we consider its importance in connection with silk culture. But its use for the purposes of feeding cattle has also been proved. In Germany cattle are fed in the large silk plantations with the leaves wasted by the worm which are too hard or dry for the worms to eat.

This fact may be of value to California farmers in seasons when in its southern counties there is little rain. By its deep growing the tree reaches more moisture and resists drought better than grass. It will withstand the hardest winter.

MORUS MULTICAULIS.—There should be some plants of the Chinese many stalked mulberry (*Morus Multicaulis*.) It differs from all others in the uncommon vigor of its growth, and the property which the roots possess of throwing up numerous flexible stalks, the great length which these stalks acquire in a short time, and the facility with which it is propagated, from layers and cuttings; and it is also *remarkable* for the size which the thin, soft and tender leaves speedily acquire, and the promptitude with which they are renewed.

MORETTY ELATA.—This does not generate by seed as some other varieties do, but it endures the hardest winters, and is the best adapted for the north. It is suitable for standard, forest or ornamental tree, is straight, elegant in shape, and has a luxuriant foliage. The *Morus Moretty* was discovered in 1815 by Moretti, Professor in the University of Pavia. From a single tree he had in 1826 multiplied them to 120,000. It is an improved variety of the *Alba*. The large, thick, substantial leaves contain as much food as half a dozen of the others. The leaves, because of their thickness, do not wilt so fast, they keep fresh

a longer time, and afford the worms plenty of time to eat the whole. It gives one pound of cocoons to every fourteen pounds of leaves.

ROSE-LEAF MULBERRY, a species of white mulberry, has large leaves, gives one pound of cocoons for eighteen pounds of its leaves, and produces the finest silk.

MORUS JAPANICA, or the Japanese mulberry tree, has the largest leaves and gives the same quantity of silk as the Moretty. It is so easily picked that the French prefer it to any other kind. It stands well in hard winters.

PROPAGATING THE MULBERRY TREES.

The propagation of the mulberry is very easy by layers and by cuttings; the latter is the best and most rapid mode of propagation.

The old way of planting cuttings with one-third of the cuttings out of the ground is not good in California. The action of our dry atmosphere, and the burning sun, dries them and destroys many.

The cuttings should be about eight inches long, the top near one eye. One statement gives the following direction: Place the slips in nursery rows, laying them nearly horizontal in the soil, so that the end designed to root shall not be more than six inches under ground, while the other end is deep enough to have the top covered about one-half inch. In this way nearly all will grow.

Another direction is as follows, and it might be well to try both: In planting slips they should be from twenty-four to thirty inches long, and planted in nursery rows, laying them almost horizontally in the soil, so that the end designed to root shall not be more than six inches under ground, while the other end protrudes not over two buds. In this way one obtains a long plant when rooted which will not be obtained if they were placed perpendicularly in any soil adapted for nursery purposes, as such soil is cold and wet at a small depth below, and would consequently rot the cuttings within six or eight inches of the surface.

Where the soil is rich and all the conditions favorable, the cuttings may at once be set out where they are intended to grow. After planting, the ground must be kept free from weeds, and be well worked with a plow, cultivator or hoe, the same as for cabbage or Indian corn.

Under favorable circumstances the cuttings will attain a height of eight or ten feet. If trimmed down, allowing about four feet, they will form side branches affording a large amount of food for the worm for the next season.

x - in one year in California

Another advantage arising from keeping the tree low is, that while the leaves and branches are equally well exposed to the air and sun, the ground is more perfectly shaded, thus retaining its moisture and rendering the tree more vigorous and productive.

Having planted the trees in rows, ten to twelve feet apart, separating the trees in rows five or six feet from each other, it would be well to reserve a space wide enough for a wagon road, at intervals of every six or eight rows. In setting trees they should be cut off, four inches above ground, as this causes them to throw out a greater number of branches, and keeps the latter down near the ground, where they can be readily gathered.

GATHERING LEAVES FOR FOOD.

In cutting off the shoots for feeding, only about one-fourth or one-third should be removed at a time, the largest being first selected, going over the entire plantation; then beginning and going over again. If the branches were all cut at once it would inevitably tend to shorten the life of the tree, and might, in this dry climate, even kill the tree in one year. The best implement for removing the branches is a pair of pruning shears. Cut your trees within four feet of the ground, making clean work as you go, cutting the branches within two or three inches of the body. The tree thus trimmed will produce a head to be taken off at the feeding time. It will be thus kept within reach, and always handsomer and better than when stripped of the leaves. The branches when cut should be laid in a cellar or cool room where, if wet, they will soon dry. After being fed from they may be planted in furrows and many will grow.

Many persons have erroneously imagined that light is injurious to the silk worm, but the very reverse of a belief so contrary to nature is evidently true, as it is in its native state habituated to the most perfect light. A due proportion of the reviving light of day is necessary to its perfect health. In the full light of day, when the sun shines, the leaves of the mulberry and other trees inhale vital air, or that pure ethereal substance which, by being inhaled, gives life and heat to the animal system, while in the darkness they evolve mephitic air which is destructive and incapable of affording nourishment.

Although the silk worm will endure a great degree of heat, yet when this heat is combined with excessive moisture the effect appears to be at least as deleterious to the insect as mephitic air.

FEEDING ROOM OR COCOONERY.

The greatest precaution should be taken to choose a suitable cocoonery. If not new it should be whitewashed or painted, so

that no insect injurious to the silk worm can harbor in secret cracks and corners. Ants have to be carefully guarded against. The cocoonery must also be carefully preserved from all disagreeable and unhealthy fumes and odors, such as tobacco smoke, or even the smell of that poisonous weed, or decayed animal or vegetable matter, carbonated hydrogen, etc.

The cocoonery should have, if possible, windows and doors on opposite sides, so that a current of air can be kept up for cooling and ventilation. In very warm climates mulberry trees should be planted around the cocoonery, so as to afford shade from the scorching rays of the sun.

The site chosen for a cocoonery should be dry, light and airy, a good form of building being one or two stories, and twice as long as wide. Some prefer brick buildings.

The proportion should be according to the number of silkworms to be raised, and can be enlarged or made smaller.

A building twenty-five feet wide, by fifty feet long, and two stories high is recommended. The wall should be brick or plastered if possible. It should have four windows on each side of the first, and also of the second story, if the cocoonery has two stories. Such a building with two stories, would give a surface of 2,500 square feet. Count Dandolo estimates the space required for a million of silkworms as follows, and in like proportion for a greater or less number:

For the first age, two hundred square feet of surface; for the second age, three hundred and seventy-five; for the third age, eight hundred and seventy-five; for the fourth age, two thousand and sixty-two, and for the fifth age about five thousand square feet of surface, which would require a cocoonery of two stories to be 35 by 70 feet.

The building of a cocoonery will more than compensate farmers for its erection, and it is evident that for storage there should be such a building on every farm. It can be built small or large according to the size of the farm, the business carried on, and the use for which it is intended.

To use the building for storage and silkworms, the posts for the shelves should be of a regular size and length, kept together by wooden pins or screws, all of the same size, or in any other suitable way. They must be arranged so as to make it very easy to put the shelves together and take them apart. When the feeding of the silkworms is done, in a few hours the shelves can be taken apart and stored in one corner of the building, and the room can then be used for storage or other uses.

Farmers pay heavy storage for grain; but if they have cocooneries, they will soon learn their advantages.

SHELVES, POSTS, ETC.

The posts to support the shelves should be from three to four inches in diameter, and eight feet apart, the cross pieces to support the boards, about one inch and a half thick by three inches wide, and eight feet long.

Inch boards, sixteen feet long can be used. The cross pieces being eight feet apart, the boards will be supported in two ends and in the middle; the boards need to be sufficient in number to make the shelves eight feet wide. The space between the shelves should be two feet six inches. The worms on the first three shelves can be fed standing on the floor. For feeding those on the upper shelves the cross piece for the fourth shelf needs to be longer, so as to put up a board on which to walk in taking care of them, and the same for the second story.

The galleries between the shelves to take care of the silkworms, are four feet wide in the center, but those along the side of the walls only three feet. The rafters are laid across for a second floor, *but they are only boarded where the galleries are for attending the worms*; the object of this arrangement is to allow the air to circulate everywhere.

In order to be able to regulate the temperature and have plenty of air, a kind of second roof on the top should be raised at about twenty inches from the other, and projecting on each side from four to five feet. This gives the appearance of a double roof. With hinges, lids can be hung that will open and shut them.

HATCHING THE EGGS.

The best season for this in California is after the winter rains are over. The eggs are brought out from the cool place where they have been kept, and are placed in a warm room, garret or a cocoonery. Care should be taken not to bring the eggs suddenly from the ice house, if kept there, into a warm room. They are oftener kept in a cool, dry room, where they do just as well. A good thermometer will be necessary to regulate the air in a hatching house. It will be required also to regulate the temperature of the feeding room.

The outer air at this season will be from 65 deg. to 75 deg.; that of the ice house about 40 deg. Take the box containing the eggs first into a cool place where the temperature will be about 60 deg., and let it remain there from half an hour to an hour, or until its contents have acquired the temperature of the surrounding air. Then bring it into the higher temperature of the feeding room, and again leave it to acquire the same temperature before opening it. It may be well to defer the second removal until night, if the weather would be unusually warm, as is some times the case in the month of May.

To The temperature of the cocoonery should be even, at from ^{95'} about 80 deg. ^{and} to 90 deg. ^x. Very minute directions are given by the French, for gradually raising the temperature by two degrees Fahrenheit, until a maximum of 92 degrees is reached. This has ^{not} been found necessary in our climate.

If, however, a cold spell has brought the temperature of the room below 75 degrees, it will be necessary to maintain a moderate fire in a stove or grate, especially at night, or cover the worms with flannel or cotton wadding, so as to keep them warm.

The eggs will hatch in from three to seven days, depending on the temperature. Those first hatched should be kept by themselves. All the worms hatched on the same day should be kept and fed apart (if they are raised on a large scale); those of each day in a separate hurdle or shelf; the shelves should be numbered 1, 2, 3, etc.

This is necessary, because when the worms are moulting, being of the same age, they are all moulting at the same time, while, if those of different ages were mixed together, some would be moulting when others would want to eat, and those eating would be very injurious to those in the critical function of casting off their skins, when it is important that they should be left undisturbed.

FOR SMALL BEGINNERS.

A table four feet long by two and a half feet wide, will be large enough to hatch and feed the silkworms from a thousand eggs. A few few pasteboard or wooden boxes, twelve to fifteen inches long by six or eight inches wide, and one and one-half to two inches deep, will be very convenient for feeding them. If no boxes are used, the table should have a small strip of wood fastened at the edge, so as to prevent the worms from falling off the edge of the table.

THE FEEDING.

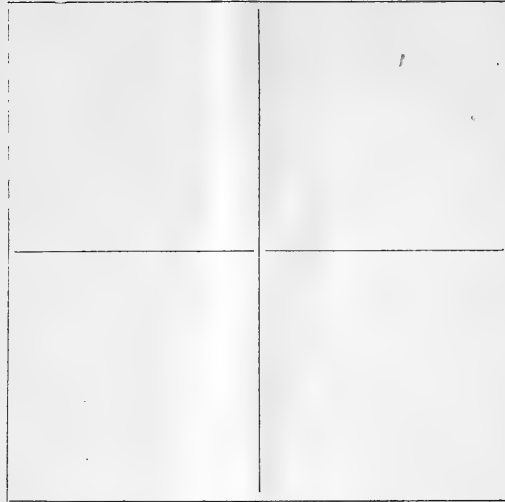
The little insect or young worm, usually comes out about four or five o'clock in the morning. The leaves must be immediately gathered and placed very near them, lest they wander away and become lost. When properly supplied with food, the silkworm is little disposed to wander, never leaving the place of its birth unless in search of subsistence. They must be fed with young and tender leaves, if possible from the *morus multicaulis*, as it has no gross or coarse fibres. (Sometimes lettuce will answer also at the commencement.) It is found that a less quantity of the *multicaulis* will suffice for the precious insect. The young leaves being replete with moisture and very tender, are the most suitable food for the young worms, because their bodies perspire largely; and as the mature leaves contain a greater proportion of solid and nutritious food, so they are the only suitable food

x after the fourth moulting

for the silkworms of a more advanced age. The last eight days the worms should be fed, if possible, only on the leaves of the *morus alba*, or white mulberry, as from this the best silk is obtained, and it possesses more of the glutinous substance resembling caoutchouc, which gives tenacity to the silk produced by the worms fed on them. The young worms, soon after they are hatched, should be placed on the different shelves 1, 2, 3, etc., (as before stated) in the feeding-room. In order to do this, young and tender branches are put on them, on which they crawl. As soon as they attach themselves, transfer the sprigs of leaves to another box or shelf, and place fresh branches for the next to come out. The leaves must be free from dew and moisture. Great care should be taken not to feed them with the young *red* colored leaves of the young shoots, as they sicken them. When they are fed with twigs they are easier removed from one hurdle to another. If possible, the leaves must never be gathered in rainy weather. When the young broods are too crowded, a part can be moved on the young twigs or branches. Suitably graduated frames are admirable for this purpose. If mosquito-netting frames are used instead of a paper with holes cut in,

SIZE OF HOLES FOR FRAME 1.

SIZE OF HOLES FOR FRAME 2.



according to the illustrations, (figures 1, 2,) they should be placed lightly over the dry and partly consumed leaves. The little insect will crawl through the meshes, to the fresh leaves laid on the netting. As the insect progresses, larger netting of twine or cane, with half-inch or inch meshes woven over a light frame, will be convenient for lifting the silkworm in order to remove the offal and keep the worms clean. If a large number is fed, frames are absolutely necessary for cleanliness. Split cane, such as is used for chair seats, is preferable, for it will make better meshes than twine.

The size and firmness of the cocoons depend much on the feeding. They will be all the better for giving fresh leaves four, five, or even eight times each day. When fed on a large scale, this is usually done. Mr. S. Whiteman says, in his pamphlet: If branches are used for feeding the silkworm, and if evenly distributed on the shelves, it will keep better till consumed; in feeding and in cleaning of the frames, much time is gained, the worms mount the twigs while feeding, and remain on them afterwards; they enjoy the fresh air, and have more space than on the flat surface; when fed with leaves, the leaves will be entirely consumed, leaving nothing but dry branches to remove; the ordure of the worm will fall through to the shelf, and they will be kept entirely free from it. On the branches, they will have a better chance to be equally fed; if this be not attended to, the ill-fed ones will lag behind. But the greatest advantage of all is, that they need not be removed from the frame, as the frame which fits and rests on the shelves is removed with the worms to sweep the offal from the shelves and then replaced from the time they are put on it till they mount to wind the cocoons. This will be a vast saving of labor, and prevent *handling* of the worms, which

is always to be avoided. The branches, as they are laid on, should be placed first crosswise and then lengthwise with the frame, making thus a sort of network, which can be easily separated in layers when you clean them off; the worms will be more healthful, particularly in moulting time, than when fed in the usual way, with leaves on a flat surface, requiring them to retire under the litter, and remain there till they change, where they must breathe a bad air, and, in many cases be smothered by the accumulation of matter. This having been the method for centuries, has very likely caused the great silkworm disease in Europe of late years, which has cost France more than a hundred million of dollars.

CLEANING.

Remove the offal and partly consumed leaves every day, and oftener if there is any unpleasant odor, mould, or dampness. Remove dead or diseased insects immediately. Some will die in moulting.

MOULTING SLEEP.

On the fourth or fifth day after hatching, the worms cease to eat and begin the process of moulting (casting off their first skins). The Chinese have remarked that the worms before casting their skins, fasten their hind legs to a branch or leaf with a kind of gum, or rather silky matter. During this process, they pass through what is called the moulting sleep, and *must not be disturbed*. A sudden loud noise, as thunder, the firing of a gun, violent slamming of a door, loud speaking, intruding strangers, or the lighting of a match, will be injurious if not fatal. They are like tender babes, and need motherly care.

They have four moulting sleeps. After each sleep they eat with increasing greediness. During the fifth age they consume a great quantity of food, and the branches must be brought for large cocooneries by wagon-loads, mostly of the *morus alba* (white mulberry), and distributed. Full-grown leaves, even the coarsest, are equally valuable; and night and day they must have enough leaves so as to allow them to eat constantly; the more they eat and the faster they feed, the more abundant will be the product of silk.

AMOUNT OF FOOD REQUIRED.

Count De Hazy says that two hundred thousand silkworms require ten thousand pounds of leaves in the different stages of their life; the first age, 50 pounds; the second age, 150 pounds; third age, 460 pounds; fourth age, 1,390 pounds; but in the fifth and last age, which usually comprises nearly one-third of the brief existence of the silkworm, they will require 7,950 pounds.

Different statements show that no sure guide can be given. Mr. Bonafoux says: From one ounce of eggs forty thousand silk worms will be hatched. In the first age they require seven pounds of leaves; in the second, 21 pounds; in the third, 69 pounds; in the fourth, 200; and in the fifth or after the fourth moulting, 1250 pounds. Much depends on care and economy in feeding. Of the *Morus Multicaulis* not so great a quantity is needed, as it has no gross or coarse fibres.

The leaves should be supplied after the first moulting sleep in abundance, whether the worm eats them all or not. Such worms as do not go to sleep at the same time as others are taken up gently with small spoons and placed in other vessels. It is sometimes advisable to separate the active from the dormant worm, by means of small sticks of straw. Worms that are tardy in arousing from their sleep are often hastened out of it by the application of a moderate degree of heat equalizing the condition of all. If while passing through the different stages the worm has been injured by an excess of heat, its head turns to a reddish color during the fourth period. If the worm seems to have difficulty in casting off its skin it is because improper food has been given it. Sudden changes of temperature must be guarded against. Danger arises from an *excess* of heat and the absence of proper ventilation. A stream of water, or pails of water, to give moisture to the air is needed in hot weather. Also wetting of the floor. The period for feeding the worm lasts generally from 32 to 34 days.

PREPARING FOR THE COCOONS.

Soon after the fourth period the worms ~~are~~ seen to crawl around, seeking anxiously for a place to make ~~the~~ nest—that is, to spin the cocoon, in which they envelope themselves, and which is to serve both as their temporary habitation and tomb.

When they have become transparent and of a pearly color; when they cease eating and are running to and fro, looking upwards, or trying to ascend; when the skin about their necks becomes wrinkled, and their bodies have softness to the touch resembling soft dough, and their backs become unusually shining, these are sure indications that they are ready to perform their last task; then and not before they must be provided with wheat or rye straw, which, after cutting off the heads, is tied in small bundles four inches in circumference. These sheaves of straw should be placed upright, spreading the tops out under the shelf above. Sometimes small branches of trees are made into rude bundles and placed on the shelves; upon these the worms climb and commence to make their nests. Sticks of wood, with shavings twisted around, are used by the Japanese; also forms made out of bamboo. Sometimes, even after the worm has ascended among the branches or the straw, it will look back and descend for the last time to take more food, and then ascend to spin its cocoon.

SPINNING THE COCOON.

The worm is now full grown— $3\frac{1}{2}$ inches long and of a pearly color—it has ceased to eat, has found a convenient branch, and fastened itself to it with a loose texture of floss silk. Within this structure is the silken envelope or cocoon proper, formed by a continuous thread about twelve hundred feet long, spun out by the worm around itself, not in concentric circles but by irregular movements of its head. The outer covering is terminated at one end, which is always found to correspond to the head of the chrysalis in a cord which fastens them to the branch. The substance of the cocoon itself can be easily separated into three or four distinct layers which seem to correspond with the changes of the skin of the insect.

The cocoon is an inch to an inch and a half long. The thread is covered with gum which makes it adhere firmly, and forms a tight covering impervious to water. The substance of the thread is a gummy, transparent liquid of a white or yellow color contained in two separate vessels about ten inches long and disposed in spiral folds on each side of the worm's stomach.

These vessels open by two small ducts, approaching near each other at the head of the worm. The silken thread of the cocoon is composed of two filaments, one from each duct. As these filaments are ejected the vibratory motions of the head of the worm cause them to unite, and they immediately harden into one inseparable thread. The right temperature of the room must still be kept up. Cold interferes with spinning; it congeals the liquid in the reservoirs, making it difficult for the worm to draw forth and to surrender the whole amount of silk which they have laid up in store. During the first day the worm forms a loose oval structure of thin, irregular threads called floss silk. Within this structure, during the three following days, it forms the silken ball. It usually takes from three to five days in the construction of the cocoon, and then it passes in three days more, by a final moult into the chrysalis state.

The worms while spinning must be kept as much as possible at all times separate. If in contact their secretions are injurious to each other, and are apt to spoil the cocoons, weakening the thread and diminishing the weight.

TREATMENT OF THE COCOONS.

As soon as the cocoons are finished, if intended for the raising of eggs, they are stored away in proper places or boxes and the chrysalides allowed to develop into the moth. But if they are to be used for producing the raw silk the cocoons are gathered and at once prepared for reeling; or if the reeling cannot be done within a week or ten days it will be necessary to kill the chrysalides. This is done in

other countries by means of artificial heat in an oven, and some times by steam. If killed by steam, they are put into a basket covered closely with a flannel garment or blanket, and placed over a vessel of boiling water for an hour. Then a cocoon is taken from the center and opened, to observe if the chrysalis moves when touched with a pin. If it does not move, the whole have been killed, and may then be spread out in thin layers to dry. Then tie in bags and hang them out of the reach of mice. In California they can be killed by being fully exposed to the direct rays of the scorching sun, from ten o'clock in the morning till four in the afternoon; two or three days of such exposure are sufficient to kill the chrysalis in the cocoon. Some recommend boxes four feet wide, and six inches high, covered with glass frames; this greatly increases the heat, and will have the effect of destroying the insect promptly and surely. In this way the cocoons will be protected against rats and mice, which are very fond of chrysalides. This mode is preferred to that of the heat of an oven which takes much of the gloss and beauty away from the silk. The object is to prevent the development of the moth, which, in its effort to escape, would tear through the cocoon, injure the thread and render it unfit for reeling.

TO SELECT COCOONS FOR EGGS.

The very best cocoons should be selected for grain or eggs, that is, those which are of a light color, and so far as possible, an equal number of males and females; the male cocoons are slender, depressed in the middle, and parted at both ends; the female cocoons are larger, more round, and resemble in shape, a hen's egg. If we will select carefully our very best cocoons, for grain, under our fine climate so very favorable to silk culture, we will in a few years obtain (in consequence of our virgin soil and the general inclination of our productions to be large) a California *variety* that will surpass in size and quantity all the varieties now elsewhere known and cultivated. Every different climate into which the worm has been introduced, has produced some change in the quality of the silk, or has altered the shape or color of the cocoons.

VARIETIES OF THE SILKWORM.

Some varieties produce but one brood in a year. The Bivalent hatch twice in a year. The eggs of the second crop only are kept for the next year's crop, as those of the first brood always either hatch or die soon after being laid.

The white silk is the most valuable in commerce, but the races producing yellow, cream or flesh-colored are generally considered to be the most vigorous.

The three most marked European varieties are the Milanese (Italy) breed, producing fine yellow cocoons; the Ardeche

(French) Annuals, producing large yellow and white cocoons; the Brouse (Turkish), producing in Europe large white cocoons of the best quality.

Owing to the fearful prevalence of *Pebrine* in Europe, particularly among the French and Italian races, the loss by disease has been very great for twenty years, and has cost France more than a hundred million of dollars, the loss being most severely felt by the small growers.

They are now obliged to send annually commissioners to Japan and China to procure silkworm eggs. Every year millions of eggs pass through San Francisco to reach their destination, and millions spoil on the way. We have seen millions of hatched eggs dumped into the San Francisco Bay.

TO SECURE THE EGGS.

Prof. C. V. Rily, a firm believer in household silk culture, says: Place the selected cocoons on shelves or tables in a darkened, retired, warm and airy place. The chrysalis state continues from two to three weeks, when the skin bursts and the moth emerges. With no jaws, and confined within the narrow space of the cocoon, the moth finds some difficulty in escaping. For this purpose it is provided, in two glands, near the obsolete mouth, with a strongly alkaline liquid secretion, with which it moistens the end of the cocoon and dissolves the hard, gummy lining. Then by a forward and backward motion, the prisoner, with crimped and damp wings, gradually forces its way out, and when once out the wings soon expand and become dry. The silken threads of the cocoon are simply pushed aside, but enough of them get broken in the process to render the cocoons from which the moths escape comparatively useless for reeling. The moth is of a grayish white, creamy color, with more or less distinct brownish markings across the wings. The males have broader antennæ or feelers than the female and may, by this feature, at once be distinguished. Neither sex flies, but the male is more active than the female. He is also known by his smaller size, and continual flutter of his wings. The female is larger in size, of a whiter color, and seldom moves.

PAIRING THE SEXES.

They generally come out of the cocoon in the morning, between seven and nine o'clock, when they should all be paired, otherwise the eggs will not be good. When paired they are removed by their wings to sheets of paper or canvas, spread on tables or boards, where they are to be left in darkness, as the silkworm when complete is a night insect. In placing them, when paired, upon the paper or cloth, ready to receive them, taking hold of their wings, be careful not to hurt or separate them from being coupled. Such as are not paired are to be

placed on a separate sheet of paper, when they soon become mated, after which they are placed with the others already paired. Occasionally a male amongst the paired ones gets separated from his companion. When this happens he should be removed, else he will cause disturbance and further separations. All those that become separated are to be put back with the unpaired ones, that they may get mated again. The unmated males placed in the box are kept for reserve. All the balance may be thrown out. The next morning the process is repeated the same as before, but if it happen that there are more females than males, the deficiency of males can be supplied from the reserve, since every female must be provided with a male, in order to produce good eggs. This process is to be kept up from day to day till all the moths have emerged from the cocoons. After all are paired, they are left in a dark place until four or five o'clock in the afternoon, when they are to be separated, by taking the wings of the male with one hand and of the female with the other, and drawing them apart quietly, so as not to hurt them. After this the males are to be placed in a box, and the females on a cloth or paper, where they are to lay their eggs.

LAYING OF THE EGGS.

The females generally begin to lay as soon as the separation from the males is effected. It is important that the two sexes be completely separated. When once the females have commenced laying they need to be looked after no further. They lay their eggs in a regular circular order, from 200 to 400 in number. Three hundred is the usual number. This done, the mission of this wondrous insect is ended. It has given its life in labor for the adornment of the human race. Its last act was a provision for the reproduction of its life three hundred fold in a new generation. It has exhausted all its vitality. As in the moth state it does not eat, it dies.

PRESERVING THE EGGS.

The papers on which the eggs have been deposited are to be rolled together carefully and placed in tin boxes, with a somewhat loose lid, two or more sides of which should be well perforated so as not to kill the eggs, as they will die if kept in air tight vessels. These boxes should be kept in a cool room, or in a dry cellar, where they will not be liable to freeze, though frost, while it retards the period of their hatching, does not destroy the eggs. Mice, rats, ants, spiders and flies are enemies that must be guarded against.

THE EGGS.

Each female is expected to lay from two hundred to four hundred eggs. Three hundred cocoons weigh about one pound; an

ounce of eggs can produce from 90 to 165 pounds of cocoons; the average is a hundred. Twenty-eight ounces of selected cocoons give two ounces of eggs, one ounce of grain (eggs) produces at least 35,000 worms; 125 females will lay at least one ounce of eggs.

The egg seed, or grain, (so-called by the silk raisers) is nearly round, slightly flattened, and in size resembles a turnip seed. Its color, when first deposited, is yellow, and this color remains, if unimpregnated. If, however, impregnated it soon acquires a gray slate, lilac, violet, or even dark green hue, according to variety. It also becomes indented. As the hatching point approaches the egg becomes lighter in color, which is due to the fact that its fluid contents become concentrated, as it were, into the central forming worm, leaving an intervening space between it and the shell, which is semi-transparent. Just before hatching, the worm within becoming more active, a slight clicking sound is frequently heard, which sound is, however, common to the eggs of many other insects. After the worm has made its exit, by gnawing a hole through one side of the shell, this last becomes quite white. The color of the albuminous fluid of the egg corresponds to that of the cocoon, so that when the fluid is white the cocoon produced is also white, and when yellow the cocoon will be yellow.

WEIGHT OF THE EGGS.

To ascertain the weight of the eggs is very important. The white paper or muslin, called cheese-cloth, on which the moth is to deposit the eggs, must be carefully prepared. The size should be 12 by 15 inches. Each piece must be dried and then accurately weighed by itself, and its weight in Troy grains (apothecaries' weight) must be marked upon it. Thus prepared it should be placed, at the proper time, under the moth to receive her eggs. Then, when the eggs are laid, each piece should be carefully weighed, and its weight distinctly marked as before, leaving both weights for inspection by the purchaser. The difference between the two weights shows the weight of the eggs.

SILKWORM GUT—FISHING TACKLE.

Worms that die during the critical period of moulting are not without value. Their intestines may be used for making a strong thick thread, which is sold under the name of "Silkworm Gut." This is of value, as it makes the fishing tackle.

SILKWORM DISEASE.

The Chinese books describe three kinds of disease to which the silkworm is subject:

Firstly—The “Yi,” (Chinese language) in which the worms are found hanging dead at the extremity of a small silk thread.

Secondly—The “Pan,” or spotted disease, in which the worms are covered with little black spots, and of which they soon die. According to the Chinese theories, the “Yi” is attributed to cold, and the “Pan” to extreme heat. This last is considered contagious.

Thirdly—A third disease, very likely the one known in French by the name of “Muscardine,” which is due to a parasitic growth in the body of the worm.

MISCELLANEOUS.

TURKEY.

Commodore Porter relates that ⁱⁿ at the foot of Mount Olympus, as in many other cities of Turkey, asses laden with limbs and leaves from the Mulberry plantations surrounding that city, are continually carrying their burdens into the city.

Mrs. Rhind, in her description of Turkey, says that the mulberry trees are chiefly cultivated by farmers who do not themselves raise the silkworm. During the feeding season the leaves are daily collected, transported and sold in the market of the city as fruits or vegetables are sold. At the proper time almost every family clears out all the rooms in the house, except the one in which they live. They hatch the worms, purchasing the leaves for feeding them, and produce that most wonderful fabric, the silk of Brorussa. Every country town in California may yet raise silk in the same way.

INDIA.

In the hot climate of India silk worms are not alone reared in sheltered buildings but also in sheds of an open and airy structure, the sides being composed of lattice-work and the roofs covered with thatch. The height is usually eight feet or more between the staging tiers, arranged one above the other, in which the shelves are arranged on which the silkworms are placed. The posts which support the staging rest in basins of water to protect the worms from ants. Many persons some years ago, succeeded in California, where the climate is very hot, in raising silkworms on verandas having the open sides closed with mosquito netting.

ORIGIN OF SILK-CULTURE IN CALIFORNIA.

Mr. H. Hentch, of San Francisco, imported, in 1854, the first mulberry seeds from France. He was the originator of silk culture in California. In 1856 he also imported the first silk-worm eggs from China, but they did not hatch. The second year another trial of eggs from China was made, but with the same result. The third year eggs were procured from China again, and also from France. Nearly all those from France hatched, while those from China proved again an entire failure. It affords something on which we may reflect, why eggs from China always failed when our pioneers were endeavoring to make silk culture a California industry. Fortunately there was another source of supply; and, with good seed, California cannot fail to be what Mr. Hentch believed it was capable of becoming, one of the best silk producing countries of the world.

NEVADA COUNTY SILK RAISING.

Mr. F. Gillett, of Nevada City, an experienced silkworm raiser, writes: A person can very well take care of 50,000 to 75,000 worms. If there are children they can help in picking mulberry leaves and feeding the worms. To rear that number of worms, a room 24 feet by 16, and eleven feet from floor to ceiling, would be required; if smaller, then a smaller number of worms would have to be raised. It is now for interested people to decide whether the production of cocoons, worth from \$1 to \$1.50 per pound (when fresh) would be remuneration enough and amply repay them for their trouble and labor. But I must say, he adds, to you ladies, the able and earnest promoters of this new movement, that without a filature your efforts will all be in vain. So I repeat again, "To make silk culture a success in California you must have a filature. A filature will create a market for the sale of the silky product of the farmer, and will insure a steady and pleasant employment for many of the now unemployed people."

THE MOVEMENT IN PHILADELPHIA.

The President of the Silk Culture Association of the United States, Mrs. Lucas, of Philadelphia, in her report to the Chairman of the Committee of Agriculture and Sericulture of Pennsylvania, gives many encouraging facts. She says that a German farmer, who is also a musical instrument string manufacturer, has for several years raised cocoons, and, strange to relate, fed the worms on twelve different kinds of food; he has even reeled his cocoons on a simple attachment fastened to his wife's sewing-machine. Thus in his quiet, unobtrusive German perseverance he has produced the silk required for his business—that of making bass viol strings, which he affirms are far superior in quality—

made of the silk of his own raising. For this purpose—the bass strings—the best silk is required.

Mrs. Lucas further states, that at the present time mechanics are constructing reels for the use of the Association, which it will soon be able to offer to the public—a simple and inexpensive reel, which it hopes to see introduced into the families of agriculturalists throughout the rural districts, which will become as useful an auxiliary to the household as the sewing-machine. These reels will soon be put in operation, and agricultural people are earnestly urged to enter perseveringly into this work, and help to retain within their own pockets the millions of money which are now annually sent abroad for foreign silks.

She says further: “Our Silk Culture Society aims to create a market for the exchange of small quantities of silk before it can reach the manufacturers, who purchase only in large quantities. Persons raising cocoons are invited by Mrs. Lucas to correspond with the Association of which she is President, or with branch associations, and state the quantity of silk cocoons, eggs, trees and seeds raised by them.

VALUE OF SILK PRODUCTS.

Raw silk reeled from the cocoons commands from \$4 to \$8 per pound, according to its quality. Unpierced cocoons and floss silk are worth \$1 to \$1 50 per pound. Silk-worm eggs are worth \$1 per 1000, \$3 per one-half ounce, \$5 per ounce.

It is estimated that a sufficient quantity of trees planted in one acre of good rich ground will yield fifty thousand pounds of leaves and support a million of worms. Two acres of land planted with mulberry trees would give food enough to produce about thirty thousand pounds of leaves. About sixteen pounds of leaves are required to make one pound of stifled cocoons, which would yield about 1,765 of fresh cocoons. These stifled would yield about 588 pounds. Dried cocoons of good quality should bring about \$2 per pound, or \$1,176. A million cocoons reeled off will produce, at the rate of 2,500 to the pound, 400 pounds of raw silk, to raise which would cost, according to the Philadelphia Society's report:

EXPENSES:

1 grown person, first ten days.....	\$10
2 boys or girls, first ten days.....	6
2 grown persons, second ten days.....	20
5 boys or girls, second ten days.....	15
3 grown persons, third ten days.....	30
16 boys or girls, third ten days.....	48
	<hr/>
	\$129

If we add \$31 for fuel, a few days' work for pruning and cultivating the trees, and a few sundries, it would cover all the expenses. The total would not exceed \$160. This deducted from \$1,176, would leave a profit of \$1,016 on two acres of land, and less than two months' time! How does this compare with one bale of cotton to the acre, the bale at \$40, and the crop of which it takes six months to make and gather? These statistics are the result of actual personal operations under favorable circumstances.

Silk culture is a business which can be readily started, and with little capital. It requires but a small amount of land and no skilled labor. It demands scarcely any other care than that of women and children, and, in any event, need not greatly interfere with other farming operations, the attention bestowed upon it being called for mostly at times when other matters are not apt to be pressing.

CORRESPONDENCE.

Any information concerning silk culture may be obtained by addressing Mrs. T. Lucas, President of the Woman's Silk Culture Association of the United States, No. 1028 Race street, Philadelphia, Pa.; Mrs. E. B. Barker, President of the California Silk Culture Association, No. 14 Stanley Place, Rincon Hill, San Francisco, Cal.; or, Mrs. T. H. Hittell, No. 808 Turk street, San Francisco, Cal., the Corresponding Secretary of the California Silk Culture Association.



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