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GENERAL INSTRUCTIONS

FOR

REARING SILKWORMS,

WITH A

TREATISE ON SECURING HEALTHY SILKWORM EGGS.

ALSO, A

Sketch of the Habits and Structure of the Silkworm.

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By ✓
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GENERAL INSTRUCTIONS

FOR

REARING SILKWORMS.

For every ounce of eggs it will require about seventy-two yards of space to rear the worms during the fourth stage. Racks can be used having many tiers of shelves. The first shelf should be about two feet from the ground, and the shelves about twelve or fifteen inches apart.

To disinfect or render pure the air in cocooneries, chloride of lime should be used. Dissolve a quantity of lime in eight times its volume of water, and leave this in the room for a short time.

The worms from an ounce of eggs will consume from twelve hundred to thirteen hundred pounds of mulberry leaves. The leaves must be healthy, vigorous, and of a nutritive quality. The worms must never be fed with leaves wet with dew or rain, as damp or wet leaves are very injurious to silkworms. It breeds disease.

Light is a necessary element of life, but the direct rays of the sun should never be allowed to fall on the silkworm.

Pure air is even more indispensable than light, for respiration. It prevents the bed, or refuse of leaves, from fermenting. Caution should be taken not to allow the bed of refuse leaves under the worms to ferment, as this is the cause of all the diseases which silkworms are heir to.

The air should be continually renewed, not by a direct current, but insensibly renewed by means of an open window or door.

Cocooneries should be kept at an even temperature, night and day.

It will take about six days for the worm to pass from one moulting stage to the next moulting, excepting after the fourth moulting, when it takes from nine to ten days for the worm to mount to the brush to spin its cocoon.

If the season when rearing silkworms should be damp, from rain or other causes, have small pieces of unslaked lime in the corners of the room. The lime will absorb dampness. Also, powdered charcoal, sprinkled on the under leaves of trays where worms are, will prevent the leaves from moulding, and will render the odor of the old leaves less pungent.

Fig. 1.

From an ounce of eggs hatching will be completed in the space of three days. Care should be taken to keep each day's hatching separate, in order that the worms will moult at their respective periods. The approach of the time for hatching may be perceived by the eggs becoming of a pale lavender color, when small-sized pieces of per-

forated paper or bobinet should be placed over them. When the worms begin to make their appearance place mulberry leaves over this covering; and as the worms

cling to them, remove the leaves with the attached worms from the receptacle where the eggs have been, and place them in the position shown in Figure 1. Eggs will generally hatch in the morning hours; but if

Fig. 2.

any should be delayed until the afternoon, place them between the rows of leaves, as is shown in illustration No. 2. At first the worms must be fed every two or three hours with fresh mulberry leaves, which should be cut into small shreds, about a quarter of an inch wide. Though the leaves that are given to the worms should not be all consumed, it is very necessary that they be renewed every few hours, as the worm constantly requires fresh food. During the moulting stage the worms should not be given any food; and after moulting the feeding should be so directed that one worm will not become stronger than another. With the proper temperature, and the requisite attention in feeding, the moulting stage will be passed in six days.

When the worm issues forth from the egg, its body assumes a chestnut color, and its head appears of a shining black. By the third day the body has become darker, and the head almost whitish. On the fourth day the body is of a yellow waxy appearance; and on the sixth day, if the worm be looked at between the eye of the observer and the light, it seems a clear, transparent, waxy substance.

During the first four days the leaves should be given to the worms every two hours, and the last meal in the evening should be given as late as is convenient, and more abundant than the morning meal, which should be given as early as possible.

First Stage of Silkworm.

Silkworm, first day.

Silkworm, second day.

Silkworm, third day.

Silkworm, fourth day.

Silkworm, fifth and sixth days.

In placing the leaves upon the worms they should be put first around the edges, in order that the worms may not heap themselves up in the middle of the trays in their effort to get at the fresh food. In the early stages, as has been said before, it is necessary to cut the leaves into shreds, that the young worms may have a better opportunity to feed, and that they be administered every two hours. In the last two days of the first stage, the leaves should be given in less quantities at the regular times of feeding, as at that time the worm loses some of its appetite.

The approach of the moulting period may be observed from the fact that the worm remains immovable, with its head erect. When it is about to throw off its old envelopment, it moves its head about, and, with a vermicular movement, struggles forth. Care should be taken not to disturb worms during the moulting period, for the reason that before going into this state they exude a gummy substance, also fine web-like threads, which cling to their surroundings, and enable the worm to liberate itself from the old skin. If there be any worms which have not

passed the moulting stage, those already moulted should not be fed until all have passed the stage. After moulting, the worms are generally very much fatigued and have not much appetite, being able to go without food for sixteen or eighteen hours without injury to themselves.

The cocoonery should be kept at a temperature ranging from sixteen to seventeen degrees Reamur, or nineteen to twenty degrees Centigrade. There should also be light and air in the cocoonery.

In the early stages the worms can be changed from one tray to another, by using mosquito nettings, by putting the latter over the tray containing the worms to be transferred, and on this netting fresh cut mulberry leaves. The worms, attracted by the fresh leaves, will crawl through the openings, and may be taken to a fresh tray in a few hours. The old leaves are then worthless, and should be thrown away, and the tray should be aired before it is again used. During the first stage the worms should be changed to clean trays twice. In the second stage, for the first two days, feed them every two hours; during the second two days, sparingly; during the following two, more abundantly; and in the last two, very lightly. In six days, with proper care and temperature, the worms will pass from one stage to another. After the first moulting, its body becomes of a dark gray color, which changes to a yellow waxy hue

when about to enter the second stage of the moulting.

Second Stage of Silkworm.

Silkworm, first day.

Silkworm, third day.

Silkworm, fourth day.

Silkworm, fifth and sixth days.

Eight hours after having moulted the second time, the worms should be placed on a clean tray by the method before explained. Precaution should be observed in taking care that the room has always a good supply of fresh air, and is well ventilated. As the worms increase in size, their respiration and transpiration also increase with their growth. The worms should always be kept so that they can eat comfortably, and without crawling over one another in their search for food.

Third Stage of Silkworm.

Silkworm, first day.

Silkworm, second day.

Silkworm, third day.

Silkworm, fourth day.

Silkworm, fifth and sixth days.

After passing the third stage they will require a much larger area, the worms from one ounce of eggs requiring a space of seventeen square yards. A number of trays can be made to occupy a small space, by placing them according to the Cavallo system, upon a rack one over the other, leaving sufficient spaces intervening. Thus they can be moved easily, fed, and attended to. Such an article could be made of laths, placed horizontally on four perpendicular uprights. The space between shelves should be about one foot. Racks can also be made as per illustration.

In this the frame is covered with tacks partially hammered in, to which cords are attached, running

across the frame in both directions, and forming squares at intersections less than one inch apart. When this is done, the tacks can be hammered home, which will keep the cord firmly in place. These racks may also be used for changing the worms. These frames may be made any size to suit the rack; three or four frames may be made to suit the length of the shelves of rack.

Tray for Rack.

When the worms have passed through the third moulting they should be again changed, as they were at the conclusion of the second moulting. Their bodies at this period is of a grayish-yellow color, and the skin of the neck and head is much wrinkled. After the third moulting the worms should be changed every two days, and also changed just previous to moulting, in order that they may have clean beds to moult on. The temperature of the room in which the worms are reared should be sixteen degrees to seventeen degrees Reamur; and if the weather is very hot the apartment may be

cooled by placing basins of cold water in the room, and sprinkling the floor with cold water at intervals.

Fourth Stage of Silkworm.

Silkworm, first day.

Silkworm, second day.

Silkworm, third day.

Silkworm, fourth day.

Silkworm, fifth day.

Silkworm, sixth day.

During this last stage the brush should be prepared on which the worms may spin. Mustard and asparagus seed stalks can be conveniently used for this purpose as brush bouquets, to which the worm can attach threads and form cocoons. Dried chaparral branches can also be intermingled with the mustard and asparagus, as in the illustration. Air should be allowed to circulate freely through the mass. The brush bouquets should be put in the frame fan-shape, and then bent over to form the arch.

Illustration No. 9.

The fourth moulting stage is the most perilous the silkworm has to pass through, and requires a period of about six days from the last moulting. The worm should not be removed from the tray before sixteen hours after moulting have elapsed. As they do not all pass through it at the same time, extra care should be observed. Leaves may be administered whole at this time, and twigs, as the worm has at this period a voracious appetite. It should be observed at this point that no dew or rain should be present on the leaves. After the fourth moulting the worms will remain for nine or ten days before they are ready to spin. The worms will eat an enormous quantity of leaves, and should not be crowded on the trays, which should be only about two thirds full, in order to give the worm plenty of room as it increases in size. During this stage the worms should be changed to clean trays every other day, and every day if possible.

*General Instructions for**Fifth Stage of Silkworm.*

Silkworm, first day.

Silkworm, second day.

Silkworm, third day.

Silkworm, fourth day.

Silkworm, fifth day.

Silkworm, sixth day.

Silkworm, seventh day.

The worms will occupy from *three* to *four* times the space they occupied at their moulting.

The worms need more air and ventilation at this period, and an infraction on this rule would be followed by grave results. After the fourth moulting the temperature must not exceed sixteen degrees Reamur, but may fall below to any degree, as after this the worm is not so subject to cold, but would suffer greatly from too much heat.

Worm Ready to Spin Cocoon.

When mature and ready to spin, the silkworm stops eating, and appears of a golden, transparent color. They wander over the mulberry leaves with heads raised, as if seeking some suitable place. When the worm begins to spin only the seric and animal substance constitute the body, which becomes perceptibly smaller. When two thirds of the worms have mounted the brush those remaining should be removed to another tray, that they may not be dis-

turbed by those already mounted. By feeding them well they will soon be able to mount like the rest. The brush arches, as per illustration No. 9, should be placed on the trays, and if not convenient enough for the worms to mount a few branches should be added. Worms unable to get up should be gently assisted to a favorable position, whence they may crawl up themselves. A free current of air is indispensable at this stage. It will take four days to finish a cocoon, which should be removed from the brush eight to ten days after having been first spun.

The chrysalis in the cocoon can be stifled by exposing the cocoon to the hot sun for three or four days, or the cocoon may be placed in an oven of moderate temperature, and in fifteen or twenty minutes the desired object will be accomplished.

Chrysalis, Lateral View.

Chrysalis.

An ounce of eggs will produce one hundred to one hundred and twenty-five pounds of fresh cocoons, if worms are well fed and care taken of them.

Silkworms well fed will form their cocoons in about three or four days from the time they commence to throw out the floss silk. The cocoons should be gathered from the brush the eighth or tenth day from the day the worm first commenced to spin. The moth will pierce through the cocoon from the seventeenth to the twentieth day. In reserving cocoons for propagating from always choose the firmest and most perfect ones. The duration or existence of the moth is from ten to fifteen days. They do not eat during this stage, as the moth does not possess digestive nor nutritive organs. Moths should be kept in a dark room, as the light acts as a stimulant upon them. The moths generally come forth from the cocoon during the morning hours. As soon as they are coupled they should be gently lifted, by taking hold of the wings of both, so they may not become separated, and placed in a tray covered with cheese cloth or other light fabric. The moths are to remain coupled about six hours. If the moths do not separate spontaneously after six hours conjunction, the male should be separated gently from the female, by taking the wings of the moths between the thumb and second finger, and with the first finger of both hands carefully separate one from the other. The female should be placed

in a cell or sack made out of crinoline or muslin, where she can lay her eggs. The male can be kept until next day, and if there are a greater number of females than males, then the males can be used to couple again.

Male Moth.

In selecting moths for propagating, one should note the following directions:

That healthy moths come out of cocoons between six and ten o'clock in the morning.

That healthy moths are of a pale white color, and their wings dry rapidly and are well spread out.

The male moth can be distinguished from the female as it has two black signs or lines on its wings. The male is generally smaller than the female.

If the eggs laid are abundant and equal in size, of a violet color, and the precautions mentioned have been taken, then the product may be considered good. Discard all eggs that remain of a yellow color after the fifteenth day from the time the moth laid them, as they will not hatch. Do not propagate from moths that are not vigorous, nor from those

that appear swollen and have, subcutaneously, a yellow fluid substance between the rings of their abdomen.

Those moths having reddish marks on their abdomen, or those evacuating a white or black substance, are not healthy moths, and in consequence should be destroyed.

After forty-eight hours the cloths or sacks upon which eggs are laid should be hung up in a cool dry place, away from the reach of mice or rats, so as to preserve them until the next season.

Female Moth Laying Eggs.

TREATISE

ON THE

Selection of Healthy Silkworm Eggs.

It is well to understand in the beginning that the two diseases, pebrine and appopleisia, to which silkworms are subject, are entirely distinct from each other, both in their causes and effects, and in regard to external and internal symptoms in the insects.

The disease pebrine was first discovered to exist among silkworms at Provenza in 1840; in 1845 it appeared at Covailinni; in the following year at Avignone, and at Nimes in 1849; in Buduza and the valley of St. Martin in 1852, and in Spain during the same year, and in the next year, 1853, at Benaco; in Berne and in the Tyrol in 1855. Thence it extended to European and Asiatic Turkey and India in 1859. In 1858 the silkworm eggs in Prussia were infected at a time when similar disturbing causes were found among the establishments of silk culture in Tuscany, Italy. Switzerland was attacked in 1860; two years afterwards it is found at Bucharest, and in 1864 at Capazzi, but up to the present Portugal has fortunately escaped molestation.

Pebrine is a fungoid disease, better known under the term "corpuscular parasites." It is one of the greatest enemies to the silk culturist, and propagates itself with remarkable rapidity. It was thought for a long period of time that these fungoid corpuscles, so called, were but an organized substance, not independent organisms. Later investigators, however, among whom Professors Haberlandt and Pasteur may be particularly mentioned, have demonstrated that they are actually independent organisms. Without treating the subject at length, or wearying the reader with minor details, the writer will limit the description of the disease in the insect to the appearance of the corpuscles and an analysis of the development of the fungoid parasite.

In the first place, it has been satisfactorily ascertained that the parasite lodges in the fluid of the egg; also, adhering to its external part, viz.: the shell. It is always present in all the organs of the infected worm, as also in the blood, muscles, and silk glands of the alimentary canals. In the single organ of the chrysalis they are found to be very abundant. In the moth affected the corpuscles are found especially in the membraneous folds of the wings, the eyes, and in the open spaces of the feet. They are also found in the ovaries of the female. These oviform fungoid are possessed of great tenacity of life. In a dry or petrified state they are imperishable; and even when placed in distilled water by

Professor Lebert, where they were kept many years, they were found to be unaltered. Neither alcohol or acids can affect them to any perceptible degree, the latter producing but a slight paleness of the corpuscles. Our only recourse, therefore, in destroying a germ of disease so indestructible, yet so destructive, is to burn up all matter infected with their presence.

It may, therefore, be readily perceived how dangerous a disease is this petechia, or pebrine (which is known scientifically under the name of "ovoidali corpusculis"), in the silkworm, in the form of the egg, worm, chrysalide, and moth.

In order to obtain satisfactory results in the rearing of silkworms, and insure the production of their quota of silk, it is absolutely necessary that the worms be in a healthy condition. As early as the year 1857, Dr. Osimo, of Padua, had discovered the existence of "microscopi corpuscules" in silkworms, infected with pebrine, and he declared them to be "algor unicellular." We are indebted to the scientist Dr. Charles Vitaldini for the discovery of corpuscles existing in the eggs of the worm. Later many other eminent microscopists verified this discovery, among whom were Frederick Haberlandt, Emilio Coma, B. G. Cavallieri, Professor Cantoni, and Professor Pasteur.

The method by microscopical inspection is the only one available in discovering the presence of

this pest, which, if not checked in time, will destroy a whole crop. Professor Pasteur recommends the following method of finding whether the corpuscle exists: It is to take a couple of cocoons you would use for reproducing eggs, and subject them to a high temperature—for instance, thirty degrees Reamur—and by this means hasten their transformation into the butterfly or moth. Then inspect, microscopically, the blood of the moth. If it is found, on examination by the microscope, that the blood contains any ovoidal corpuscles, they should not be used for propagation, but the cocoons be turned over for silk reeling, and thus made use of. If no ovoidal corpuscles be found, the cocoons are perfectly healthy, and may be used for propagating purposes. The writer, however, does not favor this way of testing the condition of the cocoons, although recognizing the great ability of Pasteur.

Forcing nature to do its work hurriedly by means of artificial heat, in her estimation, is inferior to the processes of nature. It is clear that the blood of the insect, subjected to this high temperature, must undergo a physical change, and would in all probability suffer therefrom. A better method is that proposed by Sig. Felice Franchesehini, a distinguished silk culturist of Italy. It is substantially as follows: Instead of using artificial heat for forcing the metamorphosis of the chrysalis, take a sample of cocoons, six or eight days after they have mounted the brush

to spin, from those which you wish to keep for seed, selecting some from all stages of completeness. Let some be those cocoons that were first spun, others not in so advanced a stage, and still others late in their operations. Then, with a pair of scissors or a sharp penknife, cut open the cocoons, extracting therefrom the chrysalis. With the same instrument cut open the abdomen, beginning at the lower part and extending the incision upwards. This is a simple operation, and may be performed by any one, as it is of no consequence if the cuticle be injured in the operation. Care must be taken to select the female chrysalis for this experiment, for in its abdomen lie the eggs, which may by a little practice and patience be extracted from the ovary tubes. Then, having isolated the eggs, wash them well in pure water, and they are ready for the microscopical examination. If they are found, upon inspection, to be free from corpuscular infection, prepare the whole crop of cocoons for reproduction and propagation. But should there, on the other hand, be found any traces of infection present, there is still time to send the cocoons to the filature in as good a state for reeling, because the moth would not have gnawed its way out of the cocoon.

Another method of determining the absence of this disease in the moths is by subjecting some of the blood of the chrysalis to microscopical examination, in order to see if corpuscles be very scarce, or

entirely absent. The microscope used for examining eggs and blood of chrysalis should have a power of magnifying from 500 to 600 times. The following is the method: On a glass slide put three or four eggs, which should be broken by pressure. A drop of water should then be added, and from the dense and turbid mass the eggshells should be removed. This being done, spread the mixture well upon the glass, and cover it with another glass slide. In this manner the material is fit for the microscope.

If it be found, on examination, that the mass presents the appearance shown in Figure I *aa*—thus: granulations of the yolk in a spherical shape, and of variable size, isolated or united in groups—then the eggs are free from infection or disease.

If, however, on the contrary, the eggs are diseased, the matter will present the appearance seen in Figure II *aa*, where are represented oscillating semi-ovoidal corpuscles, mixed with granulations.

To examine the blood of the chrysalis, which is the yellow liquid we find in its body, put a drop of it on the microscope's glass slide and allow it to remain so for twenty-four hours. At the expiration of this time cover it with another slide of glass, and being so covered, place it for inspection. If it be infected with disease, ovoidal corpuscles will be perceived, as in Figure IV *bb*; if the blood is free, then it will appear as in Figure III *aa*.

Extreme cleanliness and care must be observed to prevent disease or contagion in silkworms. The enormous loss of silkworms by pebrine and other diseases, and in consequence a diminution of the silk crop, may be attributed to the combined effects of bad and scanty food, want of sufficient light and ventilation; also, to a high temperature and constant interbreeding of debilitated stock. The diseases silkworms are subject to are not spontaneous, but are immersed into the organisms of the worms from the air or from damp or unhealthy leaves they may have eaten.

THE SILKWORM.

The silkworm is a grub or caterpillar of the butterfly called *bombyx mori*. It comes forth from an egg the color of ash wood, and of the form of a lentil, somewhat hollow in both surfaces. It is not exactly circular, but slightly oval. The pointed part of the egg has a little mark or indentation, called by naturalists *micropyle*. Under this mark or indentation one finds the head of the worm, and near which the worm gnaws an elliptical hole in the shell from which it emerges. These eggs are deposited by a nocturnal butterfly.

After the fatal disease infested the worms in Italy, several varieties of silkworm eggs were introduced into Italy. The most important variety were those received from Japan. The eggs of the Japanese annuals, white cocoon, are much smaller than the Italian variety. They present a violet color, with a

tendency towards blue. The eggs, from which the worms form a green or sulphurine colored cocoon, are olive colored; and those of the yellow cocoon, the eggs are a pale green color.

This grub or insect, which springs, like many others, from a nocturnal butterfly, does not present itself like other animals on first coming into life, so developed and formed that it already corresponds perfectly to the small parts of the animal in adult age, but in the course of thirty or forty days changes three or four times its skin; afterwards it incloses itself in a cocoon, a species of ball of oblong form. The cocoon serves to defend it from the atmospherical vicissitudes and from animals, whilst, as a worm, after having moulted or shed its skin for the last time, it transforms itself into a chrysalis or nymph. In the first few hours of the transformation it is enveloped in a skin the color of soft gold; afterwards it takes a brownish tint; then, particularly along the length of the back, it becomes hard and shelly.

It lives in this state a few days, having broken the membrane; after having transformed itself into a butterfly, or moth, it pierces through the cocoon and issues forth from its custody; it then lives without food, and only for the multiplication and propagation of its species. The female lays her eggs, then finally she dies, as well as the male, having performed the duties for which they were created. The eggs, from which issues forth the silkworm, were first

taken from China in the year 552 of the era Volgare, by two self-styled monks of the order of St. Basilio. It was rigidly prohibited to export silkworm eggs from China, and to elude the vigilance they hid them in the hollow of a cane, which apparently served as a staff. When they arrived at Constantinople they presented them to the Emperor Gustine Justinian. Afterwards they were introduced into Greece, Spain, France, and finally into Piedmont, Italy. Before the dominant disease affected the silkworms, only two special races of silkworms were reared in Italy, viz.: those of the race of yellow cocoon and those of the white cocoon; and since the disease infected the worms they have and are now rearing the Japanese race, which we will designate as the sulphur-colored cocoon.

The variety which is preferable to rear are those worms which moult four times. As regards the preference of races of the white cocoon and the sulphur-colored cocoon of Japan, the opinions vary. In France, the preference is for the first; in Italy, for the second. According to my mode and opinion, Italy has reason to give preference to the race of sulphur-colored cocoons.

The silkworm cannot be reared in every country, or in every region; but only in those countries where the mulberry tree vegetates and grows in the open air. The worms could be fed with the leaves of the *Maclura Aurantiaca* (osage orange, a tree peculiar to

America), also with the leaves of the *tragopogon pratense*; but from the branches of the first it would be very difficult to gather the leaves on account of the thorns. As regards the latter, we would have to have fields planted, exclusively cultivated, of the above variety, to satisfy the appetite of the voracious seric insect. Moreover, it has been observed that although the silkworm will feed on the same, so soon as one administers to them the mulberry leaves they will no longer eat the other. It is necessary to observe that we must in rearing silkworms proceed to follow as near as possible their mode of living in their natural state. To nourish them with whatsoever verdure would be quite contrary to their nature, because the silkworm was made to live on arborous plants, and not on herbaceous plants.

Even with us, as originally in China, the silkworm could be reared out of doors, on the mulberry trees, because they are robust and resist without suffering cold, heat, the rains, and wind; but abandoning them to the trees, they would not yield that profit which one would gain by rearing them indoors.

First—Because the worm out of doors has many enemies to combat with: birds, chickens, bats, ants, mice, and lizards.

Second—Then sudden rains or heavy winds might precipitate them to the ground, and very soon they would be devoured by the ants and other insects; therwise, if the ground were dusty, this, penetrat-

ing into the innumerable pores of their skin, would be the inevitable cause of a painful death.

Third—Then, when a greater number of worms were on a tree than there were leaves sufficient to nourish them with, some, for want of food, would die; others, having only had an insufficient quantity of food, would form a thin membranous cocoon, and only the most robust ones would succeed in making a perfect cocoon.

Therefore, rearing the silkworms in houses as we do now, and as the Chinese also do at the present time, they are secure as far as their enemies are concerned, also from the intemperate weather. Then they are not allowed to want food, as it is administered to them when necessary. They all live, all form a perfect cocoon of greater fineness and weight, and one can *conserve* better their own species.

It is very easy to rear silkworms in houses, they having that precious quality—which is not peculiar in all grubs—to only move a short distance from where they are placed.

The appearance of the silkworm after it has emerged from its shell is a tiny worm with six rows of hair in small tufts, of a dark chestnut color, namely, two on the back, two near the respiratory organs, and two scarcely above their little paws.

It is only after the silkworm has moulted the second time can one distinguish from the appearance of the worm the color of the cocoon it will

make, viz.: if the worm appears white, or inclined to black or striped, with their little paws white or yellowish, then, in the first case, the cocoon will be white or sulphur-color; in the second, a yellow one. So soon as the silkworm emerges forth from its shell its length is about three millimetres ($\frac{1}{8}$ of an inch), its diameter seventy-five parts of a millimetre ($.75 = \frac{1}{30}$ inch), its weight one hundred and seven parts of a gramme ($\frac{1}{107}$ gram.) When the worm has reached its full development after its fourth moulting, its length is seventy-one millimetres (nearly $2\frac{1}{2}$ inches), its diameter about the fifth ring is seven millimetres ($\frac{1}{8}$ inch), and its weight a little over three grammes.*

(The following illustration will show the conformation of the head: *A*, the mouth; *B*, the superior lip; *C*, the inferior lip; *DD*, the jaws formed like a saw, which move horizontally in gnawing the leaves; *EE*, the two major feelers; *FF*, simple eyes, six on each side; the head, of a reddish color; these eyes are immovable; *CC*, the minor feelers; *II*, digests the thread of silk which remains in the middle; *H*, the *filiæra* from which the worms spin the cocoon.)

* NOTE.—The above statistics of weight and measurement, which I think exact, have been taken from a compendious table by Prof. Haberlandt, which bears the title of "*Die seuchenartige Krankheit der Seidenranpen-Vienna.*"

The head of the silkworm is composed of horny, hard, and rigid parts; the conformation of its head is irregular, its two jaws are formed like a saw, which move horizontally when gnawing the leaves; the two major feelers on each side of the head are put in motion every time it has need to feel or touch the surrounding particles or objects; the worm has twelve eyes, six on each side, of hemispherical form, immovable, and of a dark red color. Ordinarily the real head of the silkworm is mistaken sometimes for the snout; also, some persons imagine that the eyes are those two black arched spots placed at equal distance in the first ring back of the real head; then others maintain that the silkworm has no eyes. The body of the silkworm is of a lengthened form, almost cylindrical, and is divided into twelve rings, with distinct grooves between each ring; the same approach and withdraw, according as the worm contracts and relaxes

itself. The first three of these rings, not very distinct one from the other, compose properly the thorax or breast.

The other nine rings, less voluminous than the other three, compose the abdominal parts; the eighth ring has a sharp pointed horn on the point. The ninth ring is different from all the others, because it terminates into three small wings, and underneath these, between four small tubercles, two on each side, is to be found the anus. Along the length of the body of the worm, and properly underneath the skin, one discerns a dark streak; this is the dorsal vessel; it corresponds to the heart, and it continually dilates and contracts alternately. This pulsation is more noticeable after the worm has reached its greatest size.

The silkworm has sixteen small paws; the first six are attached in pairs on each side of the thorax or breast, and are called real and perfect ones, because they remain in the transformation from grub to nocturnal moth. These paws are scaly, articular, acuminate, and furnished with small talons. These paws serve the worm, not alone to move itself, but also as claws or arms to hold the leaves when gnawing the same. Of the other ten paws, eight of them are attached in pairs, on the third, fourth, fifth, and sixth ring of the abdomen, and the other two are placed under the twelfth ring, or, more exactly, under the small wing-shaped projection which ter-

minates the body of the silkworm. These last two paws are less visible than the others, because they do not stand forth as the others do; but they are those on which the silkworm more often props itself, and by which it more easily fastens itself to objects.

The silkworm does not respire or breathe through its nose or mouth, as do other animals, but their respiratory organs are placed along the length of their bodies, a little above where their paws are inserted, and are to be found in the first and second rings of the thorax or breast, and second, third, fourth, fifth, sixth, and eighth rings of the abdomen. There are eighteen of these breathing apparatus, nine on each side of the body. They are surrounded by thick, short hairs, and closed by a strong and rigid skin, in which are pores. The expiration of air from their bodies takes place through these pores. The silkworm changes its skin four times; and, it not only changes its skin, but also the covering of its head and the lining of trachea; also, a portion of the intestines, and all the organs which serve them to masticate with.

When the silkworm is disposed to change its skin, or, more properly, is about to moult, little by little it loses its appetite, and then it ceases to eat; then it empties itself of all the material contained in its intestinal tubes; it moves about in search of a place where it may be comfortable and at its ease; it attaches fasteners of very fine threads of silvery silk

around itself, or around the nibblings of the leaves, so that these threads may retain the old skin when the worm liberates itself from it; then it keeps its head raised up and immovable. During the time it remains in this position, little by little, a new skin and the horny part of the head is formed. The indication that the time for changing the skin is near is, that the three rings of the thorax or breast swell up in a manner to cover part of the head, so that it appears as though the head had grown larger. The color of the worm seems to be darker, which is accounted for by the old skin detaching itself from the new skin, and it no longer being united to the body of the animal, it becomes somewhat dry.

When the head of the worm agitates lively, the skin on the head detaches itself like a mask; about the same time the six anterior paws creep forth from the old envelopment; finally, with a vermicular movement, the worm slowly creeps forth from its old skin, which it leaves behind him. This operation becomes facilitated by the moisture which remains between the two skins. This moisture is not produced by any particular gland, but from the condensation of the habitual transpiration; during the time the old skin becomes dead or less permeable at the time the worm is in a torpid state, this moisture condenses and produces a certain quantity of liquid which lubricates the parts that must glide over the other. The time occupied in changing the skin or

moulting is from twenty-four to thirty-six hours. It depends a great deal on the method of rearing the worms; also on the season being more or less favorable.

The worm in its new skin appears to be smaller than before the change. The worm moves very slowly, as though still weak from the fatigue of moulting or shedding its skin.

The silkworm is furnished with four senses, viz.: the touch, sight, smell, taste. The sense of touch—The silkworm gives signs of having that sense from the sensibility of its cuticle or skin, excepting in the first age, or stage, when it is less sensible on account of the thick long hairs with which it is covered. It also gives signs of suffering when wind or air is blown on it.

The sight is shown by the position and simplicity of the eyes, which serve only to see a short distance; notwithstanding this, their eyes are as perfect as can be found in such insects.

Smell—The silkworm gives signs of having this sense by moving its head towards the fresh leaves when administered to it; also, by passing over leaves that are not that of the mulberry.

The taste sense, very pronounced, which serves them to select the food administered to them, as they refuse to eat that which is hurtful or not agreeable to them.

The sense of hearing—Of this sense I should say

they were almost deprived, as they seem to remain immovable when great noise is made about or near them. But as the senses of touch and smell are so exquisite in them, these supply the want of the sense of hearing. As the silkworm is an insect of cold blood, its temperature is about the same as the temperature in which it lives. It is the contrary with the warm-blooded animals, who maintain their ordinary temperature independently from that of the atmosphere.

The silkworm has blood, this being a fluid indispensable to the life of animals. Its color is more or less yellowish, varying from straw to orange color.

GENERAL INSTRUCTIONS
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TREATISE ON SECURING HEALTHY SILKWORM EGGS.
ALSO, A
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By
MRS. LOUISE RIENZI.

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