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SERICON:

OR,

A BRIEF TREATISE

ON THE

ART OF REARING SILK-WORMS,

AND

CONDUCTING FILATURES.

It is not easy to foresee to what sum the value of exportable Silk may rise, if the art of cultivating it becomes National—the objects of the care and attention of intelligent, scientific, and patriotic individuals. * * * * *

The object is, to produce Silk in quantities either raw, spun, or manufactured, to supply the Globe with it. * * * * *

Fortunate shall I be, if I may, by inspiring the wish of rearing Silk-worms skilfully, contribute to meliorate the condition of the industrious.

DANDOLO.

BY JOHN CLARKE,

AUTHOR OF "A TREATISE ON THE MULBERRY TREE AND SILK-WORM,
AND ON THE PRODUCTION AND MANUFACTURE OF SILK."

PHILADELPHIA:
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CONTENTS.

INTRODUCTION	Page v
THE MULBERRY-TREE	13
Species, Varieties, &c.	14
Statistics for Planters	16
White Mulberry-Tree	17
Multicaulis	18
SILK-WORMS	19
1. Of four Moultings	ib.
2. Common-sized	ib.
3. Small Silk-Worms, of three Moultings	20
4. White Silk-Worm	ib.
5. Drab Do.	ib.
6. Silk-Worm of eight Crops	ib.
7. Mammoth White	ib.
8. Pea-nut Silk-Worm	ib.
9. Sina Mirabel, &c.	21
10. Hardy Sulphur-Worm	ib.
COCOONERY	ib.
Space on Shelves	23
Tabular Statistics	25
Burlington Silk-Worm Frame	26
Enemies of the Silk-Worm	31
Eggs of the Silk-Worm	ib.
Retarding the Hatching, and the keeping of Silk-Worms ...	ib.
Method recommended by Mr. Morris	ib.
Method recommended by the Author	34
Selecting Cocoons for Eggs	35
Hatching	ib.
Weight of Silk-Worms' Eggs	38
Temperature of the Cocoonery	39
Air of the Cocoonery	40
Quantity of Leaves in each Age	41
Statistics of the Natural System	44
Branch Feeding	46
Wet Leaves	ib.
Cut Leaves	47
Number of Leaves per diem	ib.
The Moulting	ib.
Appearances in each Age after each Moulting	48
Removal of the Worms after Moulting	ib.
Cleaning of Hurdles, Shelves, or Feeding-Frames	49
French system of Beauvais and Darcet	50
DIARY OF THE FEEDING-SEASON	52
FIRST AGE:	
First Day	ib.
Second Day	ib.

Third Day	Page 52
Fourth Day	ib.
Fifth Day	53
SECOND AGE:	
First Day	ib.
Second Day	ib.
Third Day	ib.
Fourth Day	ib.
THIRD AGE:	
First Day	ib.
Second Day	ib.
Third Day	ib.
Fourth Day	ib.
Fifth Day	54
Sixth Day	ib.
FOURTH AGE:	
First Day	ib.
Second Day	ib.
Third Day	ib.
Fourth Day	ib.
Fifth Day	ib.
Sixth Day	ib.
Seventh Day	ib.
FIFTH AGE:	
First Day	55
Second Day	ib.
Third Day	ib.
Fourth Day	ib.
Fifth Day	ib.
Sixth Day	ib.
Seventh Day	ib.
Eighth Day	ib.
Ninth Day	ib.
Tenth Day	ib.
Statistics	56
Spinning, Cocoons, and Chrysalis	58
Moths and Eggs	60
CURING of COCOONS	61
New Method introduced by the Author	62
DISEASES OF THE SILK-WORM	63
MISCELLANEOUS STATISTICS	64
Progressive increase	65
Progressive decrease	ib.
Cocoons obtained from an ounce	66
Pounds of Cocoons to the ton of Leaves	ib.
Artificial and natural Systems contrasted	67
Statistical Proportions	69
Statistics relative to Labour and Profit per Acre	70
REELING	73
Hamilton's improved Piedmontese Reel	81

INTRODUCTION.

SILK, in its raw or manufactured state, constitutes one of the most valuable and important articles of commerce. From the variety of textures into which it is wrought for the comfort and convenience of man, it has ceased to be an object of mere luxury ; necessity and usefulness claiming for it a general favour among all orders of the community. Like other productions of nature, however, it is cultivated by a process depending on fixed rules that are moved and directed by common sense. A little care and attention, experience and practice, are all that are required to carry the culture to a successful result. The process is simple, but it has its peculiarities, all which are as easily learned as any in the whole catalogue of human pursuits.

Every new enterprise, of whatever kind or wherever undertaken, has its initial difficulties, and that which in the result is attended with most profit, has, at commencement, usually the greatest number. The history of new undertakings would form one of the most interesting and instructive works that was ever presented to man ; and now, when enterprise and perseverance are not, perhaps, the preponderating virtues among our species ; when enthusiasm is often observed to be suddenly quenched in disappointment, and the cry of humbug is raised to screen the stupid miscalculations of one class, or the want of intellectual perceptions in another, any attempt to inspire courage and confidence, where such can be made available to the public interests, must naturally contribute to the sum of human happiness.

The facts and evidences in proof of the capabilities of our soils and climates, for producing raw silk in any desirable quantity, and of the very best quality, are ample. They show that silk, in every variety of its manipulations, from the silk-worm's egg to the purest fabric, can (as it now is) be carried forward as well in this country as in any other part of the world. No country is capable, to such an extent as ours, of producing such an abundance of this splendid and rich staple. Without an apparent effort, by the aid of suitable bounties from the several states, or from the national government, the culture will gradually extend itself, until it shall be a general favourite and unlimited in its production. There is no staple known to us, produced in this Union, which is not restricted by limits. Cotton has arrived at the maximum of demand. The proceeds of this staple are equal to about

\$75,000,000 ; but as its cultivation is extended beyond this point, the value declines, and the probability is strong, that it is now at the average price it may be expected hereafter to sustain. Not so, however, with silk. It is encouraged by all governments; its operators are protected, and its manipulations are patronized, until it has become the wealth and sustenance of many nations.

In England, the importation of raw silk from the year 1821 to 1828 was 24,157,568 lbs., which, when manufactured, was worth £120,770,580, sterling; and the hands required for its manufacture, were more than 400,000. This sum is equal to \$536,222,237! or \$76,190,462 each year. Of this amount, Italy alone furnished \$59,881,233. In 1835, Great Britain consumed, at wholesale prices, to the value of \$28,282,582 of manufactured silks. The sum paid to weavers alone, not taking into the account what was paid for throwing, winders, doublers, drawers, warpers, the soap, the dye-stuffs, and to various mechanics, was little short of \$14,000,000! the amount of silk goods, now produced in that kingdom, is stated to be *seventy-five millions of dollars!* But they raise not a pound of the *raw material*.

France manufactures \$28,000,000 of silk, and imports of the raw material from eight to ten millions of dollars worth. She could manufacture annually \$50,000,000 worth, could she procure it. England and France, in common with all civilized nations, are competitors for this precious material, wherever found; but especially Germany, Prussia, and Russia, would enter the field, making annual demands upon us, could we supply them, for from 50 to 100,000,000 lbs.! The city of Lyons manufactures annually to the amount of \$6,000,000.

The annual average importations of silk into the United States, during the last five years, was about \$14,000,000. The last year it amounted to \$23,000,000. In the year 1826 it was above \$25,000,000. Until within two or three years the manufacture of silk goods, of any description, was exceedingly limited. But several establishments are in progress of operation for the manufacture chiefly of sewing silks and other products; yet the supply for the nation is as a drop to the quantity consumed. The British operatives, manufacturers, and merchants, make an annual clear gain of more than \$70,000,000, most of which, in the raw state, was drawn from Italy and India. The American raw silk, when properly reeled, is superior to any silk known to us in the world. But the quantity produced is not at all in proportion to the demand for sewings, fringes, galloons, and other such manufactures. The fabrication of broad goods in this country has no encouragement. Hundreds of weavers are now ready to commence as soon as sufficient protection is afforded. But knowing that ruin would be the consequence of a premature undertaking, they are

now struggling in indigence at occupations to which they have been unused, in the expectation that this protection will be granted. Hope deferred as yet has been their destiny — we sincerely trust that this unenviable condition of things will speedily have an end.

The climates and soils of the United States are exactly adapted to the production of the silk staple. If the people of our country would take a calm survey of their advantages, this staple before long would be extended so as to retain the specie circulation in our own country, subsidize the nations of Europe, drain them of their treasures, and having done so, retain them in our own hands. Since the year 1835, the excess of our imports of silk over our exports, has been more than \$100,000,000, thus calling for an egress of specie to that amount to satisfy the balance of trade. At this time, when colonial produce has almost closed the European market against us, we need new staples with which the colonial cannot compete. There is none that can effect this most desirable object but silk; and if our agriculturists, together with our legislative authorities, were true to their own interests, the quantity of raw silk raised in our country would effect a revolution in the destinies of these United States, that would indeed be marvellous in our eyes.

It is not to be denied that there exists a strong feeling among the agriculturists, in favour of the silk culture. Many have, during the past year, made abortive attempts to produce silk. But the causes of these difficulties and disappointments are obvious to every intelligent man; they are such as need not again occur; and, in a great and important undertaking, the man who abandons an enterprise because he has not at once realized his anticipations, is radically deficient in those qualities of the mind which are essential to the achievement of great objects. It is he who, having been defeated, will *try again*, that can scale the mount on the top of which is the palace of fortune, and surround himself with honour and fame. The object of this book is to enable those who *try again* to insure success, and make that success permanent.

In the last ten years, including the present, there has been, of raw and wrought silks imported into the United States from foreign markets, as before stated, to the value of about \$200,000,000. All this was a drain upon our country. But how stands the agricultural condition of *other* countries? In 1834, in Venetian Lombardy, there was \$16,002,606 worth of silk reeled by 80,000 persons. Each person, therefore, reeled on the average \$200 worth of silk, at a profit to each of \$40. All this was gained in five or six weeks only, the balance of the year being occupied in other avocations. This was equivalent to \$3,200,000 in circulation, during a few weeks, amongst 80,000

persons. Now, it is clear that the people who produced this silk drew into their country so much specie, while the nation to whom it went lost it. England raises not a pound; but by her provident government and industrious population, this is made up; the profits on her manipulations, as before said, being about \$70,000,000 annually.

In the prosecution of this enterprise, let it not be said that knowledge is wanting. The amount of what is required is no more than is necessary for any crop that is cultivated, or any business pursued in our country. It more legitimately belongs to those who have the weakest minds, and feeblest energies. It is suited to the young, and the old, and the infirm, as well as to the man of learning and of intellect. The Negroes of the South, and the Indians of the West, may be successful cultivators of this staple. It may be pursued to an almost unlimited extent, without interfering with other agricultural pursuits; the hands about a plantation or farm, not suited to any other kind of domestic labour, being the most suitable for collecting foliage and feeding worms. That there is ready and ample employment for the healthy and vigorous males of our population, is a blessing that is acknowledged to exist; but it cannot be admitted that this universally applies to females, to children, or to the aged and infirm, not qualified to endure the athletic exercises of early life. Never was there any merely secular object inviting our attention and industry, more replete with the certainty of general benevolence to mankind, than the one we now advocate. The aims of its beneficence extend to the young, the aged, the infirm, the decrepit—the pauper and the wealthy. Its successful employment excludes none, except those who are determined to exclude themselves. Nor can it be overdone. Before we can produce \$50,000,000 worth, that amount will be required for domestic purposes, to the exclusion of foreign manufactures to an equal extent; but that amount of the raw material the nations of Europe would now receive from us, could we produce it. Our advantages are therefore immensely beyond the common estimate. In a century to come, we shall not overtake the home demand, nor is there any staple produced in our extended country, more likely than this to occupy our artisans and manufacturers, to the full extent of the nation's yield, the consumption of the article, in every variety of its textures, being likely to create the best of all markets for the manufactured goods—the market at home.

The silk staple will more than any other culture raise the price of lands, and with it the moral character of its proprietors. It will feed the hungry, employ the idle, comfort the widow and the fatherless, educate the youth, and give activity and cheerfulness to the aged. It will raise the dignity of our nation by throwing wealth into the hands

of the people, revenue into the treasury, specie into the general circulation, and turn the exchange between the new world and the old in our favour, and keep it so.

The fruits of unproductive labour are poverty and wretchedness; and these are often the remote, if not the immediate cause of political disquietude and crime. The importance, therefore, of the culture and manufacture of silk, both in a national, moral, and pecuniary point of view, is incalculable.

The most barren sands of the South, now given up to racoons, turkey-buzzards, and squirrels—lands from which tar only can be obtained, or those that will no longer produce rice, cotton, or tobacco, may be made to yield the richest crops of silk, and in the greatest abundance. The poorest of the sandy belt that lines the Atlantic shores towards the South, might, through this staple, be made equal in wealth and population to any other section, however favoured in soil, in any part of the Union.

Strong and powerful efforts are made by foreigners to dissuade us from touching the Cocoon after its elaboration by the worm: their aim being to retain the subsequent processes in their own hands, that it may contribute to the wealth of their own people; and they have done much to establish this belief. They tell us plainly, that we are incapable of performing this operation. One part of our labour in this work is to disabuse the public mind, and aid to sweep away a delusion that has presented so formidable a barrier to our success. With a sufficient stock of intelligence, the enterprise and perseverance of our fellow-citizens will enable them not only to prepare the raw material in the very best manner, but also manufacture it into such articles as the pressing wants of our own citizens require.

It is not our design, in this little manual, to enter into any part of the details respecting the manufactures of silk, except what relates to the raw material, as the author might very easily do, being personally acquainted with the practical operations of most of the several textures that form the chief articles of commerce, and is now directing the manufacture of sewing silk to some extent. These will unfold themselves, as the raw material becomes abundant, and the enterprising may happen to see their advantages. The chief part of the raw material produced in this country will, for some time to come, be worked up into *sewings*, the demand for this being such as to consume all that can be made, till other articles are so protected as to be made profitable. It is well that the operators limit themselves in the variety of manufactures, as the most favoured do not pay a profit to hold out encouragement at the present high price of American raw silk. But it is necessary that the price should present an inducement to the cultu-

rist to proceed, as in such case his arrangements will enable him in a short time to make large profits, and afford the raw material at a more reasonable price.

We have elsewhere said, that our chief object in this work is to contribute our aid to the establishment of a silk staple in these United States. In full view of the immense advantages of such a staple, silence, with a remote hope of stimulating the enterprising to engage in the great work, would be criminal. But it would seem that our labours in the common cause have not been acceptable to all. One writer, and, as far as we know, *one only*, has undertaken, with a bold sweep, to denounce our work as one of "pretension," and as being "pedantic," "empty," and "ambitious." This mode of criticism, it is very clear, is not according to the most approved rules. It is a species of literary empiricism that requires the smallest portion of intellectual abilities, and a still smaller quantum of gentlemanly courtesy. Any scribbler, in this way, can gratify his spleen, when the sullen humour is on him, by a turgid and sweeping condemnation, without descending to particulars. The editor of the Farmer's Register has, as he could very easily do, poured on us his censure without criticism or argument, because we inadvertently used the words "feet square," instead of "square feet;" and for having done what no one could any better do with the information in our possession, namely, show what was the value of a Milanese pound, ounce, and foot, according to the meaning of Count Dandolo, we having only the French, English, and American *translations* of that work, and these all concurring in one statement. Our mistake about "feet square," occurred in consequence of seeing the same blunder in the translations spoken of. To say that we knew better, may not satisfy Mr. Ruffin. But withal, without much "pretension," we could get credit here for as much mathematics as would pass us off even in old Virginia, without exhausting our stock. If the editor of the Register will have the goodness to look over this little work, he may find it not "the most empty of all!" From his own showing, we have reason to infer, that it was our attempt to reach a point, without data, that he could only arrive at through a knowledge of the language, that directed him to the facts and conclusions of which he so much boasts! We also infer, that his severe attack on our work was intended to shut it out of circulation, that our previous calculations might not detract from the full amount of what *he desired to claim as only his*. Any judicious and candid reader will admit this conclusion. We had done what no one had attempted; and had we access to Dandolo's work, we would have had it investigated for ourselves. More than this Mr. Ruffin could not have done; and he admits that he was himself led into some common mistakes by following Morin.

Having on a former occasion written a book that Mr. Ruffin has pronounced to have claims to "pretension," we beg leave to produce *another* of a more humble and less "ambitious" kind; and as he has declared war against all learning, we will, for his special accommodation, confine ourself to *matter of fact*. With much that has come from others, we have added somewhat of our own, and with some *experience* and *practical knowledge*, we *pretend* to speak. At the risk of a second charge of being "ambitious," "empty," "pedantic," and "pretending," we may venture to assert, that in the silk culture and its various subsequent manipulations; in most of the departments of its manufacture, and certainly in all that relate to the public wants, or in the ability to communicate to the public a knowledge of those wants, (instructed by the egotism of our critic,) we speak *knowingly*, while we are fully assured that *not a few who know nothing at all of the whole business*, strut with great self-importance, and distil their crude imaginings through the press for our amusement.

Our readers will now be able to infer, from what we have said, that although we have made a mistake in our LARGER WORK, in common with all others who have written on the subject, we are able, with sufficient data within our reach, to finish up our own work, *independently* of others, and without being "copyists." Our reviewer has probably fallen into a blunder—a very common one now-a-days, for writers equally astute and *recherche*—when he charged us with "*pretension*," in consequence of our not having made a *boast* of being able to do anything *practically*. No word of this kind, in a *puffing* way, fell from our pen. And yet the men whom Mr. Ruffin praises most, are mere visionary theorists, who, as we learn, can do nothing practically *but talk*. Forced, therefore, into the usual method of claiming attention, we beg leave to say that in nearly every branch of the silk manufacture, we ask no favours. Let us be so protected that we shall not lose by our efforts to serve the public, and we will undertake to do the work without "pretension," which others, with all their *boasting*, are unable to perform.

To remove a difficulty that might arise in the minds of some with regard to any supposed affectation in the adoption of our title, "SERICON," or, *the Silk Culture*, we beg leave to say, that after having examined the titles of all the works on the subject to which we could gain access, we were left without any other alternative except either selecting the one we now have, or incurring the charge of plagiarism by copying the titles of others.

April 1, 1841.

SERICON:

OR

A · BRIEF TREATISE, &c.

CHAPTER I.

THE MULBERRY TREE.

I. MORUS, the Mulberry Tree, is the name of a *genus*, including several species of all trees or vegetables, the most adapted to the production of silk, and, consequently, for the feeding of the silk-worm.

NOTE 1. The leaves of the Mulberry Tree appear to be providentially appointed for the peculiar use of this profitable creature; and no substitute whatever has been equally successful. Would we rear, therefore, silk-worms, our first step is, to see to it, that we are previously provided with a sufficient quantity of the leaves of the Mulberry Tree.

2. The Mulberry Tree, in some species or variety of it, is found in almost every nation and country known. There are few distinct *species* of this *genus*; but the varieties which are produced by art, are numerous.

II. The SPECIES of the Mulberry Tree, are, 1st. MORUS ALBA, or *White Mulberry*; 2d. NIGRA, or *Black Mulberry*; 3d. RUBRA, red, or *North American Mulberry*; 4th. TARTARICA, *Tartarian Mulberry*; 5th. INDICA, *Indian Mulberry*; 6th. TINCTORIA, *Fuustic Wood*; 7th. PAPYRIFERA, or *Paper-bearing Mulberry*.

NOTE 1. The *Rubra* is indigenous of our American forests. The *Alba*, *White* or *Italian*, it is said was originally brought from China, and the other species are found in different countries of Europe and Asia. The varieties and Hybrids are often very splendid in their growth and foliage,—the leaves of many of them attaining the size of 12 inches by 14 inches, and of considerable weight.

2. The Mulberry Trees selected as the best for feeding worms, should possess an excess of *saccharine* and *resinous*, and less of the fibrous, colouring and watery substances. It has been recently discovered, that the reason why the Mulberry Tree is so congenial to the nourishment of the silk-worm, is because of the quantity of *nitrogen* contained in its foliage; no other tree possessing so much of it, which is so essential to the elaboration of silk. It is said that any tree, in which is found an excess of nitrogen, will be received by, and constitute the legitimate food of silk-worms. This discovery may lead to important results in the management of this most valuable insect.

3. The White Mulberry is best known as affording food for the silk-worm. Perhaps there is no tree of the *Morus* tribe that affords better; but amongst the Hybrids* lately introduced, besides the *Multicaulis*, which has been tried, and found equal to our expectations, there is one, the characteristics of which, on trial, promise to excel all others. There are several names for this tree; but it seems that it was discovered about the same time by a number of gentlemen, in different sections of our country, each arbitrarily giving it his own name;—it was found among the seedlings of a Mulberry Tree received from China. This tree is reported to be one of the hardiest in the forest. Its leaf is plain, somewhat larger than that of the *Multicaulis*—nearly twice its weight, and containing more of the desirable properties of the leaf for the silk culture. It is not liable to *wilt* or *dry* so soon as other leaves; and the silk-worms, it is said, uniformly prefer it, prove healthy, elaborate from it the most rich and perfect cocoons; and its growth is more rapid than that of any tree of the *Morus* tribe yet discovered.

4. As an addition to our resources, however, we would earnestly recommend that the *white* Mulberry be cultivated. Wherever it is found, let the silk-worms be fed with its foliage, from the last moulting till they rise to spin; except where the *Multicaulis* is grown on high sandy soil. But unless the quantity of foliage is sufficient for the whole *age*, it should be so reserved for the last feedings, as to have no occasion, during that season, to return to the *Multicaulis*.

5. It is not our intention to say, that the White Mulberry should supersede the *Multicaulis*; nor the variety above mentioned, which is said to excel all others, but that until the culturist is careful to select the right kind of soil, and the *Multicaulis* has *age*, the White Mulberry Tree is to be preferred for the feeding, wherever it can be had in sufficient abundance.

6. Directions for cultivating the Mulberry Tree are no longer necessary. It is enough that we recommend that the requisite quantity of the foliage be previously provided. Without it, silk cannot be made; with it, no one need long be poor. Every farmer should cultivate a lot of Mulberry trees, and a few ounces of the silk-worm's eggs. When this is done, our country will be speedily relieved from her financial embarrassments, and wealth, with its concomitants, peace and contentment, will spread its beneficial influence around us.

7. The CLIMATES suitable for the Mulberry Tree, are now extensively known, as well as the mode of cultivation. Almost anywhere, from latitude 42° north, to 40° south, including, of course, the Torrid Zone, would answer for the making of silk, and favour the growth of the tree; but particular locations within this range are to be preferred.

8. The soil should be a *high, dry, warm, and sandy* loam. A *cold, damp, or heavy aluminous* soil will not answer. The Mulberry Tree will thrive better than any other on poor sandy soil, fit for no

* A variety is a variation of the same species, occasioned by engrafting inoculation, budding, or by other processes of art, or accident, but such as not to destroy its power of reproduction; but in a Hybrid, this power no longer exists, and it either yields no seed at all, or what seldom reproduces any original whether that be variety or species.

other species of cultivation. The pine barrens of North and South Carolina; the pine wastes of Louisiana and Mississippi; and the hills and barrens of Kentucky, Tennessee, and Virginia, would be mines of wealth in the hands of the silk culturists. Lands in the above states, not estimated to be worth ten cents per acre, would produce immense crops of silk. Aluminous sub-soils are not favourable.

The following cut represents the *Morus Alba*, *Morus Nigra*, and *Morus Rubra*.

The following cut represents the *Morus Multicaulis*.

III. An acre contains 4840 square yards, or 43,560 square feet.

NOTE 1. — *The following table shows the number of trees or plants on an acre, according to the distances between the rows, and between tree and tree in each row.*

Feet apart from row to row.	Feet distant from tree to tree in each row.									
	1	2	3	4	6	9	12	15	18	20
	Number of trees in an acre.									
1	43560	21780	14520	10890	7260	4840	3630	2904	2420	2178
2	21780	10890	7260	5445	3630	2420	1815	1452	1210	1089
3	14520	7260	4840	3630	2420	1613	1210	968	806	726
4	10890	5445	3630	2722	1815	1210	907	726	605	544
6	7260	3630	2420	1815	1210	806	605	484	403	363
9	4840	2420	1613	1210	806	537	403	322	268	242
12	3630	1815	1210	907	605	403	302	242	201	181
15	2904	1452	968	726	484	322	242	193	161	145
18	2480	1210	806	605	403	268	201	161	134	121
20	2178	1089	726	544	363	242	181	145	121	108

2. — The quantity of leaves that may be gathered from every tree, will vary according to different soils, modes of culture, and age. M. Tinelle, writing on the *White Mulberry*, says, "It will yield in its third year 2 lbs. of leaves each, and this quantity will be *doubled annually*, till the eighth year, provided it is cultivated as required. This leads to the following consequence: *a tree, three years old, will produce 2lbs. of leaves; four years, 4 lbs.; five years, 8 lbs.; six years, 16 lbs.; seven years 32 lbs.; and eight years, 64 lbs.* This greatly exceeds all the accounts we have yet seen on the subject. The *Silk grower* says, "Each Italian Mulberry Tree, six years of age, will produce 6 lbs. of leaves." M. D'Homergue says, that eight years from the seed it will give 30 lbs. Roberts says, that at that age it will yield 20 lbs., and at ten years old, 30 lbs. Much of this discrepancy arises from the neglect of stating whether the age of the tree is *reckoned from the seed*, or *from the time when the seedling, four years after, was transplanted into the plantation of standards*. We shall, however, always reckon the age of the White Mulberry Tree from the seed.

3. — Whatever special and extraordinary cases may be, we quote the following as *averages* not materially varying from the general truth.

A WHITE MULBERRY TREE

5	years	from the seed,	will yield	6 lbs	of leaves.
6	do	 do	 do	8 do	 do.
7	do	 do	 do	12 do	 do.
8	do	 do	 do	18 do	 do.
9	do	 do	 do	24 do	 do.
10	do	 do	 do	30 do	 do.
20	do	 do	 do	150 do	 do.
24	do	 do	 do	200 do	 do.

4. The usual way on the continent of Europe, of transplanting the seedlings of the White Mulberry, is as *standards*; that is, in a plantation where they are not again to be removed, but to form a *standard* and lucrative property, even should they attain the age of 100 years, or more, is 20 feet by 20, every way. This transplanting commonly takes place at the fourth year of the seedling, or four years from the seed. Hence arise two ways of reckoning the age of such trees. For example: a White Mulberry of six years old, is either six years *from the seed*, or two years *from the time of its being transplanted as a standard*; but writers, quoting the yield of a tree, or its age, frequently omit this distinction. We shall uniformly take it in the former sense.

5. One acre of white mulberry standards, twenty feet every way, will contain 1089 trees; and therefore ten acres will have space, at this rate, for 1089 such trees; which, at the under-mentioned ages, *from the seed in foliage, silk, and money*, will yield as follows; 200 lbs.* gross weight of leaves being equal to 1 lb. of reeled silk; and the value being taken at \$5.00 per pound.

Table for 100 acres of White-Mulberry Standards.

Year from the Seed.	White Mulberry Trees.	Wt. of leaves in pounds avoirdupois.	Reeled silk in Pounds do.	In Money, Dollars.
6	1089 × 8	8712	43.56	217.80
7	1089 × 12	13068	65.34	326.70
8	1089 × 18	19602	98.01	490.05
9	1089 × 24	26136	130.68	653.40
10	1089 × 30	32670	163.35	816.75
20	1089 × 150	163350	816.75	4083.75
24	1089 × 200	217800	1089.00	5445.00

Of these results, for one acre take one tenth.

* The common reckoning of 100 lbs. of leaves to 1 lb. of reeled silk, has been deduced from Count Dandolo's allowance of 1362 lbs., *nett weight*, or of *picked*,

6. The Multicaulis, it is computed by most writers, will yield, the first year, about $\frac{3}{4}$ lbs; the 2d year, $2\frac{1}{4}$ lbs; and on the 3d year, $6\frac{3}{4}$ lbs. Other accounts state the average quantity of foliage from the multicaulis of the

		lbs.	oz.
1st year to be		0	14
2d	do.	2	10
3d	do.	7	14

7. Hence, 10890 Multicaulis trees on one acre : i. e., four feet between the rows, and one foot from tree to tree in the same row, and of the under-mentioned ages, will yield in *foliage, silk, and money*, as follows :* 200 lbs. gross weight of leaves being equal to 1 lb. of reeled silk, and the value being taken at \$5.00 per pound.

Table for one acre of Multicaulis Trees.

Years.	Multicaulis Trees. lbs. oz.	Gross weight of Leaves.	Reeled silk in pounds.	In Money, at \$5 per lb.
1	10890 $\times$ 0 14	9528 lbs.	47.64	238.20
2	10890 $\times$ 2 10	28586 lbs.	142.93	714.65
3	10890 $\times$ 7 14	85758 lbs.	428.79	2143.95

In the above estimates we take the average produce, quoted by the most accurate observers and authentic records. If their ratios, therefore, be correct, more silk can be obtained from *one acre*, planted with Multicaulis trees, of the first year's growth, than *from ten with White Mulberry trees!* as standards, 20 feet by 20, of six years old from the seed. Yet for reasons already stated, whenever it can be done, we should not be without a collateral resource, which is always of permanent value, of the leaves of the White-Mulberry tree.

sorted leaves; by dividing by 10, for the pounds of cocoons to the ounce, or by 100, for the pounds of reeled silk, nearly. But all this is founded on the same general error, that has been copied by all who have depended on the *four* translations, without knowing that the *Milanese* pound as much exceeds the *English* pound avoirdupois, as 11768.425 English grains exceed 7000 grains of the same kind. Dandolo allowed 1504 lbs., *gross* weight of leaves to the worms of one ounce, which 1504 Milanese pounds are equal to 2528 English avoirdupois pounds; and we have now the testimonies of several culturists, both on this and the European continent, that have even exceeded this *gross* weight of leaves, in the feeding of the worms of an ounce. We speak now of the *natural* system, the *artificial* requires less. Now, as 125 lbs. of cocoons are frequently, with good management, obtained from one ounce of eggs, and 10 lbs. of these are allowed to yield 1 lb. of reeled silk, we have from one ounce $12\frac{1}{2}$, or 12.5 lbs. of silk, for which 2500 lbs. of gross leaves have been expended. Therefore $\frac{2500}{12.5} = 200$ lbs. of gross leaf to the pound of reeled silk.

* 80 or 90 lbs. of Multicaulis leaf are sometimes said to be equal, in nutritive effect, to 100 lbs. of the White Mulberry. We deny not this, provided that the Multicaulis be planted on a proper soil, as already specified. That is, it is conditionally so; therefore, we take no advantage of the difference, but throw the whole of it on the side of contingency.

CHAPTER II.

ON THE SILK-WORM: COCOONERY: EGGS: PRESERVING: HATCHING.

IV. THE Silk-Worm, or *Bombyx Mori*, is a species of that order of Caterpillars* which in arriving at its final state, passes through several transformations.†

V. The varieties of Silk-Worms mentioned by Dandolo are, 1st. *The large Worm of four moultings*; 2d. *The common-sized Worm of four moultings*; 3d. *The small Worm of three moultings*; 4th. *The Worms that produce white silk*. Other writers add: 5th. *The dark drab-coloured Worm*; 6th. *Worms of eight crops*; 7th. *The mammoth white Silk-Worm*; 8th. *The Pea-nut*; 9th. *The Mirabel*; and 10th. *The hardy Sulphur Worm*.

NOTE 1. *The large Worm of four moultings*. One hundred of their cocoons weighed one pound; and 12½ Milanese pounds of leaves yielded one pound of cocoons. But the coarseness of the silk, and other objections specified, counterbalanced any advantages in their favour.

2. *The common-sized Worm of four moultings*, includes two sub-varieties. 1st. Those that form a straw-coloured cocoon; and 2d. those that produce the deep yellow. Dandolo gives preference to the former; and informs us that it requires 13½ lbs.‡ of leaves to 1 lb. of cocoons.

* All such caterpillars are of the *Lepidoptera* order of insects; and of these, all that have four wings when they are in the moth state, are capable of producing silk.

† When they issue from the egg, Naturalists term them *LARVÆ*, which, in common language, is according to the species, called *caterpillars*, *grubs*, or *mag-gots*. Some have feet, others none. They have no wings, nor are they, in that state, capable of reproduction. Until their last form, they cast their skin three or four times, when they cease to eat, and are usually motionless. When an insect after this change does not lose its legs, but continues to eat and move, it is termed a *NYMPH*, but when the inner skin of the larva is converted into a membranous covering, enclosing it as in a case, it is called *PUPA*, by the Greeks *CHRYSA LIS*, and by the Romans *AURELIA*. Hence *Pupa*, *Chrysalis* and *Aurelia*, are synonymous. After the residence of the insect for a certain time in the *Pupa* case, or cocoon, it prepares for its last change, and becomes what Linnaeus termed the *IMAGO*; since it then assumes the perfect *Image* of its species. The chief object of this state, is the reproduction of its kind; and when the *Ova* are deposited, the greater number speedily die. Hence the four states of the insect are 1st. the *OVUM*; 2d. the *LARVA*; 3d. the *CHRYSA LIS*; and 4th. the *IMAGO*, moth or butterfly.

‡ It is singular that the Count, in all that department of his work which refers to cocoons, chooses for his unit of measure *one and a half* instead of *one*. As for example, instead of informing us that 240 cocoons weigh *one pound*, he says that 360 weigh *one pound and a half*. This being so different from all usual procedure in such cases, doubtless gave rise to the conjecture, that the French translator in his attempt to reduce a *Milanese* pound into its *French* equivalent, rudely calculated at the ratio of *one and a half* of the latter to *one* of the former; and that the *English* translator *faithfully* copied him. If this were the case, it is a ratio that has only been adopted in reference to cocoons. We shall hereafter have the opportunity to explain the *Milanese* gram, ounce, pound and foot measure.

3. *The small Silk-Worm of three moultings.* The worms and cocoons of this variety are two-fifths smaller than those of the common sort. He adds, that these cocoons yield finer and more beautiful silk, but that it requires 400 of them to weigh 1 lb., whilst 240 of the common, weigh the same.

4. *The Worms that produce white silk.* Dandolo esteems these in all respects equal to those of four moultings. This variety, however, is supposed to be the same as that named by us the *white worm*; as it produces two crops in a season.

5. *The dark drab-coloured Worm.* This variety is common in this country. It is commonly called the *black worm*. They live longer, and make a greater quantity of silk, than the larger white worms.

6. *Silk-Worms of eight crops.* Of these there are but two sub-varieties; the *Dacey* and the *Madrasa*, each producing eight crops annually.*

7. *The mammoth White Worm*, furnishes cocoons of a large size and very fine texture.

8. *The Pea-nut Silk-Worm.* The name Pea-nut is an *Americanism*, alluding to the form of the *guber-pea*. This variety in France, is called *Sina ordinaires*, or common *Sina*.† The original common *Sina* was *nankeen*; but a sub-variety was immediately produced, which is *white*, and subsequently a cross-variety between the *nankeen* and *white*. This last will be produced whenever the *nankeen* and *white* are kept together. The Pea-nut is said to be more valuable in all respects, than any other variety except the "*Sina-Mirabel*," and "*Mirabel Jaune*."‡ The peculiar qualities of the Pea-nut are extreme hardness and healthfulness; and of the cocoon, compactness; bears well transporting; one barrel holding one fourth more in weight. The cocoons are moderately depressed in the middle, reel very easily, pro-

* The distinction between *one, two, three*, crop eggs, &c., is not generally understood. The eggs of the *one crop* can be hatched successfully only from eggs of the *previous year*, kept over winter to the following spring. But the *two crop eggs* may be hatched first, from the eggs of the *previous year*; and next from the eggs of the first hatch the same season. The three crop eggs will hatch successively from the same year's eggs, in so many repeated times. The eggs of the *one crop* will not produce worms from the time the eggs are deposited till the following season.

But on the subject of the two crop worms, we are thus informed by the Journal of the American Silk Society. "So far as we can learn, the two-crop worms do not meet with much favour. *They are not manageable.* They hatch so soon after they are laid by the moths, that no preparation can be made for the young worms. In many instances, the eggs first deposited began to hatch before the last moths had finished laying. They cannot be brought under proper discipline. They hatch when they please, moult at pleasure, and spin when they are ready, and thus bring the whole cocoonery into confusion. Worst of all, if you begin with them in the spring, you must keep on, whether you wish to feed successive crops or not; for as soon as the first crop lays its eggs, they hatch in spite of you, and in a very irregular manner too, and you must feed them, whether you will or not, or lose your eggs. You cannot regulate your times of hatching with them, as with the other kinds, even if you design feeding all summer. *It has always been our opinion, that for the regular substantial business of silk-making, the large one crop kind are the only worms that can be relied upon.*" Vol. I. p. 343.

† "*Sina*," the Latin for China: it should have been *Sinensis ordinaires*, i. e., Common Chinese, instead of "*Sina Ordinaires*," Common China.

‡ See next variety.

ducing one third more silk than the Sulphur or Mammoth White. The silk is strong and very glossy.*

9. The *Mirabel*; so called from the resemblance of its cocoon to the Mirabele, the French name for a *longish* saffron coloured plum. The cocoons are similar in form to those of the Pea-nut, but larger. Of these, there are two sub-varieties, the *Sina Mirabel*, China Mirabel, and *Mirabel Jaune*, the *Saffron Mirabel*. The former has been Americanized by the term, White Mammoth Pea-nut; and the latter, by the Yellow or Nankeen Mammoth Pea-nut. It is thought that both these sub-varieties have been produced by selecting the largest of the Pea-nut to breed from. *One hundred and thirty* of the cocoons weigh, in certain cases, one French pound. The worms are white like those of the Pea-nut, and of as hardy a constitution. The quantity of floss is very small, but the quality of the silk remarkably fine.

10. The *Hardy Sulphur Worm*. The information relative to this kind, is not yet sufficient to determine whether it be quite distinct, or a sub-variety of the common Sulphur. The worm is very dark, feeds well, and produces a firm sulphur-coloured cocoon. They contain more pure silk than those of the common Sulphur, and less than the Pea-Nut.

VI. A COCOONERY is an edifice either *purposely* constructed for the production of *cocoons*, and consequently for the feeding of silk-worms; or a house, granary, barn, or building of any kind, *occasionally* appropriated to that purpose.

NOTE 1. Cocooneries are frequently made for the special object of providing sufficient accommodation for some definite quantity of silk-worms, as of 5, 10, 20, or of any other number of ounces of eggs. What should be the dimensions of the cocoonery for either of those objects, immediately involves the question of SPACE; or, in other words, how many full-grown worms should, consistently with the health of the insect, be allowed to the square foot?

2. According to the accounts before us, considerable difference appears to have existed in the practice of different culturists in this respect. Count Reina seems to allow 48 full-grown worms to a space equal to one square English foot; Mr. G. B. Smith 50 worms to the square foot; Mr. Puvis 67; Dr. Muse 72; Mr. Pleasants 80; and Mr. Strong 98. Dr. Muse says that four inches in length and half an inch in breadth, may be considered as sufficient for a full-grown worm. In theory this is *plausibly* correct, and also compatible with the condition that the insects lie in parallel lines, and eat their half inch of leaf in breadth beneath them, before they have a motive to change their

* Mr. Bell of Newark, (Del.) gives some history of his experience of the Pea-nut; "they were hatched about the 29th of May, (1839,) and the first cocoons were made on the 21st day from the hatch. They were fed the greater part of the night, as well as during the day, and were perfectly healthy. The cocoons, after the floss had been removed, and the dupions carefully excluded, numbered 240 to the lb. I had no monsters such as I have seen accounts of numbering 112 and 115 to the lb.! How so many inexperienced feeders have managed to produce such enormous results, I am unable to tell. I conjecture, however, that a good many double and triple cocoons have been numbered in some of the selected pounds."

parallel position, when they might lie at right angles, or across each other, and thus derange one another's health and convenience.

3. Should a full-grown worm be four inches in length, which it is very nearly, and eat whilst it revolves around its own centre, it would eat out as large a circle as could be cut out of four inches square* of leaf; and if every worm on the 144 square inches that compose a square foot did the same, it is evident that only nine† worms could be thus accommodated. Though this case in practice may never be realized when full attendance can be given throughout the feeding season, yet the possibility of it is sufficient to justify the spaces allotted by Count Reina and Mr. Smith.‡

4. But how are we to reconcile the quotations given above with such spaces, as through the medium of a faulty French and English translation, appear to have been assigned by Count Dandolo? Whence it has been respectively inferred, according to the views of different computists, that the Count allotted 126, 150, and even 170 worms to the square foot; whereas the mere advertence to the number of square inches contained in that space, would have been sufficient to intimate the constant errors by the said Translators, as well as by the Congress Manual, which professed to have corrected by the Italian edition, all the inaccuracies of anterior versions, imposed on all that trusted either to their learning or veracity. Since, in the square foot there are 144 square inches, it follows, that whether 126, 150, or 170 worms were assigned to 144 square inches, they must have been left rolling over one another, as a mass of crawling matter, resembling nothing but old Chaos come to life again.

5. But how could such economy be compatible with the constant declarations of the Count of Varese? Few can advocate the advantages resulting from ample space more than he does. His own words are, "It seems never to have been supposed that four or five ounces of eggs would produce 150,000, or even 200,000 silk-worms; that would all require room to breathe freely of pure air, and to secrete the substances necessary to life." And, elsewhere, he says, "They who have the means of extending the allotted spaces, may do so, because it is certain that *the more room silk-worms are allowed, the better they eat, digest, breathe, perspire, and rest.*"

6. This palpable inconsistency arose through the Translators having interpreted the Italian measure, *Braccio*, by the English word *foot*, or its plural *Braccia*, by the term *feet*; whereas the Italian measure of dimensions, *Braccio*, is within a fraction of twenty-three and a half English inches,§ and so nearly two English feet, instead of one, that

* In this case not four square inches, but four inches square.

† That is, $\frac{144}{16} = 9$.

‡ If four inches in length and one in breadth be allotted to each full-grown worm, then 36 may be accommodated to the square foot, since $\frac{144}{4} = 36$.

§ It does not appear that this information ever reached this country until quite recently, when, through the peculiar facilities possessed by a certain gentleman of the South, the fourth Italian edition, the only edition that could satisfy the question, fell into his hands; and this "Copyist" of Morin no sooner obtains it, than he falls "vi et armis," and with amazing suavity and good grace, on every preceding American writer on the silk culture, except his own infallible self!

to avoid fractions, it is in this sense that we shall hereafter take it; i. e. for one Braccio in lineal measure, we take two feet English; and for one square Braccio, two English feet square, or four square English feet. One square English foot, therefore, is only one-fourth of one square Braccio.

7. Hence the dimensions for spaces, given by the Translators, are, at least for the last age, to be multiplied by four, to obtain those designed by Dandolo himself, for any quantity of silk-worms. Thus, the 184 square feet* the Translators allow for one ounce, multiplied by four, give 736 square feet English.† There is, however, this remarkable difference, that this increase, as thus rated from Dandolo's Milanese proportions, though it nearly agrees with the experience of American Culturists, as to the space requisite for worms of the last age, does not bear any proportionality as to the prior ages. We are, therefore, compelled to furnish a table more *original* than *derived*, agreeing, however, with a fact that will not be easily denied, as to the last age, that 40 full-grown worms will not have too much space on one square foot, or on 144 square inches; which, if 30,000 worms survive out of the ounce, in this age, they will require 750 square feet. That is, this is the space which should, in due time, be provided for the worms of one ounce. But as for the worms of other ages, the spaces required, may be derived, not from their comparative length, but bulk, in each successive age.

VII. In the number of full-grown Silk-Worms assigned to the square foot, silk culturists have differed in practice, from 36 to 98. Dandolo allotted only about 40, more or less, full-sized worms, to a space equivalent to an English square foot, varying according to the number, out of an ounce, actually surviving to the cocoon.

VIII. Let one square foot of space, on the frames, shelves, or hurdles, be in readiness, and finally allotted to every 36 or 40 full-grown worms, as calculated on the number expected to survive to the cocoon.

NOTE 1. *More* than this number to the square foot, will leave too little; and *less* will give more space than is wanted for the health and

*To avoid the fractional quantity in 183 feet 4 inches, we take the next whole number, 184 square feet.

† Now, have we elements sufficient to determine the number of full-grown worms, assigned by Dandolo to a space equivalent to an English square foot? The example that he pursues with the greatest statistical accuracy, is, that of *five ounces*. In an ounce, he informs us, there are 39,108 eggs, consequently, in five ounces, 195,840; of which, it is evident, from his further calculations, that he expects, in all ordinary cases, and with due care, 144,000 to survive to the cocoon. This number, however, is suited to five *Milanese* ounces; but as the *Milanese* ounce is to the *English* ounce avoirdupois, in the proportion of 420.3009 *English* grains to 437.5 grains, out of five *English* ounces, instead of 144,000, with the same care, we may expect 149,892 surviving to the cocoon. Hence the 3750 square English feet of the table, are intended for 149,892 full-grown worms; i. e. at the rate of nearly 30,000 surviving worms to the ounce, and 40 worms of the fifth age to the square foot English. Thus it appears that Dandolo's character is vindicated, and the charge against him for crowding more worms on a square foot, than any other culturist, arises from misapprehension consequent on the negligence of his French Translator.

convenience of the full-sized animal. The following is, perhaps, the first table, as to spaces for every age, calculated on independent principles. We refer to the subjoined notes for its verification.*

Ages.	Square feet requisite on the Frames for Worms proceeding from									
	One ounce	Two ounces	Three ounces	Four ounces	Five ounces	Six ounces	Seven ounces	Eight ounces	Nine ounces	Ten ounces
1	14	28	42	56	70	84	98	112	126	140
2	30	60	90	120	150	180	210	240	270	300
3	85	170	255	340	425	510	595	680	765	850
4	250	500	750	1000	1250	1500	1750	2000	2250	2500
5	750	1500	2250	3000	3750	4500	5250	6000	6750	7500

* Since a full-grown worm is not less than $3\frac{1}{2}$ inches in length, whilst some measure 4, it is evident that we cannot, in a square foot, 12 inches every way, place more than three end-wise, or in one line, without each being compelled to eat of a leaf contaminated by another. This is thrice $3\frac{1}{2}$ inches, or 10 inches, leaving only 2 inches to be divided for intervals between worm and worm. That we cannot, with propriety, therefore, obtain any more than *three* tiers in 12 inches in *length*, requires no other proof. Neither will there be any difficulty in admitting that we cannot allow each worm less than twice its breadth to afford it any thing like freedom in moving and eating. Now the breadth of a full-grown worm is $\frac{1}{20}$ to $\frac{1}{25}$ of an inch; and if we allow the double of this, or an inch to each, we cannot have more than 12 in the 12 inches in *breadth* of the square foot, or 12 in a tier; three times 12 or 36 in a square foot: and if Dandolo admitted 40 to the square foot, we require no other proof that it is the maximum that can with any advantage be assigned to that space.

G. B. Smith says, "That though we always reckon 40,000 eggs to the ounce, yet in *practice* we find the ounce to be 30,000." This, of course, means, that out of 40,000 eggs, on the average we may find 30,000 worms surviving to the cocoon; and if of this 30,000 we assign 40 to every square foot, we shall require 750 square feet for our surviving worms. With regard to how many worms, in each age respectively, may survive, is a contingency. Assigning a little more space for the four inferior ages, than found experimentally requisite, is, if an error, one resulting to the health and advantage of our industrious operatives.

If from the preceding considerations we obtain an approximation, as to all the four inferior ages, to a general rule, we might say, multiply the length of the worm, increased by one-fifth of that length, by its double breadth in each age, to find its bulk, or the space it should occupy; and 144 square inches divided by this would give the *maximum*, at each age, that should be assigned to a square foot, or 40,000 divided by that maximum, the number of square feet requisite for the worms of one ounce.

In the prosecution of this mode of inquiry, we might add, that the length of the worms of each of the four inferior ages, respectively, are 2, .11, .5, .22 inches, and the breadths, at the same time, about .25, .21, .11, and .09. But since the application of the above, or any other general rule, to the preceding, or to any variable data, might lead to consequences more theoretical or arbitrary than otherwise, we prefer, in this, without the entire neglect of the former, to give results that have been verified by actual experiment; with the assurance that if there be, as to any age, except the last, an error, it will be an excess, which is an *advantage*, rather than a defect: and a defect in the two last ages has always an immediate remedy by *branch feeding*.

To render this subject of as much practical utility as possible, we shall give another table, for any number of Silk-Worms from 1000 to 1,000,000.

Number of Silk-Worms.	<i>Square feet requisite on the frames.</i>				
	First age.	Second age.	Third age.	Fourth age.	Fifth age.
1,000	$\frac{7}{20}$	$\frac{3}{4}$	$2\frac{1}{8}$	$6\frac{1}{4}$	$18\frac{3}{4}$
10,000	$3\frac{1}{2}$	$7\frac{1}{2}$	$21\frac{1}{4}$	$62\frac{1}{2}$	$187\frac{1}{2}$
20,000	7	15	$42\frac{1}{2}$	125	375
30,000	$10\frac{1}{2}$	$22\frac{1}{2}$	$63\frac{3}{4}$	$187\frac{1}{2}$	$562\frac{1}{2}$
40,000	14	30	85	250	750
50,000	$17\frac{1}{2}$	$37\frac{1}{2}$	$106\frac{1}{4}$	$312\frac{1}{2}$	$937\frac{1}{2}$
60,000	21	45	$127\frac{1}{2}$	375	1125
70,000	$24\frac{1}{2}$	$52\frac{1}{2}$	$148\frac{3}{4}$	$437\frac{1}{2}$	$1312\frac{1}{2}$
80,000	28	60	170	500	1500
90,000	$31\frac{1}{2}$	$67\frac{1}{2}$	$191\frac{1}{4}$	$562\frac{1}{2}$	$1687\frac{1}{2}$
100,000	35	75	$212\frac{1}{2}$	625	1875
200,000	70	150	425	1250	3750
300,000	105	225	$637\frac{1}{2}$	1875	5625
400,000	140	300	850	2500	7500
500,000	175	375	$1062\frac{1}{2}$	3125	9375
1,000,000	350	750	2125	6250	18750

IX. The dimensions of a cocoonery for any given number of worms, depend on the number of tiers of our wickers, shelves, hurdles, or silk-worm frames, the number of rows in width, and of stories in the building.*

* We now, therefore, may have an easy rule to determine the *dimensions of a cocoonery*; viz. divide the number intended to be reared by 40, and the quotient will give the *square feet to lie on the frames*. Divide this quotient by the product of the rows, the tiers of shelves on each frame, and the width of each row, and this second quotient will be the length of each row, to which add the breadth of both passages, at the ends, and we have the *inside length* of the cocoonery.

NOTE 1. The best contrivance for this purpose that we have seen, is the "Burlington Silk-worm Frame," as represented in the annexed figure.

2. The construction of the silk-worm frame "was forced upon the mind of the inventor," as he informs us, "by his experience of the total inefficiency of the hurdle system;" and in the hurdle system he includes "all plans of feeding on close surfaces, — such as shelves, floors, muslin, and all other contrivances which exclude a free circulation of air, and prevent ventilation from below."

5. Amongst the several advantages of the Silk-worm frame, may be mentioned, that "Branch feeding on a ventilated frame, secures health, and a full crop of cocoons. It saves extra hands in cleaning; for *there is no cleaning to be done.*" The worms, by a special contrivance in the frames, are prevented from falling. Instead of immovable

fixtures bolted to the floor, and divided into solid shelving, nailed fast, at certain arbitrary distances, the whole is light and portable; and when the feeding time is over may be easily removed, packed up in a small space, and laid aside for the next season.

6. "By using branches cut down with a grass-hook or scythe, it saves more than one-half the expense of gathering foliage, and feeding it out to the worms. When the stems, &c. have so accumulated as to

Next, to the width of all the rows, add the breadth occupied by the passages between them, and by those running along each side-wall, and we have also *the inside breadth*. For a cocoonery of two or three stories, take one-half, or one-third of the square feet to be on the frames, and proceed as before.

require removal, ten frames may be cleaned in the time required to clean one hurdle. The whole apparatus is as portable as a quilting-frame or umbrella, without liability to breakage. Ventilation and cleanliness are so perfectly accomplished, that disease seems out of the question, unless originating in the egg, or sudden change of temperature.*

7. "For domestic establishments; for families having but a room or two to spare, the BURLINGTON SILK-WORM FRAME is admirably adapted." It is suited to carrying on business to any extent, from a single frame, for experiment, or otherwise, to the complete supply of a large establishment.

8. "The BURLINGTON SILK-WORM FRAME consists of two upright pieces of scantling, six inches wide by two inches thick, fastened to the floor and ceiling. These uprights are to be placed four feet apart. They are supplied with grooves on each side, one and an eighth inches wide, cut half an inch deep, and placed directly opposite to each other. These grooves will correspond in number and position to the number of levels of feeding frames and roofs which the culturist intends to adopt, and that will be mainly dependent on the height of the ceiling.†

9. "The first frame is placed in the lowest groove, then a roof, then a frame, and so on, ending with a roof at the top, which top may approach to within 3 inches from the ceiling. The lowest groove should not be less than 12 inches from the floor. Let there be 12 inches clear to the next groove above, then 3 inches clear to the 3d groove, and so on, up to the ceiling. The 3 inches between the frame and roof will admit a brush to run in freely, and remove the litter from it, and allow a copious circulation of air upwards. [See cut 5.]

10. "At the lowest groove, the feeding begins: the dirt from that level falling to the floor. The worms having been kept in bulk, as is usual, until after the 3d moulting, the only critical period of their ex-

* Among the various improvements recently adopted by silk culturists, the use of LIME is, perhaps, not the least important. The method of disinfecting a cocoonery, by one or the other of its compounds, has been for some time in use in Europe, but has not, we believe, been practised in this country, till the last season, and then but very partially. Its application, however, has produced, wherever used, the most favourable results. Quick lime is caustic, and would be immediately destructive. We, therefore, allude to *slaked* lime. Lime may be slaked either by *air* or *water*; in either case it must be *perfectly* slaked, or neutralized, before it is fit for use. The former process is more precarious, and requires time, depending on the quantity of water held in solution by the air. But we obtain slaked lime immediately, provided we treat it with one-third of its weight of water; i. e. one pound of water slakes three pounds of quick lime; it then becomes the *hydrate* of lime, but not the *carbonate*, until it has been in contact with air a sufficient time to absorb the carbonic acid gas held in *mechanical* solution in the atmosphere. It is *slaked* lime, or the *hydrate*, we want, which commonly falls into powder, or is easily pulverized. A quantity is then put into a hair or fine wire sieve, and is sifted over the shelves until they are white. It is to be used chiefly from the third moulting to the time of mounting, about every other day; and the time of applying it, is when the worms have consumed their leaves, or immediately before they are fed; and, also, when they show signs of sickness. By adopting this practice, the cleansing labour is dispensed with, or, at least, rendered less onerous, because the necessity of it is less frequent.

† We originally intended to give our own description of these Frames; but, lest the reader should be misled by our method of explanation, we determined to employ the Inventor's words, as far as our limits would admit.

istence has arrived, when they are to be placed on the feeding frames.* This frame is made of stuff an inch thick by $1\frac{1}{2}$ inches wide, and it is 4 feet long by 3 feet wide; the ends, however, projecting 6 inches longer, in order to form pins to run into the grooves. Ten slips run across it, each $\frac{1}{4}$ to $\frac{3}{8}$ inches square: the ends are inserted into holes in the sides of the frame. Let the pins be run into the grooves, and the

entire frame is thus firmly suspended in air, securing to the worms feeding on it, the important advantage of being as well ventilated underneath as above. When the frame is so suspended, cover it very slightly with straw, merely to give the worms a foothold when first put on. Now, having previously laid branches on the worms, take up the branches and lay them on the straw, until you

suppose you have 1500† worms on each frame. The straw is to be put on from one end of the whole range to the other, covering the

small openings where two frames meet. It thus becomes a *continuous* frame divided into sections of 4 feet, the worms covering the whole surface, and having but two ends; no matter what may be its length.

11. "Now as this frame is supported in the air, 12 inches from the floor, it must be apparent that all the dirt must fall to the floor, while the under surface of the foliage

* It appears that the inventor, Mr. Edmund Morris, calls the whole of that apparatus which is contained between any two uprights, together with those uprights, "*A Silk-Worm Frame*;" and the latticed slide made to run into the grooves, and on which the worms are placed, he terms a "*Feeding-frame*." The distinction is not sufficiently marked out by the expression. Had the former been termed a *set of frames*, and the latter a *feeding-frame*, or a *sliding-frame*, though perhaps an improvement in the phraseology, yet it is not admitted that this difference would have expressed the distinction sufficiently strong and satisfactory.

† 1500 worms on a space of 4 feet by 3 feet, or of 12 square feet, is at the rate

is as effectually ventilated as the upper. Hence mildew, so inseparable from the hurdle system, and the fruitful parent of disease, is out of the question. At each successive feeding, branches should be laid on, so as to cross each other in various ways, and thus preserve to the whole mass the character of a riddle, and ensure a free passage through to every current of air. In feeding the branches, care must be taken to let the pile rise up with an even surface, and not to let it become higher in the centre than at the edges. It is in feeding just enough *and no more*, that the care of the proprietor should be exercised. If he exercises this care, and give fresh branches only when he sees that the last feeding is stripped of leaves, there will be no accumulation of stems to occasion inconvenience."

12. "Above this frame, at the distance of one foot, a spinning roof is suspended in another pair of grooves. This roof is 4 feet long and 38 inches wide, or 2 inches wider than the frames, so as to catch all the dirt or worms that fall from the frame above, — and prevent their falling on the frame below. This roof is composed of a frame of half inch stuff, and 2 inches deep, braced in addition by 3 common plastering laths, which connect the sides, and which are let into the latter.

13. "They furnish also, an excellent surface on which, in addition to the edge of the roof, the muslin or pasteboard covering is to be pasted. On the edges of the frame composing the roof, drive a few carpet-tacks, and run a string across from one to the other, having first loosely filled the roof with clean straw. The string thus keeps the straw in its place, when the whole contents of straw and cocoons can be promptly disengaged by merely loosening the string. When the worms show signs of mounting, they will mount into the roofs by the following contrivance. Take a strip of wood, round or square, and about 20 feet long. Plug it with old *Multicaulis* trees that are dead and perfectly dry, leaving the branches to project right and left only, like the spokes of a fan, and the stems all the same length. Suspend this ladder by the ends in loops or rings fastened to the roofs, letting the stems touch the frames. Put one of these ladders on each side of the frame, and one or two in the middle. And thus a multitude of points are presented for the worms to mount on: but they should be all ready to loop up the moment the worms show signs of mounting. The hole should not be so closely plugged up as to prevent feeding the worms that are slow in mounting.

14. "When the worms begin to mount, mark the day on the edge of the roof, and at the end of three days it may be taken away and set aside; but put an unoccupied or duplicate roof in place of that taken away, for the balance of the worms to spin on if there be many; if not, concentrate the tardy ones on another frame. The

of 125 worms to the square foot; whereas we have seen that eminent culturists have not allowed more than from 36 to 55 to that space. The inventor accounts for this by saying: "The branches when stripped of leaves, afford abundant more room than a dead level surface, and create a multitude of interstices, like coarse basket-work, in which the worms have ample room to ramble and stretch themselves, without touching each other. The branches, in fact, afford a double surface," &c. At the rate of 1500 worms on one *feeding-frame*, it is evident that if one *set of frames* have 4 levels, or *feeding-frames*, it will accommodate 6000 worms; if 5, 7500; and if 6, 9000.

roof taken down will then contain the cocoons formed during the three days it was up. Let it stand three days. As a cocoon is fully ripe and fit to gather at the end of eight days, the ages of all these are known to a certainty: namely, the cocoons of the first mounting are ten days old, those of the second are nine, and those of the third day are eight days old.

15. "Clear out the *roof*, and refill it with fresh straw, which may be done in a very few moments, and it instantly becomes a duplicate; so that a small number of duplicates will be sufficient for a large establishment. By this mode of securing the cocoon, their age is identified to a day, and any person practically acquainted with the uncertainty and danger from the probability of the moth eating out, attendant on the spinning of a large number of worms, from the great variation in the age of the cocoons, cannot fail to be struck with the vast superiority of the plan."

16. If 1500 worms can be placed on one feeding-frame, and we can determine the number of levels or feeding-frames we intend to employ between every two uprights, and the number of rows of frames the width of the cocoonery will admit, and lastly the number of stories, one or more, it will become easy at once to calculate the dimensions of a cocoonery to accommodate any given number.*

[The diagram which follows exhibits an end view of a cocoonery of *two stories*. The furniture, however, is according to the shelf system.

* Divide the number of worms intended to be reared, by the number of rows running along the cocoonery, and the quotient will be the number of worms to

17. The roof is mounted by a ventilator (1); another may be observed on the centre of the lower floor, (4) with a sliding-board to open and shut; also two on each side, (2 and 3) one above and one below the floor of the second story. The walls of the building should have windows at regular distances. Stationary blinds, moving on an axis, and rising or falling by a slip of wood attached to each in a perpendicular position, will be better than glass, the blinds being horizontal and so arranged that they will keep out the air and damp when necessary, otherwise, glass should be used. By pressing this slip up or down, the blinds will open to admit air and light, or close to exclude them, so that the windows act as ventilators. The number of ventilators in the floor and roof should be such, that they should be in every part of the building, roof, sides, and floor, ready for use when required.

ENEMIES OF THE SILK-WORM. Carefully exclude all *sparrows, swallows, robbers, titmice*, and *poultry*—all *spiders* and *spiders' webs* must be cleared away with the utmost care. Smear the lower end of each upright with molasses, or rub it well with chalk, to prevent the ascent of *ants* or *other insects*; and for the same reason, never allow any frame or hurdle to touch the walls. *Mice, rats, weasels, lizards, &c.* must be destroyed.

The EGGS OF THE SILK-WORM are so small that it requires from 80 to 100 to weigh one *English* grain. They resemble a poppy seed. When just laid, they are of a whitish or yellowish colour; but in three or four days turn to a bluish tinge. The egg has a slight central indentation on its upper surface; the under is slightly glued to the cloth or paper on which it was deposited, and is flat. Those that retain the colour they had at first, are not fecundated, and consequently worthless; and those that are brown, shrunken, and flat, are decayed. When possible, avoid sending for eggs from a distance, since they are liable to considerable injury during the voyage or passage.*

RETARDING THE HATCHING AND THE KEEPING OF SILK-WORMS' EGGS.—On this subject we have been favoured with the following article, by *Edmund Morris*, Esq. of Burlington, N. J., who has paid great attention to the subject; we therefore insert it with great pleasure.

be in each row. Divide this again by the 9600 on a six level silk-frame, or by the number we intend to have on each entire set of frames, and the quotient will be the *sets of frames* in each row; multiply this by 4, the distance between upright and upright, and add 6 feet for the breadth of the two end passages, and we have the *inside length of the cocoonery*. As for the *breadth*, it will be equal to the width of all the rows added to the breadth of all passages running lengthwise. For a cocoonery of two stories, proceed in the same way, with half the number of worms.

For example: what will be the dimensions of a cocoonery of one story for feeding half a million of worms, having four rows of frames, each of six tiers?

$\frac{500,000}{4} = 125,000$, the number of worms in each row; and $\frac{125,000}{9600} = 14$, nearly the sets of frames, and $14 \times 4 + 6 = 62$ feet, the *inside length of the cocoonery*.

4 rows $\times$ 3 = 12, the width of all the rows; 5 passages $\times$ 3 = 15, the width of the passages running lengthwise; and $12 + 15 = 27$ feet, the *inside breadth of the cocoonery*.

But if we employ 7 or 8 tiers to each set of feeding-frames, the dimensions will be proportionately diminished.

* Be cautious of eggs scraped off the paper or cloth, and put up in bottles or cases, as it facilitates the admixture of poppy seed, &c. and has been often used deceptively, to the great loss of the purchaser. It is doubted whether they can

"If the eggs of the silk-worm be kept in a *cool dry* place, from the time they are laid, until they are wanted for hatching, all experience proves that a succession of crops may be produced during the whole season of feeding. The great difficulty, however, has been to provide places sufficiently cool to counteract the increasing heat of spring and summer, in which the temperature may be maintained at the proper point at all times, without varying with the season. For the first warm days of spring are certain to impart to the eggs the hatching movement; and this, when once communicated, cannot be checked without serious or fatal injury. If they have been exposed to the ordinary changes of the previous week or two, they will frequently hatch in the coldest temperature—even upon ice itself. All attempts at retardation then are futile. The temperature should be as uniformly cold, from as early a period after the eggs are matured as it may be in the power of the culturist to maintain.

"To preserve this uniformly cool temperature, eggs have often been deposited in tin vessels, and lowered into a deep well, where they have been suspended a foot or two above the surface of the water. In this way, at Burlington, N. J., some persons have kept their eggs *for five seasons*, until August, taking them out occasionally to admit the fresh air. But eggs deposited in wells, are liable to be injured by dampness, which must be expelled by occasionally airing them. But the exposure, at the mouth of the well, to a higher temperature, is certain to communicate the vivifying principle. Hence, though wells may be excellent, because of their uniform temperature, yet the mode of depositing eggs there to preserve them, has been found defective under many circumstances. It may, however, be so improved, as to answer a highly important purpose.

This figure represents the interior of a well, in which is a tin vessel of the diameter of an ordinary stove-pipe, having a lid that fits on tightly enough to exclude all dampness. It is to be suspended by a cord tied to a handle fastened to the lid, and allowed to descend some distance into the water. At the side of the canister, below the point where the lid fits on, a small pipe is inserted, which runs up to within a few inches of the mouth of the well. As it communicates directly with the chamber of the canister containing the eggs, the latter are continually supplied with fresh and dry air, which is always maintained at the temperature of the water. Dampness is also excluded by the close fitting of the lid. By this plan we have the full benefit of the low temperature of the water itself, without being subject to its dampness. It is known that the natural temperature of all wells of ordinary depth,

at all be detached from the cloth or paper, without injury. The Chinese cause the silk-worms' eggs to be deposited on leaves, and on the first day of the year, they dip them in clear cold water, after having exposed them to the cold. They also immerse their eggs in salt-water, and they say, the eggs thus washed, produce the best silk-worms. And after leaving them many days in salt water, the silk, they say, will be much easier to wind.

say 12 to 20 feet, is 56° ; and we have found by actual trial, in August last, that this never rises above 57° , when the mouth of the well is kept closed. In December we found that the temperature of the water had fallen to 51° , in a well whose mouth was never covered; while those wells which were covered both summer and winter, stood at $53\frac{1}{2}^{\circ}$, though the open air caused the mercury to fall to 40° , showing a variation of only half a degree between the hottest and the coldest months in the year. By the use of such a well, we are always sure of a temperature that will never exceed 57° ; and this degree of cold uniformly maintained from the time the eggs are laid, is all-sufficient to retard the hatching of eggs till August. When the eggs are to be taken from the canister, the latter must be drawn to the surface, unless there be some convenience for descending to it, which is preferable. If drawn to the surface, the lid should be off as short a time as possible. The better way would be to descend half-way down the well; and the eggs should be placed in the canister in parcels of a known weight, so that the quantity required could be instantly obtained, and the canister closed.

Another mode of preserving eggs is as follows. Take a tight hogshead; as in the annexed engraving.

In a canister placed in a box, put the eggs. The canister has a pipe similar to that of the preceding method, but with a bulb top, pierced with small holes to admit air, and exclude dirt and insects. Fill the space between the canister and the box, say two or three inches all around and underneath, with tolerably fine charcoal. Place the box in the hogshead on the ice, and surround it with ice, letting the top of the canister be about even with the top of the hogshead. The hogshead being an

ice-house itself, may stand in the cellar, or under an out-house. When once filled with ice, one bushel daily will supply all the daily loss by melting. The water from which will run off through the spout at the bottom of the hogshead.

"We know from experience, that a regular temperature of about 40 degrees, can be constantly maintained in a refrigerator of this kind. It is needless to say that such a temperature will keep the eggs in perfect safety, as long as they may be wanted, provided that they have been well kept before they were put in. The true plan is to have such a refrigerator made during the winter; the eggs put into it immediately, and as soon as ice can be obtained to begin the use, and continue to use it, until the purpose of preserving eggs is accomplished.

Such an apparatus is not subject to the same variations of temperature as it is well known prevail in ice-houses. It is also cheap, and possesses the recommendation of being easy of access, whilst the culturist is absolutely certain, that just so long as he continues the daily supply of ice, will his eggs be maintained in the proper temperature without any further care."

So far Mr. Morris of Burlington, (N. J.) His remarks deserve attention, but we think they do not exhaust the subject. There are other modes of preserving silk-worms' eggs that are worthy of notice, to one of which we will refer, because it is less troublesome, more economical, and more at the command of every person engaged in the silk culture. As this is one of the most important parts of the silk culture—that on which chiefly hinges a favourable or unfavourable result, for without healthy eggs, well preserved, nothing can successfully be done, we shall dwell upon it more at length.

Let the silk-worms' eggs be carefully placed in an empty tea-chest with the lead in it; or in a tin case large enough to hold an assigned quantity, without pressure. It is always advisable not to fill entirely such a case, as room for air is essential. Let this case be placed in a box or barrel, some inches every way larger. Place a layer of two or three inches of finely broken charcoal on the bottom. Set the case on it, in the centre. Pour in the charcoal all around, and let it be pressed well in. Let two long tobacco or other pipes with similar vents, through which the air can freely pass, be inserted in the cover of the inner chest, or tin case; and then dig a hole in a retired cool part of the cellar, not liable to be filled with water.

Let the box or barrel containing this inclosure be placed in this hole in the floor; the inner box or case should be well closed, and covered two or three inches with charcoal. The head of the barrel or box should then be fastened on, making room for the two pipes, which are understood to communicate with the outer air and the inner case where the eggs are, securing them from being filled or broken. One of these pipes is intended to admit fresh air to the inner case containing the eggs, and the other is intended to let any gas escape that may generate among the eggs; for if fresh air be necessary to keep the eggs in a healthy condition, it follows that a certain degree of decomposition will take place among the eggs, and the process will evolve more or less gas, which cannot escape by the same vent that admits the air. One pipe should penetrate the eggs, and the other merely pass through the lid inside. Additional security against change of temperature, is effected by having the barrel or box, before being let down into the hole, enclosed in an old rug or blanket; the top should be covered at least twelve inches below the surface of the earth, and if a quantity of oak tan from a tan-yard be put around the barrel or box in the hole, and pretty deep over the top, the temperature will be maintained, the expense of ice saved, and the eggs be well preserved. The hole may be made deep, or otherwise according to the nature of the location, but a free use of the tan will obviate most of the difficulties. The eggs may thus be preserved for years in all seasons, as they have been kept in other countries, notwithstanding Mr. Smith's theory, without any injury. M. Beauvais, of Bergeries, near Paris, in France, preserves his silk-worm's eggs, not only to the period of hatching the ensuing

year, but to any time most convenient for that or the following year, when they have been found to hatch perfectly well, and go through all their stages with perfect regularity and vigour. If the newly elaborated cocoons are kept at a certain temperature, they will not hatch out till the following season. This has been proved repeatedly, but it should not be relied on by the culturist.

These suggestions will enable any man of moderate capacity to ascertain what is required for the successful preservation of silkworms' eggs. A variety of other modes may be adopted, but the principle of preserving their vitality and uniform temperature, as here laid down, and which, towards success, is essential, must be the subject of primary consideration.

X. SELECTING COCOONS FOR EGGS. All cocoons used for this purpose should be carefully selected: none but those which are perfect, and such as have been finished within the proper time from the hatch, should be appropriated for the supply of eggs and worms.

NOTE. *There should be no departure from this rule.* Otherwise, disappointment, or a sickly progeny, may render the labours of the culturist abortive. It is recommended that the eggs for a subsequent season be preserved from the first crop, as the subsequent ones may become failures, or the cocoons be imperfect; and the future supply, therefore, deficient in quantity, if not in quality.

XI. HATCHING should not be attempted until the mulberry leaves are in a state of sufficient advance to promise an abundant supply throughout the feeding season, increasing in proportion to the increasing appetite of the Silk-worm.

NOTE. On this account, it is always safer to be a few days too late than too early. This implies a gain, also, in affording an opportunity for a sufficient development of the leaf, which, when too young, is less healthy than at a maturer age. Hence it is a rule, to allow the leaves first to attain the size of half a dollar. The removal of the eggs from their place of deposit during the winter, must be guarded with peculiar care, preventing a too sudden change of temperature; and consequently the transition from a cold to a warm atmosphere must be gradual.*

At Broussa, the temperature of the first two days of the hatching is maintained at $63\frac{1}{2}^{\circ}$; on the 3d day, at 66° ; on the 4th day, at 68° ;

* Hence it has been recommended, that if the eggs have been kept in an ice-house, to remove them first to a cellar, and then to a cool room, leaving them 24 hours in each place, and lastly to the hatching-rooms; or, when they have been kept in a cellar, that they remain a day or two in a cool room, before exposure to the warm hatching-room.

Any room that can be easily kept warm, or its temperature maintained at any degree, or varied as the case may require, will serve as a hatching-room; but every complete cocoonery should have one, furnished with hatching-tables, or any ordinary plain tables of a sufficient size. A table 10 feet long by 3 feet, will accommodate a million. M. de la Brousse recommends that a fire be made in the hatching room early in the morning, at noon, and at 10 in the evening, for three days before the eggs are placed in it, in order that the walls be made dry and warm.

on the 5th, at 70°; on the 6th, at 72°; on the 7th, at 75°; on the 8th, at 77°; on the 9th, at 79°; and on the 10th, 11th, and 12th, at 81°. This may indicate the value this people set on the silk culture, and account for their extreme precision. M. de la Brousse would begin with a temperature of 77°, rising every day 2°, to a maximum of 92°.

Some are at a loss to know how to regulate the temperature with the precision generally recommended; and not a few ridicule it altogether, because some successful hatchments have been made without any definite rules. Such persons work always at random; and if they fail, they cannot account for their losses, or explain their difficulties. We recommend to all who aim at success, to be precise in their plans and system. The eggs of the Silk-worm, when taken out of the place where they had been preserved through the winter, may be raised to any required temperature, by placing them in a water-tight vessel and lowering them in a well, raising them a few feet each day, and transferring them from the well to a cellar, and from thence to a well-ventilated hatching-room. But when the eggs come into the hatching-room, both the *sun* and *wind* should be excluded till the hatching is complete. A wine-cask without the head, being placed in a cellar, and filled daily with cool pump-water, or supplied for a few days with ice, will answer very well to graduate the temperature, the vessel being gradually drawn up till it is withdrawn from the cool region in the lower part of the vessel. Every person who engages in the silk culture, should be prepared with all kinds of apparatus which could command success.

When eggs are thus treated, in all ordinary cases, they will show signs of vitality from the seventh to the tenth day.* *Signs of vivification* appear about the sixth. The dull brownish *slate* colour of the eggs becomes *bluish*, then *purplish*, then *grey*, with a tinge of *yellow*, and finally of a *dingy white*, when the worm is formed within the shell. The tender leaves of the mulberry should now be in readiness, and laid all round each parcel of eggs on the hatching table, and the attendant should be up by dawn to watch them.

The young larvæ generally appear from sunrise to ten o'clock in the morning, and those that do not leave their shell at the latter hour, usually remain until next day. It is of importance to keep the worms of each day's hatch by themselves, which may be easily done by removing the leaves, to which they immediately attach themselves, to a distinct table, shelf, or place convenient for this purpose. In short, the hatch of each day should be kept separate throughout the feeding season: since the hatches of different days cannot pass together through their consecutive ages and moultings, the consequence would be that worms of different ages and states would be on the same shelf, to the great inconvenience of the culturist: or worms active and eating voraciously would be on the same table or shelf with those in the torpid or moulting state, to which any disturbance is injurious.

* It is usual to spread the eggs on a white paper, placed on a clean table; keeping each ounce distinct, and leaving a space of 6 or 8 inches round each parcel, for the reception of small leaves, which the larvæ seize as soon as hatched. The larvæ that appear prematurely, that is, before the seventh day, should be raised entirely by themselves; also those hatched after the tenth day, as they are usually delicate, if not sickly.

For statistics relative to silk-worms' eggs, we refer the reader to the subjoined note.*

Because $28 \frac{1}{2} 576 = 16128$, there are 16128 *Milanese* grains in a *Milanese* pound, to which 11768.425 *English* grains are equal. And since 16128 *Milanese* grains, and 11768.425 *English* grains, are the same in weight, one *Milanese* grain is .729689, of an *English* grain; since $\frac{11768.425}{16128} = .729689$ nearly.

Hence the *Milanese* pound of 11768.425 *English* grains is greater than the *English* avoirdupois pound of 7000 grains; but the *Milanese* ounce of 420.3009 *English* grains, is less than the *English* avoirdupois ounce, which contains 437.5 of the same grains; and the *Milanese* grain is not three quarters of an *English* grain, but only .729689 of the latter.

Consequently there will be more silk-worm eggs in an *English* grain or ounce, than in a *Milanese* grain or ounce. Dandolo informs us that 68 eggs of the worm of the *common silk-worm* weigh one *Milanese* grain, or .729689 of 1, or of an *English* grain; hence of the same kinds of eggs, there would be 93.2 in an *English* grain. For the same reason, of the eggs of the large silk-worm of four moultings, of which 37.440 weigh a *Milanese* ounce, or 65 exactly, to a *Milanese* grain, there will be 90.4 in an *English* grain; and of the eggs of the small silk-worm of three moultings, whereof 42.620 are required to the *Milanese* ounce, or 74 to a *Milanese* grain, it will require 101.4 to the *English* grain.

At page 95 of the 8th volume of the Farmer's Register, we have a statement said to be accurately taken, and apparently relative to the eggs of two distinct classes of worms; of which we have five examples of the former, and three of the latter. The number of eggs to the *English* grain of the five examples of the former class, the editor would have found to be, had he accurately calculated them, from his own data, 82.474, 86.796, 85.901, 88.333, and 85.106, the average of which is 85.722. And the number of eggs to the *English* grain of the three latter examples respectively are 94.117, 96.153, and 90.322, the average of which is 93.53 very nearly according to our preceding calculation. Hence we may expect from 80 to 100 silk-worm eggs to the *English* grain, according to the kind of moth of which they are the product.

Again, as one *Milanese* ounce is equal to 420.3009 *English* grains, and an *English* ounce avoirdupois contains 437.5 grains; it will require of the common silk-worm eggs of four moultings, whereof 39168 weigh one *Milanese* ounce, 40770 to the *English* avoirdupois ounce. And of the eggs of the large silk-worm of four moultings, whereof

* STATISTICS RELATIVE TO SILK-WORMS' EGGS.—The weights by which Count Dandolo's estimates are given, are the *Milanese pound, ounce, and grain*. According to the 4th Italian edition of the Count's Treatise, we are informed that the *Milanese* pound is one of 28 ounces, and each ounce of 576 *Milanese* grains. This is also thus verified; Dandolo counts on 39168 eggs of the worm of four moultings to an ounce, and 68 eggs to the grain, $\frac{39168}{68} = 576$.

The *Milanese* pound is equal to 11768.425 *English* grains; the *Milanese* ounce to 420.3009 *English* grains; and the *Milanese* grain to .729689 of an *English* grain.

37,440 weigh one *Milanese* ounce, it will require 38,972 to the *English* ounce avoirdupois. Again, of the eggs of the small silk-worm of three moultings, of which 42,620 weigh one *Milanese* ounce, it will require 44,364 to the *English* avoirdupois ounce.

Of the three last examples quoted on the above page of the Farmer's Register, 41,176, 42,067, and 39,516 eggs respectively, are required to the English ounce, of which 40,919 are the average; nearly the same as the preceding estimates relative to the number of eggs to the ounce of the common silk-worm of four moultings.

Count Dandolo's principal feeding example refers to five ounces of the eggs of the common silk-worm of four moultings, of which 39,168 are equal to a *Milan* ounce, and therefore to 195,840 eggs, the number in five ounces; of which it is evident, from several statistical parts of his volume, that he expected, with such diligent care as he used, 144,000 would hatch and survive to the cocoon, or 28,800 in each of the five *Milan* ounces. Now, since there are 40,770 eggs of the same kind of worms in the *English* ounce avoirdupois, it affords a proportion from which we may expect, that with the same attention, 29,978 of the *English* ounce will hatch and survive to the cocoon; and out of the 203,850 eggs to the five *English* ounces, 149,890; or in round numbers, 30,000 out of 40,000 eggs, and 150,000 out of 200,000 eggs: i. e. a loss of twenty-five per cent. on the original stock, *including* the loss in the hatch. Consequently to the number of cocoons we wish to obtain, we must add $33\frac{1}{3}$ per cent. for the number of good eggs we must have or purchase. For example, would we raise 30,000 worms to the cocoon? Add $33\frac{1}{3}$ per cent. to that number, and we have 40,000, as before; we lose not a third of one, but out of $1\frac{1}{3}$ we lose the third, and keep the one.

We are informed by Mr. Gleason, that out of 85,000 eggs, about 75,000 hatched. If this could be considered as a fair experiment, it gives the proportion, i. e. 17 to 15; or out of every 17 eggs, with proper treatment, we may expect 15 to hatch. For the purpose of easy reference, we shall reduce these practical deductions to the following statistical elements:

XII. From 85 to 100 Silk-worm eggs, according to the kind of moth of which they are the product, weigh one English grain.

XIII. It will require 38,972 of the eggs of the *large Silk-worm of four moultings*, 40,770 of the eggs of the *common Silk-worm of four moultings*, and 44,364 of the eggs of the *small Silk-worm of three moultings*, to weigh one *English* ounce avoirdupois.

XIV. With good management, out of every ounce, or out of every 40,000 Silk-worm eggs, we may expect about 36,000 to hatch, and 30,000 to survive to the cocoon.

NOTE. This refers to the *natural* system; by the *artificial*, greater success is attained.

CHAPTER III.

ON THE REARING THE SILK-WORMS FROM THE
LARVA UNTO THE COCOON.

PRELIMINARY REMARKS.

TEMPERATURE *to be maintained during the feeding season.* All writers agree that due attention is to be given to this during this important period, and generally prescribe the limits to be between 68° and 75° . A temperature higher than 77° , we seldom find recommended; but by almost universal consent, 68° seems to be quoted as the *minimum*. Though a degree as low as 62° has been recorded, yet it was the result of accident, as from an unexpected frost, change of wind, or neglect of fires; and we uniformly find the worms, in such case, in a state of suffering. European writers, who have a climate that requires, and admits more of, correctives than ours, recommend that a temperature of 75° be maintained throughout the *first* age of the Silk-worm; from 75° to 73° during the *second*; from 73° to 71° in the *third*; from 71° to 69° in the *fourth*; and from 69° to 68° during the *fifth*. Above the 68° , extreme precision as to the degree of heat is not so essential as the prevention of any *sudden vicissitude* in the cocoonery, from one extreme of temperature to another, or of any sudden changes whatever. This circumstance is of considerable advantage to culturists of all sections of this Union, where the temperature is liable to rise higher, notwithstanding any reduction effected by shading or ventilation, than the maximum prescribed by European writers.

Notwithstanding the narrow limits to which our care is confined relative to temperature, much depends on it, not only within, but in some measure without the laboratory; since we are, to a certain extent, dependent on the latter for an earlier or later production of the leaf. This, though beyond our control, yet should we accordingly regulate the hatching; and in some cases, perhaps, accelerate,* and in others retard, as occasion requires, the growth of the worm. With

* An extraordinary case is quoted relative to M. Boissier de Sauvages, who, being overtaken by a premature growth of the leaves, which were out on the first day of April, to effect a collateral advance in the growth and moulting of the Silk-worms, raised the temperature to 100° in the first days after the hatch, and to 95° during the remainder of the first, and through the second age. Their maturing was thus so much accelerated, that only *nine days* intervened between the hatch and the end of the second moulting. Every one expected that the high temperature would be destructive; but on the contrary, all went on well, and the silk was abundant. In subsequent experiments, he raised the temperature to 95° in the first age, and gradually lowered it to 89° before the termination of the second, with a similar effect relative to the shortened duration of these two ages. Instead of injuring the constitution of the worms, from this early acceleration, they seemed to have received an impetus, since they passed only five days in each of the two successive moultings, although with a diminished temperature of 82° ; whilst others deprived of this advantage required seven or eight days for each, though favoured with the same temperature during these stages. It is also added, that this impetus and accelerated growth give to the worms additional vigour and activity, evidently tending, in the same proportion, to the prevention of disease, and to shorten the attendance and solicitude of the culturist. It is, however, requisite, in adopting this method, to regulate the whole by the advancement of the season, the shooting or backwardness of

foresight and care, we may generally be enabled to effect the hatching precisely when the leaves attain the size and condition already specified; and thus the leaves and the insects will be *simultaneously* advancing to maturity. The contrary might occasion the loss of the entire stock of worms. Should it become unexpectedly inclement, after more favourable weather had induced us to let the eggs hatch, it is easy, in this case, by a diminution of temperature, to retard the growth of the worms; and thus to adapt their subsequent progress to that of the previously suspended advance of the leaves.*

THE AIR OF THE COCOONERY should always be kept *dry* and *pure*. Happily for us, the air of this country is comparatively dry, and therefore better adapted to the production of silk than most other countries. Yet drizzly or rainy seasons, and the damp arising from the accumulation of litter,† especially in large establishments, in the two last ages of the worm, demand our attention. We must have at command every convenience to facilitate ventilation, to any extent. In cold or damp weather, fires should be kept in fire-places or stoves; or what would be preferable, an air-furnace, under each end of the cocoonery, by which hot and cold air can be admitted or excluded, at pleasure. Whether shelves, wickers, or hurdles be used, the litter, especially in the two last ages, should be frequently removed; the trouble of which

the leaf. If the latter should prevail, and heat afterwards set in, and advance it to maturity, the immediate acceleration by heat, of the insect growth, becomes necessary, to keep pace with that of the leaf; otherwise the latter may harden and become too mature for the worm, an evil which admits of no remedy, except to have in readiness successive crops of the multicaulis. To avail ourselves of this method, we must put the eggs to hatch ten days later than would be required under ordinary circumstances. And the duration of the several ages must be so previously calculated, and the whole management such, that the maturing both of the leaf and worm may, as far as possible, keep time together.

* Amongst the advocates of the propriety of retarding, when circumstances require, the growth of the worm, we find Dandolo, who says: "It is a highly important power to be able, without danger, to retard the hatching of the Silk-worms; and to prolong, for some days, their two first ages. To obtain this great advantage, there is nothing else to do" (i. e. on the 1st day of the 1st age) "but to lower the temperature which before stood at 75°, to 73°; and four or five hours after, to 71°, and the next day to 68°, if that be necessary. This cooling of the air diminishes the appetite of the worms gradually, and without danger; and by this means are hindered the modifications, which at the 75th degree would have led some to moulting. At 75°, the first moulting would be accomplished in five days; but six or seven are necessary at the reduced temperature. The second moulting is completed in four days at 75°, but requires more than six if the temperature is between 68° and 71°. Thus it may be seen how the culturist, by thus prolonging the two first ages, may gain seven or eight days of time to ward off the dangers of an inclement season. Some days, also, may be gained in the subsequent ages;" which is of importance where it is requisite to allow time for the leaves to grow.

It has been frequently recommended not to admit too much LIGHT into the cocoonery. Venetian blinds, or any equivalent contrivance, will afford the double convenience of a reduction of temperature, and of excluding flies or other winged insects which shun all apartments in proportion to the exclusion of light. "The sun," says one, "should never be allowed to shine on the worms; and if any of them are exposed to it, the windows should be so shaded by shutters or blinds, as to prevent it." If the cocoonery be not sheltered by trees, but covered with mere shingles, it should be underdrawn; otherwise the whole interior, in July or August, from the shingles heated by the sun, becomes close, resembling an oven, where all elasticity of the air, so necessary to the health of every animal, is destroyed.

† If there be ponds, marshes, canals, or low ground, occasionally covered with water, but from all of which the summer and autumnal suns dry the water, the exhalations from such places must be carefully avoided.

seems to be much lessened by the "Burlington Silk Frames," already described.

QUANTITY OF LEAVES IN EACH AGE, and throughout the whole *Feeding Season*.—Some writers think it unimportant to pay *minute* attention to the precise quantity to be given, and incline to leave it to the worms themselves to settle that question. Some seem afraid of giving too much, and others too little; whilst another class, to extricate us from either extreme, prescribe the exact weight to be given, not only during every day, but every part of each day of the feeding season, for the worms proceeding from each ounce of eggs. *Under-feeding* seems, questionless, more to be avoided than *over-feeding*. Both worms and cocoons of diminished size will be the inevitable result of the former. But, had those who direct a precise weight of leaves for any number of worms, rendered us no other advantage than to intimate the extent of the provision we must make for an expected colony, it would be an invaluable service.

The exact quantity of leaves, intended by Dandolo, for the worms proceeding from each ounce of eggs, has been very much misunderstood by all placing any dependence on the versions of either his French, English, or American Translator. If we rely on the information relative to the *Milanese* pound, in the fourth Italian edition, we have to increase the quantity to be given to the worms proceeding from one ounce, which, by the Translators, is quoted at 1610 lbs.* to 2706 lbs.† The difference here is so great as to lead to the inference, that American Culturists have either not confined themselves to quantities prescribed by works on this subject, and published in this country; or, if they have, cocoons in size below the average, have been the result of their *under-feeding*.

M. D'Homergue, in the work recently published by him, gives the quantities in question, in *French weights*. Though nothing has been gained by this, more than from his French predecessor, yet he, having given the proportion‡ between the *French* and the *English* avoirdupois

* i. e. the gross weight of leaf, as taken from the trees, and prior to any loss by picking, evaporation, &c.—See Dandolo, p. 321.

† From the French metrical system, quoted in the fourth Italian edition of Dandolo, the *Milanese* pound appears to be equal to 11768.425 English grains, whereas the *English avoirdupois* pound contains only 7000 grains. Hence, as 7000 : 11768.425 :: 1610 : 2706 lbs. gross weight, as taken from the trees, in *English* pounds avoirdupois.

‡ M. D'Homergue, in quoting *French* pounds, in common with all gentlemen of that nation, has not the condescension to tell us what French pound he means—whether that of *Bordeaux*, *Avignon*, *Liste*, *Marscilles*, *Montpelier*, *Lyons*, *Rouen*, *Toulouse*, or *Paris*, all of which materially differ one from another. If he intended the *poids de marc of Charlemagne*, or that of *Paris*, it is equal to 7561 *English* grains; of which 7 lbs. *French* are equal to 7 lbs. 9 oz., and not to 7 lbs. 12 oz., as given by M. D'Homergue. However, as he is a native of France, we concede the point to him, and would accept his table, could we therein find him consistent with himself. His using, in three cases out of five, the ratio of 7 lbs. 12 oz., in another of 7 lbs. 10 oz. and lastly of 7 lbs. 13 oz., affords, at least, presumptive evidence that he designed the former; according to which, and a more correct copy of Dandolo's statement, (ps. 320 and 321) his table would, instead of as we find it at page 99, of his work, have stood thus;

Age.	French pound.	American.
1	7	7 lbs. 12 oz.
2	21	do 23 " 4 "
3	69	do 76 " 6 "
4	207	do 229 " 3 "
5	1200	do 1323 " 9 "

pound, affords the means to ascertain the ratio, which, according to his interpretation, exists between them. The 1610 lbs. gross weight of leaf, as taken from the trees, quoted above, are equal, therefore, at this ratio, to 1783 lbs. avoirdupois. This affords a medium between the two extremes; one of which (1610 lbs.) has been already proved to be too small; whilst an approximation to the greater, (2706 lbs.) has been verified by several experimental culturists in this country.

The three proportions, therefore, now before us, are 1610 lbs., 1783 lbs., and 2706 lbs.; and signify the gross weights, according to their respective authorities, to be taken from the trees, for the worms proceeding from one ounce. If we reject the two former, as confessedly too small, and not agreeing with any known trial, tested by the *avoirdupois weight* of leaves, as an adequate provision for the proceeds of one ounce of eggs, whilst a quantity, varying between 2500 and 2706 lbs. gross weight of leaves has been, by accurate experimentalists, both in this country and France, proved to be not less than sufficient for the same number, it is evident that we ought to have in readiness, a quantity not less than 2500 lbs. of *gross weight* of leaves, for every ounce we intend to rear on the natural system; though a less amount will serve on the artificial, which we shall soon have the opportunity to describe.

The 1610 lbs. *gross weight* of leaves lose by picking and evaporation, according to Dandolo,* about 248 lbs., and are, therefore, reduced to 1362 lbs. of *sorted* leaves. Of these, he prescribes that 6 lbs. should be given to the worms of one ounce in the *1st age*; 18 lbs. in the *second*; 60 lbs. in the *third*; 180 lbs. in the *fourth*; and 1098 lbs. in the *fifth*; or 1362 lbs. of *sorted* leaves in all.

But practically we are not so much concerned with the *nett*, as with the *gross weight* of leaves; as it refers to the number of trees of a *known or average yield*, we must be provided with for the sustenance of any given quantity of silk-worms; the extent of land required for their growth; or to the weight of leaves we must draw from the plantation, during any day or age of the feeding season. To what this *gross weight* will be reduced by picking, sorting, &c., will be determined both by the nature of the leaf, and ordinary sagacity, which alone can be requisite to guide us in such cases. The *Multi-caulis* leaf will by no means require the same trouble in picking from the *gross* to the *sorted* quantity, and from the larger amount of nutritive matter it contains, its weight in efficient leaf will be nearly the same as so much *net weight* of white mulberry leaves.

Now, Dandolo's proportions of *sorted* leaves, of 6 lbs., 18 lbs., 60 lbs.,

* The result of the most exact calculation is, that the quantity of leaves drawn from the trees for each ounce of eggs, amounts to 1609 lbs. 8 oz., divided in the following manner:

Ages.	Sorted leaves.	Refuse picked from the leaves.	Loss by evaporation during the whole period of rearing the silkworms.
1	6 lbs.	1 lb. 8 oz.	105 lbs. 0 oz.
2	18	3 0	Refuse as before, 142 8
3	60	9 0	net wt. of leaf, 1362 0
4	180	27 0	
5	1098	102 0	1609 8
	<hr/> 1362	<hr/> 142 8	

160 lbs., and 1098 lbs., in the respective ages, or 1362 lbs. in all, are in gross weight of leaves equal to 7 lbs. for the first age; 21 lbs. for the second; 71 lbs. for the 3d; 213 lbs. for the 4th; and 1298 lbs.* for the fifth; or to 1610 lbs., as above, of gross leaf in all. These quantities, however, are given in *Milanese* pounds; and we have already said that 1610 *Milanese* pounds are equal to 2706 lbs. *English* avoirdupois; or that a quantity, varying between 2500† and 2706 lbs. avoirdupois gross weight of leaves, has been experimentally proved to be not less than sufficient for the worms proceeding from one ounce.

The *deliberate* and *published* maxim of an experienced culturist of this country is, that, “the average quantity of leaves consumed by each worm during its life-time is ONE OUNCE.”‡ Now, if we take 40,000§ worms to the ounce of eggs, the number usually calculated for, this is 40,000 ounces, or 2500 lbs. gross weight of leaves; and on the admission that each *Multicaulis* of the first year’s growth, planted on good soil, will, on the average, yield one pound of leaves; this is equivalent to 2500 such trees; or, as 10,000 trees, (4 feet one way, and 1 foot from tree to tree, the other,) will nearly occupy one acre, it follows that every quarter of such acre will maintain the worms of one ounce, or produce $12\frac{1}{2}$ lbs. of reeled silk; or one acre will thus maintain the worms of 4 ounces, or produce 50 lbs. of silk, worth \$250.

Thus are we, and all that shall hereafter engage in the same field, rescued from any further dependence on the *deceptive* interpretations of four translators,|| on the necessity of converting the *Milanese* pound to the *English* or *American* pound avoirdupois. From the testimony of our own countrymen we have the above data, divested of all foreign ambiguity or mysticism; and if dependence can be placed on experience and careful manipulations, on these elements we may rely in our future prosecution of this enterprise. *Thus have we, with*

* The nearest whole number instead of fractional quantities being taken.

† A neighbouring culturist says: “the whole number of worms fed on my quarter of an acre, was about 40,000 (one ounce); the weight of leaves they consumed was 2576 lbs. The amount of cocoons produced was 126 lbs.; which yielded 12 lbs. of reeled silk, 16 ounces to the pound.” This is a sufficient testimony in favour of 2500 lbs. of gross weight leaves, avoirdupois weight, for the worms proceeding from one ounce.

‡ We avail ourselves of this opportunity to give a transcript of the statistical proportions furnished by this gentleman (B. G. Smith); “1st. The average weight of leaves that each *Multicaulis* tree will afford, during its first season’s growth, on land of fair quality, planted 4 feet by one apart, is ONE POUND, or 16 ounces. 2d. The average quantity of leaves consumed by each worm during its life is ONE OUNCE. 3d. The space of shelf occupied by the worms is as follows; 1st AGE, 1000 worms occupy 1-3 of a square foot. 2d AGE, 1000 worms occupy 3-4 of a square foot. 3d AGE, they occupy 2 square feet. 4th AGE, 6 square feet; and 5th AGE, 18 square feet.” (i. e., 55 worms to the square foot.) “4th, 3000 worms will make one bushel of cocoons. 5th, one bushel of cocoons will make 1 lb. of raw silk. 6th, one pound of cocoons will produce one ounce of eggs. 7th. Thus 1000 trees will feed 16,000 worms the first year. These will require 288 square feet of shelf: or 8 shelves, each 12 feet long and 3 feet wide. They will produce $5\frac{1}{2}$ bushels of cocoons, or the same number of pounds of raw silk:” which is at the rate of 10 lbs. of silk to the ounce, if 30,000 succeed to the cocoon, or of $13\frac{1}{2}$ lbs., if 40,000 cocoons are realized.

§ It is asserted that the Chinese are so successful in the rearing of silk-worms that they scarcely lose one per cent. on their original stock of eggs. The French, before the introduction of the artificial mode of feeding, used to lose 50 per cent. Now they lose only about one per cent.

|| Two French, one English, and one American.

little danger of any material error, arrived at the conviction that 2500 lbs., or 40,000 ounces, gross weight of leaf, are requisite for the worms proceeding from one ounce.

XV. One quarter of an acre, planted 4 feet between row and row, and one foot apart from tree to tree in each row, affords space for the growth of 2500 Multicaulis trees.

XVI. These trees, if planted on proper soil, and well cultivated, will yield the first year, on the average, 1 lb. or 16 ounces of leaf, per tree, and each ounce will be a supply for one silk-worm to the cocoon.

XVII. Thus one quarter of an acre supplies 2500 times 16, or 40,000 ounces of leaves, sufficient for the worms of one ounce; producing, on the average, with careful management, 125 lbs. of cocoons, or $12\frac{1}{2}$ lbs. of reeled silk, worth, at \$5.00 per pound, \$62.50.

XVIII. For the same reason, one acre of the same soil, planted and cultivated in the same way, will yield 10,000 such trees, or 10,000 such pounds, equal to 160,000 ounces of leaves, sufficient for the silk-worms of four ounces of eggs, producing, at the same rate, 500 lbs. of cocoons, or 50 lbs. of reeled silk, which, at \$5 00 per pound, is equal to \$250 00 per acre.

NOTE 1. It follows then, that adopting, for the several ages, the proportions already given, 7 lbs., 21 lbs., 71 lbs., 213 lbs., 1298 lbs., or 1610 of Milanese pounds of gross weight of leaf in all, we have as referrible to 2500* English avoirdupois pounds in all;—11 lbs. for the first age; 33 lbs. for the second; 110 lbs. for the third; 330 lbs. for the fourth; and 2016 lbs. for the fifth age; or, 2500 lbs. for the whole feeding season, for the worms proceeding from one ounce.

2. Therefore, allowing 10,000† Multicaulis Trees, of the first year's growth, to the acre, we may derive the following table:

* The worms of one ounce, under the care of M. Robert, of St. Tulle, and fed on the French "high-pressure system," consumed 2254 French pounds of leaves, equal to 2495 lbs. avoirdupois, or nearly 2500 lbs., as above.—*Journ. Am. Silk Soc.* Vol. II. p. 185. If the gentleman at the Silk Convention in March, last year, at New York, understood Seigneur Tinelle to mean English pounds, when he said that the largest quantity of leaves consumed by the worms of one ounce, was 1500 lbs., they would be under the same mistake with the Translators of the Philanthropist of Parmentier.

† 10,890 trees, one foot by four, may be planted on one acre. See the table, page 18; but for the ease of the memory, we take 10,000 to the acre.

NATURAL SYSTEM.

Number of Silk-Worms.	Pounds of leaves.	Produce of trees.	Growth of an acre, or parts of an acre.	Pounds of cocoons at 125 lbs. to 40,000 worms.	Pounds of reeled silk.	Value at \$5 per pound.
10,000	625	625	$\frac{1}{16}$	31 $\frac{1}{4}$	3.125	15 62 $\frac{1}{2}$
20,000	1250	1250	$\frac{1}{8}$	62 $\frac{1}{2}$	6.250	31 25
30,000	1875	1875	$\frac{3}{16}$	93 $\frac{3}{4}$	9.375	46 87 $\frac{1}{2}$
40,000	2500	2500	$\frac{1}{4}$	125	12.50	62 50
50,000	3125	3125	$\frac{5}{16}$	156 $\frac{1}{4}$	15.625	78 12 $\frac{1}{2}$
60,000	3750	3750	$\frac{7}{16}$	187 $\frac{1}{2}$	18.75	93 75
70,000	4375	4375	$\frac{7}{16}$	218 $\frac{3}{4}$	21.875	109 37 $\frac{1}{2}$
80,000	5000	5000	$\frac{1}{2}$	250	25.000	125 00
90,000	5625	5625	$\frac{9}{16}$	281 $\frac{1}{4}$	28.125	140 62 $\frac{1}{2}$
100,000	6250	6250	$\frac{5}{8}$	312 $\frac{1}{2}$	31.250	156 25
120,000	7500	7500	$\frac{3}{4}$	375	37.500	187 50
200,000	12,500	12,500	1 $\frac{1}{4}$	625	62.500	312 50
300,000	18,750	18,750	1 $\frac{7}{8}$	937 $\frac{1}{2}$	93.750	468 75
400,000	25,000	25,000	2 $\frac{1}{2}$	1250	125.000	625 00
500,000	31,250	31,250	3 $\frac{1}{8}$	1562 $\frac{1}{2}$	156.250	781 25
1,000,000	62,500	62,500	6 $\frac{1}{4}$	3125	312.500	1562 50

Notwithstanding the great precision respecting the quantity of leaf urged on our attention by the majority of writers on this subject, Mr. Smith says: "My rule is, to give the worms a few leaves at a time, and to supply them with fresh ones as often as they consume them—*night and day*. It is directed by the French and Italian writers, that a certain quantity, by weight, must be given them a certain number of times each day; but I have always found that they do best, begin to spin their cocoons soonest, and make better and more silk, *when fed as much as they can eat, night and day*, from the time they are hatched till they begin to spin. *I do not recommend large quantities of leaves to be laid on the hurdles at one time*, but rather moderate ones; and that they should be continually watched, and supplied with fresh food,

as often as the former supply is consumed." *Continual* feeding, not with superabundance, but with plenty, is here recommended. It may be done by the unremitting attention of persons who may relieve one another, *constantly* going round with baskets of leaves on the arm, to supply here and there a leaf, whenever and wherever wanted. *Well-filled and large cocoons will be the consequence.*

The necessity of *sorting* leaves, *chiefly* refers to those of the White Mulberry. From these we must *pick* twigs, stalks, spots, and all *wilted, withered*, and useless parts, prior to the cutting and distribution of the leaf. We are thus enabled to lay 20 per cent. less on the shelves, and prevent the unnecessary accumulation of litter, and increase of fermentation. This is especially necessary in the first ages of the worm, less so in the fourth, and may be altogether omitted in the fifth, when the vigour of the animal enables it to choose, and avoid or overcome impediments; and the quantity devoured by the rapacity of the fifth age, would render the trouble of picking something like the cleansing of the Augean Stables.

BRANCH-FEEDING, or the practice of feeding by branches, in the two last ages, is attended with several advantages. It saves time. The leaves are thus preserved from wilting longer, and more worms can be accommodated on the same space. Lay the branches six inches apart, *across* the shelf, but *lengthwise* at the next feeding; and so on, alternately at each successive feeding, forming a sort of crib-work for the free admission of air. There is less objection to this, if we are provided with either the Silk-worm frames already described, or any similar contrivance, to allow the passing of the litter through lattice-work to a sliding-shelf below. The lower tiers of the pile, where it rises too high, are easily removed by passing two smooth sticks between the parts to be left, and that to be taken away; when the former being raised, the removal of the latter is easily effected.

WET LEAVES. Feeding with *wet* leaves has not been uniformly condemned, but the majority, among whom are the most experienced, contend for the opposite course. In China it is entirely rejected, and their books everywhere forbid the practice. Some have asserted with boldness, that in feeding they always wet the leaves; and that the worms fed well, grew well, and spun well in all cases. There may be idiosyncracies among Silk-worms as well as among men; but the better practice is to avoid it. An experienced culturist of the present day, thus briefly sums up the arguments on both sides:—"We know that feeding with *wet leaves* will *not always* do harm, but we also know that it will *sometimes*; and as we cannot know *when* it will do harm, we would caution all silk-growers against the risk.* Gather the leaves, whenever possible, one or two days beforehand; so that in case of rain, feeding with wet leaves may be avoided."†

* "We have had our whole crop destroyed by it, twice in succession; and the Misses Waties, in South Carolina, lost all their worms, about 1,000,000, in 1830, from this cause." The disease induced by feeding with wet leaves, is the *tripes*, that often sweeps all before it, and against which we cannot be too much on our guard.

† Keep them for one or two days, in a cool, clean cellar, where they should be shaken or stirred occasionally. The butt-end of tops and branches may be set, an inch deep, in tubs of water. Large quantities both of leaves and branches, may be kept fresh even for three days, this way, if necessity require it.

CUT LEAVES. By European culturists, and many American, minute care has been devoted to the *cutting of the leaves*. They affirm, that the "finer the leaf is chopped, the more fresh-cut edges exist, on which the mandibles of the infant worm can fasten. In this state they bite the leaf quickly, and consume it before it is wilted. The worm that cannot eat, dwindles, becomes weak, and perishes under the leaf." They not only recommend cutting, but that the manner of it should be varied according to the age of the worm. Thus immediately after the hatch, to give leaves cut into "*slender shreds*;" a day or two after, "*finely cut*;" and for the rest of the age, "*cut very small*." In the second age, "*cut small*;" in the third age, "*more coarsely cut*;" in the fourth age, cut only to "*half size*;" and in the fifth age, "*without cutting*."* Others assert that they never could discover any advantage in cutting, as the worms will cut them fast enough; and that a young worm, not two hours old, will cut through the middle of the oldest and hardest mulberry leaf in two minutes.† This controversy is reducible to the question: Can nature in this be assisted by art?

NUMBER OF MEALS PER DIEM. Dandolo uniformly fed his silk-worms four times every day, and Europeans generally followed him, allowing an interval of six hours between every meal. *In the new system of rearing silk-worms, introduced into France by M. Beauvais and Darcet, twelve* repasts per day are given in the first and second ages, *eight* during the third and fourth, and *six* in the fifth age. But the method of CONTINUOUS FEEDING, and that *night and day*, seems entitled, by those who would have well fed cocoons, to special attention. On this plan the attendant, who at proper intervals is relieved by another, is kept *constantly feeding*; always passing along the shelves with a basket of leaves, and thus keeping the worms continually eating fresh food, by supplying here and there a few leaves, wherever they are without them, or nearly so. This is preferred by certain experienced culturists to the precision of feeding at stated intervals, a certain number of times every day, and regulating the quantity of each meal by weight. This, in short, is a system of weighing meals by the worms' appetites, and watching when it exists.

THE MOULTING; or *periodic shedding of the skin of the worms*, takes place *four times*, at intervals varying according to the manner in which they have been treated, or system pursued in the cocoonery. Those fed on the *French high-pressure system*, already noticed, will moult from every four to five days, and those fed on the common method will moult every seven to nine days. They remain in this state from 18 to 36 hours. Indications of an approaching moulting are manifested by the worms neglecting their food, holding their heads

* They should be cut with a knife having a fine sharp edge, or with the *cylindrical straw-cutter*, which will "cut the leaves better, and do ten times more work than any other contrivance now in existence."

† Were it not for fear of disturbing the singing birds on the banks of the Apomatox, we should say here, "*Utrum horum magis accipere*."

‡ Many persons suppose that the worms do not eat much at night. Very true, because they cannot then get it; but when they can, we are told, and our own observation confirms it, that they eat rather more at night, than in the day.

up, being motionless, and appearing to be asleep; when they should be as much unmolested as possible.*

APPEARANCES IN EACH AGE, OR AFTER EACH MOULTING. Immediately after *the hatch*, the larva appears like a minute woolly substance, of a dark chestnut hue, in rapid motion, and raising a head with a black shining speck. Its body is covered with regular lines of down, over a whitish skin. At this moment they are not one line† in length, or so small, that it requires 136 to weigh an English grain.‡ After the *first moulting*, it is of a dark ash colour, exhibiting a vermicular motion, with rings that by contracting or dilating the intervening distance, mechanically assist its movement. Its former scaly muzzle is replaced by another of greater hardness and power to divide its food. After the *second moulting*, its colour becomes of a light grey, its down shorter and scarcely perceptible. The muzzle, at first white and soft, becomes again black, shining, and shelly as before. After the *third moulting*, the muzzle becomes more lengthened and prominent, and the head and body are much more enlarged, and at the completion of this age, more wrinkled, of a fawn colour, and no down visible. *Fourth moulting*. It now assumes a greyish or darker colour with a red tinge. The greenish colour of the rings has disappeared, and their skin seems quite wrinkled. On the *twenty-ninth day*; the silk-worms are now upwards of *three inches* in length, in some cases even four inches. Their extremities grow shiny and yellowish; their bodies of an ivory colour and polish, inclining to blue, and somewhat transparent towards the neck. Six of them now nearly weigh one English ounce avoirdupois, and one weighs $69\frac{1}{2}$ English grains.

REMOVAL OF THE WORMS AFTER MOULTING. The times of moulting are of interest to the attendant, by affording convenient periods for *removal and subsequent cleaning of the hurdles or frames*. The Burlington silk-worm frame is cleaned by one operation with a machine like a three pronged fork, as in the cut which may be seen on the following page, and described in our specification of that patented improvement.

On the worms, as soon as they have revived, lay large fresh leaves, to which they will soon attach themselves. They may then, by laying hold of the stems, be easily transported to other hurdles or shelves, already clean for their reception; or better with the above rake, by lifting the straw and branches at one operation, and without loss of time. The practice of not cleaning or removing them till the third

* The worms of one day's hatch kept by themselves and properly fed, will generally moult about the same time. Whenever only a part of them moult on one day, and the other on the next, remove these distinct moultings to separate shelves. If this distinction be preserved throughout the feeding, and proper treatment continued, all the worms on one shelf can be made to spin at the same time. The convenience of this, especially in the spinning season, when confusion and much trouble might otherwise ensue, will amply reward the culturist for his care and precaution. The Chinese bring on the tardy worms to moult with the others by frequent supplies of food. They say, their backwardness proceeds from a *disease*, which dates from their hatching. They affirm that multiplying the feeding hastens the period of their moulting, which agrees with the French *high pressure* system. The Chinese, however, caution against too much hurry in feeding, as it produces injury.

† One twelfth of an inch.

‡ 100 weigh a Milanese grain.

moulting, is not to be recommended in large cocooneries, where the accumulation of litter is considerable, and, in warm weather, pernicious.

After the *third* and *fourth* moultings, if the *Burlington silk-worm frame* is not used, it will be more convenient to place a net-work hurdle, or latticed frame, having fresh leaves thereon, directly over the worms, and so near, that they can readily ascend through the meshes, when the lower shelves may be withdrawn for cleansing.

CLEANING OF HURDLES, SHELVES, OR FEEDING FRAMES. The necessity of this, especially in the third and fourth ages, when the litter, particularly in large establishments, rapidly accumulates to a serious degree, producing at all times, but more abundantly in warm weather, mephitic exhalations, is indispensable to the health of the whole stock. This will be readily acknowledged when we are informed that, according to the testimony of Dandolo, the litter and fecal matter to be removed from the worms of one ounce, during their last two ages, amounts to 1210 lbs.* Consequently the quantity to be removed from the worms of two ounces, in the same time, exceeds ONE TON!

* During the life of the silk-worms of one ounce, there has been carried away from the hurdles,

	In gross litter.			Of which existed in fecal substances.	
	lbs.	oz.		lbs.	oz.
In the 1st age—	1	4		0	$1\frac{1}{2}$
In the 2d age—	4	8		1	3
In the 3d age—	19	8		3	$9\frac{1}{2}$
In the 4th age—	60	0		18	$9\frac{1}{2}$
In the 5th age—	660	0		132	0
	745	8		155	$7\frac{1}{2}$

This 60 lbs. of litter for the 4th age, and 660 lbs. for the 5th, or 720 *Milan* pounds in all, will be equal to 1210 lbs. English avoirdupois.

Hence not only the necessity, but the trouble attending the constant removal of such vast masses of noxious matter, may be appreciated. The labour and expense of this, to those who have no better conveniences than the common shelves or hurdles, becomes a consideration, such as to intimate the propriety of being provided with the feeding-shelves already described; or in the want of them, with any contrivance admitting of the easy removal of litter; or drawers, latticed, to allow the passing of fecal substance to sliding shelves, 3 or 4 inches below, by which it is easily removed.

Silk-worms are frequently kept in bulk until the third moulting. Common shelves or tables, divided into squares, allowing the requisite space, will afford sufficient accommodation during the *first age*. Instead of forming small squares, in the *second age*, some dispose of them in long strips laid down the middle of the hurdles; so prepared, that by widening them on each side, the whole space they should occupy may be covered. And the same are employed with the requisite enlargement during the *third age*; but after the moulting, they are removed to the shelves, or frames; taking care throughout the whole to remove no worm until it is well roused from its torpid state.

As a general rule, the worms will require about double as much space after the first moulting, as they occupied previously. After the second moulting, they will require four or five; after the third, from ten to fifteen; and after the fourth, thirty or forty times the space required in the first age.*

FRENCH SYSTEM OF BEAUVAIS AND DAR CET. Sometimes called "THE HIGH PRESSURE SYSTEM," founded chiefly on the combined influence of a high and uniform temperature, with increased frequency of repasts, and constant renewal of the air. This is also termed the ARTIFICIAL SYSTEM, in contradistinction to the ordinary method, or NATURAL SYSTEM. The former is chiefly pursued in France,† but has not, we believe, been fully tried in this country, to any great extent. This system affords a fair comparison with the latter. The Journal of the American Silk Society says: "In the *natural* system, 40,000 worms consumed 2576 lbs. of leaves; in the *artificial*, 1985 lbs. These worms produced 130 lbs. of cocoons in the *natural* system, and 178 lbs. in the *artificial*. The cocoons weighed at the rate of 300 to the pound in the *natural* system, and 225 to the pound in the *artificial*. It required 10 lbs. 5 oz. of cocoons produced by the former, to make a pound of silk; and 9 lbs. by the latter. The 40,000 worms fed in the *natural* way, made 12 lbs. of raw silk; the same number fed on the *artificial*, made 19½ lbs. The *natural* system required one week more time to produce the cocoons than the *artificial*." "Thus it appears," says the same writer, that "the careful and attentive manager of Silk-worms will make his worms spin cocoons in four weeks:‡ eight pounds of his cocoons will make a pound of raw silk; and a pound and a quarter of his raw silk will make a pound of finished, or sewing silk." The manager, according to the common system, "will require six weeks before his worms spin their cocoons; ten pounds, at least, of his cocoons, will be required to make a pound of raw silk; and at least a

* See the Table, page 25.

† By M. Camille Beauvais, Dar cet, Robinet, Vasseur, Robert, Mazade, Reiva, Frimaudet, and others.

‡ This has been *recently* actually realized, in repeated experiments.

pound and six ounces of his raw silk will be required to make a pound of finished sewing silk."

Though by the artificial system a considerable increase of care and attention is indispensable, yet on the other hand, the duration of this is lessened; and more* abundant crop, with less expense of time and labour, will amply reward for additional toil and vigilance. Notwithstanding this, in all probability in the generality of cases the ordinary method will be for some time hence followed, whilst the artificial process will be pursued by the amateur culturist.

In the steam filatures in France, 1 lb. of silk is frequently obtained from 8 lbs. or 8 lbs. 2 oz. of cocoons. In the same filatures, about 3,000 cocoons of the common system are generally required for a pound of silk; but M. Vasseur has obtained the same quantity from 1369. There is, therefore, an evident result in favour of the artificial process; showing a gain of half the quantity of leaves, labour, space, and expenses; besides the production of a more beautiful quality of silk, with a great economy of labour in reeling also, since 1369 cocoons are reeled in less time than is required for 3000.†

It has been said that the success of the French system is the result of "a high and uniform temperature, increased frequency of repasts, and a constant renewal of the air." It is not, however, so much the consequence of any very high temperature,‡ *as of one uniformly maintained, accompanied by a constant renewal of the elasticity and purity of the air, by a complete and easily manageable system of ventilation; especially in the fifth age, when most wanted.* Success is also very much to be attributed to "an increased frequency§ of repasts," which probably would be improved by the method of continuous feeding already described; and to the ample space|| allowed the little locomotives to eat, breathe, and digest.

* Three times the weight of cocoons, in the neighbourhood of Paris, from the same quantity of eggs, have been thus obtained, more than the average produce in the Southern departments.

The average quantity of leaves to 1 lb. of cocoons, appears from a variety of cases now before us, to be 13 lbs.; and Count Reina obtains 1 lb. of cocoons from 10 lbs. of leaves; whilst it requires on the ordinary plan, as pursued in the same country, 40 and even 50 lbs. of leaves to 1 lb. of cocoons. From one ounce of eggs, also, there are generally obtained from 110 to 120 lbs. of cocoons. Count Reina obtained from the same quantity 168 lbs.; whilst the common system in the same country yields an average only of 60 lbs. of cocoons to an ounce of eggs. The cocoons are likewise larger; from 132 to 240 to the pound, are the limits that generally comprise the quotations; whereas, on the natural system, the number of cocoons to the pound varies from 240 to 350, and upwards.

The accounts from the Cocooneries at Drome and Vaucluse, acquaint us with the duration of each age of the worms managed after the artificial system; viz. *five* days for the first, including the moulting; *three* days for the second; *five* for the third; *five* for the fourth; and *six* for the fifth; or 23 days in all! This rapid acceleration of the several ages, and of the whole feeding season, *has hitherto been completely successful in the prevention of diseases*; an advantage of no small consequence to the culturist.

† The expense of labour to M. Mazade, in the rearing of 12 ounces of eggs, on this system, was at the rate of 40 cents a day to the men, and 25 to the women, only \$34 63; and his 1331 lbs. of cocoons, when sold as low as 35 cents per lb., returned him \$465 85.

‡ The quotations on this subject vary from 71° to 80°.

§ M. Planel gives 12 repasts per day, in the two first ages; 8 during the third and fourth; and 6 in the fifth age.

|| Count Reina allows in most cases only 46 worms to the square foot, and never more than 50.

CHAPTER IV.

DIARY OF THE FEEDING SEASON.

NOTE. A variety of desultory and promiscuous observations, commonly intermingled with the journal of the silk-worm, having been included in our preliminary remarks, for easy reference, arranged under certain heads, will enable us to abbreviate the following DIARY for the worms proceeding from ONE OUNCE.

There is something notoriously presumptive in prescribing the quantity of leaves for each day by the exact pound or ounce; whilst what the worms can eat, and what they ought to eat, depend on circumstances. We have information from all quarters, that a *proper and uniform* temperature, accompanied with efficient ventilation whenever requisite, very much increases their appetite, whilst neglect in these points has the contrary effect. It is preferable, therefore, to assign certain limits, the *maximum* and the *minimum*, within which, in all probability, the appetite will range, or to ascertain that practically by the continuous system already described.

First Age.

XVIII. For space to be allowed to the worms proceeding from ONE OUNCE, during this and every age, we must refer to the tables* and remarks on this subject already given.

XIX. *First day.* Give to the worms, divided into regular proportions, according to the number of meals intended to be given, from $1\frac{1}{4}$ to $1\frac{1}{2}$ lbs. of leaves. A larger or smaller quantity depends not only on the circumstances already stated, but also on whether we succeed in raising 40,000 or 30,000 from the one ounce of eggs.

XX. *Second day.* Allot for the day from $1\frac{3}{4}$ to $2\frac{1}{4}$ lbs. of leaf, according to circumstances above described, and divided into proportions or not, as directed, according to whether the plan of giving a certain number of meals at stated intervals, or of continuous feeding, be adopted.

XXI. *Third day.* Give from $3\frac{3}{4}$ to $4\frac{1}{4}$ lbs. of leaf. For the manner of cutting, and for every necessary information, we refer to the *preliminary remarks*.

XXII. *Fourth day.* Give this day, $1\frac{3}{4}$ to $2\frac{1}{4}$ lbs. of leaf. Signs of an approaching change are now manifest; a decreasing appetite; the shaking and elevation of the head: some become torpid towards the close of the day.

* See page 25.

XXIII. *Fifth day.* Only a few worms will be feeding; the rest are torpid: a few may revive. From $\frac{1}{2}$ to $\frac{3}{4}$ lbs. of leaf will be sufficient. In the course of this age, the worms have consumed from 9 lbs. to $11\frac{1}{2}$ lbs. of leaves.

Second Age.

XXIV. *First day.* Give from $5\frac{1}{2}$ to $6\frac{3}{4}$ lbs.; half, in either case, may be tender shoots, and the rest leaves.

XXV. *Second day.* Give, in the course of the day, from $8\frac{1}{4}$ to 11 lbs. of leaves. Place boughs wherever the worms appear to be too close, on which they will immediately fasten, and may thus be removed to fill up places not sufficiently covered.

XXVI. *Third day.* From 9 to 12 lbs. may be given this day, towards the close of which the appetite of the worms may decline; and the meals or leaves should be distributed proportionately to the avidity they indicate.

XXVII. *Fourth day.* Give this day from 3 to $3\frac{3}{4}$ lbs. To-day the worms are restless for their change, and sink into torpor. *In this age, the worms of one ounce have consumed from $25\frac{3}{4}$ lbs. 4 oz., to $33\frac{1}{2}$ lbs. of leaves.*

Third Age.

XXVIII. *First day.* From $8\frac{1}{4}$ to 11 lbs. The worms should not be removed from the shelves until they are nearly roused. A never-failing sign that they are revived is their undulatory motion when horizontally blown over. No injurious consequence will ensue, if those that have recovered, wait twelve hours till the rest are ready.

XXIX. *Second day.* From $26\frac{1}{2}$ to 32 lbs. should be given. If the feeding be by meals let the first be the least, for the worms now become more voracious towards the evening.

XXX. *Third day.* From $27\frac{1}{2}$ to 36 lbs. The first meal the most plentiful; since towards evening the hunger of this age begins to abate. The worms now grow fast; their bodies become transparent; their heads are longer, and every thing shows that another change is approaching.

XXXI. *Fourth day.* Give, in the course of the day, from

16 to 19 lbs. of leaves. The largest meal first, the last least. If a few, amongst many that are torpid, require food, give a slight meal without waiting for any hour.

XXXII. *Fifth day.* Allot from 8 to 10 lbs. of leaves for the supply of this day. The worm now seeks rest and retirement, climbs, when it has convenience, to undergo its change in solitude; and voids all matter impeding its transformation. Renovate the air by ventilation, and the use of slaked lime, sifted over them slightly before feeding.

XXXIII. *Sixth day.* This day is a kind of holiday amongst worms, but they fast likewise. To-morrow their lent will terminate. During this age, they have consumed from $86\frac{1}{4}$ to 108 lbs. of leaves.

Fourth Age.

XXXIV. *First day.* Let from 28 to 35 lbs. be given in the course of this day; one third may be young shoots, the rest leaves.

XXXV. *Second day.* From 48 to 61 lbs, according to the variable circumstances explained, may be given.

XXXVI. *Third day.* Give from 65 to 82 lbs.

XXXVII. *Fourth day.* From 74 to 93 lbs. The first meals during these last days being the largest.

XXXVII. *Fifth day.* Reduce now the supply for the whole day to from 36 to 47 lbs., since on this day the appetite begins to decline. Gradually lessen the meals from the first to the last. The worms are now $1\frac{3}{4}$ inches long.

XXXVIII. *Sixth day.* From 9 to 12 lbs. are to be allotted for the service of the day. These variable insects begin now, until their moulting, to decrease in size, by losing part of their substance, before they sink into torpor.

XXXIX. *Seventh day.* This day is allowed the worms to awake, and go to work again. They have, in the course of this age, of leaves, consumed from 260 to 330 lbs.; but their voracity will be six times greater in the coming age.

Fifth Age.

XL. Every thing is on the increase in this age; the food they eat, the litter they produce, the mephitic exhalations

arising therefrom, and generally the heat of the weather. All these must be met, by providing, in due time for the first, frequently removing the second, and by an efficient apparatus or means for ventilation; or otherwise disease may ensue and spread through the establishment at a time when the hopes of the culturist are about to be realized.

XLII. *First day.* From 52 to 66 lbs. according to the circumstances detailed. The first meal to be the least.

XLIII. *Second day.* Give 67 to 99 lbs.

XLIV. *Third day.* Give 155 to 165 lbs. Many of the worms are now upwards of two inches in length.

XLV. *Fourth day.* Give 160 to 197 lbs.

XLVI. *Fifth day.* Give 228 to 300 lbs.

Nearly throughout the whole of this age, it will be necessary that those who feed only at stated times, give, wherever requisite, intermediate meals. The rapid advance of the worm to maturity, its consequent voracity, and our success in obtaining well-fed cocoons, render this necessary. *Continuous feeding* satisfies this desideratum. Whenever the full quantity of a meal is devoured within an hour, it warrants the inference that an intermediate meal is proper.

XLVII. *Sixth Day.* From 275 to 333 lbs.

XLVIII. *Seventh Day.* From 264 to 333 lbs. Some of the worms are now upwards of three inches in length; in extraordinary cases, they have attained four inches. In size and weight, eleven of them will weigh two English ounces avoirdupois. Their voracity now abates, their extremities become shining and yellowish, and every thing indicates their rapid approach to maturity.

XLIX. *Eighth Day.* From 185 to 261 lbs.

L. *Ninth Day.* Give 148 to 182 lbs. From the first day of this age to the sixth, it will be proper to feed only at stated intervals. The first meal should be the least, and the rest gradually increasing to the last. After the sixth day, the *reverse* order is to be observed,—beginning with the most plentiful, and the rest gradually decreasing to the last.

L. *Tenth Day.* For the worms that have not yet risen, 66 lbs., given as occasion requires, will terminate the necessity of our further care and provision in feeding. The worms of one ounce have, of leaves, this age, consumed from 1569 to 2017 lbs., and in the whole five ages, from 1950 to 2500 lbs.*

* The former quantities throughout were from M. Bonafous, and the latter, from the Milan pound, both reduced into English avoirdupois.

NOTE. The following table presents a diary of the worms proceeding from *two ounces*, fed on the artificial system. As this was practised, and the results attained in this country, it will be the more interesting.

Date. 1839.	INTERNAL TEMPERATURE.				EXTERNAL TEMPERATURE.				NUMBER OF FEEDINGS.	Weight of Leaves lbs.	REMARKS.
	6 A.M.	noon 12	6 P.M.	night 12	6 A.M.	noon 12	6 P.M.	night 12			
June 30	78	78	77	78	70	78	70	68	18	2	
July 1	78	78	78	78	62	78	77	68	18	4	Morning cool: used heat.
2	76	78	78	78	70	77	71	69	18	8	The weather clear in the morning; and the worms lively. In the evening rain; wind S. E.
3	76	77	79	76	66	76	79	67		2	Worms commenced moulting.
4	75	76	75	75	65	76	75	60	12	16	Worms finished moulting.
5	72	72	76	73	56	70	72	60	12	22	Clear. Wind N. W.
6	72	75	76	73	55	72	73	65	12	30	Wind E. Brisk fires during the day.
7	73	76	78	77	60	80	70	68		2	Commenced moulting.
8	72	77	78	75	65	78	76	70	12	14	Finished moulting.
9	74	76	77	76	86	78	76	70	12	30	
10	71	79	82	79	65	80	82	72	12	80	Clear. Wind S. W.
11	76	82	80	75	71	87	74	68		6	Commenced moulting.
12	72	75	74	73	65	74	72	62	9	80	Finished moulting.
13	72	75	75	75	61	78	70	67	9	130	
14	72	75	75	71	68	76	74	67	9	200	
15	72	76	75	73	67	78	72	65	9	134	
16	70	75	76	72	64	79	78	64		10	Commenced moulting in the evening.
17	74	76	75	76	69	80	78	67			Quite dormant: not fed.
18	70	78	80	77	69	84	85	72	8	140	Finished moulting early in morning.
19	72	82	81	79	68	88	90	76	8	260	
20	76	82	82	78	76	86	82	74	8	400	
21	75	79	78	78	73	80	76	73	8	680	
22	74	82	82	79	74	88	82	79	8	920	
23	75	79	82	87	75	82	86	75	8	600	Signs of winding: food diminished.
24	72	79	77	73	70	86	75	73	8	200	Commenced winding.

NOTE 1. The worms were what is generally termed the six-week sulphur, and it will be seen that they terminated their labours in 24 days; the amount of cocoons was 356 lbs. (or 178 lbs. to the ounce of eggs,) and it required 225 to weigh a pound. The amount of leaves fed out was 3970 lbs., which gives 11 lbs. of leaves to 1 lb. of cocoons; and 9 lbs. of cocoons being required to produce a pound of silk, it will be seen, by this system of feeding, that 99 lbs. of leaves only are necessary for 1 lb. of silk. M. Beauvais produced 185 lbs of cocoons from 2000 lbs. of leaves, and Messrs. Cheneys 356 lbs. from 3970 lbs., the difference as to proportion being very slight.

2. Before the termination of the fifth age, it will be requisite to make timely provision of suitable conveniences for the spinning of the Silk-worms; to preserve, throughout the whole season, the cocoonery clean; the air purified; the frames well dusted with slaked lime every other day during the last two ages, and occasionally in the *third* age; the room also should be kept darkened and tranquil, free from noise, and the temperature nearly equal, but at no time subject to sudden changes.

3. If these provisions be neglected until some have begun to mount, we shall be invaded by the spinning season, where the worms are numerous, without adequate power to meet the exigency; when confusion and loss will be the consequence.

4. Conveniences for spinning may be either laths, nailed on edge-wise to the under side of the shelf above, and two inches wide, having

ladders of cotton cord, lath, branch, rope, rag, or any thing that will reach from the feeding-frame to the apartments over them, usually arranged at an angle of about 45° , so that the worms can conveniently climb up from below; or oak branches without leaves; or broom corn, wisps of straw tied in the middle and about 12 inches in length; or, in short, any bush, brush or bundle free from leaves, dirt, moisture, or offensive smell, into which they can crawl to spin. Set these quite across the shelf, forming arbours and arched at top, always leaving those not ready to mount liberty to complete their feeding till they also mount to spin.

5. Cold and damp weather during the spinning season is injurious: below the temperature of 62° the gum in the secretors congeals, no silk can be evolved, and the production of the cocoon is suspended until the proper temperature, from 68° to 71° , is restored. In changeable climates we must guard against cold and damp by fires, stoves, &c.; and in warm and sultry weather, our resource is shading and ventilation.

6. Hence our care, during this important season, is, 1st. To preserve the silk contained in the secretors of the Silk-worm in a constantly fluid state. 2d. To keep the skin of the worm sufficiently dry, and constantly in that requisite degree of contraction, without which it would perish. 3d. To free the air from being contaminated with noxious influence at the time when the animal requires its utmost vigour to deposit all its collected treasure.

LII. On the last day of the fifth age, the Silk-worm is perfected; *it finishes its spinning in three or four days*, and in *seven or eight* the cocoons may be gathered from the corners in which they have been elaborated.

NOTE 1. Some worms may possibly linger, and not climb on the above day. Whenever possible, place these in a distinct room having a temperature of 73° , and a few leaves, and twigs or branches, prepared for them. This warmer temperature will invigorate them, and, in other cases, increase their appetite. Some will then mount directly, and others will eat and then rise. Those that drop down whilst spinning, should be placed with the lingering worms. A dead worm, or any thing noxious, must be removed.

2. The time in which the Silk-worms finish their cocoons, somewhat depends on the weather, and the temperature with which they are treated. Healthy worms will complete their work in two or three days, reckoning from the time they begin to cast their floss. If, on gently pushing a cocoon with the fingers, we perceive it has attained a firm consistency; or, on shaking it, the chrysalis seems to be loose and to rattle within, that cocoon is perfected. If all do not rise on the same day, it is usual not to gather the cocoons till the seventh or eighth day; or remove those that continue to feed to another place, and then collect the cocoons in three or four days.

3. Supply worms disposed to eat after others have begun to spin, with the best kind of leaves. Feed such often, late at night, and early in the morning: for the quantity of silk, strength and activity in spinning, depend on their being fully supplied so long as they have the

capacity to eat. *Give plenty, but little at a time*, is a general rule to be observed throughout the whole.

Mode of distributing the silk in spinning.

LIII. In gathering or *sorting* of cocoons, it is convenient to be accompanied with four baskets: in the *first* place those that are designed for breed; in the *second*, the dupions; in the *third*, the firmest and hardest for reeling; and in the *fourth*, those which are of a looser texture.

NOTE 1. Those which are very thin, unfinished or spotted, should form a *fifth* sort. We may indeed, reckon *nine* different qualities, the particulars of which may be seen under the head of REELING.

Cocoon, when fully elaborated.

2. In gathering cocoons, they should not be bruised, but taken carefully from the arches or bushes with their floss. They should be removed with great delicacy, the fibres not pierced, and the whole not pressed nor flattened.

The chrysalis, after the spinning has been completed

LIV. In from 6 to 15 days after the formation of the cocoon, the chrysalis emerges from its habitation, and becomes a MOTH.

NOTE 1. The precise time required for this, depends on the temperature. If *below* 66°, the development of the new state is tardy; if *above* 73°, it is too rapid to secure efficiency in propagation. The temperature of the apartment, therefore, should be between 66° and 73°.

2. The moth effects its egress by depositing a liquid on the point through which it intends to make its passage. Hence its disposition to emerge is discovered by external appearance some hours before; but sometimes even in one hour the moth pierces and comes forth to secure the last function of its existence.

3. The moth always makes its appearance from day-light or sunrise till 10 or 12 o'clock at noon, but seldom or never in the afternoon or night. The larva also appears from the egg at the same hours.

LV. This should only be suffered to take place with so many cocoons as are necessary to supply a stock of eggs; as every pierced cocoon is unfit for reeling.

NOTE 1. In most cases the moth, by piercing, injures the cocoon for winding; such, therefore, are set aside for floss, and spun like cotton. These, together with pointed, light and inferior cocoons, constitute what is called waste silk, and should be treated in a peculiar way.

2. Therefore, lest cocoons should be thus lost by negligence or delay, it is necessary, after we have selected what is requisite for the production of eggs, that the chrysalis, as shall be hereafter described, be killed in the rest, if the reeling cannot be done before the moths pierce, which is the better way, when possible.

LVI. For re-production, select the well-formed cocoons, having one or both extremities hard, a little depressed in the middle, and those that were spun in the proper time from the hatch: in colour, prefer the white, and next in order the paler yellow, the drab-brown, or mammoth white.

NOTE 1. The white cocoon is always the finest, and commands the highest price in the raw state; the reeling being under equal circumstances. The deep yellow is seldom so fine, and is usually more gummy; it will not *ungum* so clear a white as the others, always retaining more or less of the colouring matter. The duskiness, therefore, of such, can only be hidden under some dye.

2. Attention to this is of importance; for if soft or imperfect cocoons are chosen for this purpose, which are the produce generally of weak worms, the future broods will degenerate, both in size and vigour, and give more trouble, with less profit, than strong and healthy ones.

3. We should endeavour to have an equal number of males and females. There are no signs, invariably infallible, to pre-determine this. The following, perhaps, are the least erroneous. *The male cocoons are smaller, sharper at one or both ends, depressed in the middle as if with a ligature: the round, full cocoons, which are little or not depressed in the middle, but more obtuse at each end, contain the female moths.*

LVII. Fourteen ounces of cocoons are equal to one ounce of eggs; and one ounce of eggs will produce from 112 to 127 lbs. of cocoons, if carefully managed on the *natural system*; and from that to 165 lbs. on the *French, or artificial system*.

NOTE 1. Some say 16 ounces, and others as high as 20 ounces of cocoons to one ounce of eggs; or to ascertain, the number of cocoons required, it has also been recommended to divide the number of eggs wanted next year by 150. Thus, if 200,000 are wanted for the next year, divide 200,000 by 150, and the quotient, 1333, shows the number of cocoons requisite for this purpose.

2. Spread the cocoons when selected on two tables; the males on one, and the females on another, to prevent their premature union. Let the room be darkened, and the temperature between 68° and 73°.

The sex of the moth is easily distinguished when out of the cocoon: the male flutters his wings, and moves about with rapidity, especially on the admission of light; the female is comparatively quiescent.

3. When the cocoons are first laid on the table, divest them gently of their floss, to prevent the moth being entangled in its egress.

4. When the moths have had leisure for the discharge of the viscid humour, that would prevent their fecundity, which takes place in an hour, take them gently by the wings from off the cocoons, and place them by pairs, male and female, on smooth cloth, or on clean white paper; but newspapers of firm texture will answer. After being united, they should not be permitted to remain longer than from morning till evening. If they separate prematurely, they ought to be brought together again. The female moth will lay her eggs in the night.

5. If there be an excess of males, or of females, reserve them for a few hours in darkness. The males that remain longer with their first females, than six hours, may be gently separated, and put with the unpaired females, kept apart for that purpose.

LVIII. Place the separated females on white or light-coloured paper, calico, or linen, at proper distances to deposit their eggs, where leave them for forty hours unmolested.

NOTE 1. Let the temperature be from 68° to 78° . The time when the greatest number emerge from the cocoon is from 6 to 7 o'clock, A. M. Consequently the coupling takes place at about 9 o'clock, and at 4 or 5 o'clock, P. M. The males may be detached, and the females disposed of as already described.

2. The eggs adhere to whatever the moth lays them on, by the natural gum, with which they are covered when deposited. They are at first of a pale yellow, then greenish, afterwards somewhat red; and in about 12 or 15 days after being laid, they attain a bluish grey colour, which colour they retain till near the time of hatching. Their form is lenticular, and they resemble poppy-seed.

3. When the eggs have passed through these changes, the cloths or paper on which they have been deposited, must be folded so as to admit air into them, to prevent them from heating. The air should be dry, not above 45° to 51° , nor below zero, but not exposed to sudden changes of temperature; or if they can be kept between 32° and 51° without injury from damp, they may be regarded as good and sound. They must be preserved from birds, insects, and vermin.

LIX. If a stock of eggs, sufficiently large, be preserved as directed in another place, portions of them may be hatched at different times during the summer; and thus SUCCESSIVE CROPS may be raised.

NOTE. The advantages of successive crops are evident. A room that will contain only 50,000 worms at one time, may thus accommodate SEVEN times that number, at seven distinct and successive periods during the summer, by hatching a crop every three weeks, and keeping the young worms by themselves, until the old ones spin their cocoons. Thus 350,000 may be raised during the summer. One person can attend to them, with occasional assistance, when cleaning the shelves is requisite; and thus will become better acquainted with the management than could be the case if only one crop were raised.

LX. Of each cocoon intended for reeling, the chrysalis must be destroyed between the 4th and 12th day after completion, or it will cut its way through, and render the reeling of its work impracticable.

NOTE 1. THE CURING OF COCOONS has been found, under certain circumstances, a work of considerable difficulty; the plans adopted have, therefore, been various. In our former Treatise, it is observed that, "where the quantity of cocoons is small, the necessity of 'CURING' may be superseded by immediate *reeling*; or if the culturist has on his premises an ice-house, in which to deposite the cocoons, the necessity is obviated, as the chrysalis will remain in a passive state, until brought to a temperature of from 40° to 50°. Checked by the cold of an ice-house, they may be reeled without further curing, or stifling; but every one has not this convenience, or an ice-house is not always nigh at hand, and some process of curing becomes, therefore, essential.

2. There are several methods of killing the *pupa*. 1. By BAKING in an oven, heated to 88° or 89°, wherein the cocoons are shut up from four to six hours, after being first placed in bags, which must be occasionally turned, to effect an equal exposure. 2. By the SUN'S RAYS, at a temperature of about 88°; in which they may be left for three days, from 9, A. M. to 4, P. M. 3. By STEAM. For this purpose, place the cocoons in a basket lined with three or four folds of woollen cloth, to promote the equal dispersion of the steam. Let the cocoons remain in the basket, of dimensions such as to cover the mouth of the kettle. After the basket, raised upon two pieces of intervening wood, has been placed over the kettle, with water kept boiling over the fire, it must remain in this position till the chrysalides are killed. 4. By SUFFOCATION in the gas of charcoal, which is effected by simply shutting the cocoons up for a single night in a close room, wherein a pot of charcoal is placed.* 5. By CAMPHORING.† It is recommended to take about three ounces of camphor to 100 lbs. of cocoons, in the floss. The camphor is moistened with alcohol, and then rubbed into a powder; a part is sprinkled on the bottom of a box, which is then filled by making layers or strata of cocoons, laying camphor between each.

* Method recommended by Mr. G. B. Smith, of Baltimore.

† Recommended by M. Rapp, of Economy, Pa.

The box being full, the lid is then fastened on with screws — every hole and joint being covered with paper and paste to render it air-tight. After three or four days, they must be taken out, and dried perfectly. They should be assorted before camphoring, or else the bad cocoons will spoil the good ones.*

* Having given various methods proposed by others, some of which have been long practised, we will now propose one of *our own*, which, we believe, has the merit of being *original*, and in larger establishments would be more economical, speedy, safe, and convenient, than any yet announced to the public. Let a common tub-shaped refrigerator be selected, without the internal fixtures. This tub may be two or three feet, or more, in diameter, and of a proportionate height. Its lid should shut down tight. Let a *tin vessel* be made and fixed to stand on the bottom, in the centre of the tub, but two or more inches smaller in dimensions all round. Into this tin vessel, capable of holding from one to three or four bushels, throw the cocoons. Then prepare a frigorific mixture, thus:—Take snow or powdered ice, seven parts, and diluted nitric acid, four parts;—or powdered ice or snow, four parts, and muriate of lime, five parts. Throw one of these mixtures into the vessel, outside the tin case, in which the cocoons are. The temperature will immediately fall from 62 to 70 degrees below what it was before the mixture was thrown in, without injuring the silk, and will destroy the chrysalides.

If ice, three parts, and potash four parts, be mixed and thrown in

*The Chinese have another method of destroying the chrysalis, which has been successively tried in France, introduced into that country by M. Julien, and is thus described by Mr. Pavis, whilst referring to the experimental investigations of Beauvais—for a translation of which we are indebted to Dr. Emerson, of this city. The Chinese method is, by placing the cocoons in close jars, with alternate layers of common salt. M. Beauvais made many experiments to accomplish this object; and in his first trials succeeded in destroying the life of the insect, but found the cocoons softened and stained. He, however, finally succeeded in killing the chrysalides, and at the same time preserving all the good qualities of the cocoon. To effect this, he put into a jar, or vase, a layer of salt, well dried, one inch deep; and at the top of this, a bed of cocoons, six or eight inches deep, which he again covered with a layer of salt, then added a second bed of cocoons, and so on, alternately.

For the success of this plan, several precautions are necessary. In the first place, *the salt must be previously perfectly dried in a furnace.* The vessel used for stifling the cocoons *must be so effectually stopped as to be air-tight; and the layers of salt separated from those of cocoons by sheets of paper pierced with holes.* In the course of a few days the chrysalides die, and are dried by the powerful attraction which the salt has for their moisture, when dead. The salt thus used is pulverized, since in this state it occupies greater space, and exerts its drying effects more quickly and intensely.

If, as there is strong reason to believe, further experience should establish the excellency of this method, the process would be very simple, and, once adopted, would be attended with but little expense.

The cubic foot of cocoons, heaped, would weigh, on an average, at least, 12 lbs. French, equal to 13 lbs. 5 oz. English avoirdupois, or *one-seventh* of the cubic foot of pulverized salt. But the volume of cocoons is seven times greater; so that the weight of the beds of cocoons will be equal to the layers of salt. To hold 112 lbs. of cocoons, a space equal to nine cubic feet, or three hecatolitrés, will be necessary. To large establishments, tubs of cedar or pine, containing from 27 to 36 cubic feet, will be sufficient to hold three or four hundred weight; and would cost from 30 to 40 francs. After the first cost, about 30 francs for the tubs and salt inclusive. The expense incurred every succeeding year would be less than that attending the ordinary methods, since the same salt will answer at all times, by having it thoroughly dried every year, previous to using it.

upon one of the above mixtures, the cold will be still greater. And if to these mixtures we add another of ice three parts, and muriate of lime four parts; or of ice eight parts, and diluted sulphuric acid ten parts, the cold will be extreme, and the chrysalides be killed in less than an hour. The quantity of cocoons to be thus cured need not be great, as the operation will not occupy more than from thirty to sixty minutes; thus requiring a less quantity of the mixture. The same frigorific ingredients may kill several charges of the tin vessel of cocoons. They should be dried in the air to abstract the moisture contained in the chrysalides. It will be best if dried in the shade. If the operator be a man of science, he may recover the salts, thus employed, from the solution, and thereby, by using it again and again, save all future expense. The salts and ice should be always reduced to powder to produce their most powerful frigorific effect.*

LXI. The diseases to which silk-worms, generally through negligent or improper treatment, are liable, are 1. The *Passis*; † 2. The *Grasserie*; ‡ 3. The *Luisette*; || 4. The *Yellows*; 5. The *Muscardine*; § and 6. The *Tripes*. ¶

NOTE 1. The *Passis*, is a kind of marasmus, or wasting away; easily known by the *yellow tinge*, the lengthened shape and wrinkled skin. The worms eat little, languish, and are in a state of *atrophy*.

2. In the *Grasserie* they eat, but do not digest, swell, become greenish, are covered with a viscous humour, contagious to other worms, and should be removed.

3. The *Luisette*. In this disease their colour changes from a clear red to a dirty white, and becomes transparent; hence the term, the *shiners*.

4. The *Yellows*. They swell, become yellow, cease to eat, run about leaving stains of yellow, become soft, burst; and the morbid humour is fatal to the worm that touches it.

5. The *Muscardine*. Black spots, yellow, then red, hard, dry, and covered with a white mould, which, according to the new theory, is said to be a vegetable excrescence.**

6. The *Tripes*. They become flaccid and soft; when dead, they feel, it is said, like *tripe*.

7. The *causes* are said to be, defect in the egg, or from the eggs of weak and unhealthy worms; errors in the preservation or hatching of eggs; impurity of the air in which they are kept, arising from

* Two substances that have been the longest known, and are familiar to every one, are common salt and snow, or nitrous acid and snow. Powdered ice may always be substituted for snow, but it should be well pulverized, as the frigorific effect will be in proportion to the state of levigation they undergo. Chrystallized muriate of lime deserves attention, as being the most powerful frigorific material hitherto known. But the muriate of lime is difficult to keep from liquefaction. It possesses, however, very intense energy. When the salt and snow, or powdered ice, are mixed, the cold produced will freeze quicksilver. See Accum's Amusements of Chemistry.

† This vague expression signifies the mere generic idea, suffering.

‡ From the French *gras*, *grasse*, fat, full.

|| From *luire*, to shine.

§ Numbness.

¶ Mort Blanc.

** See Journal American Silk Society. Vol. i. pp. 135 to 137.

feculent deposition, exhalation, and the want of a frequent and perfect ventilation; too close crowding; sudden changes of temperature: cautions against all these have been already given.

8. French and Italian writers have prescribed many remedies. Cleanliness, and pure dry air, are, however, the only preventions, as well as remedies. The rest are fanciful and useless. Be it, however, recollected, that the French *Artificial* system, already described, by promoting the vigour, and rapidly accelerating the growth and ages of the worm, has hitherto in every case, where unsound eggs or imprudence have not interfered, been found an effectual preventive of disease; and the essentials of this system are, *ample*, or *sufficient space*, constant attention to *cleanliness*, *ventilation*, an *equilibrium of temperature and feeding*.*

MISCELLANEOUS STATISTICS.

STATISTICS RELATIVE TO SILK-WORMS.

1. FROM the time of the moths laying their eggs, until their removal to the hatching-room, or 9 months, they lose only one-hundredth of their weight. 2. From the time that they enter the hatching-room, until they begin to hatch, they lose on an average 47 grains per ounce, or about one-twelfth of their whole weight, or about 52 grains in all. 3. The weight of the shells of the eggs, after hatching of the worms, amounts to 116 grains; or in all 168 *Milanese* grains, equal to 122

* A writer in the American Silk Society's Journal says, "we are keeping the cocoonery well ventilated, clean as possible, using plenty of chloride of lime, and a French method recommended after 20 years' experience—to *sprinkle the worms freely with quick lime*!" This is certainly a mistake, for quick lime would be inevitable destruction, more from its chemical affinities, than from its causticity. This, however, is explained in a subsequent letter, without the writer being sensible of his own error. He says, "I take the lime as it comes from the barrel in the lumps, and *sprinkle it with water*, sufficient to cause the lumps to tumble to pieces, and become fine." Then it is no longer *quick lime*, but a *hydrate of lime*, or in common language, *slaked lime*. "I then take a fine wire sieve, and sprinkle the lime on the hurdles, quite covering the same with the lime. Soon after the heavy sprinkling of the lime, we feed the worms with a light portion of food, which we sprinkle with *brandy* and water, say one quarter brandy, and three quarter lbs. water. There is no fear of the lime being injurious; as it appears to revive the worms and increase their appetite. The worms, if possible, should be shifted within twenty-four or forty-eight hours after the sprinkling, and all the sick worms taken from the hurdles. The lime may be repeated [daily] until the sickness disappears. After giving them the second sprinkling of lime, we have found it to be useful, when the sickness is not entirely checked, to feed the worms very lightly, say one meal in twenty-four hours, or even to miss feeding for twenty-four hours. This of course retards the growth of the worms, but I believe will cure the *Jaundice* or *Yellows*."

To those who would become successful feeders, the information contained in the above note is of great value. *Hydrate* or *Chloride* of lime is of immense value. The frames or hurdles should be sprinkled or dusted with the slaked lime, through a fine hair or wire sieve, once in two days, or if the worms are inclined to be sickly, even more frequently. This practice has been followed in France for *ten years* with the greatest success. No unfortunate result is known to have resulted from this practice.

English grains. After deducting 168 Milanese grains from the Milan ounce of 576 grains, the worms of an ounce, or 39168, would only weigh 408 Milan grains, and in this state he found that it would require 54625 worms just hatched, to weigh one Milan ounce of 576 grains, equal to 420.3009 English grains.

And if from an ounce of 437.5 grains we deduct 122 English grains, the 40770 worms of the same kind, composing one ounce, would then only weigh 315.5 English grains, and it would require 56535 of the same kind of worms just hatched, to weigh one ounce avoirdupois.

FACTS RELATIVE TO THE INCREASE AND DECREASE OF SILK-WORMS IN WEIGHT AND SIZE.

Progressive Increase.

100 worms, just hatched, weigh about	1 grain.
100 worms, after the first moulting	15 "
100 worms, after the second moulting	94 "
100 worms, after the third moulting.....	400 "
100 worms, after the fourth moulting.....	1628 "
100 worms, on attaining their greatest weight	9500 "

Thus have they in 30 days increased 9500 times their primitive weight. 9500 Milanese grains are equal to 6932 English grains.

The length of the silk-worm, when just hatched, is about ..	1 line.
After the first moulting its length is	4 "
After the second do. do.	6 "
After the third do. do.	12 "
After the fourth do. do.	20 "
In the fifth age, many attain the length of	40 "

The length of the silk-worm is thus increased 40 times in 28 days, which are equal to 44 lines English, or $3\frac{3}{4}$ inches.

Progressive Decrease.

100 silk-worms, when arrived at maturity, weigh.....	7760 grs.
100 chrysalides weigh	3900 "
100 female moths weigh	2990 "
100 male moths weigh	1700 "
100 female moths, having deposited their eggs	980 "
100 female moths, dying naturally, after having deposited their eggs, and nearly quite dried	350 "

In the space of 28 days more, the silk-worm has lost 30 times its own weight.

The daily loss in weight of the cocoons of 1000 ounces, from the time of formation till the moth is about to escape from them, is thus stated by Count Dandolo.

Gathered from the cabins, fagots, &c., and cleaned, the cocoons weighed	1000 ounces.
First day following, the said cocoons weighed	991 "
Second day	982 "
Third day	975 "
Fourth day	970 "

Fifth day	966 ounces.
Sixth day	960 "
Seventh day	952 "
Eighth day	943 "
Ninth day	934 "
Tenth day	925 "

Thus in ten days, the cocoons lose $7\frac{1}{2}$ per cent. by the desiccation of the chrysalis alone.

As the object of the four preceding tables was merely to show the relative proportions of increase and decrease, it was unnecessary in this case to reduce them to English proportions.

Again, the increase in weight and size may be estimated by the following table.

	English avoirdupois.
At the hatch, 56,535 worms weigh	1 ounce.
After the 1st moulting, 3769 worms weigh	1 "
After the 2d moulting, 601 do. do.	1 "
After the 3d moulting, 142 do. do.	1 "
After the 4th moulting, 35 do. do.	1 "
In the 5th age, 6 worms weigh nearly	1 "

This is calculated on the premises of Dandolo's proportions,* but reduced to the avoirdupois ounce.

Number of Cocoons obtained from the ounce of eggs. It is very evident that this must depend on a variety of circumstances; not only on the species or variety of Silk-worms we employ, but also on our manner of rearing them, by the ordinary or *natural* system, as it is called, or by the *artificial* system, as practised by the French amateur culturists. We have long statistical lists in either case, which our limits do not admit us to quote at large. Suffice it to say, that the extremes of the results, according to the former, are 56 lbs. and 113 lbs. to the ounce of eggs, and the average 96 lbs. of cocoons to the ounce. Had this consideration been confined to France, or rather to that culture which is practised by the French tenants and peasantry, where often not more than 44 lbs. are obtained to the ounce, both the extremes, and the average, would have been considerably lower than those given. But that given above, is a result comprising several cases of culture in this country, which, although pursued with ordinary care, has been successful to the extent specified.

Of the results of the many cases before us, and pursued according to the French "*high pressure system*," the extremes are 121 lbs. and 178 lbs. of cocoons to the ounce of eggs; and the *average of all the cases is 150 lbs. of cocoons to the ounce.*

POUNDS OF COCOONS TO THE TON OF LEAVES; 2240 lbs. TO THE TON. The extremes of the several cases on our list, referring to the *natural* system, including those amongst the peasantry of France, where results are low, are from 44 lbs. to 130 lbs. of cocoons to the ton of leaves; and the average of all the cases is 98 lbs. of cocoons to the ton; or nearly 23 lbs. of leaves to 1 lb. of cocoons. Of the *artificial* system,

* One Milanese grain is equal to .729,689 of an English grain; and one Milan ounce to 420.3009 English grains.

the extremes are 132 lbs. to 256 lbs. of cocoons to the ton of leaves; and the average of all the cases, is 191 lbs. of cocoons to the ton; or $12\frac{3}{4}$ lbs. of leaves to 1 lb. of cocoons.

NUMBER OF COCOONS TO THE POUND AVOIRDUPOIS. The extremes of the numerous cases now before us, of the *natural* system, are from 245 to 350 cocoons to the pound, and the average of this class is 290 cocoons to the pound; with the acknowledged assurance on all hands, that even on the natural system, with proper management, cocoons as heavy as 250 to the pound may and ought to be obtained. Of the *artificial* system, the extremes are 132 to 240 cocoons to the pound, and the average is 180 to the pound.

POUNDS OF COCOONS TO THE POUND OF RAW SILK. The result of all experience on this question is, that on the *natural* system it requires 10 lbs. or $10\frac{1}{2}$ lbs. of cocoons to produce 1 lb. of reeled silk; on the *artificial*, 8 lbs., $8\frac{1}{2}$ lbs. and even 9 lbs., of which $8\frac{1}{2}$ lbs. of cocoons may be taken as the average to 1 lb. of raw silk.

The French artificial, or high pressure system, has introduced a new consideration relative to sericulture, and consequently must necessarily have its effect upon all calculations referring to the same. This subject, and the comparison resulting therefrom, have already called for the remarks of several gentlemen of well-known experience; and we cannot, therefore, do better than quote, in the sequel of our statistical inquiries, what is essential to our government in this important enterprise.

It will be recollected, in the former part of this work, that on the average 1 lb. or 16 ounces leaves, enough for 16 silk-worms, may, according to recent experience, be expected from each multicaulis tree of the first year's growth, *if planted on a favourable soil*; and that 10,000 such trees may, with propriety, be planted on one acre, producing 160,000 ounces of leaves, sufficient for the supply of 160,000, or 4 ounces of silk-worms.

"On the *natural* system, we should make our estimate thus: 100,000 trees" (10 acres) "will produce 100,000 lbs. of leaves the first season, which will feed 1,600,000 worms; and these worms will produce 533 lbs. of reeled silk," (i. e. calculating 3000 cocoons to the bushel, or 10 lbs. of cocoons to 1 lb. of silk,) which, at \$5 per pound, amounts to \$2665. "These will be most conveniently raised in three successive crops of 534,000 each, which can be attended to by one adult man or woman, and five girls or boys, in the course of the season." This is at the rate of \$266 per acre.

"The *artificial* system resulted in producing 356 lbs. of cocoons from 80,000 worms. These worms consumed 3970 lbs. of leaves, and 9 lbs. of the cocoons produced 1 lb. of reeled silk. From these data, it appears that four-fifths of an ounce of leaves was the average quantity required for each worm; and that, 2025 worms made a pound of silk. If we take this as the basis of calculation, then 100,000 trees will produce 100,000 lbs. of leaves, which will feed 2,000,000 worms, that will produce 987.75 lbs. of reeled silk, which, at \$5 per pound, will amount to \$4938 75; or at the rate of \$493 87 per acre."

"Now, let us contrast the results of the two modes. In both systems, the ground occupied by the 100,000 trees is the same, and the

amount of foliage is the same. In the *natural* system, the 100,000 trees fed 1,600,000 worms; in the *artificial*, 2,000,000.* In the *natural* system, these made 533 lbs. of reeled silk, worth \$2665; in the *artificial* system, 987.75 lbs. worth \$4938; difference in favour of the *artificial* culture, \$2273, or 85 per cent. which is more than enough, with considerable profit, to pay the whole expense, by the latter process, of producing the silk ready for market.

"Persons desirous of making silk on the *natural* system, can ascertain the number of worms they can feed, by multiplying the number of their trees by 16. Thus, A says he has 10,000 trees (say of one acre); these multiplied by 16, give 160,000 worms that he can feed; or 160,000 to the acre. It is generally considered that one ounce of eggs contains 40,000; but in practice, it is found that only 30,000 worms are obtained from an ounce of eggs, i. e. as said before, out of 40,000, 30,000 surviving to the cocoon.

"Those desirous of feeding on the *artificial* system, can ascertain the number of worms they can feed, by multiplying their trees by 20. Thus, B finds he has 10,000 trees; these, multiplied by 20, give 200,000 for the number of worms he can feed; i. e. 200,000 on every acre, or the worms of five ounces.

"It must be borne in mind that these calculations are all made on the first year's growth. The second year, the trees will produce from 50 to 100 per cent. more foliage; and on the third and fourth years, the produce will be proportionably increased.

"But let us make a calculation for the farmer's domestic use, for the production of silk, as an article that should be produced in all our farmers' families. Suppose the farmer has 5000 trees, or the trees of half an acre; his children gather the leaves, and his daughters feed and attend to 80 or 100,000 worms; (two ounces) this they can do, without materially interfering with any other management or business. They can reel the cocoons during their hours of leisure, and the result is $26\frac{1}{2}$ lbs. of reeled silk, the first year the trees were planted—worth to them \$133 33, without a cent of cost, or the addition of a cent to the expenses of the farm!"*

Admitting that the above statement alludes to two cases, each showing the best that can be done in the system to which it refers, we adopt it as affording, from actual trial and matter of fact, the elements of a comparison, and now present the whole in the following tabular synopsis:

* Journal American Silk Society, for the accuracy of which that work must be responsible, as we have not ourselves sufficiently tested the artificial system, to endorse all that is said of it. In France, however, it is said that it fully sustains all the favourable reports of it.

STATISTICAL PROPORTIONS,

Founded on actual trial relative to the NATURAL SYSTEM.

Ounces of Eggs.	Weight of cocoons at 133 $\frac{1}{3}$ pounds to the ounce of eggs.	Number of trees requisite at 2500 trees to the ounce.	Produce of an acre at 10,000 trees to the acre.	Weight of reeled silk, at 10 lbs. of cocoons to 1 lb. of silk.	Value at \$5 per pound of reeled silk.
Oz.	Lbs.	Trees.	Acre.	Lbs.	Dollars.
1	133 $\frac{1}{3}$	2500	$\frac{1}{4}$	13.3	66.66
2	266.6	5000	$\frac{1}{2}$	26.6	133.33
3	400.0	7500	$\frac{3}{4}$	40.0	200.00
4	533.3	10,000	1	53.3	266.66
5	666.6	12,500	1 $\frac{1}{4}$	66.6	333.33
6	800.0	15,000	1 $\frac{1}{2}$	80.0	400.00
7	933.3	17,500	1 $\frac{3}{4}$	93.3	466.66
8	1066.6	20,000	2	106.6	533.33
9	1200.0	22,500	2 $\frac{1}{4}$	120.0	600.00
10	1333.3	25,000	2 $\frac{1}{2}$	133.0	666.66
20	2666.6	50,000	5	266.6	1333.33
30	4000.0	75,000	7 $\frac{1}{2}$	400.0	2000.00
40	5333.3	100,000	10	533.3	2666.66
50	6666.6	125,000	12 $\frac{1}{2}$	666.6	3333.33
100	13,333.3	250,000	25	1333.3	6666.66

It will be seen, by comparing this table with that on the next page, that the difference of the proceeds of 100 ounces, reared on the *natural* and *artificial* system, is \$3222 22; and in the same proportion for any other quantity. The latter admits of no deficiency of food, and no delays in feeding; a sufficiency of manual labour must always be ready, and at command, to carry the whole thoroughly into execution. But as a compensation, the duration of this additional exertion is shortened into four weeks, instead of five or six, with an abundant increase of profit.

STATISTICAL PROPORTIONS,

Founded on actual trial, relative to the ARTIFICIAL SYSTEM.

Ounces of Eggs.	Weight of cocoons at 178 pounds to the ounce.	Number of trees requisite at 2000 trees to the ounce.	Produce of an acre at 10,000 trees to the acre.	Weight of reeled silk, at 9 lbs. of cocoons to the lb. of silk.	Value at \$5 per pound of reeled silk.
Oz.	Lbs.	Trees.	Acre.	Lbs.	Dollars.
1	178	2000	$\frac{1}{5}$	19.7	98.88
2	356	4000	$\frac{2}{5}$	39.5	197.77
3	534	6000	$\frac{3}{5}$	59.3	296.66
4	712	8000	$\frac{4}{5}$	79.1	395.55
5	890	10,000	1	98.8	494.44
6	1068	12,000	$1\frac{1}{5}$	118.6	593.33
7	1246	14,000	$1\frac{2}{5}$	138.4	692.22
8	1424	16,000	$1\frac{3}{5}$	158.2	791.11
9	1602	18,000	$1\frac{4}{5}$	178.0	890.00
10	1780	20,000	2	197.7	988.88
20	3560	40,000	4	395.5	1977.77
30	5330	60,000	6	593.3	2966.66
40	7120	80,000	8	791.1	3955.55
50	8900	100,000	10	988.8	4944.44
100	17800	200,000	20	1977.7	9888.88

STATISTICS

RELATIVE TO LABOUR, AND PROFIT PER ACRE.

This expense has been variously estimated. It has been frequently remarked, that "most of the labour can be as well performed by children from 9 to 12 years of age, as by men." Another, who did not make the best of his acre, remarks, that "the amount of helps necessary to attend to one acre, or to 160,000 worms, would not exceed the value of two females, 12 weeks each, and one male the same time: the maximum average value of this help would be here \$3 per week, including boarding. That is, the cost of producing 48 lbs. of silk, would be \$108," which, deducted from the value of that silk, \$240, would leave a profit per acre of \$132.

Mr. Gleason, whose land for the growth of the multicaulis does not seem to have been the most eligible, furnishes the following facts as the result of actual trial. "I found that the trees had produced nearly

$\frac{3}{4}$ lb. of leaves each; believing that if I had gathered all, the average would have been $\frac{3}{4}$ lb. per tree, or 14 ounces."

He then adds: "If the products of $\frac{1}{4}$ of an acre are 2775 lbs., it being $\frac{3}{4}$ lb. per tree," (here Mr. Gleason is evidently calculating at the rate of 14,800 trees to the acre, or about 1 foot by 3—whereas, throughout this volume we have taken the ratio of 10,000 to the acre,) "then the products of an acre would be 11,100 lbs. of leaves, and it requiring 218 lbs. of leaves for 1 lb., the product of the acre would then be 51 lbs. of reeled silk," which at \$5, is \$255.

"I found that an *inexperienced* person could gather 12 lbs. of leaves per hour, or 120 lbs. per day; and that one person could feed 250 lbs. per day. This would require 93 days' labour to gather the leaves produced from one acre, and 45 days' labour to distribute them."

Now allowing the feeding season to be 31 days, this 93 days' labour are equal to 3 children constantly engaged during that season, to gather the leaves of one acre; and the 45 days' labour in feeding the worms of 4 ounces, the quantity supported by an acre, are equal to the labour of one adult for the first 17 days, and of two for the last 14 days, i. e. 45 days of adult labour. Therefore, "the whole," says Mr. Gleason, "gathering and feeding, would amount to 138 days, or 23 weeks of 6 days each; which would be \$69, allowing \$3 per week." And this subtracted from the \$253, would leave \$186 profit per acre.

M. Bourdon states, that from 672 to 784 lbs. of white mulberry leaves, may be gathered by one experienced person, furnished with proper conveniences, in one day. This certainly materially differs from the preceding account. He quotes the wages of men, in France, at 40 cents per day; for women at 25 cents, and for children at 20 cents. In the example he furnishes for 10 ounces of eggs, it appears that the services of men were in very small proportion, amounting only to 4 days in the 4th age; and 16 days, i. e. 2 men, in the 5th age of feeding; whilst all the rest of labour is charged for the service of women and children.

M. Mazade, of Anduze, France, informs us that the whole amount of labour required in raising the produce of 12 ounces of eggs, consisted of 111 days; of which, those of men were 46, and those of women 65 days. His 12 ounces of eggs yielded about 111 lbs. of cocoons to the ounce, or 1331 lbs. of cocoons, producing 140 lbs. of raw silk, which, at \$5 per lb. (the price here) would be \$700; from which, if the 46 days' labour for men, and the 65 for women, be deducted, (at prices in this country) or \$67, it leaves a profit of \$653 on 3 acres, or \$217 per acre.

Had M. Mazade been an equally successful culturist with Count Reina, he would have obtained 168 lbs. of cocoons to the ounce of eggs, or 2016 lbs. for 12 ounces; that is, 224 lbs. of raw silk. Now, calculating the value of this, and labour, at rates prevalent here, or deducting \$67 from \$1120, we have \$1053, or \$350 net profit per acre.

The net profits then per acre, taken from these four authorities, are \$132, \$186, \$217 and \$350, respectively, a variation consequent on difference in the mode of treatment, and other circumstances; any one of which, however, is a much larger amount of profit per acre than can be realized from any other crop.

TABLE RELATIVE TO THE REARING OF SILK-WORMS PROCEEDING FROM ONE OUNCE OF EGGS.

1813.	Age and days of rearing.	Date.	Gross Weight of Leaves.	Internal Temperature.	External Temperature.	OBSERVATIONS.
						FIRST AGE.
1st age.	May	Lbs.				} The whole of this age, cloudy, rainy, with but little sun. The day of rearing begins after 12 o'clock, or noon. Dry cold air. The exterior temperature was from 62° to 64° at 5 o'clock, A. M. Rain.
Day 1	18	1 1-2	75	66		
2	19	2 1-4	75	64		
3	20	4 1-4	75	66		
4	21	2 1-4	75	66		
5	22	3-4	75	63		
						SECOND AGE.
2d age.		11				} Rain. Fogs: rainy, and so throughout, with but little sun. Fine weather. Dry air.
Day 6	23	6 3-4	74	64		
7	24	11	74	64		
8	25	12	73	65		
9	26	3 3-4	73	66		
						THIRD AGE.
3d age.		33 1-2				} The weather, during this age, nearly the same as before. Little variation in the external temperature. South winds prevailed; heavy air: rain. The dry air prevalent in the second age, had imparted great vigour to the insects.
Day 10	27	11	72			
11	28	33	72			
12	29	35	71			
13	30	19 1-2	71			
14	31	10	71			
						FOURTH AGE.
4th age.	June	108 1-2				} Rain and sun. Clouds and sun. Fine. Some silk-worms, placed in a temperature of 64°, become torpid during fifty hours. Sun and rain. Fine. Fine.
15	1	0	71			
16	2	36	71			
17	3	60	69			
18	4	82	69			
19	5	92	69			
20	6	47	69			
21	7	13	69			
22	8	0	69			
5th age.		330				} Rain and sun. As yesterday. The season was extremely unfavourable from the 13th until 18th. The thermometer placed in the West, stood, during the 15th, 16th and 17th, as low as 53°, at 5 o'clock in the morning. Cold rain almost uninterrupted; although the barometer did not indicate great moisture of atmosphere. Rain and sun. Clouds and rain. Rain and sun.
23	9	66	69			
24	10	99	69			
25	11	155	69			
26	12	197	68			
27	13	299	68			
28	14	359	68			
29	15	333	68			
30	16	261	69			
31	17	182	69			
32	18	66	69			
						</

The above table is extracted from Dandolo; but adapted to the worms of one ounce of eggs instead of five; and the weight of leaves refer to the gross weight of *Multicaulis foliage*, instead of the net weight of sorted leaves of the White Mulberry, expressed in English pounds avoirdupois, and not in the pounds of Milan.

CHAPTER V.

REELING.

THE word *FILATURE* has two meanings; it is called by some *reeling*, and by others the place where the reeling is performed. The operation of reeling from the cocoon, is called in French *filer*, to spin; the word *filature*, a derivative from *filer*, means, therefore, an establishment where the reeling is performed.

Before the process of reeling can be properly performed, the cocoons should be well assorted. The following are the *nine* different qualities into which cocoons are divided, namely:—

1. **GOOD COCOONS**, or those fully brought to perfection. These, whether small or large, are always compact and free from spots.

2. **POINTED COCOONS**, or those having *one end rising in a point*. These give out their threads in reeling a short time, and then break or tear at the point where the silk is weak, and can be wound no further.

3. **COCALONS**, or cocoons that are larger than the regular cocoons, but do not contain more silk; their texture being less compact. These, in winding, must be immersed in cold water, as they furze and become tangled in the operation. They should always be separated from the others, and reeled by themselves.

4. **DUPIONS**, or *double cocoons*. The threads of these are so intertwined, that they frequently break in reeling, and sometimes cannot be wound at all. These are usually *one per cent.* of the whole quantity.

5. **SOUFFLONS**. These are very imperfect cocoons, with a loose texture, and are often transparent. They cannot be wound.

6. **PERFORATED COCOONS**, or those that have been pierced at the end, and the filaments broken by the moth, and therefore cannot be wound.

7. **GOOD CHOQUETTES**, or cocoons wherein the insects have died before perfecting their task. These, when shaken, do not rattle, the worms adhering to them. These are as pure, but not so strong and brilliant as the first named. They are apt to furze, and must be reeled separately.

8. **BAD CHOQUETTES**, or defective cocoons, spotted or rotten. They furnish foul, bad silk, and of a blackish colour.

9. **CALCINED COCOONS**, or those wherein the worms, after completing their cells, are attacked by some peculiar disease, which sometimes petrifies them, and at other times reduces them to white powder. In the former case they are called *COMFIT* cocoons. These cocoons are of the very best quality, and in Piedmont sell for half as much more as good cocoons. They are rarely met with.

The cocoons on the mountains are considered better than those on the plains. They contain more of the white, but the balls are less, and the worms in proportion smaller.

The Piedmontese reel is the best known to us. Any other reel of similar proportions and traverse, will answer equally as well. The

following specification will enable any competent mechanic to construct one. The cut here given, presents the reel in its connexion, and also the several parts which are important to be understood.

The frame is 6 feet 5 inches long, $4\frac{1}{2}$ by 3 inches thick. Distance of the upright posts A B, 4 feet $4\frac{1}{2}$ inches.

C C. Length of the braces of the frame, 20 inches in the clear. D D. Legs of the frame, 2 feet $3\frac{1}{2}$ inches long. E. Shaft with a crown wheel at each end. The wheel F, 9 inches and 1-10th in circumference, has 22 teeth. The wheel G, 10 inches and 1-10th in circumference, has 25 teeth. This shaft has an iron pin at each end, 1 inch long. The pin at the end O, plays in a hole in the shoulder near the top of the post O, so as to enable the teeth of the wheel to catch and work in those of the pinion at the end; also plays in a hole in the post O. The pin at the other end of the shaft, plays in a hole at the post K, and the teeth of the wheel F work in the pinion H, fixed on the top of the post K, by means of a burr screwed on the pin projecting from the post, and passing through the centre of the pinion. This pinion has 35 teeth. On the top of the pinion H is a crank, having a sweep of four inches, and receives, on its top, the end of the iron wire carrier of the traversing bar I. The crank is fixed half an inch from the commencement of the grooves of the pinion. This crank is shown in the figure H. I, a traversing bar, 2 feet 10 inches long, $\frac{5}{8}$ of an inch wide, $\frac{3}{4}$ of an inch thick, and playing through the posts B K; height of the posts from the frame, 17 inches. L, an iron carrier of wire, No. 1, 18 inches long, fixed to the bar I, to work free by a screw. The other end is fixed by a burr, to the pin passing through the centre of the pinion H. M M, two wire hooks, (rampins,) $7\frac{3}{4}$ inches apart, at equal distances from the ends of the traversing bar,

through which they pass. The wires to the commencement of the turns of the hooks, are 5 inches in length. N, the *reel-arms*, 2 feet 2 inches and 1-10 long in the clear, $1\frac{1}{2}$ inches wide, and 1 inch thick, rounded on the upper side to receive the silk as wound on in the operation. These reel-arms should not be grooved as some have them. Rails $20\frac{3}{4}$ inches long, 2 inches broad, 8-10 of an inch thick. Two of the arms are jointed, to allow the skeins of silk to be taken off, when reeled and quite dry. There ought to be an extra reel to put in the place of the one taken off, to prevent the work stopping. O, upright support for the axle of the reel, on the ends of which the pinion is fixed to work with the wheel G, at the end of the shaft E. The pinion of the axle has 22 teeth. P, an iron plate with 4 holes, 12 inches in the clear, slightly hollowed, projecting $3\frac{1}{2}$ inches from the bar: the piece thus projecting $3\frac{1}{2}$ inches contains 4 holes, so arranged, that from the centre of the one to the centre of the other is $\frac{3}{4}$ of an inch, but the 4 to be in the exact centre, that is, equidistant from the bar. Distance from the two inside and nearest holes 4 inches and 2-10. Q, the copper basin to contain hot water, in which the cocoons are immersed when reeled off: it is 18 inches long, 1 foot broad, and $4\frac{1}{2}$ inches deep. R, the furnace to contain the charcoal and keep the water hot. Distance from the centre of the posts A B and O K, 3 inches and 1-12th. Circumference of the reel 6 feet 11 inches. Distance from the top of one arm, where it enters the rail, to another arm, $18\frac{1}{2}$ inches. From the axle of the asple and the traversing bar I, 4 feet 8 inches. The law of Piedmont says 3 feet 4 inches and 2-5, American measure; that is, from the guide-wires and the centre of the reel. Seven rotations of the reel, causes the traversing bar to move 5 times from side to side.

DIRECTIONS FOR REELING. — The operation of reeling gives the cocoons their chief value, and requires great attention. In this country the raw silk produced is nearly all used up in making sewing-thread, a small quantity only being wanted for organzine, singles, or tram. The reeling should therefore be so conducted, that the raw material will answer the end proposed. *Organzine, singles, tram, and sewing-silk* require each a distinct process of filature. In speaking technically of raw silk, we do not say that a *strand* is composed of so many *fibres*, but we designate them from the finest to the coarsest, by saying, it is composed of from 1 to 3; 2 to 4; 3 to 5; 4 to 6; 6 to 8; 8 to 10; 10 to 12; 12 to 15; 15 to 20; 20 to 25; 25 to 30; 30 to 35; and 35 to 40. The strand is seldom required to be so coarse as the two latter. Organzine requires from 1 or 2 to 3 or 4; sometimes from 3 to 5 or 4 to 6, but seldom more. Singles from 8 to 10, 10 to 12, or 12 to 15; sewing-silk from 15 to 20, 18 to 22, 20 to 25, but not often above, unless the order is for especial purposes. Tram ranges from 20 upwards. In no case should the range of fibres in the strand be more, from the least to the greatest, than the numbers above stated. The *range* of the very coarsest should not exceed *five* fibres. The shameful practice of making strands vary in the same hank from 2 to 20, and all numbers between, as is sometimes done in filatures, must soon cause the raw material to fall on the reeler from its utter worthlessness for any purpose in the manufacturing processes. The labour of *winding, drawing, doubling, milling, &c.*, is such, that whoever purchases a

lot of silk, reeled in the manner just mentioned, will never try it again. On such raw silk the *waste* is enormous, and the careless or indifferent reeler should bear the loss. Whatever range of fibres the reeler commences with, he should continue till the hank is finished. If the range of fibres is greater than *five* (it should be less if possible), in the high numbers, the difficulty of *comparing* in the *wet-winding* is great, and the greatest efforts will not always prevent the sewings from *riding*, and being therefore unmerchantable.

The reel we recommend is the *Piedmontese*. No other should be thought of, unless it is made to work on a similar *traverse*. The *Italian* reel should not be used, and we trust it will be laid aside for the *Piedmontese*, or be altered so as to have a similar traverse, which may be easily done. We speak from experience, having daily opportunities of observing their relative merits in "THE PHILADELPHIA SEWING-SILK MANUFACTORY," the operations of which are superintended by the author of this little work.

The longitudinal dimensions of the asple, N, in the specification, should not be fluted, as we sometimes see them. The rails, N, should be at least one inch thick, and made round on the surface for the silk to lie on. By fluting, the raw silk touches a narrow surface, and the gum, which is always *hard* where the silk crosses the rails, is liable, when pressed, to break off short, by which the hank is lost. The hanks should always be *smaller* as the strand is finer, and the size may increase as the fibres are increased. The fine strand will not, in swiftling, have strength to draw the swifts round without *breaking*, when the hanks are heavy. This is very important, and should be carefully attended to.

The reeling should be performed in dry weather, and, for the work, women preferred to men, having smoother fingers, the fibres being often broken by the rough hands of men. The air should be calm, the building lofty, open on one side, and exposed to the sun and air, but sheltered from the winds. A chimney or flue should conduct the steam from the place of operation, and the building should be so wide, that when the winders are arranged on each side, the manager should have a central passage to enable him to overlook the work. It is supposed that the floss has been stripped from all the cocoons intended to be reeled; and that the *imperfect* cocoons have been carefully separated from them.

When the apparatus is ready, the *softest water* must be chosen for soaking the cocoons. Experience must in general regulate the temperature: but until that is obtained, we shall lend our assistance. Some require more, some less heat; some require water from 168° to 190°; others from 190° to 202°. Some point between these should be chosen, and here a good thermometer is almost indispensable, until the superintendent has, by frequently feeling the water, become familiar with the degrees of temperature by the feeling of his hand, which he will soon do, but the temperature should never reach 212°, the boiling point.

The good white and yellow cocoons are most easily wound. *Coccons* call for the greatest care and skill. They require cooler water, and if expertly managed, they will then make silk equal to the best, but they furze out in *hot* water whilst winding. The Dupions, Cho-

quettes, and steamed or baked cocoons, in stifling, if kept a long time, require the hottest water. The dupions require soaking for five or six minutes before they are reeled. The unsteamed, or unbaked cocoons give off their fibres very freely, and require a lower temperature in the copper. The fire under the copper should be increased or diminished according to the description of cocoons to be reeled, the characteristics of which are stated above.

The intention of the hot water is to soften the gummy substance they contain, and thereby facilitate the winding of the filaments. The person having the management of the reeling should be prepared with the broom corn whisk, or birch twigs, cut sharp at the points; and being seated on the opposite side of the basin from the reel, and facing it, the water being of the requisite temperature, and the basin on a charcoal furnace, he must throw into the basin a handful or two of cocoons of one sort or quality. They should then be pressed gently under the water, for *two or three minutes*, in order to soften the gum and loosen the filaments. He should then stir the cocoons with the whisk lightly and gently, *just touching them*, until one of the fibres adheres to it, when, disengaging it, and laying down the whisk, he must draw the filament towards him until it discharges itself freely from the floss or coarse silk which adheres to the cocoon, and the fine silk appears. The thread is then broken; the loose floss collected and laid carefully away; the whisk is resumed, repeating the process in each instance, laying the collected fibres separately on some frame of wood near the furnace for that purpose, or on the edge of the copper in which are the cocoons, until so many fibres have been collected as are designed to make a strand of fibres. These are placed together and drawn through the *outer* or *inner* holes of the iron plate, resting horizontally over the copper. The same process is repeated until another strand is collected and also carried through the corresponding *outer* or *inner* hole in the iron plate. The preparatory operations are called the *battue*. If the strands are coarse, they are carried through the inner and nearer holes; if fine, through the most distant and outer holes. After being thus passed through these holes, they must be crossed or put round one another, in the manner in which a rope of two strands is twisted, for about twenty or twenty-five times, before being carried through the rampins or guide-hooks M M of the traversing bar I. They are then carried forward and fastened to one of the arms of the asple or reel N. The *distance* between the rampins on the traversing bar, is that which must regulate the distance of the threads on the reel, it being understood that two hanks are reeled at the same time. The filaments should not be allowed to cross till brought together at the holes of the iron plate P. In reeling, if the silk filaments come off in blurs or knobs, the water is *too hot*, and should be immediately cooled by stopping the draught of the furnace. Also if the water is too hot, it will start the gum, and thereby greatly injure the appearance and value of the material.

In commencing the operation, some employ a second person to turn the reel, and others turn the reel themselves by the aid of a long pole attached to the crank of the reel, while they sit by and attend the copper. The winding should always begin slowly with a regular motion, until the threads run freely and easily. Should some of the filaments

prove false, as they sometimes will, a new one must be added to complete the number intended for the thread or strand. The new end to be added is always thrown into the centre and is drawn up with the rest. A few additional cocoons should always be in the copper, with their ends ready to supply any that may run out, thereby keeping the strands *uniform in size, which is one of the perfections of reeling*. The crossing of the threads forming the two strands thrown on the asple during the operation, is intended to give them a proper roundness. It aids in drying the threads, causes floating fibres to adhere, prevents the injurious gluing of the threads on the asple, and by its rotary friction removes their inequalities and roughness, and thus causes a perfect adhesion of the fibres, insures their strength, uniform thickness, and cylindrical form. Without it they would be flossy and flat. Fine silk may be crossed eighteen or twenty times; coarse twenty or twenty-five times.*

We have now the reel in motion; the operation, slow at first, increases in speed if the balls give out freely; but if they leap up towards the iron plate P, the speed must be slackened, and the spinner, who attends the balls, directs the motion. He then strikes his hand down the fibres, and places the balls again in the water, and increases somewhat the temperature of the water in the copper. The speed must now be increased or diminished, the motion always regular and equable. If the cocoons become blurry or in knots, the speed should be accelerated to the quickest motion, without endangering the breaking of the threads, or preventing the spinner from supplying the strand with fresh fibres, to keep it even, as the old ones run out.

The quicker the motion of the reel, the better the cocoons wind off, and the better the ends join to the threads. The fibres, when given off freely, are less likely to break by a quick than a slow motion. The threads do not intermix on the reel; they are distributed in such a manner, that each thread ranges within a certain limit upon the asple, and no two threads lie on the same track, the traversing bar distributing them so regularly, that it requires as some say 400, and others 800 revolutions of the reel, before a thread lies upon the same exact course of any previous one. The intention of this is, to prevent the strands from lying together, lest the gum should prevent their being unwound; to enable them to dry on the reel, so that an equal degree of tension may be preserved, and also to assist the swifter to find more easily the filament when she is throwing it on bobbins. When the skeins are finished, which, if the strand is fine, should always be small and in proportion, another asple should replace the one just used, so that while the first one is set aside to dry, the second may be in operation. The spinner must be always replacing and having in readiness fresh cocoons while the reel is in motion, so that no delay may be occasioned in the process. The operation is uniform, and constant attention and repetition will enable any person to acquire experience in a few days, if not hours. There should be no more cocoons thrown into the copper than are intended to be wound, as by being too much soaked in the hot water, they are apt to wind off in blurs. The cocoons should be equally soaked, and when thrown in, kept under, as they are apt to swim until saturated with the water.

* A law of Piedmont regulating this procedure, appoints officers to inspect the filatures in order to preserve the character of their raw silk.

In joining a new thread to the strand, it may be necessary sometimes to place it along with one in the winding, by rubbing them with the fingers, or gently pressing them. The art of uniting threads is acquired only by practice. The difficulty of keeping the strand even is great. The filament of each ball is not of equal tenuity throughout, and the skill of the reeler is therefore required, so to arrange and bring them together, that the same thickness may be continuously preserved throughout the skein.

The quantity of silk reeled in a given time, depends on the quickness of the reeler in supplying fibres to the thread from fresh cocoons. The reeler should have at her side a bowl of cold water, and also some chips or shavings, with which to regulate the temperature of the water in the copper. The cold water is also necessary to cool her fingers in when too much heated. The facility of reeling depends much on the right temperature of the water. If *too hot*, the thread is technically *dead*; if too cold, the ends will not join well, and the silk will be harsh. The winding cannot be performed in cold water, as the fibres easily break, and, with the least moisture, the filaments of the strand or thread separate, which is not the case when hot water is used.

In some of the French filatures, particularly at Cevennes, the following plan is adopted in reeling. "In preparing fine silk, the cocoons are not wound off entirely, so as to leave the pellicle of the chrysalis bare, for two reasons: first, because the additional fibre required to be added, when the first and strong part of the fibre is observed to be spent, might make the compound thread too stout, and thus cause a waste of silk: secondly, because the fibre of a cocoon which has been entirely wound off, besides being weak, also abounds in knots, which would cause it to break in winding, and injure its uniformity, in which the goodness of the thread mainly consists. Therefore, on winding fine silk, when the cocoon has given off three-fourths and a half of silk, that is, about 325 yards, it must be replaced by another cocoon, the remainder of the first cocoons must be set aside, and their silk added to that of an inferior quality. When the first parcel of cocoons is nearly finished, take out, with the ladle, all those on which some silk has been left; let them be opened, the chrysalides taken out, and the shells put in a basket with the floss that had been first pulled off. Those cocoons which are partly wound off must, on no account, be permitted to remain in the basin; for they will obscure and thicken the water, and injure the colour and lustre of the silk, which is then used only for dark colours. Besides this, the consistency of the silk is injured, and waste ensues in the winding. The shells must be immediately buried, or placed among composts for manure. *As a general rule, the water in the copper should be changed as often as discoloured.* On commencing, the holes and rampins should be wet, to cause the thread to run easily. The waste silk, whether the remains of cocoons or of the floss collected in the *battue*, should be carefully put aside. "Gather up the fragments that nothing be lost," is a good rule in this case. Carded and spun like cotton, it will compose excellent fabrics. The gearing of the reel should always be complete, the mortise in which the traverse bar plays should be well oiled, the cog-wheels should play in proper contact, and the *bassinets* or defective cocoons found in the copper, which will not wind off with the good ones, being full of knobs, must be taken out of the copper, and kept and wound by themselves. The breaking of the filaments

arises from ill-formed cocoons, or the improper heat of the water. The whole thread is sometimes broken in its passage from the copper to the reel, through the stopping of loops in the layer, by knobs or by the reel being turned by a jerking motion. They should not be knotted, but slightly twisted, which will sufficiently unite them. The value of silk is increased or diminished according to the quantity of knobs or knots with which the raw silk abounds. If the silk be *clean* when the skein is opened, it is a sign of being well reeled."

The Soufflons, royal cocoons pierced, and other perforated and imperfect cocoons, which will not stand the filature, are boiled in water; the soufflons for half an hour, the perforated cocoons somewhat longer, and the royal cocoons a full hour. They then undergo a process to reduce the chrysalides, and prepare them for making *fleuret*. Boiling and heating will increase their beauty. Of *fleuret*, the royal cocoons make the best; next the perforated, and lastly the soufflon cocoons. The coarse floss and refuse of the filature, make very inferior silk. The cocoons from which the moth has escaped, it has been shown, can be frequently reeled as well as the best.

When the reeler leaves off work for a time, the cocoons should be all raised out of the water with a ladle, till his return. The better practice, however, is to let fresh hands relieve the reeler, and keep the operation in motion throughout the day. The eye should be frequently upon the threads and rampins, to see that every thing is right. No sand should be allowed in the water, as it will cut the fibres as would a knife. The water containing it, should be immediately renewed. In a large filature, a boiler might be so constructed as to supply the coppers or tin basins from which the cocoons are wound, and the latter be supplied with heat from chips, to regulate the temperature; as charcoal, unless in a fire-place, is dangerous from the carbonic acid gas evolved in combustion. In using the whisk, and in reeling, the temperature of the water is soon ascertained; as, if too hot, the cocoons rise to the iron plate, come off in blurs, or are drawn off by the whisk in lumps. If too cold, the whisk will not catch the ends of the fibres. A good reeler will reel *one pound* of silk for organzine in a day, of 3 to 5 fibres—and in proportion upwards.

When the hank is finished, pick off the coarse fibres; then take a handful of the coarse silk, and, after washing and squeezing it, dip it lightly in cold water, and with it rub the silk on the reel, at the same time stroking it with the palm of the hand. Open the window; turn the asple of the reel with a rapid movement for 8 or 10 minutes, to dry the silk; then lay the asple aside, and place another on the reel and proceed as before. The reeled silk with the asple, should be left in a dry place where the sun does not shine. This operation adds greatly to its lustrous appearance.*

To reel *dupions*, the water must be boiling hot. When the machine stops, the person who turns the reel should pick off the loose floss and lumps from the skein. The satiny cocoons do not require the water to be so hot, but only regulated as the cocoons are free, or otherwise, to give off their fibres. The water in the copper should be often changed, and a few only put in at a time.

The silk should never be taken from the asple till *perfectly dry*. If

* The Piedmontese law forbids any thing but the dry palm of the hand to be used.

it is taken off damp, it curls up and has a very bad appearance. Disbanding is a simple operation, but yet requires judgment. The cocoons, if not well sorted in reeling, will produce different degrees of tension; and this will be somewhat the case under all circumstances. Some cocoons being longer in the water than others, will contribute to this cause. They do not all give off their fibres with equal facility, and hence an inequality of tension; which, though slight, has its injurious effects. To make the disbanding perfect, the skein should remain *six or eight hours on the asple*, which brings any inequality of tension more uniform. By this time the threads are dried and the fibres united — an important point. Before disbanding, the several hanks should be squeezed close together; the hanks are then tied with threads of the refuse silk, at the places where they bore on the bars, and also at the opposite end to the first tie. It may then be slid off the bars, doubled, and *laid by in a dry place*.

Numerous improvements, or what are called such, have been made on the Piedmontese reel; but of these we have seen only one that deserves our attention, and this was placed before us at too late a period to present a drawing of its particular merits in this work. The inventor placed in our hands a *model*, and some remarks describing its movements, the substance of which we will now give, premising, that some years after its invention, one of his reels was seen in New York by some individuals; and the result was, that a patent was subsequently taken out for the reel, by a person who had either seen, or had it described to him, unjustly claiming to be the original inventor.

The original inventor, however, is WILLIAM B. HAMILTON. In 1831, this gentleman, on observing the Piedmontese reel, thought he discovered a defect in the finish of the thread forming a strand of several fibres, when reeling from the cocoons; and a little reflection suggested a most important improvement, consisting of an additional movement, by which the long-sought *desideratum*, a *round, even, and polished* thread, was fully attained. This new movement consists of a horizontal ruler of three inches in width, upon which another ruler moves rapidly from right to left, (both being covered with cloth,) between which the threads pass on their way to the distributing rod. The motion is communicated from the horizontal wheel of the distributing rod by an endless cord. The silk, after the usual crossing between the iron plate over the basin and the rampins, passes between those horizontal rulers covered with cloth, the rapid movements of which cause the thread to become round; and compresses the fibres and the flossy filaments so effectually, as to give the strand, as it passes to the asple of the reel, a beautiful glossy and perfect finish, greatly excelling any other raw material now in use.

The dimensions of HAMILTON'S Piedmontese reel, are as follows: — The bed of the frame is in length 6 feet 6 inches; width sufficient to allow the arms of the reel to be full 2 feet long. The wheel on the axle of the reel must revolve 29 times while the wheel of the distributing rod revolves 47 times. If proportions are accurate, the silk will be distributed on the arms of the reel in diamonds of mathematical accuracy. A woollen cord, without end, is necessary for both movements. The more rapidly the ruler is made to traverse, the better; taking care not to make it too heavy. The height of the machine may be to your liking.

THE END.

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OR, *John Clarke*

A BRIEF TREATISE *as author*

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