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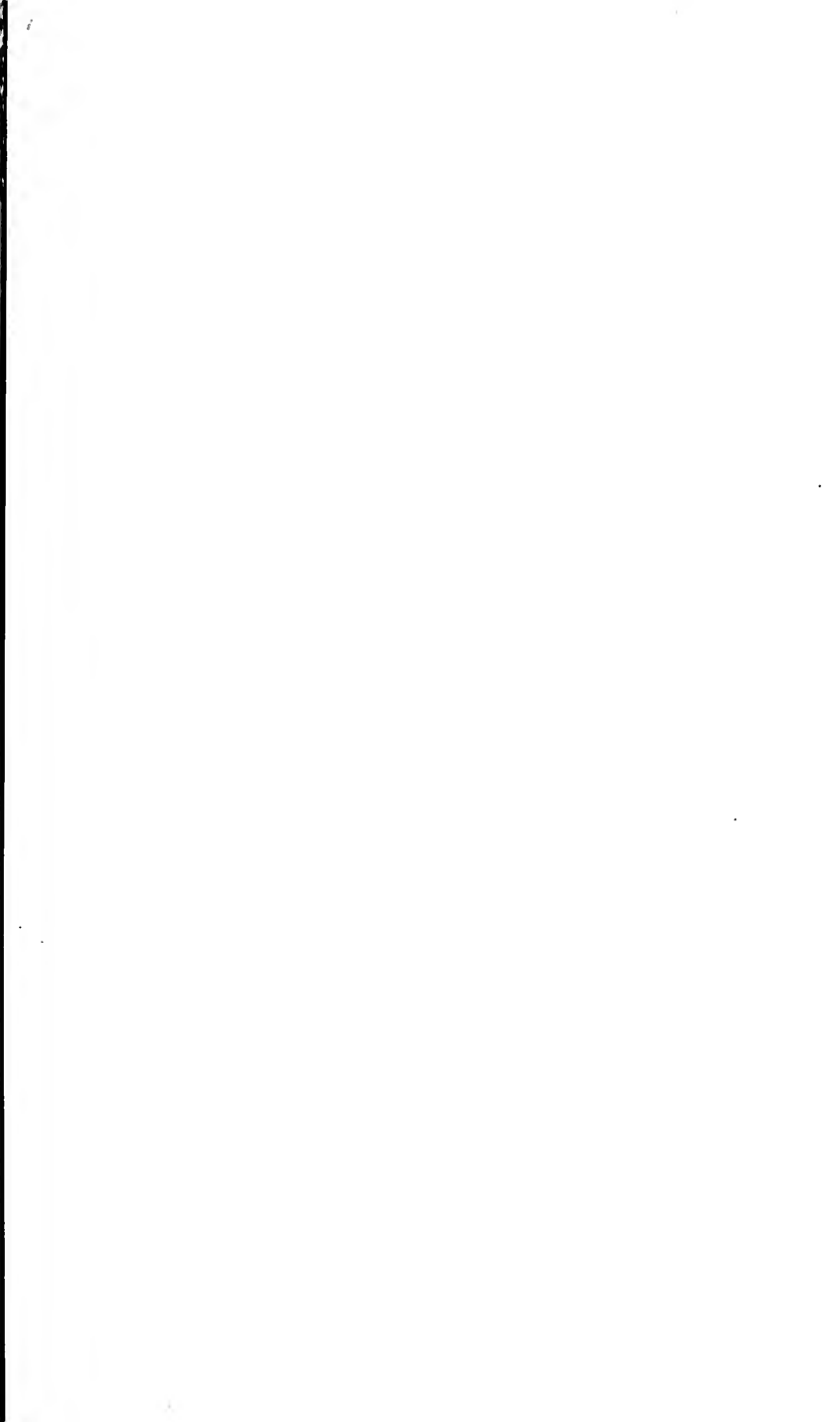


Plate I.

Fig. VII.

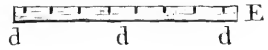
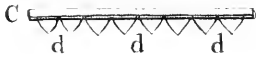
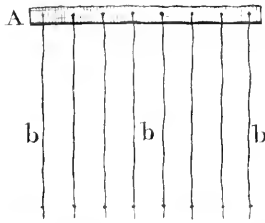


Fig. III.

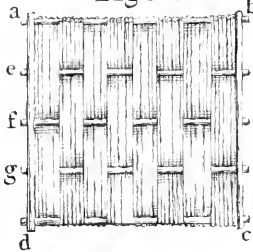


Fig. IV.



Fig. V.

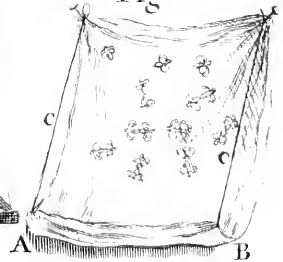


Fig. I.

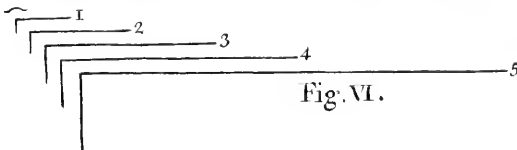
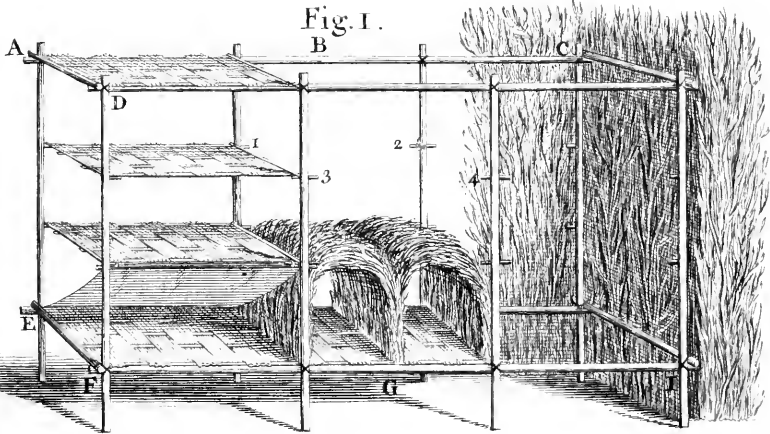


Fig. VI.

Fig. II.



THE
CULTURE of SILK:
OR, AN
E S S A Y
ON ITS RATIONAL
PRACTICE and IMPROVEMENT.

IN FOUR PARTS.

- | | | |
|---|--|--|
| On the raising and planting
of MULBERRY TREES. | | III. On obtaining their SILK
and BREED. |
| I. On hatching and rearing
the SILK-WORMS. | | IV. On reeling their SILK-
PODS. |

For the Use of the AMERICAN Colonies.

BY

The Rev. SAMUEL PULLEIN, M.A.

*Ant hasten to the Work each beauteous Maid,
Draw hence expressive Dreſs to Beauty's Aid,
Your Labour to the pleaſing Task is due,
The willing Inſect toils and ſpins for you.*

PULLEIN'S Tranſlat. of Vida's Silk-worm.

L O N D O N :

Printed for A. MILLAR, in the Strand.

MDCCLVIII.

NB 1112

TO
HIS ROYAL HIGHNESS
THE
PRINCE of WALES.

S I R,

TO encourage such endeavours
as aim at the advancement of
arts, has always entered into the most
shining character of Princes.

The great Condescension of Your
Royal Highness, in patronizing the
following Essay, while it is a proof
that Your Royal Highness has adopted
that maxim, is also a presage that
attempts to promote knowledge will
ever have Your Royal Highness's
protection.

The Culture of Silk was first
brought into Europe by the efforts

DEDICATION.

of a great Prince; and Britain's Commerce has its glory in the care of her Princes.

That your Royal Highness may, in Peace and Prosperity, see this and every other branch of it advance to perfection, is the sincere wish of

YOUR ROYAL HIGHNESS'S

Most dutiful,

And obedient Servant,

SAMUEL PULLEIN.

been a practical art, yet books are still written upon that subject, which has without doubt this good consequence, that it engages many in that business who would otherways never have thought of it, because they had no rule to set out by.

The few things which have been published, in *English*, on the culture of silk, have not explained even the present practice in such a manner, as to extricate persons from the difficulties they would meet in their first tryals ; much less have they attempted to lay any foundation for future improvements : they were too concise to take in the various incidents that might disturb a young practitioner, and, in many difficult parts, so obscure that they seem to be only verbal translations, without any knowledge of the subject. As an instance of this, let any one read the description given of the reel in a quarto, dedicated, I think, to the Lords Commissioners of Trade, in which there is either a total neglect, or a total ignorance of its most essential movements. I need not mention the many material circumstances which are omitted in the hatching, feeding, and obtaining the breed of Silkworms.

In

In the following treatise I have attempted to bring together the best and most material things which have been delivered by different authors. And, having myself many times gone through the practice of the four different parts into which I have divided the subject, I have thence taken occasion to mention such improvements as I had actually tryed, and also to suggest such as I had reason to think would, on tryal, be found useful: by these means attempting to impart what I already knew, and directing to such tryals as might discover more than I knew, and striving to enter so far into the reason of things, as might give some light to future discoveries.

If some should think I have treated the subject too minutely; I can only say, that this was owing to my observing that brevity in rules which were to be put in practice was often the cause of obscurity and error.

If inaccuracy of expression should occur, I can only offer in excuse the multitude and variety of precepts, where the mind, while exercised on the matter, must be often inattentive to the form.

If the number of rules should be thought too great to be suddenly comprehended, I shall not deny it, but at the same time I flatter myself that many of them will, from time to time, be consulted as difficulties occur, and often shew, or at least suggest some remedy.

In short it may happen that this treatise may be suddenly censured, and slowly found useful; or may without either praise or censure sleep in obscurity. But, while I am convinced of the intention with which it was wrote, and of opinion that it can at least do no injury to the cause which produced it, I shall not add sollicitude about its credit, to the trouble which it has already cost me; I do not shew it to the publick with the over-valuing fondness of a parent for a child of his own begetting, but only offer it as a foundling whose aspect gave some hopes of its proving useful to its country: I have wrapped it up in such homely dress as came readiest to my hand, and in this deliver it to be educated according to its talents.

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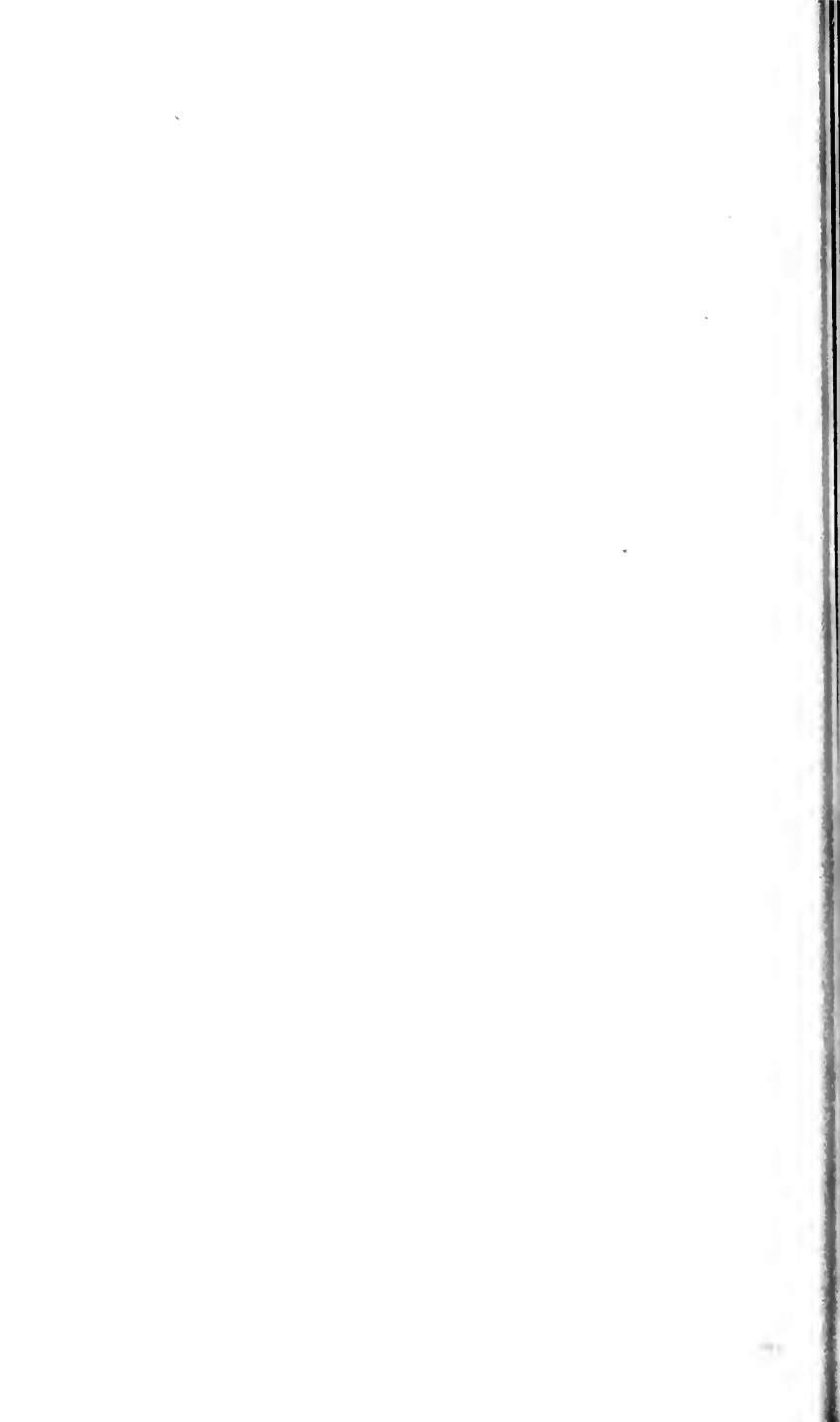
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T H E

Culture of SILK.

P A R T I.

C H A P. I.

Some introductory observations on the breeding of Silkworms, with regard to different climates.

NEITHER Animals nor Plants; when transported from one climate to another of a different temperature, are immediately naturalized; there is some time required, and often some successions of generation, before their nerves and fibres can adapt themselves to the different influence of the air and sun; and if the seasons were steady and regular in their native country, but mutable and irregular in that to which

B

they

they were brought, some time must be necessary before their fibres can acquire a facility of contracting and extending with sufficient quickness to answer the sudden changes of the weather. Thus we may observe, that the natives of *England* and *Ireland* are not so affected by the variability of our seasons, as those born under the steady climates of *Italy* and *France*: hence also we can account why old persons, whose fibres, by growing rigid, have lost the power of adapting themselves to the sudden changes of the weather, are very sensibly affected by its variations.

The consequence which I would draw from the foregoing observations is, that it cannot be expected by us, that silkworms bred from eggs, imported recently from *Italy* or *France*, can immediately thrive. Those therefore who attempt the breeding of silkworms here in *England*, had better raise their stock from eggs which have, for some preceding generations, had their original among us.

With regard to our colonies on the continent of *America*, silkworms might be rear'd in them all to perfection, from *New-England* to *Georgia* inclusive; for the mulberry-tree will
will

will grow in most of them without any culture, and the summers in the most northerly provinces are sufficiently warm; but many of them are so engaged in the planting of tobacco, that no hands can be spared, the management of that, and of silkworms, being at the same time of the year, and those who are employed about tobacco are very unfit to attend silkworms; and yet I believe it would scarce be a loss to *England*, if the former was somewhat neglected for the sake of the latter. The great quantities of silk which might be imported thence into *England*, the number of hands which it would employ, the various manners in which it might be mixed with the manufacture of wool, and the revenue that might in time arise upon its importation, seem to be things well worth the encouragement of the *English*; and in *America* the comfortable subsistence and enrichment of many small families, by raising silk, would be of much more benefit to our colonies, than that the labour and industry of the poor should be laid out only for the advantage of some rich planters.

4 THE CULTURE

In some of the colonies a double produce of silk might be obtain'd in one season, and the warmth of the climate would make the slightest accommodation of houses or even sheds sufficient, and many of the cautions and observations delivered in this treatise unnecessary; so that, there, what regards the keeping of the silkworms warm, need not be so much attended to as what gives them air, and keeps them clean. I suspect however, that the moisture, which is occasioned in several parts of our *American* colonies by their being not yet clear'd of their woods, may be of disservice to the rearing of silkworms; at least, I believe, this may make it a matter of some importance, to choose those places where the woods are well clear'd away, and to avoid those which are situated near swamps and great lakes, or exposed to the north and north-west winds, which, in our part of *America*, are the most cold and piercing.

Some attempts having been made to rear silkworms in *England*, it may not be improper here to say something concerning them. And first, I must observe, that the changes which frequently happen in our weather is the greatest obstacle; for though the
time

time in which filkworms are fed and spin be no more than about six weeks, yet there frequently happens, in that time, so many days of hazy and moist weather, or such sharp winds, as greatly retards their coming to perfection, and often kills one half of the brood.

This inconvenience of the climate may in some measure be remedy'd by persons of substance, who can choose a convenient and warm part of their houses, and occasionally light a fire to conquer the inclemency of the air; and who besides have time and leisure to oversee and direct the management of the filkworms. But these being things which are out of the power of the lower class of people, I shall take it for granted, that the culture of filkworms cannot be performed by them, and shall therefore only address what I say here to such as have leisure and abilities, and may, in the culture of filkworms, find a pleasing summer amusement, and not altogether unprofitable.

I have mentioned, that cold and raw weather may be palliated by the situation of the room, which should have windows to the south, and also by occasionally

6 THE CULTURE

making a fire, which last should especially be regarded during the two or three days in which the worms are employed about spinning their silk-pods; for if the weather is then cold or raw, they will make little or no silk, and so you will lose all the advantage which was expected from them. The same caution should also be observed when the moths are coupling and laying their eggs, otherwise they will lay but few.

Since mulberry-trees, especially the black sort, can be easily rais'd, I shall say nothing as to the objection of want of food; but shall only caution any persons from attempting to breed silkworms, who have not plenty of leaves at their own command, since I know with what difficulty they are procured from others.

Another objection is, that the worms are often hatch'd by the heat of the weather, before the leaves are come out to feed them; but if you keep the eggs in a small viol bottle, covered with a piece of paper prick'd with two or three pin-holes, and placed in a cool situation, where neither the heat of the sun nor the air of a fire can affect it, yet free from moisture

or cold winds, this will hinder them from hatching during the latter part of April and beginning of May; and if you are not then prepared with food, place the bottle in a vessel of cold water so deep as the eggs lie in it, or a little deeper, and this will further retard their hatching.

It may be said, that the constant attendance of feeding the worms three or four times a day would occasion too great a confinement, but this is a work which any servant, who has once seen it, may easily perform; and therefore, I think that a lady might, even in these climates, make herself a suit of silk with the tenth part of the trouble, and by a more agreeable amusement than that sedentary one, which compleats a wrought head-dress. Most indeed that go about breeding silkworms, do, for want of method, or by following fanciful ones, make it a troublesome business, and oft-times the very pains which they take creates more labour. They let the eggs be laid on paper, they are hatch'd at very distant times, they are sometimes pick'd up singly as they hatch, and placed on ten times more leaves than are necessary, which occasions frequent clearing away of

8 THE CULTURE

their litter ; when they are fed, numbers often perish under an overabundance of leaves ; young and old are mix'd together, and by that means the proper management during their periodical sickness becomes impracticable ; at last, when those worms which survive this management, are ready to spin, they are watch'd, and pick'd up one by one, and placed severally in little paper cells, which are afterwards pinn'd one by one to the sides of the room.

This is the method generally followed by those who keep silkworms among us ; and as every part of it is wrong, every step toilsome, it is no wonder that those who proceed in this manner, soon grow tired of the work ; they reckon over all their worms, and when they have rear'd one or two thousand, they account it a prodigious number ; they perhaps afterward reel off some of the balls in a method both tedious and toilsom ; and, having at last produced an ounce or two of silk, they are amazed at the great number of worms, and the great labour which is necessary to produce a small quantity of silk. But this is much the same, as if a farmer should run into every wrong method of husbandry, and at
last

last complain of the fatigue, and of the many millions of grains that went to make a few barrels of corn. But when it can be shew'd, that two or three large mulberry-trees, or a proportional number of small ones, will feed a sufficient number of worms to make above a pound of silk; that the stand which holds these worms will not take up a yard's space in a room; that one person skill'd in reeling can, with the help of a boy to turn the reel, wind off two or three pound of silk in a day; that one pound of this silk will make near five yards of paduasoy; that the whole time, from the hatching of the eggs to the reeling of the silk, amounts to no more than six weeks; and that a small part of each day is sufficient for the proper attendance; that besides all this, it can be done with much less trouble than is generally undergone; these things, I say, being considered, and, as I hope, shewn in the progress of the instructions given in this book, then the management of silkworms will appear perhaps in a more inviting light, and be look'd upon as an entertainment neither unpleasing nor unprofitable.

An opinion indeed has gained ground, that the rearing of filkworms is an unhealthy employment; but this I am sure has no foundation, unless where they are kept in a slovenly manner, and their litter or the dead worms suffered to corrupt and taint the air; for while the litter continues dry, and the worms healthy, I never found the smell to differ much from that of hay, though by a person's being prejudiced, that smell, as coming from worms, may be imagined very disagreeable. Indeed the sedentary employment of poking over the worms, and picking them from the leaves, is not a very healthy amusement for the person who uses it, and I am sure it is hurtful to the worms.

If the method follow'd here by ladies were pursued in the silk-countries, silk could scarce be sold for less than its weight of gold; but if rules and method are properly followed, the pains which they bestow upon ten worms would serve for ten thousand. An improper method of hatching the eggs disturbs the whole process of rearing the worms for ever after; and improper steps in the management of them disturbs all the subsequent ones; and therefore

fore to lay aside their present practice, and set out upon a new method, is the only thing that can make the feeding of silk-worms in *England* an easy amusement. The intention of this treatise is not only to prescribe the present practice in the silk-countries, but to point out some things, and give some hints, for its improvement, especially at a time when there is a fair prospect of introducing the culture of silk into our *American* colonies.

C H A P. II,

Of the different kinds of Mulberry-trees.

THE mulberry-tree is the foundation of the silk manufacture, its leaves being the food so peculiarly adapted to the worm which affords us their rich materials, that no other can be substituted for it with any advantage.

There are two sorts of mulberry-trees, one call'd the black, and the other the white. The black is that which is commonly planted in gardens for the sake of
its

its fruit, which, when ripe, is of a black colour, its leaves are very large and rough, and of a darker green than the white sort, its stem generally inclines to be warped and crooked, and its bark rough.

The white mulberry-tree is so called, because its fruit is either of a white, or a pale grey colour; it grows with a straighter stem and smoother bark, which is also of a lighter colour than that of the black mulberry, and its leaves are smooth, thin, and much smaller. It is rarely met with in gardens, for its fruit is of no value, being very small, and of an insipid sweetish taste.

Some of the writers on silkworms mention a third sort of mulberry-tree, which they call the white mulberry-tree, bearing little red berries. This is perhaps only a variation occasioned by soil and climate, for the white sort sometimes bears reddish berries. There may chance also to be different kinds, by the *farina*, or male-dust, of one sort impregnating the seed of another, when the trees of different species grow near one another. Perhaps mulberries, strictly speaking, may be all of one species, and the varieties which appear
among

among them only accidental; this might be ascertained, by impregnating the seed of one sort with the *farina* of another: for if the mules produced from this mixture bore fruit whose seed was prolific, and would grow when sown, then we might conclude them of the same species; and this is perhaps the surest method for distinguishing the kinds in all plants and animals, since it is well known, that mules, both vegetable and animal, are barren; Providence seeming to have fixed this quality as an obstacle to the infinite confusion of species, which would otherwise have follow'd from infinite mixtures; but this I only mention occasionally: In treating of silkworms, it is sufficient to preserve the distinction of mulberries into the black and white sorts.

Beside the use of the mulberry-tree in the production of silk, its timber is said to be very serviceable, and it has the property of bearing wet, without rotting, better than any other; yet there is no tree whose bark so readily parts from the wood, if the wet gets between them while in a growing state. The inner rind of this tree is tough, like hemp, and might be
twisted

twisted into a strong cordage : most cattle are very fond of its leaves, which are very fattening ; for which purpose they are also given to poultry, being bruised with a mixture of oatmeal. The black sort is a very delicate and wholesome fruit, and useful in many disorders of the throat and mouth ; the tree itself makes a very fine appearance in summer, scarce any other having a more beautiful shew of foliage.

The root of the mulberry tree shoots very deep into the soil, and is no hinderance to almost any thing which is planted about it, since the surface of the earth is not impoverished by it, as it often is by other trees whose roots do not go deep ; neither is its shade, nor the dropping of rain from its leaves, reckon'd injurious to plants.

Since the root of the mulberry strikes so deep, in order to bear good fruit, the black sort ought to have a deep rich soil which shou'd be digged and manur'd annually like that of other fruit-trees ; it is therefore a very bad method, which is generally followed, to leave a grass plat under it which prevents the ground from ever being opened and manured : this grass-plat is left for the sake of saving the fruit
which

which are apt to fall with a very little wind, and are very easily bruised, but a coarse cloth or winnow-sheet wou'd serve as well, and not hinder the culture of the tree.

When mulberry-trees are only kept for the use of silkworms, the soil and culture are not of such consequence; and the less they run into fruit it will be the better; however, you shou'd always have some planted in a good soil and situation, and properly manured, to hasten their coming into leaf, that so you may have food for your silkworms early in spring, and not be obliged to keep their eggs from hatching till it is so late, that in hot climates, the midsummer heat wou'd come before they went to spin, or that, in temperate climates, the cold might advance before they laid their eggs, either of which wou'd be very hurtful.

Both the black, and the white mulberry leaves will feed silkworms, but the white sort is preferred, and generally used, at least in Europe; for which the following reasons are alleged. First, that their leaves are more tender and delicate, and more eagerly desired by the worms. Secondly, that they

they come into leaf a fortnight, or more, sooner than the black, by which means your silkworms can be fed earlier in spring, and you avoid the inconvenience of hatching them late as mentioned above. Thirdly, the white is a quicker grower, and will not be so much hurt by pulling its leaves, nor be so incommoded with fruit as the black. Lastly, the silk produced from its leaves is said to be finer.

The early budding of the white mulberry is very advantageous, because the silkworm is often apt to be hatched before there is food for it. The tenderness of its leaf, and its agreeableness to the young silkworm, is also very useful, because the young broods, whose teeth are tender, cannot so easily pierce the thick leaf of the black mulberry; and any one may easily observe with what difficulty the worms eat any part of a leaf, except the edge, until they have made a hole in it, and so formed an edge for their teeth to lay hold on. Indeed after their three first sicknesses are past, they scarce have occasion to make holes, because four or five worms attacking a leaf on its edge soon devour it. The inconvenience of much litter and
moisture,

moisture, which might follow from the fruit of the black mulberry, may also attend the use of the white mulberry leaves; but such trees as are great fruit-bearers, should not be chosen for feeding silkworms. Lastly, if finer silk is made from the white mulberry, it is a material circumstance. Yet I think it not improper to have some of the black mulberry-trees as well as white, since it is certain that good silk can be produced from them, and that one tree of them is equal to two of the others for quantity of leaves; so that, in case of deficiency, they would always be a resource; in the colder climates I know they thrive best, and even in *Persia* they are said to be made use of in rearing silkworms; however, for our colonies, I would always be supposed to intend the white mulberry-tree; and though, in the subsequent rules for raising them, I shall make no distinction between the black and white, since the method of raising one sort may serve for the other, yet at the same time I must observe, that, since many of these rules are adapted to climates where the tree requires some care and nicety to raise it, therefore the very same care and caution will not

be necessary in warmer climates, and such countries as some of our colonies, where it may be accounted a native of the soil; a person's own judgment will here direct him in the variation he ought to make in raising plantations.

Since therefore the mulberry-tree is the sole subsistence of the silkworms, it is a vain thing to attempt breeding them, without having plenty of trees; and the nearer and more convenient these trees are for gathering the leaves, so much the fewer hands will they require, and the leaves not being carried far, will be so much the better; and beside, upon any unforeseen deficiency of food, or any appearance of rainy weather, you will be able readily to supply yourself; and these are circumstances of no small moment.

I must acquaint the reader, that great part of the method which follows for raising mulberry-trees, is drawn from some of the best authors which have wrote on that subject for the climate of *France*; to which however I have added whatever I have met with, which seem'd useful, in other writers, and some things which were deduced from my own experience; nor have I omit-

I omitted giving hints of such improvements as, though I have not had time and opportunity to try them all, yet seem to me reasonable, and will perhaps upon experiment be found useful.

C H A P. III.

The manner of saving the seed of the mulberry for raising plantations.

TH E R E are three principal methods of raising mulberry trees. First by sowing the seed of the berry. Secondly by layers depending upon the mother tree, till they have taken root. Thirdly by branches quite separated from the mother tree, and therefore call'd cuttings. I shall begin with the method of raising them from seed, as it is both the surest and most effectual way to produce great numbers; and numbers of small trees will answer the end of large ones.

The mulberries whose seed you intend to save should be perfectly ripe, this you may know by their beginning to fall from the trees, by their softness, and if you examine

mine nicely by the kernel being compleatly ripened in the small shell which encloses it; you shou'd not choose the fruit of those trees which have been stripped of their leaves that year, or even the year before, if you can avoid it. Those berries of the white mulberry which incline most to a dark colour are reckon'd best. It is a good method to shake the tree moderately every day, from the time that the berries begin to be ripe, for mulberries do not all ripen together.

These berries shou'd be laid thin on the floor of a granary or other airy place, for four or five days, that they may attain their full ripeness, and should be removed and stirred every day for fear of heating and rotting, especially if they lie thick upon one another, after this they should be poured into a bag of course cloath or canvas, which shou'd be put in water and rubbed very well, to dissolve and separate the grain from the pulp. If this is not done in a river or running water, you must change the water two or three times: then take the pulp and feeds which remain mixed in the bag after having press'd out the moisture pretty well, and put it
in

in a vessel of water, where, after stirring it a little, the seed will sink, in three or four hours, to the bottom, and the pulp swimming uppermost may be poured off with the water. The seed should then be taken out and dried upon a cloath in the sun or in some airy place, stirring it often. If it is done in the sun don't let it remain above an hour or so for fear of the heat injuring it, but rather take it away as fast as it dries. After this you may winnow out any dust which is in it, and keep it in boxes or bags out of the way of mice till the season of sowing.

Sometimes the seed will not easily sink to the bottom in the water where you wash it from the pulp, if it is not very found; when you find this to be the case, you may spread the pulp and seed as they are mixed together pretty thin till it is quite dry, taking care that it doth not heat or grow mouldy; and when it is quite dry, which will take a good many days, you may keep it in that form till the time of sowing, then you must pour a little water on it to reduce it again to a soft pulp, and when it is about half dry mix an equal quantity of dry sand or earth, rubbing them

well together; this will separate the grains, and make them fit to be sown.

Or without mixing any sand the pulp may be sown moist, by rubbing it on a small hay rope which is to be set in a drill of earth with the mulberry seed sticking to it, as will be more fully mentioned hereafter; and for this purpose it wou'd have been sufficient to have only squeezed out the juice of the berries without washing them in water, as before mentioned.

Those who will not be at the trouble of saving their own seed, but buy it from the seeds-men, should take care that they are not imposed on; much of what is sold being often good for nothing, which proceeds either from its being ill saved, gathered from unripe berries, or from trees which had been disleafed; or from its being too old. Seed that is very good and sound may be known by its sinking in water after having been steeped in it for three or four hours; though, as I mentioned before, when the shell is not compleatly filled by the kernel, a good deal will swim, and may be skimm'd off and sav'd. It is as sure a method as any of knowing good seed, to crack a few of the shells, and observe whether

whether they have found kernels; this is easily observed in the black mulberry, which has pretty large seeds, but not so readily in the white, whose seeds are very small.

In the more temperate climates it is necessary to have good trees, well manured, and in a good aspect, in order to have sound seed and well ripened; and, in any climate, it would be useful to have a few trees of the best growth peculiarly set apart for seed. And if, for want of better, you are obliged to make use of the seed from trees whose leaves have been pulled for the worms, let it be from those trees which were last used, viz. when the worms were in their last age, which have their fruit pretty well grown before they are disleaf'd, for the berries are hindered to fill when the leaves are pull'd early. If the berries are ripe on any tree whose leaves you have occasion for, it will be convenient to shake the tree moderately every time before you pull the leaves; for so you will both save the fruit for seed, and hinder it from mixing with the food of the worms; and on this last account you should preserve for seed those trees which are so greatly loaded with fruit as to have but few

leaves, since it wou'd be almost loft time to pull the leaves, and they wou'd be fo mix'd with the berries as to occasion a great deal of litter among the worms; and if they were fo ripe as to fhed their juice among the leaves, it wou'd make them unwholfome food.

I muft add, to what I have already faid about separating the feed from the pulp, that if, after having been very well rubb'd in a coarfe bag, it is put into a wicker fieve wrought juft fo clofe as not to let the feeds pafs, and kept under a fpout of water, rubbing and fhaking it all the time; you will foon have all the feed clear'd from the pulp. And, by winnowing it when it is dry, you may feparate the lighter feed from the heavy; the former muft be fown thick, as a great part of it will not come up.

C H A P. IV.

*The soil proper for the raising and plantation
of Mulberry-trees.*

THE ground for raising mulberry trees either from seed, layers, cuttings, &c. shou'd be a rich loose mould inclining to sandy, that the tender new formed roots may be the better enabled to extend in it. A small depth of soil will be sufficient for these, especially those raised from seed; but it ought rather to have gravel under it than any sort of stiff clay, which might hold the wet and chill the young plants. In temperate climates the border under a south wall, lay'd so as to slope a little toward the sun, will make a very good seed bed.

Though a small depth of soil is sufficient for raising trees which are to be transplanted, yet when they are rais'd where they are to stand (as will be shewn in the raising mulberry hedges) or when they are transplanted where they are to remain, a deep soil is best; because mulberry trees

shoot downward with very long tap-roots. It is true indeed, that when they have taken with the ground, they will live, and throw out abundance of leaves, even in a bad soil; but then these leaves are not so good to nourish silkworms, and especially, when the trees are planted in low watery grounds, they afford but bad leaves, though they may have a greater quantity; for, as they abound too much with moisture, their leaves approach to the nature of those which grow on the suckers of the mulberry tree, and endanger the busting of the worms which feed on them, especially if they had been used to better leaves before.

Choose therefore a rich mould inclining to sandy, loose, and as deep as you can, where your mulberry trees are to remain. If the ground is not rich enough you must help it by digging about the roots, and laying in the mould of old hot beds or other good old manure; and if it is too wet, you may ease it of the moisture by drains. Ground sloping to the south is the best aspect for a plantation, and it will be the better if defended by a wood or grove, on that side from which nipping winds might hurt the young buds in spring.

C H A P. VI.

*The first method of raising Mulberry-trees
from the seed.*

FOR raising mulberry-trees from the seed, you should choose some part of an inclosed garden, which has a good exposure to the sun, and is defended from the north wind; the earth should be well stirred, and enriched with some very old dung, and ought naturally to be a good fine mould; then lay out the ground in beds, a little raised above the surface of the earth, of what length you think proper, but not above four feet broad, that they may be conveniently weeded.

The best time for sowing the seed is in *February, March, or April*; the sooner it is done in spring, when frosts of any continuance are no longer to be fear'd, it will be so much the better, as the plants, by coming up early, will have time to get strength, and be the better able to bear the ensuing winter. As the plants require, according to the difference of climates, six or eight weeks after the seed is sown before they

they begin to appear, I think it is a good rule to sow the seed about six or eight weeks before the time in which the mulberry bud begins to open, which may be a sort of general direction for any climate.

Take therefore the seed which you had saved, and steep it for one night in water, then make it about half dry, and mix an equal quantity of sand or dry mould with it, the better to separate the grains; sow this mixture on the beds prepared as above, and sift over it some fine rich mould, such as that of old melon beds, to about a quarter of an inch depth: The beds must be watered at least every second day in dry weather, especially toward the time when you expect the seed to spring up.

While the earth appears moist you need not water them, since it is very apt to thicken the surface of the ground, and make a crust gather on it, which hinders the up-spring of the young plants; and therefore when you water them, it should be with a watering-pan whose rose has very fine holes; or else you should have two or three light hurdles of osier, straw, or rushes, which you should lay upon the several parts of the beds as you water them,
which

which will prevent the mould from being beaten into a cake. If either any frost happens, or the weather be very hot when you sow the seed, it is proper to cover it with some straw for four or five days; this will defend it from either cold or drought according as the season is, and also from being scratch'd up, and pick'd by birds. If the seed is sown on hot-beds, made like those for melons, the plants will advance the better, and not be endangered by cold; but it must be watered oft, because such beds soon grow dry on their surface, from their high situation.

Another way of sowing the seed is in small drills made in the beds, about an inch deep, and two or three inches asunder; by this method you can readily observe the weeds, and distinguish them from the plants, and also the snails, which are great destroyers of the young plants. I would choose to make these drills run across the bed, and not lengthways, because you will thus easier discern the weeds and snails, and can also the readier, with a small hoe or fork, stir the earth between each drill, which will check the growth of weeds.

If

If the seed had been preserved with some of the pulp about it, as mentioned in the foregoing chapter, you may sow it in a drill in the following manner. First steep it in water till it becomes a soft pulp; then make drills across your beds as before directed, only somewhat deeper; then having some small ropes made of hay, about as thick as a bulrush, fix them with two pegs directly over each drill; take now the moist pulp and rub it along the rope, so as the seed may stick here and there upon it; having done this, thrust the pegs down, so that the rope may lie in the bottom of the drill, and cover it with earth, after which you may draw out the pegs. This is a very easy and good method, and the seed will in all likelihood be defended from frost by the hay rope, and also forwarded in springing by the heat of it when it rots.

In climates where the mulberries ripen early in summer, they may be sowed in this manner as fast as they ripen, without any further trouble than rubbing them, as you did the pulp, upon the hay ropes; by which you will gain almost a year in the growth of the trees; but as this is
done

done in summer, the beds should be duly watered, and the plants, when winter comes on, not being so large and hardy as those sown in spring, should be defended against frost with straw or some other covering, which should not lie too close for fear of suffocating them, and in mild weather should be taken off.

The mulberries may also be sown as they ripen, by first squeezing out their juice, and then mixing the pulp with so much sand as may serve to separate the grains; after which sow it upon a bed, and sift mould over it, as directed in the first method of this chapter.

If the seed which is sown in summer were made to pass in digestion through the stomach of animals, it would greatly hasten its springing; by which means, though sown late, it would not be much inferior in growth to the crop sown in spring. This is true also in all seeds which are covered with shells or stones, many of which stay often two seasons in ground before they spring: poultry must not be used, for their stomach grinds the seed; but dogs and other animals might be made to eat great quantities of the berries

ries as fast as they ripen in hot climates, by mixing them with a little flour or meal, or kneading them with it into a paste; and from the dung which they make, mix'd immediately with sand or dry mould to make it fit for sowing, the plants would speedily spring up.

There is nothing so destructive to the mulberry plants, upon their first coming up, and for some time after while they are low, as snails and slugs; they will eat numbers of them down to the ground in one night, and if it is a moist season, they will almost ruin a whole nursery: You should therefore be diligent to destroy them, especially a little after sun-set, which is better than in the morning, for then they have done their night's mischief. You may likewise guard the beds, by surrounding them with dry soot or ashes, sprinkling fresh on it when it is grown wet by rain, but no soot should be thrown on the beds, being too hot and scalding for the young plants; the slugs will not care to pass over this fence, especially while it remains dry.

Sand strowed on the beds is also a good defence, and I have found a handful or

two of wormwood, put into the pan with which you water them in the evening, to be a good preservative for that night; but the best fence to hinder them from coming on the bed is a rope of hair, which should be trimmed with a pair of scissars, to make it as bristly as you can; this being pinned close to the ground round the border of the bed, will so prick their tender skin, that they will not venture to go across it. Therefore, if the place is much infested by slugs or snails, you may use all, or as many as you think sufficient of these methods; but if you are neglectful in this point, you may lose almost all the plants of your seed-bed. The seed-beds of your mulberries must be kept very clear of weeds, which would otherwise easily rob the young plants of their nourishment, and stunt their growth; nor must you forget to water them at least every second evening in dry weather; and if the sun should be violently hot, so as to endanger the scorching and making them wither, you may shade them from its noon heat, by some straw or such like thrown lightly on the beds, and removed when the violent heat of the day is over; but this in

the cooler climates will scarce ever be necessary.

If violent rains should have washed away the earth, and made the young seedlings too bare toward their roots, a little fine rich mould put between each drill will repair the injury, and also help their growth.

In such climates as *England* the young seedlings will not be above three inches high the first year. In warmer ones they make a great advance, for in some parts of the *East-Indies* it is said that they sow large quantities of mulberry-feed, whose crops they reap down, and feed their silkworms with them; and that the silk made from these tender shoots is easily discernable, by its fineness, from that which is raised from the leaves, which again shoot the same year, and are used for a second brood of worms. If this is so, it is likeliest to be done by those who live between the tropicks, where, having a double spring, the crop which was sown the spring foregoing, may serve to feed the worms that are hatched in the beginning of the spring following, but of this we have no perfect accounts, as neither of their methods of managing the silkworms, in which

they are said to be much more expert than the *Europeans*; and this is not unlikely, they having been in possession of the art perhaps almost as early as the flood.

If large crops of mulberry-trees were raised by sowing the berries immediately when they became ripe, (I mean in our *American* colonies, for it must be where they are of quick growth) such crops might, on the ensuing spring, make a good and early provision for the worms while they were in their first age, and required but a small quantity of food; the whole young crop might successively be reaped for the use of the worms, and the small stems and roots might have sufficient strength to throw out young shoots, which perhaps might be again reaped for a second brood of silkworms. I mention these methods rather as hints and mementos of trials which may be made, than as positive precepts, one intention of this treatise being all along, to urge persons to such experiments as may breed silkworms to more advantage than by the common practice.

I shall here by the way mention a method of hastening the growth of seed sown early in spring, in such climates where the wea-

ther is not then sufficiently warm, *viz.* After sowing the seed, sift over the seed-bed the sweepings or dust of pit-coal, turf-mould, or any such materials as are of a black colour, which, by imbibing the sun's rays, will greatly encrease the heat of the bed, and promote vegetation. This may be renewed as oft as the rain washes the materials into the ground, till the plants appear, and then should be discontinued, that the plants may have the advantage of the reflected heat; if a border, which lies under a south wall, be thus managed, a person would scarce imagine what a degree of heat the border will conceive. Note also, that it will much further the springing of all stone feeds, of which sort is the mulberry, if they are put into an earthen vessel with an hole in its bottom, and so buried abroad in the earth during the whole winter, and till you design to sow them in spring; they should be moisten'd beforehand, and a slate fitted to the inside of the vessel's mouth, (but so as not to prevent the rain from keeping them moist) to hinder mice from getting at them, who, if once they found them out, would in a few days totally destroy them, therefore you should

should now and then look whether they had got at them.

C H A P. VII.

*The second method of raising Mulberry-trees,
from cuttings.*

THE next most easy and quick method of raising mulberry-trees is from cuttings; and in this method though you cannot so readily raise the same numbers as from seed, yet you have an advantage in the quickness and strength of their growth. The mulberry is easier propagated from cuttings in moist and temperate climates, than in those which are extreme hot and dry; for the branches which are separated from the mother tree, having no roots to subsist themselves, require to be plentifully supplied with moisture, in order to keep them alive till the roots are formed, and where the climate denies this, the defect must be made up with watering.

The cuttings which are to be propagated should not be small single twigs, but pretty large branches, of at least three inches round in the thickest part, with all the smaller

branches on them; pretty large arms taken from an old superannuated tree will serve very well for this purpose, and the old tree will have an advantage from this pruning, by putting forth young wood, which will bear larger and better leaves; these arms may be divided and cut into lesser ones, of about a yard or more in length, in order to be layed down in the earth.

As I shall hereafter shew the advantage of planting those trees which are designed for silkworms in a sort of espalier hedge, so I shall now direct the laying down of the cuttings in such a method as that, without any future transplanting, many such hedges may be raised, and also good numbers of plants to be afterwards transplanted into hedges; and I am certain from experience, that if cuttings thus managed fail to grow, at least in a temperate climate, it is owing either to want of watering, weeding, or a good soil.

The best time for planting cuttings is as soon as the leaves have fallen in autumn, that the parts which lie under ground may be prepared to put forth roots the spring following; for, if they are planted in spring they will mostly fail, for want of roots to
supply

supply the large quantity of nourishment which the leaves will soon require. The earth where the cuttings are to be set, should have been dug, broken, and cleansed of weeds some weeks before, and, if there was a necessity, enriched with some good loam, very old dung, sand, or some manure, so as to make a fine loose mould, proper for the young fibres of the roots to shoot into; in this make furrows of about one foot in depth and two in breadth, sloping from the edge to the bottom of the furrow, and of the length which you design your hedges; the distance between each furrow need not be above four feet, if you design future plantations, by taking away and transplanting one or more of the intermediate hedges; but if no more hedges are planted than you intend to stand in the same places, then the trenches should be four or five yards distant. The ground that lies between the trenches need not be lost, but may be made use of for any low vegetables, that will not overshadow the young mulberry plants. The trenches should run from north to south, for reasons given in the chapter on the form of a mulberry plantation.

When you would plant the cuttings, first fill the trenches about one third with some of the fine mould which was taken out of them, then begin to lay in the cuttings, by placing their main stem as flat as you can in the bottom of the trench, and turning up the small branches on each side, so that their ends may stand above ground from three inches to a foot, as they can be conveniently bended and turned up; for which purpose, place that side of the main branch undermost which has fewest twigs growing out of it, you may bend the small branches, and make them comply as much as you please, they will not grow the worse, and where they are stubborn you may pin them down with hook'd pegs.

When the large stem of the cutting has but few or no lesser branches coming from it for a considerable way, you need not then bury it above three or four inches under the ground, that it may the easier shoot forth buds from its unfurnish'd part. And when several bushy clumps of small shoots spring from the ends of the lesser branches, as is common when the cuttings are taken from old trees, then that part of

the lesser branch, from which they spring together, should always be placed under the earth that they may produce distinct roots, for then each of them will, when separated, be a distinct tree.

In laying down the cuttings in the trench, place the thick end of each subsequent branch to the small end of the foregoing one; and, when they are all properly placed, cover them with mould to the depth above-mentioned, without pressing or treading it, only make some little allowance for the sinking and settling of the mould, and therefore raise it with a small swelling all along the trench, but so as to leave the smaller branches above ground as was directed before.

Having thus planted all your rows, you have nothing further to observe till spring, unless it be that, in case of a hard frost, you should cover them with straw, pease-haulm, or such like, always taking care that neither goats or other cattle may get at them.

In spring, and especially in summer, according to the dryness of the season, they must be constantly watered, every second day at least, in spring about noon,
and

and in summer about sunset, and this for the first year can hardly be overdone; and if they were in danger of being hurt by a very hot season, they might be defended, during the noon hours, by strips of old matting thrown over them, and they may be uncovered when the violent heat of the day is past.

These cuttings thus managed, will on the first summer put forth shoots of about five or six inches length, more or less, according as they have thriven, and at the same time they will fortify themselves with roots; so that if they have made shoots, and preserved their leaves till autumn, you need not doubt of their growth, but if any have fail'd, you should then place others in their room.

On the ensuing spring and summer, tho' they will then be more out of danger, yet you should continue to water them in very dry weather; and they will this year make shoots often half a yard in length, and furnish themselves compleatly with roots, so as to be fit for transplanting in autumn; and then you may raise up and cut off from the main stem all those bushy clumps mention'd, with their own roots, in order
to

to plant other hedges, leaving only such behind as shoot in a line from the principal branch, and in quantity as you shall judge sufficient to form your first planted hedge; those that you cut off you may separate and divide into distinct plants, according as their roots will answer such separation.

As the hedges grow up they may be train'd and kept to a flat form by sticks woven across the branches, until such time as you begin to pull the leaves for the use of silkworms; and then, by stripping the leaves of those branches which shoot right forward, and afterwards clipping them off, you will always preserve them in this form; you may also, by laying down the suckers and lower branches, be frequently supplied with young trees for new plantations: this method therefore of raising mulberry trees I take to be as advantageous, and dispatchful as any that can be pursued; for branches quite separated from the mother tree will, as I suppose, sooner furnish themselves with roots than layers can do, which, by being attached to and depending on the mother tree, are not under such a necessity of putting forth roots to feed themselves;

feldes ; befides, that the branches of large trees can rarely be brought fo low as to be lay'd, but cuttings can at all times be had in plenty.

I would recommend, before the cuttings are put in the ground, as above directed, to dip the part that is cut in tar or melted pitch, or with a hot iron melt it into the cut ; becaufe when moisture infinuates where a branch is cut, efppecially in the mulberry tree, it generally makes the bark part from the wood and grow rotten ; befides the pitching over of the cut will as I imagine, hinder it from taking in a large quantity of crude and improper juices, which will now be forced to ftrain through the bark, and the better prepare it to put on the nature of a root ; the fame method of pitching fhould alfo be ufed to thofe cuts which are made in pruning the mulberry tree, that the rain may not injure it.

A late *French* author has made fome improvements in the raifing of all trees from cuttings, by which he, with appearance of reafon, fhews that they will more certainly take root. He twifts a piece of brafs wire, round the feveral parts of the
branch

branch from whence he would have the roots produced. The theory upon which he builds his improvement is, that as the branches of trees are produced generally at acute angles from the stem, and tend upward; so the roots are produced at acute angles, but in an opposite direction downward. The ligature therefore of wire checks the motion of the sap, and turns it into that direction which is proper to produce roots; and he seems to be convinc'd of this theory by experiment. Perhaps small pieces of lead or even tieings of cord, may be found more proper for ligatures than brass wire, as they will give way to the growth of the branch, and not cut through the bark as the other appears apt to do.

The method here given for raising mulberry trees from cuttings, may perhaps be advantageously apply'd to the producing nurseries from many other trees, as well as from the mulberry; all that seems necessary for producing trees from cuttings, is, that the part which is under ground should, as soon as may be, put on the nature of a root, so as to feed the branches; wherefore the less any particular tree is apt to
strike

strike root from cuttings, the more of the branch must lye under ground to make up the defect, and the more should such other artifices be used, as will make it put on a rooty nature ; for otherwise, though a branch may bud and keep alive during the beginning of summer, yet when the leaves are expanded, and perspiring much, require much supply of sap, as they will do with the advance of the season, the branch will often, for want of due nourishment, decline apace and at last die.

CH A P. VIII.

Of raising Mulberry-trees by layers, and other methods.

THOUGH the two methods of raising mulberry trees, from seeds, and cuttings, are the quickest and most advantageous, yet, where large plantations are to be suddenly raised, all other methods may be at the same time used ; layers may be made from low trees, and from suckers, which are sometimes produced plentifully from the roots ; but the method of making
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ing layers being generally known, need not be particularly insisted on; the branches now are bended and pinned down in the earth, leaving only their extremities above ground, and in this situation they subsist on the mother tree, until the parts which are under the earth have formed roots sufficient to maintain themselves, and then they are to be separated from the tree and planted out.

These layers are more certain of growth than cuttings, and do not require such watering while they depend on the old tree; but then this dependance makes them lazy in putting forth roots, with which they often appear but moderately furnished, when you come to separate them from the old tree: therefore it would not be amiss to twist wire about the parts laid under ground, as in the case of cuttings, and also to water them well. The time for making layers is the same as that for planting cuttings, and in two years they will be fit to transplant. It might however be of use, if at the end of the first year, you began to wean them from the mother tree, by nicking their branches half through, and putting tar upon the cut; this might
the

the better force them to put forth roots for their subsistence.

Suckers often spring from the ground about the roots of trees, which have had their heads torn of by winds, or many of their principal branches lopped of; at least this may be promoted by digging and opening the ground about the roots of such trees: but though such suckers spring out of the ground, it is useful to their well rooting, that they should be bended down, and have earth laid on their lower parts, in the same manner as was done with branches layed down.

Besides the foregoing methods, mulberry trees may be propagated from parts of the root taken up, the more length they have will be the better; these may be laid horizontally about two or three inches under ground, in a loose fine mould, and placed in lines to produce hedges as was done with the cuttings; they may be planted early in spring, and will soon shoot forth plants, which being in their original, sufficiently rooted, are scarce at all liable to failures. The ground however, should be watered in dry weather, both before and after they have sprung, because the
roots

roots lie near the surface, being so plac'd in order that they might the easier push forth plants above ground.

Mulberry trees may be inoculated, the white on the black sort, and the black on the white; the latter method is directed in order to have a straight free growing stem to your fruit trees; but these being only niceties of culture, and not serving to propagate the tree, I forbear dwelling on them, as also on what is delivered by some authors, concerning the grafting or inoculating of the mulberry trees of a different species; the success of which I very much doubt, having tried it on some and failed in the attempt.

C H A P. IX.

Of the planting out of the young Mulberry-trees.

MULBERRY trees raised from seed, or from parts of the roots layed in the ground, may be transplanted the second autumn after; or you may take up only the most thriving plants out of the seed beds, in order to thin them, and let the remain-

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der

der stand another year. Those which are thus taken up are only to be transplanted into nurseries, where they should remain two years more before they are planted out; and one foot is sufficient distance for the seedlings to be planted afunder at their first removal from the seed beds.

Those which were rais'd from layers or from cuttings may be planted out, in the hedge form as they are to stand, on the second autumn after they were rais'd; but as these are now but small and may therefore be planted, in the hedge pretty near one another; you may after two years more take away every second or more trees, and plant other hedges with them, and those which remain will soon enough spread and meet one another. This same method you may take with those hedges which were originally planted from cuttings, thinning them, as occasion requires, and making new hedges from those which you take up.

In raising up the mulberry plants take care to break as few of the roots as possible, and let as much earth as you can stick to them, and afterwards proceed to plant them in furrows, made after the same
manner

manner as was directed in planting cuttings ; this is to be understood of those which you plant out in the hedges where they are to stand ; for young seedlings may be set down in holes when they are only transplanted into nurseries.

Though some authors mention that mulberry trees may be transplanted in spring, yet the surest season for doing it is just after the leaves have fallen in autumn ; for the dry weather, which often happens in spring before the roots have settled and begun to draw nourishment, will much endanger and often kill the plants ; but when planted in autumn this is avoided, and there is then nothing to be fear'd, except a smart frost happens soon after planting ; but this may be hindred from doing any hurt by laying some fresh litter, straw, or such like on the ground over the roots.

C H A P. X.

Of the form of a Mulberry plantation for Silk-worms.

IN the foregoing chapters I have advised the planting of mulberry trees in a flat form or sort of espalier hedge; for though in *France* and *Italy* they use only large standards, yet I conceive this to be a very inconvenient form for gathering the leaves, which cannot be come at without ladders and clambering among the branches, in which method much injury must be done by breaking them, and also frequent danger of falling incurred by the gatherers; besides more time spent in gathering, and after all, the leaves will not be so regularly pulled.

Du Halde, in his history of *China*, says that they are very careful to prune and keep their mulberry trees in such a form, as shall be most convenient for gathering the leaves, without injuring the trees, and in the most speedy manner; for which reason they keep them cut to an hollow form, with no branches in the middle; so that a person, by going round the tree,

can gather all the out-side leaves, and afterward, standing on the inside, those which are within, only by turning round to the different parts; for the trees are kept low, and there is no necessity for climbing upon the different branches; so that in this method each tree is a sort of round hedge.

But flat long hedges planted at proper distances, one behind the other, are both easier made and kept to their form, and can have their leaves more regularly and speedily pulled; for, beginning at one end of an hedge, you may pull, day after day, all the leaves which are one side of it, and then, going to the other side of it, you in the same manner pull its leaves, after which you go to a fresh hedge; but you never return to pull any second growth of leaves, which may spring from an hedge already pull'd, for the leaves would injure the worms, being too young for their age: but in six weeks you might perhaps pull them for a second brood.

If your hedges run in length from north to south, which will be their best situation, as both sides will then equally enjoy the sun; in this case it is best to pull the leaves of the east side of each hedge, one hedge

after the other ; because, as you are to pull them in the morning, these will have enjoy'd the morning sun in the beginning of the feeding season ; and after having pulled all the leaves on the east side, you may then begin with the west side ; for the season having now advanced, there will be sufficient heat to dry the dews on the west side, though the sun has not yet shone on it in the morning, when you begin to pull the leaves : besides, the sun will have some influence, in shining through the hedge, the leaves being already thinned on the east side, not but that you may, if there is a necessity, order your time of pulling the leaves after the sun has shone a while on the western side.

These hedges may produce branches and leaves almost to the ground ; by which means they will be easier pulled than those of standard trees ; and if rain should have much wet the leaves, and you are in immediate want of food for the worms, you can with a forked pole, fixed against the larger branches, shake and dislodge great part of the wet : besides, if rain falls with a little wind either from the east or westerly points, then one side of the hedge will
not

not be so soon wet, and you may then take the advantage of pulling the leaves on the leeward side ; when you are forc'd to this, for the better regularity keep to one hedge, and mark the place which you pull'd, by thrusting a stick into the hedge, that you may not disleaf the same part a second time.

Besides what has been mentioned, the ease with which leaves can be gathered from hedges is of great importance, as the gathering of them makes one of the principal labours in feeding silkworms ; and I dare affirm it will be found by experience, that one person shall be able to pull twice the quantity of leaves from hedges which he could do, in the same time, from standard trees ; for there he can readily see what lies in a flat form before him ; he will not be delayed in clambering from branch to branch, as he must in pulling the leaves of large standards ; nor will he injure the trees by breaking the shoots, as frequently happens when persons are obliged to climb for the leaves. And if the hedges are clipped for the worms, which is practicable, especially in the white mulberry whose shoots are slender, it will

make still greater difatch. This however, need not be done till the shoots have got some length of growth, for when the worms are very young, it is easy to make provision for them.

It is of consequence also to have the plantation at no great distance from the place where the silkworms are kept, that you may not spend much time in bringing the leaves home, and also that you may the readier be supplied upon sudden occasions: or when the weather threatens rain, and warns you to make a provision of leaves before they have received wet, because it would be a great labour to dry them for large quantities of worms, and yet this must be done if they have receiv'd any moisture.

These are some of the principal advantages which would be obtain'd by mulberry-trees being planted in the form of hedges; the same would be obtain'd, if the single trees were train'd in a flat form, though they did not compose one continued hedge, in which case the branches might be allowed to extend laterally as far as they could, and when they become too long to support themselves, they might be supported here and there by branches of ash or
other

other timber fixed in the ground with the thickest end downward, the smaller shoots of which branches being cut short, would make so many hooks for the mulberry branches to rest upon; and indeed where mulberry hedges grew so thick as to hinder the lateral extension of their branches, it would be proper, from time to time, to take away every second tree, and transplant them so as to form a new hedge, still leaving so much room between the trees, both in the new and old hedge, that they should not quite join in two or three years, by which method you would not till then be obliged to thin them again.

It would be of use to have your mulberry plantation sheltered by some taller trees, on that side from which sharp blasting winds do proceed in the spring of the year; a row or two of trees planted in this manner would often preserve your mulberry-trees from being nipped in the bud, and would always contribute toward their budding more kindly, and somewhat earlier; these trees would also make the better shelter if they were train'd in an hedge form; and where any grove happens to be already planted, the sheltered side of it
may

may be made use of for a mulberry plantation, if it is in other respects convenient, for such shelters should not be too near the mulberry-trees. Fir or other large ever-greens would make the best shelter against any sharp winds, which might blast the buds of the mulberry in winter and spring.

C H A P. XI.

Of the culture, pruning, and management of Mulberry-trees both for Silkworms and Fruit.

FEW persons bestow much trouble on those mulberry-trees which are designed for silkworms; and yet it is certain, that the leaves will be more wholesome and the trees thrive the better by culture. In those countries of *Europe* which produce silk, the leaf-gatherers do, for the most part, clamber on the trees, and, thro' haste in pulling, break the branches, and otherways very much injure the trees; for this reason, and other advantages mentioned in their proper places, I have all along

along recommended hedges, or trees train'd to a flat form. The chief culture which these will want is, now and then to dig and stir the ground all along over their roots, and if the soil is poor, to help it with some very old dung mix'd with sand, lime, marl, good mould, or other such manure as lies most convenient, and is best suited to temper and improve whatever natural defect there is in the soil; this at least will be very useful for such a part of your hedge as you desire should bud soon in spring for the new-hatch'd worms.

These hedges should be pruned by clipping of the shoots from which you have stripped the leaves as soon as you conveniently can, for being done in summer, the cut will better heal, new branches will be form'd for the ensuing year, and the hedge will be kept flat and regular: understand this when you do not clip but strip the leaves to feed your silkworms, for if you clip them they will want no other pruning.

But if your trees are common large standards, they may want pruning either when the branches are grown so old as not to bear good leaves, or when they have
grown

grown so very long as to become top-heavy, and not well furnished with leaves throughout their whole length, or when you desire that some of them should produce more delicate and tender leaves.

On these occasions, some persons in the silk-countries manage their mulberry-trees as fallies are sometimes used, by cutting off the whole head, that new shoots may spring out; but this is a very bad method, for it hurts and damages the tree beyond measure, so many and large wounds scarce ever healing without letting the moisture in, and so rotting the trunk, that the tree never after becomes sound, and beside some years are lost before it can again completely furnish itself with branches; whereas, if you prune the tree in such a manner as to leave a good length of all the larger branches, these will soon furnish themselves with young wood, and the tree will not be in such danger of being rotted by the moisture, or killed by too large amputation.

The branches should be cut sloping, that the rain may not settle on the cut. By this kind of pruning, you will still leave somewhat of the form of a tree, only
with

with its branches considerably shortened, and a few seasons will make it as handsome as it was at first, and will not leave it a large unhealthy trunk, with a thick bushy head, as the other method would do; and this pruning may be performed, as I hinted before, in any of the summer months, immediately after you have used the leaves for the silkworms, by which means you will have reap'd the advantage of your trees before you lessen their branches, and in summer pruning, the bark sooner covers the cut.

It may be convenient in the foregoing method of heading trees, to leave a few of the smaller branches and twigs upon the larger arms, and the leaves of these smaller branches should have been spared and not pull'd off, that they may serve to draw nourishment, and keep the tree alive until it has furnish'd itself with young wood; the cut also made in pruning would be the better, if made close to some smaller branch, that the bark might the sooner cover it, and a little smearing with tar would be of advantage.

Trees which are thus largely disbranched, should not have their leaves pull'd for the
silkworms

filkworms till the second time of their budding after it, both because the leaves would be too tender and unwholome for the worms, and also the life of the tree endangered by it.

The black mulberry-trees, which are kept for the sake of their fruit, will require the foregoing culture, when they become so superannuated that the berries grow small, and ripen ill, as is the case of many trees in cool climates, where people complain of the mulberries not coming to perfection, yet use no culture to perfect them; and besides this, even young trees should have the ground about their roots dug, opened, and enriched with manure, in order to make them bear well, and to make young plants bear the sooner, they should have been grafted or inoculated from a good kind.

The ripe black mulberries would, I believe, make a most rich and delicate wine, could they be gathered in sufficient quantities at once, but they seldom ripen together, therefore it would be necessary to have a great many trees, in order to have quantities worth pressing, for when full ripe, they will scarce keep above one day
without

without beginning to grow mouldy ; perhaps it may be found that they will ripen more equally in espalier hedges, and also that the fruit can be gathered with less trouble than on standards. In *London*, where they have mulberries in great perfection, they use ladders, pretty wide at bottom, but tapering so as that the two legs become join'd in one for about a yard in length at the top, this makes it easy to be fix'd between the forks of the branches against any part of the tree, without danger of overturning ; they gather the fruit in long chip baskets, tapering to the bottom, which keeps off the weight of the upper fruit from pressing that which is below, the mulberry being of all fruits the easiest to be bruised ; the basket is hung by a hook'd stick across one of the branches of the tree near the gatherer, which allows him to have both hands at liberty, and he moves it as he sees convenient from one branch to another.

This method doth very well for gathering small quantities of mulberries, but would be too tedious for making wine, since mulberries don't grow in clusters, but single, and must be gathered one by one ;

one; therefore it should be try'd whether they cannot be shaken on a coarse woollen cloath, not by climbing on the tree, but by placing a forked pole against the branch, and shaking it gently, so that only those which are ripe may fall; and in this way perhaps sufficient quantities might be collected from a good number of trees, and press'd every day as they were gathered, so as to make good wine.

Mulberries afford a great quantity of very rich juice, it stains the hands much, and will not come off with soap and water, but any acid, such as vinegar, lemon, or sorrel immediately discharges it; the pulp which remains after pressing may be preserved to raise seedlings.

I must not omit mentioning, that the mulberry-tree, by being planted against a wall, may be made to ripen its fruit in very cold climates, and that one or two trees are very sufficient to furnish table fruit, which, as it doth not ripen all at once, will often continue to afford a fresh supply every day, during the space of six weeks.

Many of the observations made here concerning the mulberry, may be apply'd
to

to the raising and culture of several other trees; and though in many places there are things mentioned only as probable conjectures, it is hoped they will afford some foundation for useful trials, which however should always proceed with caution, and not be made in such a large manner, as to become extensively dangerous; it is thus that experiments become useful. But if they are made all at once, and in a very extensive manner, then, though they should be founded in reason, they will most commonly prove abortive, because some minute circumstance will be omitted, while the attention was engaged wholly on what was indeed more material, but not entirely sufficient for the success of the trial; and it is chiefly for want of a prudential conduct, that experimentors have often suffered, both in their fortunes and in the opinion of the world.

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Culture of S I L K.

P A R T II.

C H A P. I.

*A general brief view of the Silkworm's life,
with the choice of place proper for rear-
ing them in.*

THE silkworm proceeds from an egg laid in summer; it is yellow when first laid, but in three or four days turns of a blueish colour; its size is about that of a grain of mustard; it is preserved till the following spring, and is then hatch'd either by the natural warmth of the weather, or by artificial heat.

The worm that proceeds from this egg is about a quarter of an inch long, as thick as a small pin, and of a black colour; three or four days warmth generally hatches it. This worm, from so small a size, doth,

cloth, in the space of about six weeks, grow to be above two inches and an half long, and an inch and half round, after which it desists from feeding, and begins to form its silk-ball.

It begins the outside of its work first, and keeping still in the inside, forms an hollow ball of silk round itself, which it generally finishes in three or four days from the time of its beginning to spin.

It lies inclosed in this ball a certain space of time, in hot climates fifteen days, in cold ones a month, and so proportionably, at the end of which it is transform'd into a very large moth, and works it way out by an hole which it makes through the ball.

The male and female moths then couple, and when they are separated, the female lays her eggs to the number of three or four hundred, and in a few days afterward both males and females die.

Their eggs are kept safe till the ensuing spring, at which season they are again hatch'd into worms. This is the general sketch of a silkworm's life when it is preserved to breed; for millions of silk-balls are wound off to manufacture before the moths spoil them by boring their way out.

While the silkworms are very young, they take up but very little room, and during the first fortnight at least, may be kept in shallow broad drawers, boxes, and such like, and that in great numbers; for a foot square may contain above ten or twelve thousand of those newly hatch'd, but as they grow larger, so must also the space that contains them. Those therefore who have large nurseries of silkworms, should provide a place large enough to hold them when at their greatest size; a foot square will not contain above an hundred worms conveniently, when they are full grown.

As to the temperature of the place in which they are kept, cellars and all moist places are to be avoided, nothing being so great a detriment to their thriving and health as moisture; high places, such as those next the tiles of an house, are also to be avoided, for here they would be too hot in warm weather, and too much chilled in cold weather; an equal degree of heat is what best agrees with them, and that heat always from a dry and not a moist air. The temper of the climate is therefore to be regarded, so as in hot climates

mates to avoid violent heats, and in temperate ones great colds, and in both moisture.

The room in which they are kept ought to have windows opposite one another, that is to say on the East and West, or on the North and South, so as that, by opening the opposite windows during very hot weather, the air may have a free current through, in order to refresh and clear the place of bad air or smells. These windows, provided they shut close, may be made either of thin canvass, which is best in warm climates, or of glass, oiled paper, transparent membranes, or any other material which will prevent the cold and admit light; and it will be necessary to have nets, or something of that nature, to prevent the entrance of birds when the windows are left open, which might make great havock among the worms, unless you only open them while you are present. No bad smells, such as those of smoak, sewers, or such like, should approach their lodgment; and all crevices which might admit or harbour rats, mice, snakes, spiders, crickets, or other vermin should be close stopped, for spiders and other ver-

min will prey on them while very young, and snakes or lizards at any age.

Under the foregoing conditions, it is no matter what sort of building they are kept in, a mud-wall tenement is as good as any, nay on account of its dryness perhaps preferable to any other; the barns and other out-houses of farmers may be used for this purpose; or, in hot countries, occasional sheds may be made, which, in such climates as some of our colonies enjoy, will sufficiently answer the end; for the reader must here take notice, that several circumstances, which will be mentioned in the course of this instruction, are rather conveniences for those that would do things in the neatest manner, than absolutely necessary, and that many of the precautions against cold and wet will be useless in some climates. Those circumstances which are absolutely necessary to be observed, the practitioner will, from his own experience, soon distinguish from those which are not so material, or which the nature and conveniences of the country determine him to make choice of; and the course of his practice will also make him supply what may haply be forgotten among a number of minute and various circumstances.

C H A P. II.

Of choosing good eggs, and the time of the year proper to hatch them.

THE way to be certain of having good eggs of your own breed will be shewn further on in Part III. but if you are only beginning to feed silkworms, and are obliged to buy your eggs, you must, in a great measure, depend on the honesty of the feller, especially if you send for them to a distant country; the principal rule to be depended on in this case is, for the buyer to choose the largest and most plump eggs, and of a lively blueish or grey colour, for if they are small they are of a weak and puny breed; those that are white or yellow have been laid by the female without coupling with the male, at least are not impregnated, and therefore good for nothing; and those that are brown, shrunk, and very flat are decay'd. If you are near the place where the eggs were bred, you can best discover their size and goodness, before they are taken from the

materials on which they were laid by the moth.

Some give as one mark of good eggs, that they should make a noise in cracking them with your nail, and that the moisture that comes from them should not flow thin, but these are no certain signs. Some are said to kill good eggs by the heat of the fire, in order to hinder the propagating them in other countries; and at best, it is to be feared that many who make sale of them are not very careful of the breed, but take them indiscriminately from weak as well as strong worms. Beside the choice of good eggs, some regard is to be had to the climate in which they are to be rear'd, so as to buy your eggs from a country which enjoys nearly the same degree of heat; or if any difference is to be made, I would rather buy them from a country a small degree colder than the one to which they are brought.

It is also to be observed, that you must not put more eggs to hatch than you can procure mulberry leaves to nourish them with; it is hard to give a rule for this; three or four large trees, or about a dozen or fifteen small ones may feed about an
ounce

ounce of eggs, if they are the white mulberry, but if you use the black, its leaf being much more gross and broad, you may reckon one of the black equal to two or three of the white sort. The best precaution is rather to have too many trees, than too great a number of worms.

Being furnished with eggs, the next thing to be regarded is the time of hatching them; and the best and surest rule for this is, to do it when you shall observe the mulberry buds begin to open and spread into small leaves; and it will not be sufficient to observe this in one or two trees, which may chance to stand in a warm and sheltered situation, but it must appear through the bulk of all your trees, otherwise, though you may have a great number of trees, you may be distressed for want of food; for though some have taught to supply this defect with lettuce, and other different kind of leaves, as elm, mallow, bramble, rose and nettle leaves, yet it is not worth while to amuse one's self with rearing worms which have taken their first nourishment from any of these, as they will neither be strong nor make good silk. The bramble or blackberry
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has been prescribed, because its fruit resembled the mulberry, but the flavour of the leaf has not the least affinity, being austere and styptick, whereas the mulberry has a mild sweet taste, with a peculiar flavour, and the others have been prescribed perhaps, because the worms, to avoid being famish'd, would eat them. But as each particular species of caterpillar has its peculiar plant allotted for food, so the silkworm has the mulberry, which alone it willingly eats, of all plants or leaves yet tryed; neither do other caterpillars willingly eat the mulberry that I have heard of; I tryed the speckled hairy worms that feed on the nettle and several others, but they would not touch it. I once indeed met with a green worm, about an inch long, and as thick as an oaten straw upon the mulberry-tree; I fed it in a box with the leaves of the mulberry; it was very nimble and wary, it changed into a small brown-winged moth; I believe, as it was single, it was not a native of that tree, but came there by accident.

These things being considered, I think the ill consequences of giving the worms any thing for food but the mulberry-leaf will

will appear, and I should rather choose to give up those worms, that were hatch'd before there were leaves, for lost, and begin a new hatching of eggs, than attempt to feed them with any other thing than the mulberry, unless it were for two or three days, and even this, only when I could procure no more eggs that season.

But even the necessity of doing this may be prevented; for if you fear that your eggs should hatch before the mulberry-leaf comes out, remove them into a cooler place, and this will backen them for some time. Or if it is found necessary to keep them very cool in any of our colonies, in order to prevent their hatching too soon; they may be put into a bottle with a pipe fix'd in its neck, and then the bottle may be kept under water or in a well, the mouth of the pipe must be above the water, to admit fresh air, and it should be coated well with wax, at the place where it is fix'd in the bottle, to prevent the entrance of the water. I have tried this with a small bottle of eggs kept in a vessel of water, and it has kept them from hatching for three weeks, after others had hatch'd of themselves; yet perhaps very cold spring wells

wells might destroy the vivifying principle of the eggs, especially if the weather was already grown very warm, and they had a tendency toward hatching, the change then from heat to cold might be too great: the experiment may at first be made upon a small quantity of eggs. The bottle need not be above half fill'd with eggs, that a larger surface of air may be in contact with them; and it should be loaded with some weight, and the pipe buoyed with cork in some part, answering to the depth you would have it sink in the water.

If your eggs had began to hatch before you took this precaution, you must then proceed directly to hatch them, by putting them in shallow boxes, as mentioned in the next chapter but one; for you must not put them in bags because it would now hinder their coming out by their lying in an heap. And now as they hatch you may feed them even with the small buds of the mulberry though not yet opened; this indeed makes some waste of their future sustenance, but if you have plenty of trees it is not much matter, as the worms now eat but a small quantity.

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Even the green bark scraped from the branches will feed them, but this injures the trees, if it is scraped with an iron knife I suspect that it might give an astringent quality to the bark which would hurt the worms, one of glass or a sharp flint would do best. It would be proper, if the climate is liable to those inconveniencies which arises from a late spring, blasts or sharp winds, to have a good many trees in a sunny place, but sheltered from the severe winds, which may give you food for your worms as early as is necessary, and by the time that these leaves are used the other trees will be ready; but if the latest trees are ready time enough, it would then be best to preserve these early trees to the last, when the worms are full grown.

Besides observing the budding of the mulberry-tree, you should choose a day clear, dry, and warm, when you put your eggs to hatch: some also advise that you should, if in other respects convenient, choose the new moon, in order that the worms may begin to spin on the full moon of the following month, which they think makes them spin the better; but as in very warm climates time is chiefly to be gain'd,

that the worms may be rear'd before the weather grows violently hot, which is very apt to injure them; therefore the earlier you begin will be the better, without regarding the influence of the moon; besides, as in some climates you may rear two broods in one summer; this is another reason that you should begin as early as you can, that your second brood may have finish'd their business before the weather begins to grow cold.

Having fixed upon your time of hatching, observe that all those directions which follow, concerning the manner of doing it should be pursued in a chamber well closed, and secured from cold and wind; and observe that the bags and boxes which shall be hereafter mentioned for putting the eggs to hatch in, should be made as warm as your skin before you do this; and when you use the boxes they may be lined with a piece of silk or cotton stuff.

If the weather should happen to grow cold or moist, after you have begun to hatch your eggs, you must be more careful to guard against the injuries of it: you must continue the same degree of warmth as near as you can, and not remit

of it, unless it be a very little after your eggs have begun to hatch, and this only to avoid erring on the extreme of too much heat, which would at that time injure the worms which were hatched or near hatching.

C H A P. III.

The method of hatching the Silkworm's eggs.

THE nature of the silkworm's eggs is such, that like those of other insects, they will as the weather advances in warmth hatch of themselves; but as, in this manner, there would be a great distance of time between those that hatched first, and those that hatched last, in so much that, as some would every minute be hatching, it would be impossible to attend or collect them together, or afterwards to feed them, on account of their being sick at different times; therefore it is necessary to make use of artificial warmth in order that numbers may be hatch'd at one time, and that your whole quantity of eggs may come out at least in two or three days, so that you may
be

be able to separate each days hatching, or rather two or three times a day, and feed them by themselves. And this is a thing so absolutely necessary, that without it there would be no possibility of feeding any quantity of silkworms to advantage, as I shall shew hereafter.

Various methods of making the eggs hatch may be used according to the conveniences of people; but whatever method is used should aim principally at this end, viz. of making them hatch as nearly as may be together. And the thing that will most effectually do this is an equal degree of warmth, as near as can be attained, and constantly apply'd till they are hatched.

This degree of heat, which is called the heat of incubation, is that which the skin of a healthy person can communicate, or any other heat equal in degree to it. And the method for hatching them by this heat is as follows.

Divide your quantity of eggs into parcels of one or two ounces each, and put each quantity into a bag of cotton, silk or stuff, tying it so as it may not spill: these bags are to be kept in the breasts, next the skin, by a person who do not use
violent

violent motion, or who might otherwise endanger them by crushing or squeezing them too hard, this they do for the space of two or three days, or until they suspect that the eggs are within a little of hatching; which, if the eggs were not too forward before, will be in the space of three days and nights; at night the bags are taken into bed with them, but care must be taken not to crush them, and therefore it would be well, having first warmed the bolster thoroughly as warm as the skin, and taken care that the outside be not hotter than that, to lay the bags under it, placing over them a small box or drawer, sufficient to hinder them from being crushed, with its bottom uppermost.

When the eggs are ready to hatch, which will be about the end of the third day, it is inconvenient any longer to keep them in the bags, because the worms which hatch'd would be squeezed and hurt as they came out; and therefore each parcel must now be gently poured out into a shallow box, of such a breadth as that the eggs shall not lie on the bottom above a quarter of an inch thick, so that the worms, as they hatch, may be able to make their way

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through

through. The box ought to be of clean firr, such as wafer boxes or the like.

The eggs of different bags ought not to be mixed, because they may have received different degrees of heat and so would hatch unequally. The best time of putting the eggs into these boxes is just before you go to bed, that you may put them under your bolster warmed as was before directed; covering the box close with its lid, which lid ought not to come so close to the eggs, but that there shall be sufficient room to lay the sliced leaves of the mulberry over the worms when they begin to hatch.

The next morning early, after having put your eggs into this box, open it, and, if the worms have not yet begun to come out, return the box under the bed-cloaths, where they may remain about two hours after you have left the bed, for about so long a sufficient heat will remain; after which the boxes must be placed between two pillows heated very moderately, for a small over-degree of heat would injure the worms when near hatching, and you must have other pillows ready warmed, as these cool, and so continue them, all day be-

tween pillows, and at night in your bed, till they begin to hatch.

In warming the pillows you may place them as near the fire, and heat them as quick as you please, and let them be heated thoroughly; but take care, before you place your boxes between them, that they may cool so as to be no hotter than your hand when thoroughly heated in your bosom, and to preserve this heat, the longer in the pillows, you may wrap round them a quilt or coverlet, the thicker it is, the better, and this may be heated as hot as you please, it cannot injure the worms through the pillows.

Where large quantities of eggs are to be hatched, several pillows may lie upon one another, and be fastened by a couple of strings, tying them across, and may then be placed at such a distance from the fire as that the heat exceed not that of the human skin; this distance you may find by warming your hand in your bosom, and approaching it towards the fire till you just begin to feel the warmth, here fix the stack of pillows with the boxes, and place a quilt or such like behind them, to hinder the back from cooling too fast, and thus

turning the whole stack now and then, to give all parts an equal degree of heat, you will save the trouble of often changing and warming the pillows. Or instead of placing them before the fire, you may, when the sun shines clear, place the stack of pillows in the window where the wind doth not enter, and hanging a coverlet behind them, turn them as before, which, while the sunshine continues, will sufficiently preserve their warmth; the boxes should sink into the pillows, so as to have all sides completely covered; and when you suspect the eggs to be near hatching, you may, every three or four hours, flip different boxes out to try them, taking care, as often as you do it, to expose the eggs as short a time as possible to the cool air.

The method of hatching the eggs in bags by the heat of the skin might perhaps be improved, by putting the bag into a box fitted to its shape, but rather a little smaller, that so it may keep steady; which it will the better do if the bag is made so deep that its mouth may be turned outward over the rim of the box; this will also keep the lid of the box firm, and hinder the new hatched worms from creeping between the bag
and

and the box which contains it. But as air is necessary for the hatching of eggs, the box should be all over pierced full of small holes, and the bag should be made of thin silk or stuff.

The eggs thus inclos'd may be kept in the bosom, or by men in pockets made on the inside of their waistcoats, or in any other way near the warmth of the skin, without such danger of crushing as when kept in bags alone; besides, as the eggs should not quite fill the box, they may, by turning it softly round, be shifted and mix'd so as to enjoy an equal degree of heat; and when they are put under your bolster at night, there will be no fear of injuring them: but, when the eggs are near hatching, they must be pour'd into the broad shallow boxes; and treated, in all respects, as those poured out of the bags into such boxes.

Some, without putting them at all into bags, hatch them from the beginning between pillows in shallow boxes, keeping them by day between the warmed pillows, and at night in bed, or under the bolster in the manner which has been already related. The eggs while in the boxes, may

be sometimes stirred and mix'd, with a small spoon made of wood, that they may equally share the heat which is used in hatching them: the boxes may be near full of eggs till they begin to hatch, after which the eggs must be spread thin in other boxes.

Many authors direct the steeping of the eggs, in wine made as warm as the skin, for half a quarter of an hour, and then drying them in a moderate warmth, by gently rubbing them in a dry napkin, just before they are put to hatch. This makes them come out more equally together, for they, at this time, separate those eggs which, after having been half a quarter of an hour stirred in the wine, swim at top, and throw them away, or at least don't mix them with those which sink; because they are of a weaker constitution, and would not be likely to hatch so soon. This method also separates those which are decayed and rotten, which may be of good use if, as is said of pullets eggs, the rotten ones will affect the rest.

I have been the more particular on this circumstance of hatching the eggs, as it is one of the most necessary points in breeding silkworms, yet notwithstanding the many
and

and minute things which are set down, the practice will be found sufficiently easy; I shall only add that in some of our hot colonies, heating the pillows, and afterwards managing them by the meer warmth of the sun, in the day time, and at night in bed, by the method before prescribed, may be found sufficient to hatch the eggs effectually; but to expose them naked to the hot sun, I take to be a very bad method in any climate, the heat being too great, and neither equally imparted nor equally continued. I shall now proceed to the management of the worms when they begin to hatch.

C H A P. IV.

The method of treating the Silkworms during the time of hatching.

WHEN the worms begin to hatch, you should have in readiness two pieces of paper, fitted to the inside of each hatching-box, pricked full of holes as big as a large pin would make. Lay these two papers over one another in each box,

and strow over them some mulberry-leaves, sliced into shreds, so as to cover the whole surface ; then shut the box and lay it in your bed if warm, or between the warmed pillows, the heat of which should now be rather more moderate than before, for fear of injuring the worms ; the box also would be the better for having a few holes in its lid to admit fresh air.

The worms, as they hatch, will come thro' the holes of the paper and fix upon the leaves, and when you perceive them almost quite black with worms take off the upper paper, and gently slide the leaves, with the worms which adhere to them, upon the place where you intend to keep them. Or you may with a large pin take up the fibres in parcels, and so spread them ; but don't spread them thinner than just that they may not lie in heaps upon one another. I have practised an easier method than either of the foregoing, for shifting the worms of the pricked paper, which is to hold it inclined in one hand, and, bringing the surface of another peice of paper close to the worms and fibres, gently to turn them over, and so the pricked paper lying uppermost may be taken away,
and

and placed in the hatching box, as before, for fresh worms to come on it.

The reason for using two prick'd papers to each box, is to avoid taking up the eggs when you remove the paper ; for many of them are apt to stick to the paper which is next them, by a fine cobweb which the worm begins to spin the instant it is hatched. Two pieces of gauze or cyprus, wove wide enough to let the worms pass, would save the trouble of pricking the papers, and do better, especially, if by means of two or three shreds of fine hay, their surfaces did not lie exactly close to one another ; this also should be taken care of when you use prick'd paper, otherwise the holes of the upper paper, by lying close to the under one, might not afford a passage to the worms to come through. In this manner you must continue to manage your worms until they are all hatched, you should visit your boxes at least twice a day, in the morning early and at sunset, if your worms hatch fast you may do it thrice ; and be sure not to mix those that hatch at different times together ; this would create you an infinite trouble in your future management of feeding and cleaning them, on

account of their moulting-sickness coming on at different times. If you keep the hatchings of every six hours distinct, provided they come out fast enough to cover the leaves in that time, you will have the less trouble afterwards; but those of twelve hours distance must never be mixed together; wherefore number the drawers or papers into which you put them, according to their different times of hatching, that you may not afterwards mistake.

The greatest number of worms are generally found hatched early in the morning, and may then lie too thick on the leaves, so as to crowd one upon the other; in this case, when you distribute them into the drawers, place the heaps that you take out of each hatching box at some little distance from one another, and lay some fresh mulberry leaves between them, that the worms may spread themselves, and not be crowded. The rule for which is, that they should nearly cover all the leaves, so as to make them appear almost quite black, but not lie upon one another; if they lie thinner than this, they will not have eaten their leaves before you give them the subsequent feeding, and so will remain among
the

the old shreds, not coming up readily to the fresh leaves, by which means the leaves will also grow withered before they are quite eaten, and thus continually heaping leaves, you will both waste their food, and bury many of the worms under the heap of fragments. Note, for the first eight or ten days of the worms age, let the leaves always be sliced. In two or three days, if things have been managed well, your eggs ought all to be hatched; but if you have not as many hatched on the third day, reckoning from the time of their beginning to hatch, as you intend to feed, you must continue to keep the eggs warm as before.

Some, to avoid tediousness in getting their quantity of worms hatch'd, put a considerable greater quantity of eggs to hatch, than they intend to feed, and then in a day or two from their first coming out they have all their number, and not so many different ages among their worms as they would otherwise have had. What eggs remain after this may either be given to somebody else to continue their hatching, who might happen to want eggs, or else should be thrown away. A few eggs extraordinary are of little value, and what are

are thrown away are still of less account, as the weakest worms are likely to be the last coming out: manage what way you will, there will always be some which come out so late as not to be worth attending on, as also some very early ones, but so few in number as not to deserve a distinct drawer or place of feeding; both these may be thrown away.

I have here all along mentioned the putting your new-hatched worms in small drawers or boxes; for though hereafter I shall give directions for making large stands to feed the silkworms on, yet these need not to be used till the worms have at least passed their second moult, or sleep as it is called; this is to be understood of worms bred in the more temperate or cool climates, such as *France* or *England*; for in the hot climates, such as *Georgia* and others of our colonies, they may in fine weather bear the open air soon after they are hatched, and be laid upon papers spread on the large hurdles, or on an open table, with only some slight covering of paper thrown over them for the first days; but if it is cold weather, drawers will be found very convenient, as they can best regulate the
necessary

necessary degree of warmth. I will suppose you have a frame containing six drawers one over the other, and that each drawer is about an inch in depth, and twenty inches by twenty square; there will then be nearly the space of three square feet in each drawer: I will also suppose that one square foot will contain all the worms that are produced from an ounce of eggs when just hatched.

Suppose now you were hatching three ounces of eggs, of which you intend to make three different fortments, as coming out at three different times, an ounce each time; then the first ounce that hatches should be put into the middle of the uppermost drawer, and marked as the first hatched; it will in this drawer take up the space of one square foot, and there will be the space of two square feet left in the drawer, which will be occupied by the worms by the time they have pass'd their first moulting. The same is to be understood of the second hatched ounce, which should be put into the third drawer; and of the third hatched ounce, which should be put into the fifth drawer. When the first hatched worms have grown to the size of their
drawer,

drawer, half of them must be placed in the second drawer, and they will fill both these by the time they have passed their second moult; in the same manner the second hatched will fill the third and fourth drawers, and the third hatched will fill the fifth and sixth, and then they may be distributed upon the large stands.

Thus you see the six drawers will contain all the worms which come from your three ounces of eggs, without confounding different hatchings. I suppose that the worms will occupy thrice the space after each moulting that they occupied at the moult foregoing, which I believe is pretty nigh the truth, and will hold through all the different moults, and also from the fourth moult to the time of their spinning; and I have run through this method only as a sample of the regularity which, in some degree, should be used through the whole process of feeding silkworms, when they are hatched at different times.

The drawers above-mentioned may be made of any slight materials, such as laths, with paper bottoms, supported by two or three strings or sticks, to hinder the paper from swagging; or they may be made of
straw

straw smeared with cow-dung and dried, as best suits the climate and your convenience.

The frame which supports the drawers need be only four uprights, with cross bars for the drawers to run upon, being open on all sides, that the fresh air may occasionally have access, for which reason also there should be an inch or more distance between each drawer; a cover of coarse stiff paper may be made to go over the whole, and keep the young worms warm when there is sharp weather; and one side of this cover may be loose, so as to throw back when a lesser quantity of fresh air is necessary, and you do not care to uncover the whole frame.

This nest of drawers can easily be moved from one part of a room to another, can be secured from cold by covering it close at night, and also from mice or other vermin, by hanging it out of their reach.

I mentioned above the laying of the worms in the middle of the drawer, the reason of which is, that they may regularly spread themselves, so as to fill the whole drawer as they grow large; they are made to do this by spreading the leaves
a little

a little round them as you feed them, and perceive that they lie too throng, for the worms will follow the leaves that are laid close to them. The same may be effected, by making three or four different parcels of the worms in the same drawer, and so feeding them till they meet.

Thus much was necessary to be said here concerning the management of the new-hatched worms ; but before I proceed farther in the method of feeding them, it will be convenient to give an account of the stands which are to keep them as they increase in size. The manner of gathering the mulberry leaves, and their periodical sickness, which I sometimes call moulting, because they then cast their skins, and are disordered like birds that are casting their feathers. These are the subjects of the three following chapters.

C H A P. V.

The manner of preparing the large stands and shelves on which the grown silkworms are to be fed, and on which they afterwards spin their silk.

IT will be convenient for those who feed large quantities of silkworms, to have the stands and shelves on which they are to be kept, or at least some of them, prepared before they are absolutely wanted, in order to avoid being hurried when they become necessary; and those who are provident will prepare them in such a manner, that the same materials can every year be quickly and easily put together and refitted, and when there is no further occasion for them, taken asunder and laid by in small room.

The stands (see plate I. fig. I.) are made by erecting poles about an inch and half thick, according to the weight of shelves and worms which they are to support; they are placed at the distance of three or four feet asunder in a square situation, and are ty'd firm to long streight transverse

H

poles

poles reaching from one to the other, so as to form partitions for the shelves where the worms are fed. The shelves must be fourteen or more inches asunder, and their size not more than that, when you are on one side, you can reach half way over, in order to give the worms their leaves, and attend them, and then going on the other side, you can reach to those which are fed; therefore each shelf ought not to exceed four feet in breadth.

Thus the shelves on which the worms are to be fed, form stories one above another in these stands; they are hurdles composed of reeds, small oziers, and such like. The hurdles made of small reeds are preferable I think to boards or any other shelves, on account of their cheapness, lightness, and dryness, and also for other reasons, which will appear in treating of the manner of feeding and cleaning the worms.

If the hurdles are made so as to let the litter drop through, there might be a receiver of coarse paper to hinder it from falling on the leaves and worms of the next lower story; these receivers may be fixed so as either to be brought up close under the hurdle, or to let down on one side,

side, so as to form a slope when you would sweep away the litter that has gathered on them. But because the fixing of these receivers may appear too troublesome to many, it may suffice to make the hurdles of reeds placed so close to one another, that after the worms are a fortnight old, none of their litter can pass through; and before they arrive at this age, they may have paper or other convenient materials spread under them on the hurdles, which will hinder their litter from annoying the lower shelves, and also be convenient in taking out each sheet of paper by itself when you would examine or clean the worms, unless you keep them in drawers, as taught before.

Hurdles seem much preferable to shelves of boards; for though when the worms are large and make much litter, their hurdles must be taken out, shaken, and swept, yet this need not be done near so frequently as when they are kept on boards; for the air, which will have admission through the vacancies of the reeds, will keep them sweeter, by drying the litter and also the shreds of leaves that remain on them, and will hinder them to grow so moist and

mouldy as they would be apt to do on boards, where the air could have no admission from beneath; for any great moisture and mouldiness of the heap of litter on which they lie must always be guarded against, and their hurdles cleaned as often as shall be found necessary.

If you are stinted in room, your stands may be raised ten foot, but then it will be necessary to have a ladder, in order to be able to feed the uppermost shelves; and this ladder ought not to lean against such slight materials as these stands are composed of, but ought to support itself with two striding legs, like those used to clip high hedges; and therefore it will be best not to have your uppermost shelf higher than that you may, by standing on a stool or bench, reach your hand to feed the worms, unless, as was before mentioned, you were stinted in room; for which reason, though you may make your upright posts ten foot high, you need put no shelves higher than necessity shall from time to time oblige you to do, the low shelves being easiest attended.

Several rows of these stands may be placed in a room, leaving alleys between each
each

each row of them, so broad as that two persons, in feeding the worms, may pass one another when they meet, and also room to take out the hurdles. Some advise to make each hurdle narrower than the next lowest, in order that the worms which chance to drop from one story may be caught by the next; but this would lose a great deal of room; the worms, until they are ready to spin, never wander from the leaves, and may easily be secured.

Those who have no great nurseries of worms, or want the means of making such regular conveniences as I have described, content themselves with nursing the worms in the room where they lodge on all sorts of boards, shelves, tables, wicker hurdles, &c. fixed in whatever manner is most convenient; and the worms do well, provided they are guarded against rats and other vermin, and creatures that might prey upon them or disturb them; nor are they hurt by the frequency of people, nor by moderate noises, if they are accustomed to them, but shocking, harsh and sudden sounds should be always avoided: but though this ordinary way of keeping them may do, it will still be best to

keep them in the most convenient manner, it will abridge and methodize the trouble of feeding and cleaning them, and this being a great part of the labour attending silkworms, every thing that shortens or eases it, whether by what I have or shall hereafter mention, or by what the practitioner shall himself find out, is to be considered as a material point.

Plate I. Fig. I. shews the structure of the stands where the silkworms are to be fed when they grow large and require much room. It is a sort of scaffolding composed of streight poles tied together. Its breadth A D three or four feet; its length A C may be continued according to the dimensions of the room which contains it; its height A E about five feet, unless you are stinted in room, and then it may be as high as the ceiling.

The upright poles A E. D F. &c. should be niched where they are tied at top, in the manner represented at Fig. II. to let the transverse poles A B C, &c. into them, that the scaffolding may stand the firmer; but at bottom the transverse poles E G I, &c. should be niched, and not the uprights,
because

because, as they sustain the whole weight, it might weaken them.

When you untie the short transverse poles A D, &c. which are at the ends of the stand, the front and back of the scaffolding comes asunder, and may be laid flat against one another, so as to take up little room, till you have occasion again to use them. The division next A shews the shelves, which are a sort of hurdles made of small reeds. They are ranged above one another at about the distance of fourteen or fifteen inches.

Over the lowest hurdle is represented a sloping receiver of coarse paper, or thin bafs matting; its use is to defend each under hurdle from the litter of the worms above it. These are only necessary when you choose to weave the reeds so open as to let the silkworms litter fall through; in which case there should be a receiver under each hurdle; but when the hurdles are made so close as not to let the litter pass, there is no occasion for the receivers.

The division at B is left clear of shelves, to shew the pins 1, 2, 3, 4, 5, &c. upon which the hurdles rest; the breadth of each hurdle must be equal to the distance

H 4

between

between the upright poles, that it may easily be put in and taken out; but its length must be three or four inches more, that it may rest securely on the four pins which support it. It may be inclined to one side when taken out or put in. The branches, for the worms to spin at the division C, &c. will be described in Part III.

Fig. III. represents one of the hurdles composed of small reeds, its rim made of four strong reeds or sticks tied together at a, b, c, d, where two nitches, such as that of Fig. II. are let into one another. This kind of curved nitch is not apt to break, nor doth it weaken the part, as an angular one would do. The strong reeds or sticks e, f, g, over which the small ones are woven, may be tied in the same manner. The small reeds are woven in parcels of twenty or thirty, and close to one another, when you intend that the litter of the worms should not drop through, yet there will be still space enough between them to let the air pass.

C H A P. VI.

*The manner of gathering the mulberry leaves,
and keeping them fresh.*

THE hands of those that pull the leaves should be very clean, as also of those who attend and feed the worms; they should not have handled any thing that has a strong offensive smell, such as leek, garlick, and such like; neither should they have eaten them, nor use tobacco, especially in smoaking, when they feed the worms.

The time in which they should pull the leaves, ought to be as soon as the dew is off them in the morning, for they ought never to be pull'd with moisture on them. As the worms ought to be fed with leaves which are tender and young, in proportion to their tender age, therefore you should begin by pulling one tree regularly after another; you must not begin to pull a second tree till you have pull'd all that you ought to do of the first, for you must not quite disleaf a tree for fear of hurting it; nor must you pull the same tree twice,
though

though by the time that you have pull'd a good many of your other trees, it should have thrown out a considerable quantity of leaves, both because it would injure the tree, and because these leaves would be improper for the worms, being a second growth and tender; whereas the worms will then be advanced in age, and require older leaves.

If your trees are kept in a flat form, being planted like an espalier hedge, you may begin regularly at one end of your hedge, and pull the leaves regularly on, making a mark every day as far as you have pull'd, that you may not go over the same part twice; and thus when you have gone in order down one side of the hedge, you return up the other, and so proceed to another hedge.

If the hedges run in lines from north to south, pull the east side first, because in spring, when the sun is weakest, it will be first dried after the morning dew; but as the season advances in warmth, the western side will be sufficiently dried, though the sun has not shone upon it when you begin to pull in the morning. It is best I think to have the hedges run from north to south, that each side may share the sun alike;
but

but if a shower of rain have driven with an easterly or westerly wind, pull that side which lay to the leeward, as being least moist.

In pulling the leaves it is much better to do it easy, taking the leaves in your hand, than to take the whole branch or shoot in the fist, and thus to rake off as many leaves as you can at once; for this both bruises the leaves, which makes them bad for the worms, and also breaks and damages the branches, and fills the leaves with shreds of broken boughs; wherefore one of the gatherers should be a skilful person in feeding and managing the worms, and such as can be trusted to direct and oversee the others; for as it is common to pay the gatherers by measure for the quantity of leaves they bring in, they will be apt only to make it as large as they can, without either choice or skill. The leaves as they are gathered should be thrown into clean baskets, and not too much stuffed or pressed together, which would make them heat and otherways damage them; each gatherer should have a small basket, which he may hang beside him to the tree, by a hooked stick, that he may not be obliged
to

to stuff his hands too full before he empties them; and thus all the gatherers having fill'd their small baskets, may empty them into one or more large ones, in which they are to be brought home.

Such a quantity of leaves ought to be gathered each morning, as will serve to feed the worms during the rest of the day, and also enough to give them their first feeding, early the next morning, before the new leaves can be gathered: after one or two feedings you will easily judge what quantity will be necessary for this, and give directions to the gatherers to fill their baskets accordingly. The leaves which are brought home should be kept in a cool place, but not in too great an heap: if they are young, and such as are gathered for new hatched worms, they may be kept in a glaz'd earthen vessel, as they then make but a small bulk; and when they come to make a large heap, as they must for a great number of worms that are grown large, they may be kept in large wicker pinniers or baskets, or even in the corner of a cool room for two days. It is accounted best not to feed with the leaves fresh taken from
the

the tree, for they are good as long as they remain green and firm.

Though your general method of gathering the leaves may be as has been described, yet, if the weather tends to be rainy, you must provide at least two days food, or in proportion as you foresee the difficulty of gathering, which if possible should not be in wet weather, especially while the moisture is actually upon the leaves: you may keep the leaves tolerably well for two or three days in a cool place, but you must take great care that they do not heat and grow mouldy, which would greatly injure your worms. If the leaves, therefore, any way tend to this state, you must often turn, and give them air; spreading and placing them where there is a current of air, or on some of the hurdles of those stands which may happen not yet to be employed.

Notwithstanding the foregoing caution, it may often happen, that on the very morning when the gatherers go out, and when you have no provision for that day, but what they shall bring in, there shall fall rain, and wet the leaves: in this case you are under a necessity of having the leaves
gathered ;

gathered ; they should therefore shake the trees before they begin to pull, and if it is an hedge in the espalier manner, they may shake it with a forked pole without wetting themselves, and thus they will throw off a good quantity of the moisture ; and for what remains, it must be taken off by shaking and tossing the leaves between two dry sheets of linen, and afterwards spreading and airing them as above ; for no necessity should force you to give them to the worms while any moisture remains, it is better they should fast. The gatherers should not stay till they had pulled their whole quantity, in this last case ; but should at least send in a sufficiency of leaves for one feeding, as soon as they have gathered them, that they may be sufficiently dried by the time they are to be used.

As gathering the leaves in moist weather is to be avoided, so is also the pulling them after they have born the scorching heat of the mid-day sun ; they might then be too destitute of sap, and would be apt to wither, and grow unfit for the worms before they were all used.

The leaves of trees which grow in moist grounds, or where they are so shaded that

the sun cannot shine on them, are bad for the worms; so also are all spotted, blasted, and yellow leaves; and those which are upon suckers, or other proud shoots growing from the trunk or principal branches, are only fit for newly hatched, or very young worms. Therefore you may pull all these sorts at first, through your whole plantation, as long as they last; and then go regularly from tree to tree, as before directed; but observe that even the young worms, if they had been used to feed on firm leaves, would be kill'd by giving them those which grew on suckers; so that if these are us'd, it must be at the first.

Some mulberry-trees are apt to have such quantities of fruit, that it is difficult to pull the leaves without having great quantities of the berries mixed along with them; these, besides that they are said to be hurtful to the worms, will occasion a great quantity of litter, and mouldiness; and will oblige you to clean the shelves much oftener than would otherwise be necessary: you should rather therefore avoid pulling such trees as are thus loaded with fruit, if you have enough without them; or, if you are obliged to use them, you should separate the berries,

berries, if they are in any great quantity, by shaking the leaves in wide mash'd sieves or some such way : but if you spare pulling such trees, the berries will give you seed for new plantations ; for if they are stripped of their leaves, the fruit will not ripen well nor grow large,

Beside the foregoing observations, the gatherers must be cautioned not to bruise the leaves either by pulling them roughly, squeezing them in their hands, or pressing them into the baskets ; not to break the branches of the foregoing year, nor mix the fragments of broken branches among the leaves. In short, to injure the trees as little as possible, and to pull the leaves with clean hands, and bring them home in as neat a manner as they can. Not that it is absolutely necessary to follow minutely every thing which is above mentioned ; but if your conveniency answers, you will find them of advantage.

Some authors say that if the leaves are pulled by stripping them downward, it will disbark and hurt the branches ; but I have found that this is not fact, for they come off by stripping downward much easier than upward, and without injuring the

the bark, or being so much bruised by the hard grasping, which you are forced to use when you strip them upward, which makes them less agreeable to the worms, you must however take hold of the end of the branch with one hand when you strip downward.

C H A P. VII.

Of the four sicknesses or moultings which the Silkworm undergoes.

THE filkworm is subject to four sicknesses, from each of which it recovers by what I shall hereafter call moulting, or throwing off its skin; and the times in which this happens are carefully to be observed, together with the different appearance, which the worms makes both at the time of its sickening, and after it has moulted; because these are periods which greatly regulate your conduct in managing your broods.

The times of their sickness are so variously set down by many different authors, that scarce any fixed times can be taken

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from

from their accounts, especially for the first sickness, some fixing it to the seventh or eight day after hatching, and others not till the twelfth: but *Malpighius*, in his accurate anatomy of the silkworm, says that those worms which he hatched in *May* were eleven days old before they fell into their first sickness; those hatched in *July* ten days, and those hatched in *August* not quite nine: yet as he observes these times vary according to the weather and other circumstances. Some *French* authors fix the seventh or eighth day for the first sickness, in *France*, and I found it to be about the same time in *England*.

That you may not be at a loss for the time of their first sickness, upon which the other three depend, I will be somewhat more particular concerning its approach, and concerning the appearances which the silkworm has during its first age; because from its smallness, at this time, they might escape a common observer.

The silkworm when it comes out of the egg appears quite black, this in two or three days changes to a light mouse colour: upon the approach of its first sickness, the head begins to swell so as to be
apparently

apparently larger than it was, in proportion to the body; it appears also more pointed towards the mouth than it did before, and upon their actually falling into the height of their sickness they leave off eating, and remain quite motionless with their heads swelled, and raised, generally, above their bodies; and their colour is now a light yellowish brown, in which the rings of their body may be seen, if you view them closely.

They continue thus, without feeding, about three days; then the swelling of their heads begins to fall, and they cast their old skins, which tho' on account of their smallness you may not readily observe, yet is as compleatly cast now as at their last moulting, of which the magnifying glass will fully inform any one. You will know that they are quite recovered by the different appearance, which they immediately make after moulting, for they now appear of a very light grey colour about their necks, and the rest of their bodies a dark grey; their heads are no longer swelled, nor their nose sharp; their bodies also appear slender, and not so stiff and shortened as when they lay

in their sickness; and in half an hours time they fall eagerly on their food.

In the above description observe, that the swelling of their heads is the obvious sign of their approaching disorder; their motionless situation with their heads erected shews their continuance in the height of it; and the light colour about their necks, their motion, and beginning to eat, shews their recovery.

Though they fall into their sickness by some degrees, yet their recovery is almost instantaneous; for from the time that they begin to throw off their skins till it is quite off, is oft only about two or three minutes space. They cast it by fixing their tail to the leafy fibres, and then moving their body forward, after which they seem to rest themselves for a short time, and then begin to eat.

Having fed about three days, they begin to fall into their second sickness with much the same appearances as the first, and lasting the same time, viz. three days, therefore it need not be particularly described; only observe that though they are said to be well and feed three days, and to fast and lie motionless for three days more, yet this

this is not to be taken strictly, because they eat a little even after they begin to sicken, and therefore are something longer in an eating condition, than in a fasting inactive one: you must make this same allowance for what shall be said of their third and fourth sickness; observe also that the warmer the climate is, so much the shorter is the time of their continuing sick.

Having recovered from their second sickness, they continue in health for about three days, and then their heads swell as before, and they begin to fall into their third sickness; their bodies grow somewhat glossy of a pale yellowish colour, and somewhat lessened in length; they remain motionless with their heads rais'd, which now also appear sharp toward the mouth, as in their former sicknesses. After three days, the swelling of the head falls, and sometimes they suddenly grow as it were speckl'd with dark streaks, which colour proceeds from their old skin then beginning to separate; they then continue stretched out at their length, for about two hours, after which they begin to strip off their old skin from the head downward towards the tail, which is always the manner in which

it is done, and from the time in which they begin to strip it till it is quite off, there is but about one minutes space: they appear now of one uniform colour, which somewhat resembles that which the small smooth branches of an ash-tree have: the new skin at first appears something wrinkled, but as they begin to eat it stretches and grows smooth.

After their recovery from the third sickness, they continue in health about three days, as before, and then their fourth sickness begins with the same appearance as the third, and therefore need not be particularly described, being much of the same duration, and, as the worm is now grown large, easily observed; this is their last sickness: after their recovery from it they appear of the same colour as after the third; two black comma's, in this situation ("") appear on their back, a little below their first ring, which before this moult were not so manifest: after this they continue eating, and in perfect health for about ten days, that is till their time of being ready to spin.

I have in the foregoing account only mentioned the casting off of their skins;

but I must inform you that they do at the same time, by rubbing their heads among the leafy fibres, cast the entire scull including their teeth, and all other parts of it; and as their skin is stripped downward off their tail, so the skull comes forward off their mouth, and this is what gives their muzzle that sharp appearance which it has during their sickness, it being no more than the old scull sticking to the point of the new one. When the worms are large you can easily with the naked eye perceive this casting off their sculls; and through the microscope you may perfectly discover their jaws, teeth, &c. in it, together with seven most excessive small holes, on each side near the mouth, which were those of their eyes: for the two broad appearances on their head, which some mistake for their two eyes, are only two bones of their scull: their eyes are seven, as I have said, on each side, but so small that when greatly magnified with a glass, they do not exceed a small grain of sand. The spots which, when the worms are grown, appear at regular distances down each side of the body, are also by some mistaken for their eyes, but these spots are the breathing holes

through which the air enters into their lungs ; and all the kinds of worms, and caterpillars which change into flies, do, in their principal organs and transformations, somewhat resemble those of the silkworm.

From what has been said, it will easily appear that their sickness is not sleep, or a state of rest, though by some called so ; but rather a fever, like that which accompanies the toothing of children, or the casting of the feathers in birds, attended with a lethargick motionless state, which indeed resembles sleep, and a total loss of appetite, and abstinence from food till they cast their skins and the disorder goes off.

The final cause of their thus casting their skins, &c. seems to be, that their bodies may have room to grow and enlarge ; their old skins, it is likely, growing too tough to admit of further extension, for which reason a new and tender one is necessary.

I hinted above, that though the duration of their sickness, and of their subsequent health, is set down at three days each, from the beginning of their first moult to the end of their last, yet this should not be taken in too strict a sense, since they eat a
little

little sometimes after their head begins to swell ; and their state of total inaction doth not come on immediately ; so that they are perhaps a day longer in a state of eating, than they are of absolute fasting. So that you might reckon four days, in three of which they feed heartily, the fourth eat a little, and on the two next totally fast.

Malpighius, who took his dates of their sickness from the beginning of their totally inactive state, divides the times of their health and sickness in the following manner : after their being hatched, they continue in health for ten or eleven days, then they are sick about a day and an half ; their health after recovering lasts four days and an half ; and their second sickness a day and half ; their next health continues for three days ; and their subsequent and third sickness a day and half ; the next health, which proceeds their last sickness, he sets down at four or five days continuance ; the last sickness at two days and an half ; and their last healthy state nine or ten days and then they begin to spin : but he observes that the weather, and other circumstances make these times vary.

Notwithstanding that the particulars which I have set down on this head, will inform you pretty well of the times of their sickness, yet to be more perfect in it, you must add your own diligence of observation; and also consider the climate and weather, which if it be cold or moist, generally retards and lengthens out the times of these changes and moultings in the silkworm; but your own experience, join'd to the tokens and marks which are given above, will enable you readily to know what stage of life, and what condition the worms are in, and also to know what will next happen, and consequently what accommodation and management you are to prepare for them. Their times of moulting being, therefore, the principal thing which regulates many particulars in your attendance, and which when well known will ease you of much trouble, I need not insist how much they are to be regarded.

The time preceeding each moulting of the silkworm may be called one age; so that to the fourth moulting there are four ages; and from the fourth to the time of its being ready to spin may be reckoned a fifth age. Each age is about five days long

long except the first, which is about seven, and the last which is about ten, in the climate of *England*; but in a warm season, or in warmer climates. None of their ages are of so long duration.

The size of the silkworm when first hatched, and at its recovery from each moulting is shewn, Plate I. Fig. VI. the little curve line at top shews it just hatched. The numbers 1, 2, 3, 4, shews its size at the moultings which correspond to them; the horizontal line being its length, and the perpendicular its diameter; and number 5, shews it a little before it is ready to spin; for, when quite ready, its size is somewhat lessened.

C H A P. VIII.

Of feeding and managing the silkworms during their two first ages, or till they pass their second moulting.

THE silkworm's life, unto the time when it is ready to produce its silk, has been divided into five ages, reckoning one age at each recovery from moulting, and

and the fifth age from its fourth moult till it is ready to spin. The whole five ages together comprehend the space of five or six weeks, more or less, according to the coldness or warmth of the climate.

The silkworms had just began the first of these ages, being newly hatched and distributed into their nursery-drawers, when I left them in order to shew the method of getting food for them, and to give you a general description of their four moultings; I now resume the management of them at this first age.

They begin to eat as soon as they come out of the egg, and immediately fix themselves on the mulberry leaves, which are thrown upon them; and from this time, until they become ready to spin, they continue almost constantly eating, except at night and during the time of their moultings. Now, as they are placed in drawers large enough to admit of their increase of size until they arrive at their first moult, you will have no occasion to touch them until they have pass'd it, and will have little more to do than to feed them regularly, by strowing the tender sliced leaves of the mulberry over them, and to give them

them a little air, or to keep them close and warm, according as the weather is hot and close, or cold and damp.

Some authors prescribe, that they should be fed only twice a day till after their first moult; but as the strowing of a few leaves over them is a matter of small trouble when they lie in so narrow a compass, I should rather choose to do it thrice or oftner in a day; for if you give them in the morning the quantity which is to serve them the whole day, you must lay them thick on the worms, and most of them would be withered, or unfit for food before night; and when you gave them fresh leaves, many of the worms would not come up to them, but would continue attached to those that happened to be a little fresh among the former old leaves, and thus you would, from time to time, bury and hide many of the worms among the fragments that remained, and it is by no means practicable, or worth the toil, to be searching and picking for them among the leaves.

But if you only strew sliced leaves thinly over them, so as that they shall just touch one another or thereabout, but not lie in heaps; or if you give only so many leaves

as

as you find by experience your worms can eat before they decay, excepting the grosser parts and fibres, then at every new feeding your worms will quickly come upon the fresh leaves, and you will not then bury the worms underneath, neither will you make such waste of food, nor such a great quantity of litter, or of moisture and mouldiness; and thus no more than some dry wither'd fibres will be left, which are of use and service, as the dung of the worms will fall and be buried among them, and not at all taint the fresh leaves which you from time to time give the worms.

You should therefore avoid giving too great a quantity of leaves at any age of the worms; for though when they are well grown, they will not be so easily buried, except at their moulting, yet by thus heaping, you will both waste food and increase litter, mouldiness and moisture, and the labour of often being obliged to clean them. You should rather defer giving them a fresh meal for some little time, than give them it before the former was eaten, if it remained fresh or fit for food; nay, if at any time you find the worms, while they are out of their moult and well, lazy to come

come on the fresh leaves which you give them, it is a sign that they are too full, and you would not do amiss if you let them fast a little beyond the time in which you used to give them their next meal.

I have been thus particular, that you may avoid the great trouble which I have known to proceed from heaping too much food.

When you feed the worms, let the first feeding be as soon as you can conveniently in the morning; this must be done with the remainder of the leaves which were gathered the day before, and let the last feeding be as late as you can before you go to bed.

As the worms lie in the middle of the drawer, and at their first being placed there should only take up about one third of it, you may enlarge the space they lie on, at the time of feeding them, according as you perceive them to grow large and crowd one another; to effect this, you have no more to do than to place leaves round about, so as to touch those the worms lie upon; and thus, as you see it necessary, you may extend their space, for they will always follow and spread themselves over
the

the leaves which are contiguous to them ; but if you spread the worms too much, they will not be able to eat all the leaves you throw over them, the inconveniency of which I have mentioned ; therefore always keep them as throng as they can lie without being crouded upon one another.

While they are very young, you must, in cold weather, keep them close and warm, shutting the drawers or boxes as soon as you have fed them, and exposing them as little as possible to cold air ; you may for this end keep a blanket or such like over your whole chest of drawers.

But you must, on fine and warm days, use them to the open air, according to their age and vigour, pulling the drawers in which they are kept about quarter or half open in the middle of the day, and for as long as you shall judge convenient ; and when you shut the drawers, turn that side which was out inmost, that when you air them next, the other side may have the benefit of it ; for which reason the drawers should be made to go in at either side. Scarce any general rule can be given for the time of thus airing them ; the climate, weather, and other such circum-

circumstances must direct you. In temperate climates they should be kept close and warm till after their second moulting; in hot climates too much heat and want of air will oftener hurt them than cold.

It would be of good service, where great quantities of worms are kept, to have a thermometer; and having, by your experience, determined the greatest degree of cold and the greatest degree of heat which they could bear, without any manifest signs of harm, you might afterward, as the spirit in the thermometer varied above or below these points, regulate your conduct. You can give a good guess at their health by the vigour with which they eat, and their alacrity in coming on the fresh leaves which you give them, and hence you might pretty well ascertain the degrees of warmth in which they thrive best. A like good use might be made of an hygrometer, which measures the moisture and dryness of the air, and moisture hurts them more than cold; but these are niceties which few can or will make use of. If the worms are near their moult, you must not then judge of their health by their listlessness and inactivity, for these are at that

time natural tokens of a natural and periodical disorder, which though it is by some called a sleep, yet is rather a sort of lethargick fever.

In about five or six days after hatching, the worms will begin to fall into their first sickness, which precedes their moulting. When therefore you perceive their heads to swell, and that they do not eat so heartily as before, give them their leaves more sparingly, adjusting the quantity of their food so as that it shall be eaten before next meal, and when you perceive them all to lie inactive, with their heads erected, and that they no longer attempt to eat, you should then desist from giving them any more leaves, and by no means disturb or move them either now or in any of their moults, but let them lie quiet and warm, by shutting the drawers or boxes where they lie, especially if the weather is cold, during their two first moults.

You will often perceive some worms grow sick a little before the rest, though they were all hatched together, on account of some inequality in their strength or constitution; or because, though they were all taken out of the hatching boxes together,

ther, some came out of the egg perhaps three or four hours before the rest; these early ones will be a sort of notice to you to moderate their food, for that the others will soon be in the same state.

If by any mismanagement worms of different ages were mixed together, you may now separate them from one another; if, for instance, a great number of your worms which are in the same drawer abstained from their food, and grew motionless in the morning, and the rest continued eating till late at evening, then by giving a few fresh leaves these will come upon them, and so may be taken away from the rest with those leaves on which they have fixed. But as the picking the leaves up in order to remove them is tedious, and also unless great care is used may crush many of the worms, whether by taking hold of the leaves with your fingers or with pleyers; therefore I think it a better way to separate them now by the means of papers with holes cut in them, in the manner directed for taking away the worms out of the hatching boxes.

But if all your worms fell sick together, you would now have nothing more to do

than to wait for their recovery, and would not have the trouble either of separating those of different ages, nor of feeding some which were of a different age in separate drawers. And this you might effect, by getting all your eggs to hatch at once, which therefore you should, as much as you can, strive to do. It is true indeed, that though all your worms had been taken out of the hatching boxes at one time, there might be some which would sicken a little sooner than the rest from different strength of constitution, and consequently recover and begin to eat sooner; and if the difference of time were about twelve hours, and that there were a sufficient quantity of such worms to deserve a distinct place, it would be best to separate them; but then this may be done after their moult, by giving them a few leaves when they recover before the rest, and then taking those leaves with the worms on them, and placing them by themselves in a distinct drawer. But if you have large quantities of worms hatch'd at different times, and that almost all your first hatched sickeneth at once, then you may take away those few that are later than the rest and put them among your second hatching,

hatching, and the few that shall happen to be tardy among the second hatching transfer to the third, and so on. Yet if there is but little distance, for instance, only half a day, or even almost a whole day, between the sickening of those which lie in the same drawer, you may defer separating them till their second moult, or till their third, if the difference of time is too little at their second; the difference generally increasing at each moult.

You must however take care to feed those which are in a feeding state among the sick ones, if you do not separate them, but do it very sparingly, sprinkling the leaves very thin, that you may not bury the sick worms. Most of what I have been saying tends to one principal end, viz. that of keeping the worms of different ages distinct from one another, and whichever of the methods you choose, you will be sensible that it is an useful and necessary thing.

You will not be at any loss to know when your worms have moulted and recovered from their first sickness, the appearance they then make being very different from that which they had during their disorder, according to the marks given in

the chapter on moulting. And now, as they recover, give them their leaves gathered as neat and clean as possible, and if they lie too throng, separate and distribute them into other drawers as they come upon the fresh leaves. You may either distribute them in small parcels at some little distance in the drawer, so that they shall spread and meet as they grow large, or you may place them all in the middle of a drawer, and let them extend and spread all round, by laying leaves round them when they begin to lie too throng.

Your worms are now in their second age, and enlarged in size; and the leaves which are to feed them are also grown firmer; with these you must continue to nourish them: and the rules which have been already delivered for their first age being, with your own discretion, sufficient for this, their appearance also and time of moulting being much the same, excepting their size, I shall only refer you to what has been already taught, to avoid the tediousness of repetition. After about three days health and three days sickness, you will find them recovered from their second moult, in which state I shall take them up
in

in the ensuing chapter. Observe here however, that a worm just recovered from any moult is not larger, but rather less, than one which is going to fall into the same moult, lest you should mistake their age on account of their size, which size only advances during their health between each moulting. Take notice also, that the drawers and warm-keeping here mentioned are only for climates where the spring is cold at the time of hatching silkworms, and are not necessary in the warmer latitudes.

What I have said in this chapter is sufficient for the management of the worms during their two first ages ; I have made no mention of cleaning away their litter, or the broken fibres of their leaves, for at this time it is unnecessary ; the litter they now make is soon as dry as dust, and the fibres of the leaves are also soon withered, and make a soft bed, on which the worms lie cleaner than if they were placed on paper, for the litter runs down among the fibres, and so doth not at all incommode them, especially if they lie on a hurdle made of straw, reeds, or such like, through which the litter can pass. I have known

some of our ladies who kept silkworms give themselves an endless trouble in cleaning and picking them from the old leaves and fibres every day, a thing which cannot be done without injuring the worms, and for which there had been no necessity, had not their food been crouded faster than they could eat it, and the leaves given without slicing them, which would have hindered them to curl and envelope the worms.

I have read, that in *Spain* they keep the very young worms in flat straw baskets smeared on the inside with cow's dung, and then dried, and that they reckon the smell of the dried cow-dung wholesome for the worms.

C H A P. IX.

How to manage the Silkworms during their two next ages, that is, from their recovery out of their second moult to their recovery out. of their fourth.

WHEN the silkworms are recovered from their second sickness, they will be able to bear the air on open shelves if the weather is fine, and you had accustomed them to the fresh air at times before, when you found the day warm, to inure them to it. You may therefore now place them upon some of your shelves made of hurdles, in the large stands, and as there has been no occasion as yet to take away their litter, if it remain'd dry and they were properly managed, so neither is there any now; it is no more than a loose cake of dry fibres connected partly by its own materials, and partly by a fine cobweb which the worm is almost constantly spinning from its birth; the little dung, which lies among the fibres of this cake, is also quite dry, and in this case I never found a worse

worse smell proceed from it than that of dry grass or hay, but indeed if it had contracted much mouldiness and moisture for want of air, or by heaping too much food, it would be otherwise, and have an offensive smell.

You might have inured the worms to the open air, by laying the drawers, or whatever else they were nursed in, upon the hurdles in the day time, and returning them back into the chest of drawers at night, and afterwards, if the weather is warm, by letting them lie all night on the open stands in the same drawers.

When you intend to shift them out of their drawers to the hurdles which compose the shelves of your large stands, you need only raise the whole cake of fibres with the worms on it, and lay it on the middle of the hurdle, or raise one edge of the cake over the edge of the drawer upon the hurdle, and then gently shift the drawer from under it; this would be the easier done if one of the ledges of the drawers had been contrived to slip off.

As the worms will as yet take up but few of your shelves, you should place them on those shelves where they will be easiest fed;

fed ; that is about three foot high, and always observe to keep the high and most troublesome shelves empty of worms as long as you can.

When the worms lie thus on the cake of fibres in the middle of the shelf, you are sensible that as they grow and spread on the hurdle, those on the edge of the cake will have scarce any thing under them but the reeds or twigs of which the hurdle is composed ; if therefore you think this keeps them as yet too cold, or that your hurdle is so wide that they drop through, or any other inconvenience attends this, you may remedy it by laying sheets of coarse paper, but free from every thing offensive to the worms, round the edge of the cake of fibres, and as the cake extends with the growth of the worms, by the same degree you may draw out the papers, still leaving some under the edge of the cake, till you find no inconvenience follow from taking them quite away. A little fine hay, spread thin over the empty part of the hurdle round the cake of fibres on which your worms lie, might answer the same end.

On these shelves continue to feed your worms thrice a day ; do not be at the trouble of laying the leaves over them one by one, but, taking them by handfuls, scatter them at first thinly over your worms, not letting them fall in heaps ; it is best to scatter them first where the worms lie thinnest, which will draw them from lying in crowds, and afterwards you may throw them over those places which remained unsupplied.

As the worms are now to continue on these shelves, you must, if the weather should change to cold, keep the doors and windows very close, and you may further guard against the cold, by throwing a covering of thin light paper over them, so long as the bad weather continues ; and these remedies will have the better effect, if, while the weather was warm and fine, you had not kept them too tenderly, but had given them the fresh air now and then, especially in the heat of the day ; an equal temperature of heat being what agrees best with them, and to this your conduct and contrivance must come, as nigh as you can bring it.

Now

Now after the third day from their recovery out of their second sickness, your worms will begin to fall into their third; their heads will swell, their bodies look smooth and glossy, and somewhat shorter, and they will, after some time, desist from eating, remaining motionless, with their heads generally raised, as in the former moultings.

Those which continue feeding six or seven hours after the others have done, may now be removed, taking up the leaves on which they are, and classing them with those of the same time of moulting, or you may wait till they begin to grow well, and then separate those that first recover from their moult. Their moult ends in about three days as before, but their appearance just before they moult is somewhat different from the two former moults; for having been during their sickness of one uniform light colour, they now, about an hour or two before their recovery, turn dark and speckled; they then lie inactive for about an hour or two, the swelling of their head falls, and they strip off their skins from the head downward, and cast their sculls forward off their nose like a
mask

mask taken from the face, as you may now observe with the naked eye; their colour also after this moult is different from what it was after the two foregoing ones, having no more that light grey on the neck, or that darker greyish colour which they had on the rest of their body, but being of one uniform hue, like the smooth bark of an ash branch, but a little more inclined to a red colour.

Your worms being recovered from this third moult will be pretty large, and some of them should be distributed on other shelves to make room for their further growth, which will be pretty considerable before their next sickness. You may distribute them on the other shelves or hurdles, by taking up the fresh leaves with the worms on them in what quantity you find convenient to take away; but it would perhaps be best to take them entirely from one side of the hurdle, and not pick them up here and there, for this might leave those that remained so scattered as not easily to be fed, and I mentioned elsewhere that they should always be kept as close as they can, without crowding on one another.

Or

Or you may distribute them on other shelves, taking what portion you think proper of the cake of fibres whereon they lie, by putting your hands under it and gently separating it from the rest, and then laying it where you intended, repeating the same method if you had not taken enough at first.

And if at any time you find this cake of litter moist, mouldy, or fetid, your worms should all be taken from it when they come upon the fresh leaves, and all the cake of litter should be thrown away, or at least you should separate the upper layer of fibres whereon the worms lie from the under part; which you may pretty easily do, as the cake is generally composed of many layers of fibres, by raising the layer at first on the edge with your hand, and still as you raise it, sliding a thin board under it; the board should have a short handle like a wool-card, and when you have as much of the cake as it will take of, separate it from the rest, and gently slide it on the shelf you designed it for, and so proceed to take more. A little shovel or board of the above kind, with a small ledge on all sides, except the forepart, may be found at other times

times convenient for carrying parcels of worms from one shelf to another.

When your worms after this third moult are distributed conveniently, continue to give them leaves thrice a day, in such quantity as they can consume between each feeding, and according to those general rules given concerning the quality of their leaves.

As the worms may now take up so much room that some must be placed on hurdles under others, you must guard that their dung falling through may not incommode the under shelves; coarse paper, thin mats made of bafs, or other such like cheap materials may be placed under them on the hurdle to prevent this; or rather, fix these mats, so as that one side of the mat being fastened to the bar of the stand which goeth across, the other opposite side of the mat having a rod fastened to its edge, (as large maps are sometimes framed) may hang with a slope, the rod bearing on the outside of the uprights which form the stand. If these are thought too troublesome, the hurdles should have been woven so close as not to let the litter pass through; or at least you should take out the hurdle

when you go to clean it; but if the hurdles were made so close as to hinder their litter from falling through, there would be no occasion for any thing under them.

After about three days feeding of the worms, which must be managed much the same way as in their foregoing age, they will begin to fall into their fourth and last moult, which having the same appearances as the former need not be insisted on. In three days they recover from it, being of a colour the same as after their former moult, but their foreheads broader and their feet larger and furnished with claws; their tails also broad, and furnished with an infinite number of fine hooks, with which they are enabled to cling and support their weight.

N. B. If each receiver has two rods a little longer than its edge, one rod may lie over the pins which support the hurdle above it, instead of making cross bars, as mentioned in the last paragraph but one. See Plate I. Fig. 1.

C H A P. X.

The management of the Silkworms during their fifth age, that is from their recovery out of their fourth moult, till they are ready to spin their silk.

IF you did not distribute the worms upon other shelves on their falling into their fourth sickness, it must be done now upon their recovery from it, by some of the methods given in the last chapter; and though they be kept on the wide-woven hurdles, yet they need have nothing under them, unless it were some loose straw or such like, that the air may have the better access both to dry the fibres which the leaves make, and to keep the worms cool and refresh'd; for too much heat or any moisture would at this age very much hurt them.

The sloping receivers of coarse paper, bass-matting, or such like, will hinder their dung from dropping through one hurdle upon another, if they are such hurdles as were woven wide for this purpose; and this litter may easily with a feather or light brush

brush be swept off these receivers when there is occasion ; but these are unnecessary with close hurdles.

It is in this last age that you will most find the benefit of keeping the worms on hurdles ; for as they will now eat during nine or ten days before they are ready to spin, and will grow very large, making a prodigious deal of litter ; they would, if they were kept upon shelves made of boards, require to be cleaned every day, which cannot be done without removing them every time you clean them : but on hurdles made of small reeds, which are very dry and light materials, and have vacancies between them, the air will have access to that litter which sticks and remains among the fibres and shreds of their leaves, and it will not so suddenly grow putrid, moist, and mouldy, as it would do if the whole quantity of litter and fibres lay on boards or shelves, which did not admit the air underneath.

It will, however, often happen that pretty large shreds of leaves which are not eaten, shall so clog and fence up the interstices of the hurdle, as to hinder the air from passing through, and will make it neces-

fary to clean them in some manner or other : to do this I would propose the following method, when the hurdle is made so as to let the litter pass through. Raise the hurdle on one side so as to stand aslope as much as the next upper shelf will let it, and fix it in this situation secure from dropping down ; then take a small fork made with two or three wide teeth of pretty strong wire, and a little hook'd at the points, and thrusting it underneath between the interstices of the hurdle, so as to take hold of the under fibres, draw them down, and thus going over the bottom of each hurdle, most of the litter which before stuck will run down on the receiver.

The fork should not be very sharp, but have round blunt points ; and, if the fibres are not very thick, take care of hurting the worms as you pull them down : it will also promote the falling down of their dirt, if either before or after this, you do with a copper or brass bodkin or such like instrument, a little raise the fibres on which the worms lie, so as to make them lie loose, which will disengage the dirt from them, and will also make the worms eat those parts of their leaves which remain fresh ;

fresh; but which, by lying flat under the worms, would not otherwise be eaten: it would be best therefore to do this before you give them a fresh feeding, if much of their former leaves remained unconsumed.

If your worms lie on shelves of boards, or in any other way that their litter cannot fall through, and, that it is necessary to clean away all their litter from under them, you may do it by removing the worms when they come upon the fresh leaves to one side of the shelf which is empty, and then making clean the part from which they were taken, remove the next nearest worms upon this, and so on until you have clean'd them all; and you need not at this age of the worms be afraid of taking them up with your hands, provided they are clean. But in removing the worms thus with your hands, do not by any means pull away those fibres which shall cling to their claws, but lay them along with them: the tearing and forcing them from these fibres, I take to be a great cause why many of them do not care for mounting the branches where they are afterwards to spin; their claws being so blunted and strained, that they

cannot lay hold of the twigs and climb, without being subject to fall and tumble down, which so fatigues them that they give over the attempt.

The worms at this fifth age will eat a prodigious quantity of leaves, which should now be of the best sort you can procure for them, because it is now that they collect and digest the matter out of which they afterwards form their silk: if you were to open a worm before the fourth moult, you would find nothing but a watery humour mixed with the green mucilage of the leaves which they feed on; but when they are somewhat advanced in this last age, you will find in their silk-vessels a pale or yellow gum, out of which they form their balls of silk.

The goodness, therefore, of their silk depending, in a great measure, upon their being properly fed at this time; you must take care that their food may be, in all respects, as good as can be got; not the soft tender leaves of suckers, or of trees growing in moist watery places, or of those which are very young, but the firmest dark green leaves from your oldest trees; and these always free from dew or moisture,

ture, which would now make the worms dropfical and burft them.

They muft in the beginning of this age be fed four or five times a day, viz. very early in the morning; about ten of the clock; about three in the afternoon; about fun-fet; and at night juft before you go to bed. Your gatherers fhould therefore be abroad as foon as the dew is off the leaves, that they may fupply you at ten of the clock; or, if they have far to go, and cannot return fo foon, you muft always preferve two feedings out of the former day's leaves.

During the ten days in which the worms are now to be fed, before they are ready to fpin, you muft increafe the quantity of leaves which are gathered every day; for the worms every day will eat more than on the former; and when they are within a few days of fpining, you muft not confine them to four feedings, but muft take care that they get them as often as they want, remembering always to feed them late at night before you go to bed, and as early as you can in the morning.

In this laft age alfo you muft give them air, by opening the windows for three or

four hours during the heat of every fair day; and even though the weather is foul, yet, if you perceive the place where they are kept to smell strong upon your coming into it, you must, notwithstanding this, open the windows for a short time to refresh the air; and you should afterwards examine whether their litter is not gathered too thick, and clear it away. Nor should you now keep the worms too throng, but as airy, clean, and neat as you can conveniently.

Notwithstanding the many rules and instructions which have been given, chiefly that you might not be at a loss in any circumstance, yet before their fourth moult, you will not find much trouble in managing the worms; but in this last age your labour of feeding, and attending will be considerably increased; yet as it lasts but about ten days, and as the advantage which you are to reap from the silkworms depends much on your diligence at this period; you must subject yourself without reserve to it, or lose the profit which you expected.

The worms being fed plentifully as already mentioned, will, within ten days after

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ter their recovery from their fourth moult, have arrived to their utmost growth, being two inches and an half long, and an inch and quarter round, nearly ; their colour light, but not glossy, with some mixture of a dark greenish hue : but in a days time, having prepared and digested the materials of their silk, they will lose this greenish colour, their bodies will get an ivory colour and polish, toward their necks somewhat transparent, with a little of a faint orange colour. They will leave off eating, and before they are ready to spin, they will somewhat lessen in size ; but their bodies will feel more firm and consistent than they did before.

They will now totally desist from eating, and begin to wander about, stretching out their heads in quest of a place proper to fix in and spin their silk-balls. Now though, on account of preserving some little order and method, the instructions for accomodating them, at their spinning time, are not given till the beginning of the next part of this treatise ; yet it is proper that you should have look'd forward into that part, in order to have made the
necessary

necessary preparations for them sometime before-hand; for you would find yourself greatly embarrassed to do it when numbers of the worms were to be accommodated if you had not made some provision before.

It may be proper, before I end this chapter, to inform you that the worms which are hatched from six ounces of eggs, require the attendance of two persons till they have passed their fourth moult, after which they require five or six. They will produce from fifty to sixty pounds of silk, and in a favourable season a good deal more.

T H E

Culture of S I L K.

P A R T III.

C H A P. I.

The method of accommodating the Silkworms with branches proper to spin their silk in.

I Have now brought the filkworms to that period of their lives, at which your labour of feeding them ends; for from the time that they are quite ready to spin, they no more take any kind of food, though their life in different forms last above a month longer, and, in cold climates, a good deal more. Yet, though you will be eased of the trouble of feeding those which are come to their spinning time, you will for a few days, till they are all settled in their work, be obliged to give them a diligent attendance.

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In order to dress the shelves for your worms to spin their silk, you should have prepared before hand good quantities of broom, heath, pruning of vines or such like materials, of which broom is the best, which should be very well dried, in the sun, sometime before you use them, and should be free from leaves, and all dirt, moisture, mouldiness, or offensive smell; these branches should be laid in bundles like a whisk or besom, their small tops placed as equal together as you can, and then you should with a bill-hook cut off their thick ends, so as to leave them half a foot longer than the distance between each shelf, that, when the thick ends are set on the shelf, the small twigs being bended, may bear against the bottom of the shelf which is above it. With these twigs you are to form several long arbours, arched at top, quite across each shelf; the distance between the sides of these arbours, should leave the arch open quite through, about a foot wide, that there may be room to put in your arm, and feed those worms which are not yet quite ready to spin.

You must form these arbours by the following method: first place one row of
twigs

twigs within two or three inches of the edge of your shelf, bending their tops inward, so as to bear on the shelf above; then place another row of twigs, at about a foot distance, with their tops bending so as to meet and form an arch with the first row. The third row of twigs, which is to form one side of the next arch, must be placed within two or three inches of your second row, with the tops bended the contrary way; and the fourth row, which compleats this second arbour, at about a foot distance, with the tops bended so as to meet and arch with the third row; and thus proceed till you have formed as many of these arbours as the shelf will contain, which will not be above two, in a shelf of three foot square, or three on a shelf of four foot square; because the bushy partitions between the arches, and also those of the outer sides, will each be four or five inches in thickness. You must shift the worms aside to make vacant lanes where each partition ranges.

You should form these arbours so as to have a sort of bushy appearance without being too thick or too thin, but so that the worms may have room enough to spin, and yet the vacuities among the twigs not be

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be so large as that they shall waste a great deal of their silk, before they can fix on a proper place; the size of their balls, which is that of a pigeon's egg, will direct you in this matter; and the better to accomplish this end, you may leave the vacant spaces, among the partitions of the arbours, pretty large and open, till you have done forming the arbours; and then you may thicken them properly by placing in these vacancies, either small twigs, or some kinds of large hollow tubes, such as those of full grown angelica, and others which have no bad qualities. You should gather these tubes the year before, when they are white and withered, and if you slit them lengthwise from end to end, they will make a very good conveniency for the worms to form their balls in, being very light and dry, and soft, and smooth on the inside, and of such a form that the worm will immediately fall to work in them, and make very little floss or useles silk; and if you bundle, and lay them by when you have done with them, they may serve you many times over; you may thrust these, along the vacancies, into the partitions of your arbour, among the twigs and branches, and you will

will find the advantage of them; since, as I mentioned before, the more any place is adapted to the size and figure of the silk-ball, the less silk will be wasted in floss and useless web; besides that the worms will more quickly set about, and finish their balls.

With these therefore, or any branchy materials, you may fill up the partitions of your arbours; observing still to leave the arches clear and open, so that you may readily thrust in your arm, and feed your worms that are plac'd under them, which must be supplied with leaves, moderately, till they climb up among the branches to spin.

I have said that, whatever materials you make use of, in forming these arbours, they should be very dry, and clean; for fresh branches with the sap in them are not proper, nor should there be any leaves on them, for these would so stick among the floss silk of the balls as to render it useless; it is best therefore to cut the branches of broom in winter, and have them dry'd against summer, for broom, on account of its pliability, is very convenient for forming these arbours, the structure of which

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I have given from *Isnard* a *French* author who treats the management of silkworms.

If the making of such arbours as those I have mentioned be thought too nice, and troublesome, it may sufficiently answer the same purpose, to place branches of broom round the sides of the stands. And to do this; first surround the stand with a cord tied very loosely to the uprights, so as to leave room to thrust in a sufficient quantity of branches; the branches now may be as long as the height of the stands, and their thick ends, being thrust down between the cords and the stands, may rest upon the floor; and thus you may thicken them to what degree you please; but you must remember to keep an open on one side of the stands, to feed those worms which shall not yet have climb'd the branches; and because the lower ends of the branches are not so bushy as the upper ends, you may place some with the bushy part up, and others down, to make it all alike branchy.

If the branches are not tall enough to reach as high as you have worms on the stands, you must place other branches resting on these where they end, and support-
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ed by other cords ; and thus you may quickly furnish your worms with a convenient place for spinning their silk.

If the hurdles are very broad, you may, when the worms are near spinning, draw them towards the sides where the branches are, by scattering the leaves toward the branches when you feed them ; or you may, if necessary, place them near them with your hands ; or, which is easier, you may make bushy partitions across the end of each hurdle by branches laid horizontally.

Du Halde, in his history of *China*, says they there make use of matts for their silkworms to spin on ; in the middle of this a thin strip of about an inch broad is fixed on its edge, and forms spiral rounds, at about an inch distant, over the whole surface of the matt ; and between these rounds the worms spin. There would be less loss made in this method, but then the breadth of mattings must exceed the breadth of all the hurdles whereon the worms were fed, because a silk-pod takes up much more room than a silkworm.

It would be endless to recite all the methods which might be contrived for this

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purpose,

purpose, for a silkworm will spin in any corner where it can stretch its threads, so it is able afterwards to form its oval pod upon them; that contrivance which, with little trouble, will have the least floss produced, would be the best.

Note, that in placing the broom round the stands, it may be useful to place some branches across, mixing them with those which stand upright, to give them some stiffness; otherwise the spring of the thread which the worm spins may, after it has begun its ball or pod, draw the twigs too close, and not leave it space enough to spin in, which I have sometimes seen happen among some of the small detached twigs, that were not made firm by others mixing with them.

Plate I. Fig. I. in the middle division of the stand at G. is shewn the manner in which the arched arbours are to be formed on each hurdle for the worms to spin in, according to *Isnard's* method.

In the other division at C I. is shewn a part of the stand surrounded with branches, according to the other method. The whole stand is to be surrounded in the same manner, leaving only an open in front at each division

division to feed the worms. Branches may also in this method be superadded to those which surround, by laying them across the hurdles on the sides which are quitted by the worms.

C H A P. II.

The management of the Silkworms during the time of their spinning.

WHILE the silkworms are searching for places to spin their pods, some of them will often wander about the middle of the hurdles, wasting their silk in useless floss. Indeed, if the stands are furnished with arched arbours, as described in the first part of the foregoing chapter; or if there is a bushy partition made across the hurdles, which have the broom only placed round them; in either of these cases the silkworms will scarce miss of a place where they may readily spin their pods; but in large hurdles, that have the twigs only placed round them, you must often look, and whatever worms you find wandering under the hurdle, or far from the

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arbours,

arbours, you must take and place near the twigs, provided they are ready to spin, and their wandering from their food is a sign that they are ready; you need not fear hurting them by taking them in your hands, only let these be clean, especially from tobacco, onions, and such like; and you may take as many at once as can lie in your hollow'd hand without squeezing; but observe to take them up with whatever sticks to their claws, without tearing it away, for fear of blunting the claws by which they are now to climb. Wooden shovels, which have a smooth surface, on which they cannot lay hold with their claws, are the fittest to convey them from one place to another, because they can readily be taken off them without using force.

As a great many of the worms will continue to eat for some time after others have begun to spin, you must constantly supply them with the best kind of leaves, sprinkling them very thin over them, and feeding them often, and this even at night just before you go to bed, and as early as you can in the morning; for their quantity of silk, and their strength and activity in spinning it, depends now upon their being
properly

properly and fully supplied as long as they continue to eat; for which reason, you must give them their leaves often, though but few at a time, because if they lie under the arbours it is not easy to clear away their litter, which yet however must be done, if it grows throng and smells much.

If you find that as many worms have got among the branches as can conveniently spin there, then take away those which have not yet mounted, and place them upon another stand, among worms which will spin nearly at the same time; for if the worms are too much crouded in the arbours, they will be more apt to spin double balls, which having two worms in one pod, cannot be reeled off; and therefore, as you look over the arbours, wherever you see two worms begin one common pod, you should take one of them away, and place it in some other part of the twigs.

A little before the worms on any of the stands were ready to spin, you should have clean'd away their litter from all the hurdles, that the stands may be sweet and airy at the time of spinning, and that you may not at that time disturb or shake the

arbours where they are spinning; for this would stop and interrupt their work, so that some would desist from making any more silk, and the pods of others would be ill-formed, and difficult to reel off; for which reason you must always take care, in whatever way you are employed about those worms which are spinning, to shake or molest them as little as you can.

As you were directed, in feeding the worms, to keep those which were of the same age on the same hurdle, so you should also, in distributing them as they grow large, always have kept them on the same stand, that they may spin at the same time, supposing that you have many stands of hurdles.

When most of the worms that lie on any hurdles have climbed the branches in order to spin their pods, you will generally have some on each hurdle, which, though they are ready for spinning, yet are either too lazy, or too infirm to climb the branches, and remain below, wasting their silk among the shreds of leaves; these should be collected from all the several hurdles where they lie, and should be placed on beds of branches strowed pretty thick on some spare shelf, or other convenient

nient place, which branches may be mixed with the shavings of deal boards, peelings of osiers got from places where baskets are made, and such like materials, being well dried. Among these such worms will spin, unless they are much spent and grown very short; in which case you may place them in paper cones, or such hollow tubes as I mentioned above, where, if they have any ability left, they will not fail to spin; their balls however will be but small and imperfect, and none such as these should ever be saved for breed. A warm place helps the spinning of weak worms.

It is useful to visit all the arbours from time to time, and to replace such worms as may have tumbled down, and such as have strayed into places where they cannot fix their balls; or rather you should put them upon such beds of branches as have been just now mentioned, if they are late spinners.

If the worms, at the time of their going to spin, do seem in general lazy or sickly, to perfume their room with thyme, lavender, and such like sweet aromattick herbs, is good for them; it may be done, by putting the herbs on an earthen plate over a

chaffing-dish of clear charcoal, and shifting it to different parts of the chamber. The fume of vinegar is also said to be good for them, and these things are also directed at other times when they are sick, but if they are well they will rather hurt them.

Cold and damp weather during the time of their spinning is extremely hurtful; in very cold weather the worms desist from their work; you may see them, while their balls are yet thin, either moving very slow, or quite inactive; if you remove one of the balls to a warm place, the worm immediately begins to work with activity, and desists again when put in the cold, where, if it continues, the worm at length totally leaves off its spinning, and is changed into a *grub* or *chrysalis*, which is its state in the ball before it becomes a moth. This interruption of its work, though it should continue to spin, makes the ball difficult to wind off, the thread often breaking; wherefore, if this kind of weather should happen, you must keep the room close and warm, using perfumes and fires of clear charcoal on iron chaffing-dishes as above, and it is advised by some to put a piece of iron among the coals, to
keep

keep down the sulphurous vapour of them. If the fume of the coals should become very sensible, it were best to admit the fresh air for a little while.

This inconvenience of cold and moisture will happen chiefly in cold and changeable climates; but in hot climates you will oftener have occasion to guard against sultry and suffocating heats, which can easily be done by admitting the fresh air. An easy method of introducing either fresh air, or aromattick vapours into the room where you keep the silkworms, may be seen in the chapter on the diseases of silkworms.

C H A P. III.

The manner of the Silkworm's spinning its silk-pod or ball; its continuance in it, and the changes it suffers while it remains there, till it comes forth in form of a moth or butterfly.

THERE is scarce any thing, among the various wonders which the animal creation affords, more admirable than the variety of changes which the silkworm

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undergoes;

undergoes ; but the curious texture of that silken covering with which it surrounds itself when it becomes a moth, and arrives at the perfection of its animal life, vastly surpasses what is made by other animals of this class. All the caterpillar kind do indeed undergo changes like those of the silkworm, and the beauty of many of them in their butterfly state greatly exceeds it ; but the covering which they put on before this change into a fly is poor and mean, when compared to that golden tissue in which the silkworm wraps itself. They indeed come forth in variety of colours, their wings bedropp'd with gold and scarlet, yet are they but the beings of a summer's day, both their life and beauty quickly vanish, and they leave no remembrance after them ; but the silkworm leaves behind it such beautiful, such beneficial monuments, as at once record both the wisdom of their Creator, and his bounty to man.

The matter out of which the silk is formed is, while contained in the silkworm, only a fine yellow transparent gum, contained in two vessels as thick as a gross knitting needle, and, when unfolded, about ten inches long ; these open close to

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one another in two exceeding small orifices below its mouth ; on which account it is, that though the silk thread as it is spun seems only single, yet it is in reality two threads sticking slightly together by their sides from beginning to end, and they may be easily seen and drawn asunder by the help of a microscope, or even without one. This gum is of a particular species, neither dissolvable in water nor spirit of wine, though they will a little soften it, and it receives its firmness and tenacity immediately upon the silkworm's drawing it out in a thread, by the air exhaling its moisture.

I take this gum to be of the nature of horn if it were in the state of a jelly ; for the silk vessel, being taken out of the worm and hung up, will, in a day's time, become quite dry and hard, not differing in appearance from a piece of tough yellow horn, and having the same smell when burned : thus silk will be only an excessive fine hair, with some small portion of gum on its surface, of such kind as water can dissolve, and which causes several of these hairs to cling together when they are reeled out of warm water, and it is this
dissolvable

dissolvable part of the gum which occasions the waste suffered by silk in boiling it ; but there is a much greater waste than this would occasion when the silk is artificially gummed, as is sometimes fraudulently done, to increase its weight, or to make it lie smooth when they comb it to conceal what has been ill reeled.

The silkworm can fix and form its ball in any angle, or hollow place that is nearly of a size with the ball ; it generally roams about for some time among the branches, till, having got a fit place, it begins its work by first spinning thin and irregular threads which are to support its future structure ; upon these it doth, on the first day, form a sort of oval of a loose texture, which is called the floss-silk ; within this, on the subsequent three days, it forms the firm and more consistent ball of silk ; it remains always on the inside of the sphere which it is forming ; during its work it rests on its hind part, and with its mouth and forelegs fastens and directs the thread. This thread is not directed in continued rounds on the inside of the ball, but is spun in spots forward and backward, in a sort of wavy figure ; and this is the cause why a
ball,

ball, in winding off its filk, will perhaps not turn once round while ten or twelve yards of filk are drawn out.

At the end of three or four days the worm has usually finished its ball, in size and shape like a pigeon's egg; the inside of it is generally smeared with a sort of gum of the same nature with that out of which the filk is formed, and which seems designed in their natural state to keep out the rain, for it resists the wet so well, assisted by the filk which is round it, that the balls, when put in hot water to reel them off, swim on the top like small bladders, not admitting it within side unless they are imperfectly formed, or the filk almost quite reeled off. When the filk-ball is finished, the silkworm, being now much shortened and wrinkled, so that the rings of its body appear very deep, rests a while, and then throws off its skin; this is the fifth time of its moulting, though not mentioned among its other moults, because it doth not interfere with your management: and now, upon opening the filk-ball, you would see it in the form of a *grub* or *chrysalis*, in shape somewhat like a kidney-bean, but pointed at one end, having a brown smooth skin

skin composed in rings, and the worm's skin which it threw off lies in the ball with it.

In this form it continues, according to the different heat of the climate, from fifteen to thirty days; in *England* it is thirty, reckoning from the time of its beginning to spin; it then throws off the grub's skin, which may be called the sixth moult, and has now the compleat form of a large white moth, with four wings, two black eyes, and two horns or antlers branching sideways, like two very small black feathers. It then immediately begins to moisten the end of its silkball with a clear liquor which it throws out of its mouth; and thus softening the gumminess of the silk, it, by frequent motions of its head, loosens the texture of the silk, but doth not break it, and thus widens a passage by which it comes forth in the form of a moth, as described above.

Though the silk is not broken, yet the balls which are thus pierced by the moth can never be reeled off, on account of the fuzzy burr of silk which is raised and loosened at the hole where the moth comes out, which immediately entangles the
threads

threads upon attempting to reel them; therefore, that you may reap the advantage of the worms, it is necessary that the chrysalis or grub should be killed in those silkballs which you have not leisure to reel off before the time of the moth's piercing them; after having first made choice of a sufficient number of balls to breed from; the manner of choosing them I shall give in the following chapter. But here I must mention one thing which I had forgotten, and this is, that after the silkworm has begun its first loose threads, it generally lets fall a drop or two of moisture, the more in quantity as the season has been wet; at the same time it evacuates its last litter, which is very glutinous and moist; and by thus emptying itself before it is inclosed, it avoids fouling the inside of the silkpod.

C H A P. IV.

Of disbranching the arbours where the worms spin. How to choose those silkpods which are designed for breed, and sort those which are to be reeled.

THE time in which the silkworms finish their silkpods varies according to the weather; if it is warm and dry, the worm makes quick dispatch; but if it is cold or moist, they are languid, and spin slowly. You may know whether they have finished by shaking the pod in your hand, for if the chrysalis is loose and rattles in it, this is a sign they have done spinning, that is to say, all that began to spin at or near the same time with the one on which you make tryal. In three or four days after the time when the worms began to spin, you may generally gather their balls or silkpods from among the branches. Begin with those shelves where they spun first, taking the branches and twiggs down regularly, and pulling the balls from among them successively as you take them down.

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In gathering the balls you should make four different sortments of them, for which purpose place four different baskets, in one of these place gently those which are designed for breed; in another put all those which are double, having two worms in them; in the third put the firmest and hardest of those which are to be reeled; and in the fourth those that are of a looser texture. Those which are very thin, unfinished or imperfect, may make a fifth sort.

Let your choice of those which are for breed, be always from those shelves or arbours where they spun earliest. Choose from these the largest, the firmest, and the deepest coloured balls, that your breed may be strong and healthy. For if you make use of small, or soft and imperfect balls, which are the produce, generally of small and weak worms, your future broods will degenerate, both in size and vigour, and give you vastly more trouble, and less profit than strong and healthy ones.

In choosing these balls you must, as well as you can judge, take an equal number of males and females: the balls which contain the males are generally more taper

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and sharp at the ends than those which hold the females, which are more blunt and round at the ends, and somewhat more swelled in the middle; the reason of which is, that the female, having a grosser body as being full of eggs, adapts its ball to this form. You might mistake those which are spun double for females; but besides, that these are of an extraordinary size, you may distinguish them by their clumsy shape, which is rather round than oval, and a little observation will make you pretty expert in this knowledge. You cannot however expect to distinguish exactly equal numbers of males and females, there may after all be a considerable difference, and therefore you may keep as a superfluity, some of the best among those which are spun double, and when the moths are come out (for you will then easily distinguish the males and females) you may add from these to the side that was defective. A *French* writer has indeed hinted that these double balls would produce worms, which would also spin double balls, and that therefore they are improper to breed from; but this has no foundation, since it is accident, or a con-

confined place which brings two worms to spin in one ball ; and therefore the largest and strongest of the double ones would be as good as any for breed ; and as they can't be winded off would be so much saved : but as they are twice as strong as the single ones, the moths cannot well make their way out, therefore you had best cut them with a pair of fizers, and take out the chrysalis, which being laid in a box, and covered about an inch thick with chaff, will change to a moth as well as the rest.

An hundred males and an hundred females will together produce about an ounce of eggs, from which computation you may determine what number of balls you will keep for breed ; and you should rather keep too many than too few, to prevent failures which may happen either in the moths coming out ; or their breeding ; or the eggs which are to be kept till the ensuing year, some of which generally decay.

The balls which you choose for breed being thus fixed upon, take a pretty strong thread and with a needle pass it through the outer filk of the balls, taking care not to hurt the animal which is inclosed, and

having filled a thread of three or four foot long in this manner, tie the two ends of it together, and hang it up out of the reach of rats or mice, which would infallibly destroy it. Proceed with the rest of the balls designed for breed in the same manner, and string the superfluous double ones by themselves. Let them all be hung up in a temperate situation, if it is a hot climate, but, if it is a cool climate, a warm room will hasten the coming out of the moth. The moth will the easier make its way out if before you string the balls, you strip off the outer floss; and if you string the males and females upon separate threads it will have a convenience which will be mentioned hereafter in the directions about breeding.

The rest of your silk-balls which are to be reel'd, must either be reel'd off directly, or, must be proceeded with so as to prevent the moths piercing them, till you have leisure to do it; for though the silk of those balls which are reel'd off without keeping is said to appear somewhat more bright and glossy, yet there will be no difference in the goodness of their silk, and of those in which the grubs are killed, in
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order to preserve them till you have time, provided you kill them in a proper manner; besides where you have a great quantity of balls it cannot be expected that you should be able to reel off many before the time of the moths piercing; therefore you must be careful in preventing this, which, if it happened, would be an irreparable loss; and thus by having all the balls in a condition to wind them off at your leisure, you will be able to go the more regularly about it, and to reel off their silk to greater advantage and perfection.

Most persons in the countries where silkworms are bred, do not reel off their balls, but sell them to those who make this their business; and there is no doubt but that all manufactures are the more expeditiously carried on, the more branches they are divided into: yet where persons who breed silkworms have leisure and conveniency, they will considerably increase the profit of their silk by reeling it themselves. Three thousand three hundred silkworms, with the chrysalis in them weigh about twelve pounds, and may be worth about eight shillings, according as the silk

season has prov'd favourable, or not; these twelve pounds will make about sixteen ounces of reel'd filk, which is worth near sixteen shillings, besides about eight ounces of floss. So here then the reeling of the pods doth double the profit.

You will see the advantage of sorting the balls, as mention'd in this chapter, when you come to that part which treats of winding the filk; I proceed now to the method of killing the grubs, to hinder the balls from being pierced.

C H A P. V.

The methods of killing the Grub or Chrysalis, to prevent the Silk-balls from being pierced.

THE sorting and separating of the strong, hard, and thick filk-balls, from the thin and soft ones, as directed in the foregoing chapter, will be of some service, when you intend to kill the grubs within them, in order to prevent their piercing; for as this is done by the means of heat, the thick and hard balls will require to be placed where the degree of heat

is

is greateſt, that it may penetrate more effectually through their thick and hard ſubſtance. There are three methods of ſuffocating the grubs in the ſilk-balls: firſt by the ardent heat of the mid-day ſun; ſecondly by the heat of ovens; thirdly by the ſteam preceeding from ſcalding water; in the firſt and the third of theſe methods there is no danger of the heat injuring the ſilk, and therefore they are to be preferred, when your conveniency permits.

In order to kill the chryſals or grub by the heat of the ſun, you muſt chooſe a clear day, without clouds or wind; about ten or eleven of the clock, ſpread the ſilk-balls to its rays, and letting them remain in this manner for about four or five hours; wrap them up cloſe in coarſe cloths, which ſhould alſo have been expoſed to the ſun's heat, to the end that their ſtiſſing warmth, added to what the balls have before received, may the better answer the intended effect. If the cloths were black or of a dark colour they would conceive the heat better, and after the worms are wrapped up in them, they ſhould remain in the ſun's heat ſo long as you perceive it can preſerve any conſiderable warmth in them.

The best situation for exposing the balls to the sun is before a south wall, or in the angle between two walls which lies open to the south, if such can be obtained, the reflection from the walls giving an additional heat.

It is hard to determine the time which is necessary to kill the grubs; in the more temperate climates, the balls will require to be thus exposed three or four successive days; the colder climates such as *England*, will not do it at all effectually, and, even in the hot ones, you may be disappointed in the weather, and be obliged to repeat the operation, or, at last, to have recourse to the heat of the oven, or the steam of scalding water.

The best method to determine the least time which is necessary to kill them by the heat of the sun, is by exposing a few during different lengths of time, and then observing which is the least time which can effectually prevent the moths from piercing, by opening the pod and seeing if the grub is kill'd: you may make this trial while you are exposing to the sun all your silk-balls, but the experiment can only be of service to you the ensuing season, for
you

you must make sure of the balls which you intend to wind off; and it is better to overdo than not to expose them sufficiently. After having wrapped the balls up in cloths as directed above, keep them so while any warmth remains; and take care not to admit the cool air to come at them, else the chrysalis may recover and pierce the balls.

The heat of an oven, such as it has after the bread is drawn, will generally kill them; but this requires nicety and attendance, for if it is too hot, or they remain there too long, it will scorch and injure the filk; and if too cool the grub will recover as above: the balls should be put in baskets, or in some ordinary bags that they may not be scorched by touching the sides of the oven; it might also be of service to moisten the bags, in order to prevent this scorching; the oven mouth should be well stopped, and in about a quarter of an hour after they have been there, it will be time to take them out; especially if upon listening you hear a small crackling noise come from them; after taking them out, you must wrap them up in cloths made hot, as was before directed
in

in killing them by the heat of the sun ; and, when they are quite cold, expose them to the air, or to the sun, because the heat of the oven will make some moisture sweat out of the grubs which are killed, which should thus be dried up, least it rot or injure the silk. It is advised also by some to take the floss off before you put them into the oven, because, being very delicate, it is apt to be scorched and injured ; but if this is necessary, it would take up too much time, which at this juncture might be very dangerous, especially if it was near, the time in which the moths pierce the silk-balls.

The third method of killing the grub or chrysalis, which is by the steam of boiling water, is preferable to either of the others, as it performs the work without any injury to the silk, and also with certainty and expedition ; and, surely, some regard is to be had for creatures which die for the use of man, so as to kill them as quick and with as little torture as possible : it may be done in the following manner.

In a large wooden vessel, such as those used in brewing ; put about two foot depth of boiling water ; over the water fix an
hurdle

hurdle of wicker, fitted to the inside of the vessel, about an inch distant from the water : you may fix it thus by driving three or four nails, which shall support it firmly at this distance.

Having fixed the hurdle firmly, and also supported it by a prop in the middle, if it is liable to bend, throw over it a coarse woollen cloth, or something of the nature of taylor's wadding, which will easily let the steam pass ; and on this place the silk-balls, covering them close with a thick strong cloth. You may pile them about four inches, or as high as the suffocating steam of the water can reach, which you may judge of, by putting your hand under the cloth which covers them ; when they have been there long enough for the steam to get through them, for if the heat there is uneasy for the hand to bear, it is sufficient, and an hour or two continuance in such heat will kill the chrysalis.

When the water cools, so as not to be uneasy to the hand, it must be changed for other boiling water, therefore you should have a kettle constantly on the fire to supply you, and one supernumerary vessel which you should fill with boiling water
when

when any of the others do not retain sufficient heat to kill the chrysalis, and thus the water which was used but still retains some heat, being poured again into the kettle, will soon boil, so as to furnish you with fresh supplies. It would make this method of killing the worms, by the steam of boiling water, much more commodious, if, instead of placing them on the hurdles as before directed, you proceeded in the following manner, viz.

Have a broad but shallow wicker basket made, pretty open in the twigs, and of such a size as will fit and go into the kettle or boiler; it should be of such a depth as you find by experience, the steam can penetrate through the heap of filkballs; this basket should also have a wicker cover, to shut over the filk-pods which are put into it.

Having filled it with pods, shut the cover, and let it down to within an inch of the hot water, supporting it by nails, as you were directed in using the hurdle, then cover it with a cloath. After it has remained in this situation, till you think the chrysalis is killed in the lower part of the pods, take the basket out, and turning it
upside

upside down, fix it in the same manner as before over the steam, thus will the pods which were before uppermost be now next the water. Thus when they are sufficiently stoved, pour them out in a heap on a blanket made very hot, and wrap them up close, but not so as to bruise them, that by this continued heat you may be more certain of having killed the chrysalis; then fill the basket again, and proceed in the same manner till all your balls are stoved.

When the balls are cold in the cloth where they were wrapped, they should be spread in the sun, or in an airy place to dry any moisture which they may have gotten from the steam of the boiling water. If the weather is not favourable for drying them abroad, you may do it by spreading them on the shelves of hurdles where the worms were fed, at the same time opening the windows, that the air may have a free passage. You may, after they are quite dry, heap all the balls on the shelves of the stands till you have occasion to reel them of; they will be more secure here than if laid on a floor, where rats and mice may get at them, and will gnaw and destroy a great many for the sake of the grub

grub which is in them. Therefore if the place where you fed the silkworms was liable to be infested with rats or mice, beside laying traps for them, you should guard the feet of the stands, by stringing some sharp thistle-burrs on a thread, and wrapping it two or three times round each of the feet, close to the lowermost shelf, which should be at least fourteen inches from the floor; this will secure both the worms and the silkballs from being preyed upon. The thistles are most fit for this purpose when their flower begins to decay, before they begin to open and shed their down and seeds.

Having thus secured your silkballs ready to be winded off at your leisure, you will not be hurried in that business, for the balls might now be kept for some weeks; they will however wind off easier by not being kept too long, which is apt to harden the gum which binds the threads together, and if they are kept till the grub withers, they cannot be reeled, not having weight sufficient to keep them down in the hot water, besides they will soon smell very offensively.

Having

Having thus brought your filkballs into such a state, that you need not be anxious about any mischief happening to them, it is time that you give some attention to those which were separated for breed, the method of managing which I shall now proceed to.

C H A P. VIII.

The management of those silkpods which were chosen for breed. The coming out of the moths. The method of coupling them. The materials proper for them to lay their eggs on, and how to preserve the eggs till the next spring.

THERE is nothing of greater importance in the management of silkworms than that of obtaining a strong and healthy breed, whether you regard the trouble which it will save you in feeding, or the advantage of their silk. Every method therefore which improves the breed is carefully to be attended to, for when you have once got a good kind you can easily keep it up, but if you let your worms degenerate
and

and breed promiscuously, the weak with the strong, in a short time you will have none fit to raise a good breed from.

I have already given directions how to make choice of such filkballs as are proper to breed from, and how to string and hang them up, the next thing you must expect to see is the coming forth of the moth. The time of its coming forth is various, according to the warmth of the season and climate; in *Spain* and *Italy* it is about eighteen days from the time of the worm's spinning; in *France* about three weeks, in *England* and *Ireland* about a month. However, you may hasten the coming out of the moths in the colder climates, by hanging the filkballs in a warm room, such as a bed-chamber, or where there is a fire generally lighted, against the side of the room opposite to it; and this in the colder climates is very necessary, that the cold weather may not have advanced before the time of their laying their eggs, which would hinder their doing it in perfection.

When the moths are near the time of their coming forth, the strings of filkballs should not hang so as to bear against the wall, because some of the balls might
press

press against it in the place where a moth was to come out, which is always through one of the ends of the silkball; for which reason also, in threading them you should have run the thread across the side, that the two ends of the ball may not bear upon one another; and if you had hung the string upon two nails about three inches asunder, the sides of it would not touch one another, so as to hinder the eruption of the moth.

The moths generally come out in the morning, and cling with their feet to the outside of the balls; some odd ones may chance to fall, and if the place is subject to have rats or mice they will destroy them; cats will also infallibly kill them. To prevent any accidents, you may place a strip of paper under each string of balls, which will receive those which fall.

When you choose the balls for breed, I advised the putting the males and females on separate threads, because if they were on the same, they would begin to flutter about and couple as soon as they came out, and would hinder that regularity which you should observe in putting them together. You may chance indeed to mis-

take some males for females, and the contrary, while they are in the filkballs; but this is of no consequence, for when the moths come out they are easily distinguished, the females having a large round belly, their colour somewhat whiter, and their horns not so large nor so black as the male; besides the difference of shape, which in the body of the male is more slender and sharp at the end, you will observe him fluttering his wings with great quickness, and moving about with activity; whereas the female remains very quiet, and stirs her wings very little. When you find the moths are come out of the balls, you should nail against the side of the room a piece of smooth woollen stuff, no matter how old and ordinary, about a couple of yards broad every way, or in proportion to your number of moths; then, by means of two or three short threads fastened to its lower edge, you may turn this edge up about three or four inches, and fastening the other end of the threads a little higher into the stuff, fix two or three short sticks sharpened at the ends, to make the lower edge of the stuff stand out from the wall, like a kind of shelf, about three or four inches

inches broad. This will hinder any of the moths, which are to be coupled on the stuff, from falling to the ground.

Now take the moths gently from off the silkballs to which they cling by their claws, and place them by pairs, a male and female together, on the above-mentioned piece of stuff, to which they will fasten by their claws, and, having purged themselves of a liquor, in colour like brick-dust, which spurts from their bellies in a small stream, the male and female will couple together.

You may, in thus pairing them, put the strongest and largest nigh one another on the stuff, and you may quite reject those that are very small, weak, or some-way injured, by which means you will further meliorate the breed.

You should have another piece of stuff, hung in the same manner with that already described, in a different part of the room, and, as often as you find the moths coupled, take them off the first stuff, and place them, thus coupled together, on this second one; by which means you will avoid any confusion, which might arise from your not knowing which had coupled and which had not.

When they have remained thus coupled, on the second piece of stuff where they were placed, about eight or nine hours, which will be till the evening of the day when you placed them there, you must separate them by gently drawing them asunder, the male from the female; the male may be thrown away as of no further use, unless you happen to have a superfluity of females, and then you may keep a few of the males which remain most vigorous to pair with them. It is better however, if you can so adjust it, to let none of your moths couple a second time; for the eggs produced thus are not so good, nor do they give so strong a breed as those which are laid after the first pairing. In separating the male and female, take care not to hurt the latter; you must draw them asunder softly and gently, taking some time to do it, and if you find any which will not come asunder without danger of hurting, quit them for some little time and go to others, after which you may return to these. Some hold them by the wings while they separate them, but I think if you hold them gently by the body, it does as well.

The

The reason of separating the males and females, and not waiting till they uncouple of themselves, is, because their vigour being now but of short duration, the female should have time to lay her eggs while she remains in strength, whereas, if you left them to uncouple of themselves, they would frequently not do it in less than two days, especially in the more temperate climates.

You should visit the moths at times, while they are paired, and should bring together those that wander out of the way, and those which uncouple too soon, that is to say, in an hour or two, that they may pair a second time.

Before the moths are unpaired, whether they do it of themselves or by your means, you should have in readiness proper materials for the females to lay their eggs on. The fittest things for this purpose are the leaves of the walnut-tree, or rushes, which last you may cut to the size of any broad drawer, and spread so as to cover its bottom. From both these you can with great ease separate the eggs, in order to preserve them in little boxes till they are to be hatched in the ensuing spring; but do not by any means let the moths lay their eggs

upon paper or linnen, for to these the eggs will stick so fast, that it will give you vast trouble to get them off, and even that cannot be done without bruising many of them, and scraping off a great deal of down along with them, which is apt to obstruct and entangle the young worms when you come to hatch the eggs. Some use the smoothest sort of woollen stuff, which has no pile, for the moths to lay their eggs on, and afterwards scraped them off with a blunt knife; this is better than paper or linnen, but yet is nothing comparable to the walnut leaves or rushes.

The drawers in which you fed the worms when young may serve to put either the walnut leaves or rushes in; or if you have not drawers enough, tables or shelves, which are out of the way of all vermin, and creatures which might injure the moths or eggs, may serve; for, besides rats and mice, ants and crickets are said to destroy the eggs, as will birds and poultry; cats or dogs would also kill or disturb the moths.

The walnut leaves or rushes being prepared, take first those female moths which had separated of themselves, and place them
them

them upon them ; then separate the others which remain coupled, in the manner before directed in this chapter, and place them also on the leaves or rushes, and so proceed with the rest of your moths after they have coupled the proper time of eight or ten hours. The males are to be thrown away, and none of them to be left among the females which are laying their eggs, for they would only disturb and hinder them. In putting the moths on the leaves or rushes, you may place them so throng, that there will be about twice so much space empty as what they cover, which will leave sufficient room to lay their eggs.

If you make use of a small net of the size of your drawer, looping it over the heads of a few small nails all round the edge of the leaves or rushes, and propping the middle with a piece of bulrush (because they will lay their eggs on the prop) about three or four inches long, to keep the net from pressing on the moths, you will by this hinder them from creeping off the rushes, and laying their eggs against the sides of the drawer, from which you would find it very troublesome to separate them. Or you may with a needle and thread

string some rushes, so as to make a sort of mats, and fix them all round the sides of your drawer for the moths to lay their eggs on, otherways you must visit them oft, and replace such as creep from the rushes.

On these leaves or rushes the moths will lay their eggs, each moth will lay about four or five hundred, more or less, according to their strength and fecundity; so that an hundred females will produce about an ounce of eggs. The eggs stick, to whatever the moth lays them on, by a natural gum with which they are smeared; they are first of a pale yellow colour, then greenish, afterwards they grow somewhat red, and in about four or five days after being laid, they attain a blueish grey colour; this happens sooner or later, as the weather is favourable; and of this colour they always remain, unless they afterward happen to be damaged by too great cold, heat, or moisture in keeping them. The eggs which do not get this blueish colour, but remain yellow, are good for nothing, having not been impregnated by the male.

When the moths have done laying, or begin to lay but slowly, and those eggs small, you may take them off the rushes or
leaves

leaves, and put them upon some leaves strowed on a table, where they may lay the rest, which should not be mixed with your first layed eggs, because they will not be so good, and many of them will not change to the blueish colour. If the rushes from whence you took the moths after laying are not very full of eggs, you may put other moths on them to lay, but if they are full, take them away, and place others in their room.

When the moths have done laying, and the eggs have attained the proper colour, you must take the rushes, and rub the eggs off gently, by drawing them through your nails over a drawer, that none of the eggs may be scattered. They will very easily separate either from the walnut leaves or rushes, especially when these are a little withered, (for they should be green and fresh when the moths are placed upon them to lay) either by rubbing them gently, or where the eggs stick somewhat more fast, by loosening them with your nails, or a blunt knife; but indeed most of them will come off upon the least rubbing.

As often as you separate any quantity of eggs from the rushes or walnut leaves, you should

should put them into a glazed earthen vessel, and cover the vessel with a plate or saucer, to prevent any injury from rats, mice, &c. after which place it in a cool, but not a moist part of the house, and there let it remain so long as the weather continues moderately warm, for fear of bringing the eggs into a tendency to be hatched. When the weather begins to grow cold, pour the eggs into clean little fir-deal boxes, such as those made to keep wafers, and shutting their lids close, place them in a chest of drawers among woollen or silk cloaths, but not among linnen, it being apt to draw moisture to it; or you may put the boxes among the floss-silk which came from the outside of the silk-balls, and thus they are to be kept till the ensuing spring.

The place where the chest of drawers stands should be such as is neither exposed to moisture, heat, or cold; for moisture rots many of the eggs, and on this account too, those who let them be laid on paper, and keep them so all the winter, will have many decayed ones; for paper draws moisture to it. Heat is to be avoided, because it might bring the eggs to hatch before

fore their time; and great cold would mortify them as effectually as moisture; a bed-chamber therefore is a proper place to keep them in, but not near the fire; and if the weather grows warm before the mulberry leaves open in spring, they should be removed into a cooler place, to retard them till there is food for the worms. Observe also, that if the weather is cold or moist when the moths are put to couple or to lay their eggs, it should be done in a place with a fire in it, otherways they will not lay many, nor so good.

P L A T E I. F I G. IV.

- A. shews the manner in which the pods kept for breed are strung and hanged.
B. shews a little shelf of stiff paper or paste-board hanging under the eggs, to receive any moths which chanced to fall.

F I G U R E V.

Represents the cloath, on which the moths are to be put to couple, placed against the wall; its lower edge A B. turned up by means of two threads C C. to hinder the moths from falling.

N. B.

N. B. The chief reason for placing this cloath against the wall is, that the red liquor which the moth throws out may not fall upon the cloath. If the moths do not cling well to it, but fall in crowds to the bottom; it is then best to spread it on a table.

C H A P. IX.

On the breed of Silkworms degenerating. An experiment proposed to be tried, in order to hinder it. Another experiment of curiosity proposed for tryal.

SOME *French* authors say, that it is necessary to renew the breed of silkworms every four or five years by eggs brought from other countries that are warmer or more natural to the worms, as from *Spain* and *Sicily* to *France* and *Italy*, and that without this renovation the breed will degenerate in four or five years. It may however be suspected, that much of this degeneracy is owing to persons not being careful to raise their breed from a healthy and strong stock, according to the rules

rules already given in this treatise, among which that of steeping the eggs in warm wine, or even warm water, and separating the small and weak ones which swim, seems of great use, and no disadvantage, because if you want a sufficiency of eggs, you may rear and feed those which swim, but you should not breed from them.

Yet supposing even what is said of renewing eggs by those brought from different countries to be necessary; in case I was obliged to have eggs from a climate which was warmer, it should not be to raise an entire new stock from them, but only to cross the strain, between some of the best of them, and the strongest of my own which were already naturalized; because it often requires some time to make the constitution either of plants or animals adapt itself to the change of climate.

But another kind of degeneracy, as I imagine, may proceed from the worms being fed, and kept in a manner which differs a great deal from their natural way of living; for as you cannot reap any advantage from them but by keeping them in houses, because of the injuries they would be liable to both from birds and the
weather,

weather, they by these means have neither the advantage of air or exercise; their food is constantly supplied, and they are pampered and full fed without having any labour of searching about and going from one branch to another, which they are obliged to do in their natural state. Now though this method of your supplying them with food is unavoidable, and though it may for the present make them large, and produce a great quantity of silk, yet I think it must at length cause the breed to be less healthy, and less fit for propagating so strong and vigorous, or so numerous an offspring as the worms which enjoy a free air, and are forced to move about and hunt for their food: for I believe it will be allowed that if a cock and hen were confined to breed in a coop, and their offspring to do the same, the breed would soon lose its mettle, and degenerate.

To prevent this degeneracy in the health and vigour of silkworms, and to continue the breed in full perfection, I would propose an experiment, viz. that a few might always be bred wild on the mulberry-tree, with the best of which you might cross the strain of your own breeders. To effect

fect this, in climates where the weather will not injure the worms, no more care need be taken, than to secure them from birds; and you might perhaps do it, in the following manner.

Take as many as you think proper of your first hatched worms, and throw some fresh leaves on them, in order to divide them so, that there may not be above a score on each leaf; when you have thus divided them, fasten each leaf with the worms on it by pinning them here and there among the small branches of the mulberry-tree, and secure them from birds by covering the tree with a net. If the tree was trained against a wall! it might be the more convenient, because its leaves would be the more forward, and it would not be liable to be so much shaken by winds; you could also the easier secure it by a net, which you might fix in such a manner as to be at some little distance from the leaves, so that no bird could come at any of the worms; this might be done by some covering of boards or such like, which, projecting from the top of the wall, might have the net hung to it, and would be an additional advantage against
perpen-

perpendicular rains and dews; however, you should choose a wall with an aspect toward the least rainy point, but the north aspect must be excepted; the net also should come close to the wall on the sides of the tree, and be fastened with wooden pins to the ground. By this method the worms may perhaps without danger subsist themselves in their own wild and natural state, and may afford you not only an agreeable entertainment, but also some useful observations, drawn from the worm's own natural œconomy.

When these worms are ready to spin, they will find convenient places between the wall and the branches of the tree, and, as soon as they have finished their silk-balls, you shou'd take them down, and stringing the best of them, keep them in the same room with the rest of your balls designed for breed, that the moths may come out about the same time; and then pair the wild males with the house bred females, and the wild females with home bred males, as far as their number and time of coming out will conveniently answer; the better to effect which, you might mark some of your own shelves for breed, which went to spin at the same time with these

I

wild

wild ones, if the worms on those shelves were strong and healthy, although not the first that went to spin: or you may hasten or delay a little the time of either coming out, so as to make them answer, by a small difference in the warmth of the place where the pods are kept when strung.

The foregoing method may be tryed in those countries which are not subject to such rains, winds, or cold, as would hurt the worms. The following one for trying to keep silkworms on small trees within doors is proposed as a matter of curiosity, for those who keep them only for amusement, which if it succeeds, will save the trouble of attending and feeding them.

For this end get two or three young mulberry-trees as bushy, and full of branches as you can procure, and of such a size as that when placed in pretty large but flat boxes of earth, they will pass through the door of the place where they are to be fixed. These trees should be such as spread into branches within about half a foot of the ground, that by these means they may have the larger heads and more leaves, and yet pass the easier through the door, which they will also the better do if they are of a

flattish form ; if they were not originally trained to this form, you may bring them to it when you are going to make use of them, by bending the branches alternately across pretty strong sticks placed among the branches on each side of the tree. And this form will both make the branches lie thicker, and the better enable the worms to shift from one place to another ; and will also give you a fairer view of them : but in bending the branches take care to secure them so that none of them may start, after the worms are plac'd on them, for this might destroy many of the worms.

These trees should be planted in the boxes of earth, with all their roots taken up as whole as possible, and at least on the autumn preceeding the spring when they are to be used ; though I think it would be better to transplant them in *February*, and to let them stand one year in the tubs before you used them, and if on transplanting you cut off any of the branches, let it be only those which shoot strait forward, and which would not so easily bend to the flat form. They should stand abroad in the warmest situation which you can find, that they may bud the sooner,
till

till just before you want to make use of them ; and then may be carried into the room which you design for them.

Before you put the silkworms on the tree, you should take a piece of bays or any ordinary cloth, and making a cut half across its middle, let the stem of the tree go into it ; then sew up the cut and bring the cloth close up to the under branches of the tree on each side, and fix it, thus spread, in such a manner, that if any worms chance to fall, they may be caught by it, and also by its lying close to the branches, may make their way up again ; then place the worms on it in the same manner as was directed in the former part of this chapter, when they were to be placed on the trees abroad.

If you think the weather too cold, or that the leaves are not sufficiently opened, you may, in this as well as the foregoing method, defer putting the worms on the trees, till they have even passed their first moulting. Neither should too many be put on a tree, lest they should have eaten all the leaves before they were ready to spin ; about two hundred worms will be enough on one of these small trees, even

though it is very full of leaves; and the tree should be forwarded by a warm situation, so as to have its leaves opened to about the size of a sixpence, before you put the worms upon it. However, you may have a spare tree in a box for a resource, in case you find any of the others over-stock'd with worms, and you may bring the flat part of this close to the flat side of that on which the worms are, so as that their smallest branches may a little mix, by which means the silkworms will go from one tree to the other, and the over-stock'd tree will be eased. That the flat part of the trees may the more readily be thus brought together, the boxes were directed to be of a flattish form.

While these trees are within doors with the worms on them, you must take care to give them air by keeping the windows open when the weather is good. You may prevent any moisture at the bottom of the box from injuring the floor under it, if it is a boarded floor, by placing it on a couple of pretty thick square posts laid on their sides, which will keep the bottom at a distance from the boards, and give the air liberty to pass between them. If the

box is pitched on the inside, it will both preserve it the longer from rotting, and also hinder the earth from drying too fast, by means of the wood soaking up its moisture; and as the tree while it stands within doors, will not have the benefit of rain or dews, the earth should be pretty plentifully watered, especially when the weather is very hot; and there should be a small hole in the bottom of the box close to its edge, to let out any superfluous water which may drop into a vessel placed to receive it; for which purpose the tub should be fixed with a small inclination towards the side where the hole is made.

When the worms begin to spin, if you think they have not enough of convenient places, you may fix some sprigs of heath here and there among the branches; and thus if the experiment succeeds, you may rear silkworms within doors in the natural wild manner.

If the leaves of the trees, thus kept within doors, are found apt to flag for want of the evening dews. Perhaps it might be helped by winding three or four united ropes of soft tow round the stem of the tree, and afterwards separately round three

or four of the principal arms, after which, being again united, their end might lie in a vessel of water placed or hung above the tree. This rope drawing moisture from the vessel of water, would keep the main branches and stem constantly wet, and by these means help to supply that great quantity of fluid, which the most sagacious Dr. *Hales* has proved to be perspired by the leaves; and if the rope drew more than the bark imbibed, the superfluity would moisten the earth in the box.

C H A P. X.

Of the diseases and mortality incident to Silkworms.

WITHOUT reckoning those accidents, by which the eggs of silkworms become decayed and mortified before they are put to hatch, and which have been already mentioned; the silkworm during the time of its formation in the egg, that is, during the time of hatching, is subject to accidents and mortality: these have been partly guarded against in the directions

rections given for making the eggs hatch. However, I cannot here omit mentioning, that the hatching of eggs in persons bosoms, as is practised in many places, may possibly often kill the embryo worm, and make the breeders of silkworms wonder at their eggs not producing according to expectation, though they were very sound and kept in a due degree of warmth; yet this I think may often happen to eggs hatched in the bosom. If the eggs of pullets are smeared with any clammy liquid which stops the pores of the shell, there will no chicken hatch from such eggs, till that which thus stops the pores is removed. The perspiration and sweat of persons, who hatch silkworms eggs, must often pervade the bag in which they are kept, and may produce the forementioned bad effect on many of the eggs; some persons, however, will produce this bad effect more than others, and therefore all people are not alike fit to hatch silkworms in this manner.

Indeed, in all the present methods of hatching silkworms eggs, the fresh air has too little access to them; whether it is done in bags kept in the bosom; or in boxes

kept in the bed, or between pillows. It may therefore be of advantage to open the boxes now and then in a warm place, and stir the eggs that the fresh air may have access, and the eggs, by stirring them, enjoy an equal degree of warmth; but they must be exposed only a very short time, lest they cool too much.

It would be easy to make a communication between the external air and the box, by means of a small reed or a few quills, and the air which passed through such a tube, would be sufficiently warmed by the pillows before it came into the box: such a tube might also be fixed to the top of a little box, fitted to keep eggs in a person's bosom or pocket, and then there would be no occasion for having such box pricked with holes to admit the air thro' the bag which is in it, as I mentioned in the method of hatching the eggs; and the box being close, and only communicating with the outward air by means of its tube, there would be no fear of the persons perspiration or sweat hurting the eggs. A little tube of leather kept open by rings, which could be cut out of a quill, would bend in any direction, either out of the
bosom

bosom or pocket, so as to communicate with the outward air.

Thus much I have thought necessary to hint, in order to prevent any ill consequence which may be suspected to arise from the method of hatching eggs; for I think steam and moisture may hurt them, as much as an improper degree of heat or cold.

Some few silkworms are also liable to die in hatching by not readily getting out of the shell, which, as it is not fixed to any thing, is apt to be dragged after them in their efforts to get out, till growing tired they are not able to extricate themselves; this, however, happens to but a few, and those perhaps weak worms. But the method in which the eggs must be hatched makes this unavoidable, neither is it of great consequence.

It is likely that eggs often are hurt by not being washed, as mentioned in the chapter on hatching; for then many of them will remain smeared over with that moist substance, which the moths cast out a little before they lay their eggs, and this will stop their pores in the same manner as was said of sweat or perspiration. It
might

might not be amiss to wash them as soon as they have got their grey colour, before they are laid up.

The distempers incident to silkworms after they are hatched proceed, generally, either from their food, or the temperature of the air in which they live. The regimen of their food may err either in quantity or in quality. I have formerly mentioned the manner of regulating the quantity of their food: it will be a pretty sure rule to avoid giving them too much, if after they have eaten all their leaves, they are left without any for half a quarter of an hour or so. But if by any accident they have fasted too long, it is safest to give them sparingly and often for sometime after, and then of the wholesomest and best leaves. And if they have surfeited by over-eating, let them fast a longer time, and afterwards feed them also sparingly.

But silkworms are much more liable to suffer from the bad quality of leaves than the quantity. The leaves of mulberry-trees which grow in moist grounds, or in places shaded from the sun, are unwholesome; and those which grow on suckers produced from the trunk, or root, or principal

cipal arms, being full of sap and moisture, crude and immature, will produce a most dangerous fatal distemper in silkworms: even by only giving them one feeding, they grow immediately surfeited, and throw out of their mouths a greenish liquor, and a clear pellucid humour out of the pores of their skin, particularly out of the little point which grows near their tail. This clammy moisture by their rubbing against one another closes up the vents by which they breath, which are those black specks that appear down each side; and I scarce ever knew worms recover from this disorder, so as to make silk worth any thing. It is therefore much better to avoid the distemper than to attempt curing it; however, as all may not be alike infected, pick out those which are in the worst condition, and if you have a mind to make experiments on them you may. Then make the hurdles of those that remain, clean and dry; and letting them fast two or three hours, give them afterwards some of the best leaves you can choose, but little at a time, and gathered a good while before.

Du Halde's history of *China* mentions a powder made of the dried mulberry-leaves
in

in autumn, and reserved for a cure against a distemper in silkworms which he doth not describe. He says, they moisten the fresh leaves and strew this powder on them, being ground very fine. Perhaps it might be good against the surfeit above mentioned, as hay and dry food would be to cattle. But his account of silkworms being a translation from a very antient *Chinese* manuscript, and in all likelyhood by persons who were not acquainted with the subject, cannot be depended on. The moisten'd leaves would, I think, be hurtful.

Mulberry-trees may also have peculiar distempers in themselves, which may make their leaves unwholesome for silkworms, but this will best be discerned in the growth of the tree and of its leaves: and the distempers incident to the silkworms easiest avoided by not using such. Air is the next thing to be considered, and my much honoured friend the Reverend Doctor *Hales*, when simple nature chose for her favourite, because he courted her with candid simplicity, has shown in variety of instances how air affects animals, and by a
variety

variety of incomparable contrivances, how it may best be turn'd and attemper'd to the uses of life.

Now silkworms are more liable to be affected by the air, which is perpetually necessary to animals, than by any other circumstance of their lives: sudden changes from heat to cold, and from cold to heat, are very prejudicial to them, and such climates as are much subject to such changes unfit for them. These changes however, can be tempered by art and contrivances, inasmuch as silkworms are kept within doors; but putrid air occasioned by the worms being either kept too close, or not having their hurdles cleaned, is apt to destroy great numbers; yet the cause of such distemper is easily seen, for the abundance of their litter, and the smell which it spreads over the room, are sufficient indications that the hurdles want cleaning, and that the room wants a supply of more wholesome air. Indeed, a very little contrivance would keep the rooms constantly supplied with fresh air, which being a thing of the utmost importance, I shall here mention an easy method of effecting it, which is founded upon that remarkable

property of the air, that when purest, it is always most heavy; and when mixed with vapour, either putrid, aromatick, or watery, or indeed with almost any thing that affects the sense of smelling, it is lightest.

Now, in any room where silkworms are fed, if an aperture, about nine inches square, be made in that angle of the ceiling which is farthest from the door, and this aperture continued by a funnel of board, till it communicates with the open air, then will the putrid vapours, occasioned by the litter and the multitude of worms, constantly ascend thro' this funnel, and the pure heavy air will succeed by the door in its place; or rather, if an aperture is made towards the bottom of the door, of the same size with that in the ceiling, with a small shutter to open and close as occasion requires; then will the fresh heavy air come into the room with greater advantage, by raising up, and carrying of the foul air which is above it: or if two of these apertures are made in the opposite walls of a room, near to the floor, and opening into the air abroad, they will have this convenience that you can take the advantage

vantage of opening that aperture, which is on the windward side, when the room wants to be suddenly and thoroughly clear'd of the foul air thus forced thro' the funnel.

If it be inconvenient to carry up a funnel as mentioned above, then an aperture made through the wall, close to the ceiling, may serve tolerably well to carry off the unwholesome air, provided you use some of the apertures which I have mentioned, for the admission of fresh and wholesome air. Thus, if the proper cleaning of the worms, and the due admission of fresh air be practis'd, the distempers arising from dirt and putrefaction will be prevented, so far as they arise from the manner in which people are obliged to keep silkworms in houses; and, until such cleanliness and airing of the rooms is observed, there will be always complaints, as there are at present in the countries which breed silkworms, of unaccountable mortality among the worms of some persons, while those of others remain healthy. But the smell of the room will give warning of the danger, and point out the best cure, which is prevention.

It is true indeed, that distempers of the same kind may arise from some peculiar putrified state, or malignancy in the atmosphere, as in a hot and moist summer, or in places abounding with mineral exhalations, or subject to earthquakes, which let loose such steams. But then, the distemper will appear more universal, and will more or less affect all the silkworms in adjacent places; in this case, often cleaning the litter away will contribute to preserve the worms, as also not keeping them too much thronged and crowded together. The malignancy of the air may perhaps be in some measure qualified, by keeping *Benzoin*, or even rosin melted in a pan, so as to mix its fume with the air of the chamber; for I find the fume of such aromattick gums recommended in some books, but without distinguishing precisely for what kind of disorders; with these also they mention the fume of hot vinegar, and this last, being of known efficacy against putrid and pestilential disorders, has probably been found useful to silkworms in such distempers, though indiscriminately prescribed, to other disorders it would prove ineffectual; and this method of prescribing
 must

must be too often practiced in distempers incident to brutes, who are incapable of describing their ailments, and generally under the care of persons who have little discernment; yet it would be of great use, if persons, who have skill and opportunity, would apply themselves to distinguish the distempers which are peculiar to animals, especially such animals as are profitable to mankind.

The fire which is used, in order to raise the fumes above-mentioned, should be of very clear charcoal, placed in a chaffing-dish, into which some advise to put a piece of iron, in order to absorb and keep down the noxious sulphur of the coal, and also to move the chaffing-dish from one part of the room to another, that it may be equally fumigated, and not let stay over-long in the room. However, the inconvenience and trouble of the fire might, as I think, be easily avoided, when gums or other things are used, which require to have their fume raised by heat. For a funnel, about half a yard long, may be fitted into the air-hole on the outside of the room; in the under part of this funnel, near to the air-hole, should be made a hole, some-

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what

what less than the mouth of an earthen pot, which holds the fumigating materials, this pot being placed on a chaffing-dish of coals, and its mouth brought up close to the hole in the funnel, will send the fume up into it, which the air, entering by the funnel's mouth, will drive it into the room, and the offensive steam of the coal will be thus avoided. It may be convenient to let the funnel incline a little, that the fume may the easier ascend into the room. This method supposes the room to be contrived in some of the manners above described, for the admission of fresh air, and letting out the foul, because the fume should come in by the apperture which admits fresh air.

When silkworms become sick and languish by a continuance of moist weather, it is difficult to relieve them, it being as yet a desideratum among inventions, to supply quantities of dry air from a moist atmosphere. Fires may indeed warm the air, and so hinder the bad effect of its coldness; but still the air which is constantly drawn into a room where there is a fire must be supplied by the atmosphere, and bring its moisture along with it. It is best in this case to admit no more external air
than

than is necessary to keep that within fresh. It may also be of use, before you feed the worms, to strow over them some very dry chaff, straw, or hay, so thin that they can come through it, and upon this to strow their leaves, this may imbibe part of the moisture which is in their litter, or on the surface of their bodies, and at least it will keep them from lying upon their litter; on which account it may be used also at other times, when there is a good deal of litter on the hurdles, and you have not leisure to clean them immediately. Silkworms sometimes die during their spinning, or after they have finished their pods, before they change into a chrysalis. The proper regulation of heat, cold, and fresh air in this case is all that is in your power by way of prevention, and this has been mentioned in its proper place. When the worm dies before it has finished its pod, it never feels loose in it upon shaking the pod; therefore such pods must never be chosen for breed, nor indeed ought the pods to be taken from the branches till the chrysalis shakes in them.

Such diseases of the moths as are within your reach, are only languidness in coupling

or laying their eggs, occasioned by the coldness or moisture of the weather, which indicates warmth and a dry place as the proper cure.





Plate II.

Fig. III.



Fig. II.

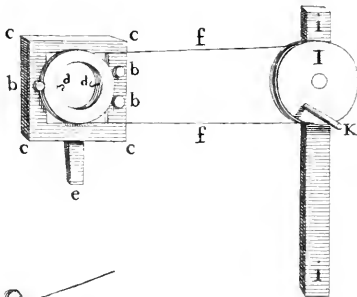
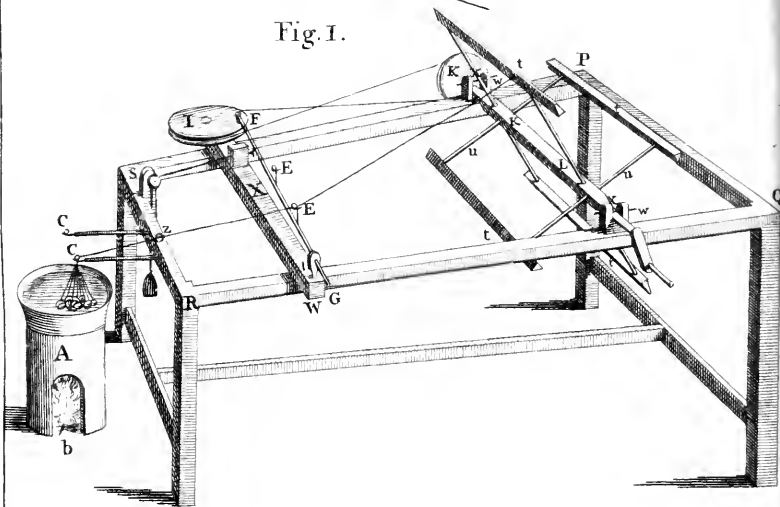
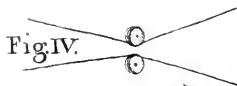


Fig. IV.

Fig. I.



T H E
Culture of S I L K.

P A R T IV.

C H A P. I.

The nature of the silk-thread as spun by the worm. A general idea of the manner of reeling it.

THE three foregoing parts of this treatise have only taught how to obtain the silkpods in that form which the worm spins them; and these pods are now no further advanced toward being woven into the various stuffs which silk can compose, than flax or wool are before they are spun into yarn.

But the first operation that takes place in the silkpods is not like that of either flax or wool; each silkpod is two continued
glossy

glossy threads, without breach from beginning to end, yet so glued together by their natural gum, that to the naked eye they appear but as one thread, in fineness equal to the smallest hair; were this thread to undergo the operation of carding or combing, its smooth uninterrupted surface would be destroyed, it would be reduced to a mass of broken and entangled fibres, fit only to be spun in the same tedious manner as flax or wool, and incapable of making stuffs with that fine gloss for which nature extended it to a thousand foot length.

Yet, to reel off each filkpod separately, would be of no use, as the fineness of the thread would then be insufficient for manufactures; it is therefore contrived that a number should be joined and reeled at once out of warm water, which softening their natural gum, makes them stick together, so as to form one strong smooth thread.

This thread however is not formed by joining a certain number of filk-pods, and so winding them all off till their threads ended, for by this method the thread which is formed of them all together could not exceed a certain length, and by these means

a new

a new set of pods must be chosen, and a new thread begun so often as would greatly interrupt the work ; besides, the thread would continually lessen in thickness as the single threads of the silkpods do, and by the breaking of some, and by others ending before the rest, there would be a waste of what remained. They contrive therefore to be continually adding the single threads of fresh pods as often as others end or break, by which method the thread is continued to what length they please. The single threads of the new added pods are not joined by any tie, but only simply laid on the main thread, to which they adhere by their gum, and their ends are so fine, as not to occasion the least perceptible unevenness in the place where they are laid on.

For your easier conception, I here give a general sketch of the manner in which the pods are reeled. First, the pods are cleared of their soft outward floss, and a handful or two of them are thrown into a small kettle of water, under which is a fire to keep it hot. The ends of the threads are found by stirring the balls with a small besom made of fine heath ; then, accord-

ing to the intended thickness of the thread, a number of these ends are taken and passed together through a small loop of wire, which projects over the kettle, and hinders the reel from pulling away the pods; the thread is then passed through a wire-loop in a stick which is called the guide; this stick, by a contrivance which shall be described hereafter, moves perpetually forward and backward, so as to hinder the thread from ever falling on the same part of the reel, by which means the several rounds would be glued together, and could never be winded off again. From this guide-wire the thread is passed, and made fast to the reel, which is turned by one person, while another, sitting by the kettle which contains the silkpods, perpetually supplies fresh ends according as they break, wind off, or grow small. The principal perfections of silk when reeled off are; that the thread should be smooth, of equal thickness and strength, not flat, but of a round form, having the small threads of which it is composed as equally stretched as can be attained, and as firmly united; and lastly, that the several rounds as they lie on the reel should not be glued together.

together. The methods by which these qualities may best be attained, will be further taught in the more particular description of the instruments and manner of reeling the silk; and it should always be remembered, that this is a part well worth attending to, as the value of the silk may be greatly raised, according to the perfection in which it is reeled.

C H A P. II.

Of the furnace, reel, and instruments for winding the silk from the pods.

I Shall here describe the several parts of the instruments which are used in reeling the silk off the pods, according to that order in which the silk-thread is conducted from the pods in the cauldron to the reel.

The furnace marked A. Plate 2. Fig. I. is either a little round building, or an earthen vessel about a foot and an half in height, and a foot and an half diameter in the clear; it has a small opening b. in its lower part to receive the fuel, and a funnel in its upper opposite side to let out the
smoak.

smoak. A thin copper cauldron of the same breadth with the clear of the furnace, and about four or five inches in depth, is fixed upon its upper part : this contains the water in which the pods are winded off, its shape may be oval, the better to contain two parcels of pods.

The ends of as many pods as are thought proper, being united, are passed through a loop of wire. c. which I shall call the stop-wire, fixed in the end of a rod which projects about a foot from the bench of the reel. Its use is to stop the pods, and hinder their being drawn farther towards the reel ; and this wire projecting over the copper, causes any of the pods which chance to leap out of the water to fall directly down again. It is usually made by giving the wire a turn like one round of a bottle-screw, making the end come a little across. By this method the silk-thread easily slides into the loop, which, if instead of this contrivance it were a ring, would give trouble in passing the thread through; this wire is fixed into the end of a small stick, which should project about a foot from the front of the stand. P. Q. R. S. which supports the reel and the loop should

should be about a foot or more distant from the surface of the water, and should be made of brass wire, as should every loop through which the silk passes; for iron wire, though mentioned by most writers, when it takes rust, becomes a sort of file, and would fret and break the thread; but brass wire doth not take rust by being wetted.

From the stop-wire C. the silk-thread was formerly conducted over a small pulley fastened to a piece of wood about three inches high, which stood in the front of the reel's bench directly over the rod, which holds the stop-wire. The intention of this little pulley, or bobbin, was to press the moisture out of the silk-thread before it came to the reel, but a better contrivance has been substituted for it.

From this pulley the silk-thread passes through a loop of wire E. which I call the guide-wire; this loop is formed in the same manner as the loop of the stop-wire before described; the wire is fixed in a small stick F. G. called the guide-stick, the use of it being to guide and spread the thread E. t. in such a manner on the reel, that it may not always fall in the same place,

place, since this would so glue the moist thread together, that it could not afterwards be separated.

The guide-stick receives its motion from a wheel marked I. which formerly turned on a pin fixed in the side of the reel's bench, but that situation is now changed ; its diameter is from eight to ten inches, according to the size of the reel you use ; it has holes nearer or farther from its center to shift the pin which goes into the guide-stick, and so spread the silk less or more upon the reel. This is a round pin, and is received into a round hole in the end of the guide-stick F. so loose, as to allow the wheel to turn freely. It is turned by means of a band which passes over another wheel K. fixed to the axle of the reel. The best proportion of this wheel K. to the guide wheel I. for distributing the thread on the reel, is as twenty two and an half to thirty seven. The wheel I. being put in motion by the turning of the reel, doth in each revolution make the guide-stick F. G. go and return, its end G. being round and sliding forward and backward in a hole which is made in a piece of wood L. The pin on which the guide-stick moves must
be

be made with a little collar, so as the guide-stick may not lie close to the surface of the wheel I. lest in its motion it should strike against the axle or pin, upon which the wheel turns. From the guide-wire the silk-thread is drawn to one of the bars of the reel I. and there made fast in order to be reeled.

The reel is composed of an axle, H. which is best made square for the advantage of boring it true, in order to let in the cross stick, u. u. &c. which are to support the four bars, t. t. t. t. for this purpose it is bored within half a foot of each extreme, with two round holes pretty near, and at right angles to each other. The axle may be about two inches square, and the holes about an inch diameter, into which the cross supporters u. u. &c. must fit tight at their middle part, though they may taper to half an inch diameter at their ends. These ends fit tight into holes made in the four bars, t. t. t. t. the cross supporters must be of such a length, as to make the four bars t. t. t. t. stand two or more feet distant from each other, making the round of the reel about eight feet.

The

The four bars have been generally made round, but I would recommend, as a better method, to form them first rectangular, about one inch by two, and then to plane down the edge, which is to be the outermost and receive the silk, to any angle less than a right angle; for being placed thus edgewise on the cross supporters, they will resist the spring of the silk as joists do the weight of a floor; for one could scarce imagine, if he had not tried it, how great a power a thick skin of silk has to warp and bend the bars of the reel. Another advantage of planeing their outer edge down to less than a right angle, is, that in this case the silk will only touch the bars in a point, whereas if they were round, it would lie upon one half of the circumference of each bar, which would cause a good part of the skin to be flat, and the threads to be more glued together in the four different parts which lay upon the four bars. The angle however should not be left sharp and cutting, but should have its edge a little rounded. And the bars should be made of wood which is pretty hard and smoothly polished, for if it has any splits, or roughness, the threads
of

of the skain will be apt to catch and break when you are disbanding it from the reel.

The axle of the reel turns in two grooves, made in two pieces of wood x. x. fixed in two opposite sides of the bench, by means of the wince or handle, L. the axle is rounded and reduced to about an inch and an half diameter, at the parts which lie in the grooves; in which it is kept by two wire pins, w. w. one of which sinks a little into a small groove turned in the axle itself, by which means it is kept very steady, or it may be kept steady by two shoulders, if they are exactly at the distance of the two pieces of wood which support the axle.

In this description of the reel I have, for brevity's sake, only mentioned one silk-thread; but as two may be reeled at once upon different parts of the reel according to the expertness of the spinner, which is the person who supplies fresh ends when any of the pods break, or are winded off, therefore you are to suppose the other thread conducted in the same manner, as that already described thro' the other stop-wire, C. &c. at about six inches distance
from

from the other, in the manner which you see delineated in the figure.

The foregoing descriptions mentions the manner in which the silk-reel is at present made and used, but the plate which represents it shows it with the new improvements made lately by Mr. *Vaucanson*, and described in the memoirs of the academy of sciences at *Paris*, but without giving any figures of the description. The reason and foundation of these improvements are considered more particularly in the following chapter.

C H A P. III.

The improvements of the silk-reel, and the manner of reeling.

WITH regard to the motion of the guide-stick, Mr. *Vaucanson* observes that it was found that the band which passes over the two little wheels K. I. by being variously stretched by the weather, inequalities of the wheels, &c. could not make the guide-stick F. G. move in so uniform a manner as always to dispose the
different

different revolutions of the thread upon the same parts of the reel. And therefore it was contrived that the guide-stick should be moved by a set of three or four wheels with teeth, or cogs communicating with that on the axle of the reel. But these being made of wood, and frequently breaking, and going out of order, occasioned delay and loss in the reeling of the silk; he therefore revives the method of working by the band, and to keep it always at the same degree of extension; contrives that the wheel I. which moves the guide-stick should turn upon an axle, which is fixed in one end of a bar of wood, W X, this bar is moveable on a pin. y. passing through a hole in its other end, (the lower part of that piece of wood through which the guide-stick goes and returns may serve for this purpose) then the end W. on which the guide-wheel turns is drawn by a string passing over a pulley near S, to which a weight of one or two pounds is fastened. And thus the band is kept constantly at the same stretch.

The next defect was found in the small pullies, or bobbins, whose use as mentioned in the foregoing chapter, was to squeeze

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some

some of the moisture out of the thread as it passed over them. This however, they did but very imperfectly, and were besides found by their pressure to give the thread a flat form, whereas its perfection is to be as round as possible. In stead therefore of these pulleys, they contrived to make the two threads cross by twisting three or four times round each other, between their passage from the stop-wiresto the guide-wires, which they called winding in cross. This method had great success; the threads by being thus wrapped two or three times round one another became round and compact. And the pressure made by the crossing one another, added to the frequent vibrations which were made at the angle, where the two threads separate in winding, caused them to arrive at the reel well drained of their moisture, and of a more round form.

Mr. *Vaucauson* observes on this method, that the threads are made to cross by twisting them over one another with their fingers, which have no accurate sense of feeling, by being continually employed in the warm water; and that by these means the

the

the degree of crossing is not accurately determined. He advises to encrease it by making a double crossing, and describes a method both of doing this and determining the degree, or number of the times, that the threads are crossed, in the following manner.

A wooden ring marked A. Plate II. Fig. II. is made three quarters of an inch in thickness, and one inch broad, its inner diameter is six inches and an half. Its outside rim has a groove for the reception of a band, f. f. this ring is placed between three little wooden rollers b. b. b. which turn on pins fixed in a square frame of wood, c. c. c. c. the frame is fixed by the pin e. which comes from its lower side into a hole, Z. which is bored in the middle between S and R in the reel's bench, Fig. I. the band which goes in the groove of this ring goes also round a groove in a wheel I. of the same size, which turns on a pin going thro' its center into an upright, i. i. which is fastened in a hole to such a part of the reel's bench, R. where it can most conveniently be reached by the hand of the spinner, who sits by the cauldron,

and turns it by a little handle k. when when the threads are to be crossed.

Now the two silk-threads after having been passed thro' the loops of the stop-wires, c. c. instead of going over the bobbins, or pullies, are made to pass over two little hooks of brass wire, d. d. placed opposite to each other on the inside of this wooden ring. From whence they go each thro' its own guide-wire, and so to the reel.

And now, by giving the wheel I. over which the band passes two, three, or more turns; the wooden ring, over which the same band passes, is turned the same number of times, and so many times are the silk-threads crossed over one another, and that in two places, *vis.* before they arrive at the wooden ring, and after they pass thro' it. By this double crossing, or twisting over each other, the silk-threads in reeling, are as it were, wrung and squeezed; and the gummy moisture, which they receiv'd in the kettle, drained and pressed out, so that they arrive at the reel much dryer than they otherwise would do; and from the pressure which they undergo at the crossings are made more firm, compact,
and

and round ; so as to appear in some measure twisted.

Mr. *Vaucanson* mentions a further use of winding in the cross : which is that it shews on which side the spinner ought to add fresh silk-pods in order to keep the two threads of equal strength and thickness : he justly observes that keeping always the same number of silk-pods will not preserve the same thickness in the thread ; for the single thread of one pod that is but a little winded off, may be as thick and strong as two, three, or more that are almost exhausted ; but the cross which is next to the stop-wire will, as soon as either thread grows weaker than the other, swerve towards the side of the stronger thread, and thus give notice that some silk-pods are to be added to the other side.

But I must observe that this swerving of the cross, to either side, will not happen unless the hooks of the wooden ring, over which the threads pass be kept in a position horizontal, and also each hook on the same side with that stop-wire from which its own thread proceeds ; and, tho' Mr. *Vaucanson* mentions this as a method of keeping each thread to the same thickness

with which it began, it will only keep them of the same thickness with one another in corresponding parts. For the addition of pods on one side or the other, in order to bring the cross to the middle, may happen to be superadded to equally, that, tho' the threads equal one another, yet at long run you shall either add more thickness to each thread than you set out with, or fall short of it; some regard must therefore be had to the number of silk-pods with which the threads were begun, so as not considerably to encrease or lessen their number.

Mr. *Vaucanson* observes that when the cross swerves much to the side of the weaker thread, and remains long in that situation, the thread is then apt to break; he therefore sometimes made the cross stand between the fangs of a small fork, that young beginners, who were not expert at reeling in cross, might have time to add fresh pods to the weaker thread, the fork confining the cross so as not to let it swerve much.

Thus I have given the scope of Mr. *Vaucanson's* improvement of the double crossing, and the advantages he proposes from it.

it. He says indeed, that the women who reel the pods will with difficulty be brought to use it, because the threads thus crossing twice are liable to be broken, and occasion delay, especially if they are not kept clear of any floss, or burr, which is apt to rise either from the pods not being at first well clear'd of the floss, or from the water being too hot. Mr. *Vaucanson* therefore proposes this double crossing chiefly for such silk as is to serve for warp; which, because it suffers a considerable stress in the operation of weaving, is therefore to be made more compact and strong.

It may be observed that the apparatus of the wooden ring is only for the readiness of crossing the two threads, for they may receive a double crossing by means of two little hooks plac'd at each extreme of a stick six inches long, and fixed in its middle point upon another, so as to form the figure of a T. this being placed erect in the place of the wooden ring, the two threads which pass parallel over its hooks will receive the double crossing, by taking off the top of the T. which is only fastened by a hole in its middle; and, after it

has been turned round so many times as is necessary for the crossing, replacing it.

I mention this because it requires little apparatus; the double crossing may first be tried in this manner, and, if it comes into practice, Mr. *Vaucanson's* method may afterwards be used. The chief advantage of two crossings are the starts and vibrations which the two threads undergo when they separate at the crosses; this makes them shake of the moisture with which they are loaded, more speedily, as the vibrations are double of what they would be with only one crossing.

Some dimensions of the reel, &c. which are as yet undescribed, are as follows. See Plate II. Fig. I.

The length of its bench, P. S. about five foot.

Its breadth S R. two foot and a half.

The feet at S and R next the cauldron, two foot high.

Those at P. and Q. next the reel, two foot and a half high.

The stop-wires fixed in the two rods C C. project one foot from the transverse, S R. and are about six inches asunder, *viz.* equal to the diameter of the guide-wheel

I. and about a foot distant from the cauldron.

The bar M N. which supports the guide-wheel I. and guide-stick E. G. is two foot distant from the end C. of the stop-wires, the guide-wires are so long as not to let the silk-thread make an angle at the m.

The axle of the reel K L. is three foot distant from the guide-stick.

The reel's diameter, *viz.* the length of the cross-bars about two foot for fine warp. for woof it is often four or five foot ; but this is not reel'd in cross.

The guide-wires, E. E. are at the same distance from each other as the stop-wires, *viz.* about six inches.

The diameter of the guide-wheel's groove is to the diameter of the small wheel's groove, as 74, to 45 ; for ranging the silk in the best manner on the reel ; the size of these wheels should enlarge with the reel's diameter, but the proportions should be kept. The bench must also be lengthened when the reel is made large.

The Furnace A. is round, or oval, with a fire hole, B. and it would also be the better of a flue to carry of the smoak.

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The copper or cauldron is shaped to the form of the furnace; (the oval form is best for reeling two or three parcels of of pods) it is about four or five inches deep; it may sink into the furnace, and be supported by its ledge; or it may be only a pan standing on the top of the furnace, in which case the furnace must not be much above a foot high.

Though the fore feet of the reel's bench are by authors directed to be made only two foot high, and the hinder ones two foot and an half; yet it would answer better if they were made higher; for then the stop-wires C. C. would be raised somewhat more above the cauldron, which would give better scope to the adding of fresh silk-pods by having more length of threads beneath the stop-wires, for it is these separated threads that catch the fresh ones which are added and carry them up. Besides, the pods in the cauldron would not then be so apt to rise and strike against the stop-wires, which often breaks some of the threads. The feet therefore should be so high, as that the stop-wires may be at least a foot and half above the water in the cauldron, and the cauldron itself not
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so low as to be uneasy to the woman who supplies silk-pods, by making her stoop too much, as she sits by it.

Small models of the reel are made by Mr. Thomas Becher, Cabinet-maker in Broadlow-street, Holburn.

C H A P. VI.

How to take of the floss or loose silk from the pods, the reason of sorting these according to their different degree of fineness, in order to be reeled.

BEFORE the silk-pods can be reel'd, it is necessary to free them from that loose fuzzy silk which is on their outside, and is called the floss, it being of so fine and loose a consistence, and partly broken by taking it from the branches where the worms had spun it, that it cannot be reel'd off in water. It may be taken off by opening it on one of the ends of the silk-pods, and then thrusting out the hard part of the pod, which is that which is to be reeled, clearing off the loose silk which adheres to it, and throwing this part with
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the floss, in order to make ordinary cheap silk.

And now, at taking off the floss, is a good time for sorting the silk-pods according to their different degrees of hardness; this is a thing which is very little attended to in the countries where silk is produced. They carelessly throw into the hot water all kind of silk-pods, and so reel of the strong and the tender, and often the double ones mixed with them, the consequence of which is, a great deal more trouble in the reeling, the silk breaking much oftener, and being much the worse.

For the proof of this, let us suppose only two silk-pods, one compact and hard, and the other of a loose and soft substance thrown together into the hot water, in order to be reeled off together, and to make one thread: if now the water be sufficiently hot to let the hardest of the two silk-pods wind off with ease, by dissolving its gumminess, then that water will be too hot for the other pod whose substance is loose, so that it will run off in burrs, that is flakes of the silk will come off without being drawn to their extent, which burrs as they pass the stop-wires, or guide-wires, will

will endanger the breaking of the thread, filling it also with lumps and inequalities.

On the other hand, if the water is just properly warm for the soft pod, so as not to occasion the above inconveniency, it will then not be hot enough for the hard pod, so that its thread will not be disunited from it, without some stretch and violence endangering its breaking, and giving the trouble of adding a fresh pod. And in both cases the single hairs of the silk-pods, being unequally stretched in reeling, will make the combin'd thread the weaker, and also less even, and glossy, since the single hair of that pod which was most stretched by the reel will, upon disbanding, contract itself more than the other, and be separated from it in some places.

On these accounts, having first separated the double pods, and also those which contain nothing but floss, with any others, which, being imperfectly formed, cannot be reeled; sort the perfect pods into three kinds, and do this at the time that you are stripping off the floss, which being removed, you can readily perceive their different

ferent degrees of hardness, and throw them into three different baskets. The first sort will consist of all that are very compact, having their single hairs very firmly glued over one another; the second of those which are of a middle consistence; and the third, those whose hairs are loose and open. The hard or loose consistence is not judged of by the floss, but by the compact part of the pod which remains under the floss.

It may not be amiss to observe that children may readily be taught the business of stripping the floss from off the pods, but to judge of their consistence and sort them, will require a person of some skill; and though the stripping off the floss may be performed by candle light, this time is not very convenient, either for sorting, or reeling, these requiring a good light and a quick eye; though with regard to the compactness or softness of the pods, you will partly be guided by the feeling, and partly by the appearance, those being the hardest, and requiring the water in which they are reeled warmest, whose hairs appear most firmly adhering, and most glued over one another. The time spent in sorting will be

be very inconsiderable with respect both to the time and labour which it will save in the reeling, and with respect to the advantage and value which the silk will receive from it; for which reason, I do the more earnestly recommend it as a work which is both easy and of great importance.

C H A P. VII.

How to reel the silk from the pods.

THE kind of water in which the silk-pods are reel'd is of considerable importance, water which is called hard; such as that of springs and wells, is by no means to be used, for it will not dissolve the gumminess of the pods, so that they will wind off with difficulty, and their threads be liable to break often. Choose therefore the softest water from slow running rivers, or ponds, and which has been longest exposed to the air. This water being put in the cauldron of the furnace before described, let it be made just to simmer, or come to boiling, and then, with a

skimming dish, take off any scum which rises on the top.

For the hardest sort of pods a scalding heat will be necessary, but a less degree for the others. However, the heat cannot be ascertained till you begin to reel, for then, if the silk comes off in burrs, or lumps not stretched to their extent, the water is too hot, and the fire must be abated under it. On the contrary if the silk comes off with difficulty, which is known by the pods often leaping out of the water, it is then too cool, and the fire must be increased.

The spinner, which is she who attends the management of the silk-pods in the cauldron, must be provided with a brush made of the finest twigs, or tops of heath bound together, and cut off flat at the brush part. Then being seated before the cauldron, she throws into it an handful or two of the silk-pods, of one sort or degree of firmness, and pressing them gently under water with the flat brush, the ends of the silk-pods will adhere to the twigs: she then takes as many of these ends as are necessary, according to the thickness she intends her thread, and, bringing them together,

gether, draws out the united thread until she finds that the single hairs of which it is composed come off easy and free from floss. She then breaks off so much of the end of the thread as came off coarse with floss, or burrs in it; and, throwing it aside, delivers the end of the perfect thread to the person who stands ready to turn the reel, who immediately passes it through the stop-wire, and through its guide-wire, and then makes it fast to the reel, as mentioned in the description of the reel. In the mean time the spinner has another thread prepared for him, which he passes through the other stop-wire, &c. in the same manner; and if the silk is to be reel'd in the cross, you are to understand its being passed over the crossing-wires.

And now, both threads being fastened to the reel, it is turned with a regular even motion, at first somewhat leisurely, till the threads are found to run free and easy, for it will happen that some of the ends which were taken to compose the thread were false ones, because in taking off the floss, there may be two or three breaches made in the beginning of the hairs, which in winding will soon end, and must be added anew to make up the number

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which

which you design in the thread. It might therefore be convenient in the beginning of the thread to put a few more pods than you intended to continue, which will soon be reduced to the proper number.

As soon as the pods begin to give the thread freely, the reel is turned with a quicker motion, and the same thing which, as I mentioned before, regulates the heat of the water, will also regulate the motion of the reel; for if the pods leap up often, and beat against the stop-wire, the motion of the reel must be slackened, and if the thread comes off in burrs, it must be turned quicker. And of this the spinner, who has her eye upon the balls and thread, must, as she sees occasion, apprise the reeler; and at the same time the fire must be increased or diminished, that the reel may be allowed a proper motion, which ought to be as quick as may be, without endangering the breaking of the thread, or hurrying the spinner, so that she cannot add fresh pods as fast as the old ones are ended.

While the reel is turning, the spinner is continually adding fresh pods to each thread as fast as she can find the ends, not waiting till some of the number she began

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gan with are ended ; but being before hand, and at any leisure intervals, preparing fresh ends by dipping the heath brush among fresh pods, of which such a quantity must be constantly thrown into the cauldron as will suffice to supply the two threads which are reeling, but not more, least, by being too longsoaked in the hot water, they should wind off in burrs ; and these pods which are thrown into the cauldron, must be often forced under water, that they may be equally soaked ; for, as they swim with their greater part above water, that part would remain hard and stubborn, while the part which is under water would be too much soaked : or otherways you may with a brush frequently throw some of the hot water upon them, as you may likewise do on the pods which are reeling, when you observe them grow dry at top, and yield the thread stubbornly.

The supplying of fresh ends is performed by laying them slopingly across the single silk hairs which continue separate till they reach the stop-wires, for here the added one is readily caught by them and drawn up ; for which reason the stop-wire should be about a foot above the water.

There is a readiness in adding fresh pods which can only be acquired by practice, in which some are so expert, that they can supply three threads of silk passing thro' three different stop-wires.

You will know when any pods are completely winded off, when you see the small remainder of the pod rise out of the water, and stick at the loop of the stop-wire; the worm having then dropped out, the remaining silk becomes too light to remain in the water. You will know when the ends of any pods break before they are winded off by their remaining at rest in the water, and generally by their quitting the company of the rest, and lying close to the side of the cauldron. When the spent pods leap up and adhere to the loop of the stop-wire, they must immediately be taken away, else by choking up the passage, they will endanger the breaking of the whole thread.

The quantity of silk which can be reeled in any given time is, *cæteris paribus*, in proportion to the quickness with which the spinner can add fresh ends. Thus if you suppose that every silk-pod, at a medium, will either break or be winded off at the end of five hundred foot, then, if
five

five such pods are reeled together, a fresh end will be wanted at every hundred foot that are reeled; if ten are reeled together, one will be wanted at every fifty foot; if sixteen together, then at thirty one foot, and so on. Nor doth it make any difference whether twenty pods form only one thread, or whether they are divided so that each five forms a distinct thread, in both cases, if they are reeled at once upon the same reel, they will require nearly the same dispatch to supply fresh ends; and this points out a method of employing spinners according to their different skill, for if one spinner can supply two threads each of ten pods, then another spinner who can supply ends only half so fast, can only attend two threads each of five pods, or one of ten pods.

The seldomer that pods end or break, the greater number of them can one spinner attend, which shews the advantage of large and sound pods, and of every artifice which can hinder either the breaking of the single hairs, or of the whole thread.

The breaking of the single hairs is principally owing, either to bad silk-pods, *viz.* being ill formed, as they will be when the

worms were disturbed and interrupted during their spinning, either by shaking, or by cold weather rendering them torpid and inactive at their work, a thing at that time very manifest to the sight. Or the single hairs may break by an improper regulation of the heat in the water, when it is not sufficient to make them wind off easy ; or when it is too great, and occasions burrs which may stop at some of the wire-loops through which the thread runs ; pods also which have two worms inclosed will perpetually break.

The whole thread may also break, by burrs stopping at the wire-loops, or by the reel's being turned by jerks. It need not however be knotted, but may be fastened by laying the parts on one another, and giving them a little twist ; or the end which broke may be carried up to the reel and so fixed as readily to find it again, and may be reel'd on without uniting it to the other, for all delay should be avoided. To avoid the breaking occasioned by burrs, the wire-loops should not be too small, but so wide as to let them easily pass, and if the distance between the reel and the pods were increased ; the thread then by having
length

length would have time to let the burrs stretch out, and thus make the thread more even.

I think it would be convenient for the spinner to have a little stick erected close to the side of the cauldron, which having two or three pins in it would serve to hang her heath brush by means of a little hook at the end of it, and also any other little instrument which she may want, such as a sharp fork with which she may draw away the pods which are spent, and have dropped the worm; or such as, being near spent, have the bag drawn together and stick at the stop-wire; and as the heath brush will frequently take up more ends than are immediately to be added, and as the spinner will sometimes have occasion to employ both her hands, the brush will at that time conveniently hang by the cauldron, while the pods which are attached to it remain in the water, and the ends will be in readiness as they are wanted; in this case the pods which do not reach the water may be drawn down to it between the spread fingers of her hand.

If the spinner is under a necessity of leaving her work for any length of time,

the pods should all be raised with a skimming-dish out of the water till her return, otherwise by over soaking they would wind off in buris; but it is best to continue the reeling without interruption, and to let fresh persons succeed those who are tired, The water however must be changed as it grows foul, and sometimes fetid, from pods where the worms have been killed some days before; the chrysalids when the silk is reeled off them are used to feed hogs or poultry.

The person that turns the reel should have an eye to the threads and to the loops of wire through which they pass, that he may apprize the spinner when any thing is wrong, for her eyes will be sufficiently employed about the pods. The reeler might also rectify any thing which goes amiss in those parts of the thread which are near the reel, for he will always have one hand unemployed, and must even stop from turning for a little while upon emergency. Though the reeler can change hands as they tire by turning, yet for his ease I think he might have a support for his arm opposite to the axle of the reel, and so to turn the handle only by that motion
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which he can give it by the arm moving upon the elbow as upon a centre.

I must observe here that the business of winding the silk from the pods is, in some countries committed only to persons who upon examination are found properly qualified, and that the several regulations which regard the reeling are established by law, and penalties annexed; but I doubt whether strict regulations would be proper in the infancy of a manufacture of this kind in our colonies, I believe it is better at first to encourage all endeavours, and to let regulations grow upon time and experience.

It is necessary to inform you here, that as the heat of the water in the cauldron will require to be varied according to the ease or difficulty with which the pods give their silk, therefore the spinner should always have some cold water within her reach, in order to cool that in the cauldron quickly, when the silk comes off too easy and in burrs, and some chips or shavings should be at hand to augment the heat quickly when the pods are stubborn in letting the silk wind off. A contrivance indeed might readily be made by which the fire, lying upon a little grate with close

bars, might readily be approach'd to or withdrawn from the bottom of the cauldron, which would more suddenly vary the heat. This might be done by making the grate hang on a swivel, with a handle coming out of the fire place by which it might be raised or depressed.

It would be convenient also to have a tap-hole in the side of the cauldron, at its bottom, for emptying the water, when it grows foul and fetid from the chylalids which soon corrupt it, and, as they sink to the bottom, cannot easily be taken away without drawing off the water, which besides its offensive smell doth, by its foulness, diminish the lustre of the silk.

C H A P. IX.

Some further hints for the improvement of reeling the silk from the pods.

I AM inclined to think that a method might be contrived, for reeling silk from the pods, nearly as advantageous as winding in the cross, and subject to fewer inconveniencies.

Mr.

Mr. *Vaucanson* says, that silk reeled in the cross has an appearance as if it were twisted ; that this can be no more than an appearance I think requires little proof, for the end of the silk-thread at the reel and at the pods may be supposed fixed, and therefore any twist which is given at the place of crossing, goes off as soon as that part of the thread has passed the crossing ; it can no more remain than if one should fasten any stretched thread at its two extremes, and then twist it in the middle between the finger and thumb, as soon as those are withdrawn the thread untwists.

The real advantages of crossing are the wringing out the superfluous moisture, and the compression of the thread, whereby it is rendered more compact : the inconvenience attending this method is the frequent breaking to which cross'd threads are subject. I leave it to experience to determine whether the following method will not procure advantages nearly equal to those which arise from winding in the cross without its disadvantages.

Let a slender square pole of about three or four foot long be fixed perpendicular in
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the forepart of the reel's frame, just between the two stop-wires. At the top of the pole let an ivory pully of about one inch diameter turn upon a smooth wire-pin fixed in the side of the pole; and let another pully of the same kind be placed in the same situation near the bottom of the pole. These pullies should have a groove formed to the angle of an equilateral triangle and smoothly polished; they should also be formed with a little round navel at their center to keep their flat from rubbing against the pole. The pole stands in a round hole, and can be drawn out as occasion requires, or turn'd awry. See Plate II. Fig. III.

Now when the silk-pods are to be reeled, the thread after having passed the stop-wire is conducted over the upper pully, then under the lower one, from hence to the guide-wire and then to the reel. By this method the length of the thread from the cauldron to the reel may be increased to what degree you think proper, *viz.* either by having a longer pole, or by having two pullies above and two below, and so making the thread pass up and down over them. By these means it may have fifteen or twenty foot space to run thro', and
shake

shake off its superfluous moisture, which will be further promoted by the pressure which it suffers in passing over each pulley; this pressure will at the same time help to make it compact; and the groove of the pulleys being the angle of an equilateral triangle will throw it into a figure which by the time it arrives at the reel will be sufficiently round: yet this roundness is not only to the grooves moulding the thread into a compact figure, but to a cause less apparent which is this: the plane of the pulley should not be exactly parallel to that of the thread by which means the thread will always roll a little on the side of the groove, and so will receive a small twist as it approaches to, and as it leaves each pulley.

That this theory is also true in fact, you may easily prove by stretching an untwisted silk-thread on two pins; if you then roll one of the above-mentioned pulleys along it, holding its axle between your finger and thumb, you will perceive that any small particle of down, which you may fasten to the thread, will begin to turn round as the pulley draws near it, provided you give the pulley a very small
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inclination, and do not keep its plane exactly parallel to the thread.

The small twist which the thread suffers as it approaches the pully has this further use, that it secures the ends of the fresh pods which are continually added, from the hazard of sticking to the pully, and so of being stripped from the main thread and winded round the pully; and this will be more effectually prevented if the thread is made first to pass over, and bear a little upon a small wire hook placed within an inch or so of the upper pully; for then the whole twist will be confined to that part which lies between the hook and pully, and will thus secure the end just where there is a necessity: but without this hook the twist would be spent over the whole length of thread which lies between the pully and the stop-wire, so that it would be but very little in any one part of that length. However, there will be no occasion for the hook unless it is found by experience, that the end is apt to catch and stick to the pully, which in my tryals I have not found.

I mentioned before that the groove of the pully should be very smooth, by which I chiefly mean the very edge of the angle
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where the thread rests; I don't know whether there can be a better method of effecting this, than, after the angle of the groove is formed in the turning-lath, to use a piece of the finest steel-wire, as small as a hair, stretched on a bow, which being held against the angle of the groove, while the lath turns the pulley, may take off any roughness, and also make the edge of the angle, instead of being quite sharp, somewhat approach to a circular form, which may be of use to the thread that runs in it, which from pulleys thus regulated will at least not receive that flat form which it did in the old method of reeling over the bobbins.

C H A P. X.

Of disbanding the silk from the reel, and tying it up in skains: the use of the floss-silk.

WHEN a sufficient quantity of silk is on the reel and you intend to take it off, there should seem to be no great room for much instruction. Yet here I shall take occasion to mention some things

things which will be found useful, even in this business.

One cannot consider attentively the manner in which the silk is reeled from the pods, without observing that the single silk-hairs of which the thread is composed, are liable to suffer very different degrees of stretching as they are winded from the pods. If the balls are not sorted well, this different degree of extension will be the greater, and, even when they are sorted, they must still be subject to different stretching, because some are a little longer in the water than others and therefore give their silk easier; and also because the weak latter end of some pods wind off with the strong first part of others.

The hairs being thus stretched unequally, will occasion (when the skain is taken from the reel too suddenly) those hairs which are most stretched to contract more than the others, by which their union will be in some measure destroyed, and the thread composed of them rendered less compact and firm, the single hairs appearing in several places disjoined from one another.

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To remedy this the skain should not be suddenly taken from the reel, but remain there till the unequal extention which it suffered in winding is by the stretch which it undergoes on the reel brought nearer to an equality, and till the thread by being well dried has its hairs firmly united. This would be best effected by having two reels, and when one was filled they might immediately proceed to wind upon the other. That which has the skains being taken off its frame should stand in the sun, or at a moderate distance from a fire till the other is filled with silk, and this is again wanted. This would also prevent delay as the skain might be taken off, and the reel made ready by a person not employed in the reeling. When the skain is finished there should some mark be tied to the end of the thread, otherwise it may be difficult to find it, if it mixes among the threads of the skain.

When the skain is quite dry, and you proceed to disband it from the reel, you must first squeeze it together all round, by which it will become loose upon the bars, because its threads were all laid obliquely on by the guide-stick ; then, with a piece of

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twine made of the refuse filk, make a tie just on that place where it bore up on the bars of the reel : then slide it off the reel, and make another tie on the part opposite to that where you made the first ; after which you must double it, and tie it round near each extremity, and then it may be laid up for use or sale.

As to the floss silk which was on the outside of the pods, it is sometimes carded and spun on the wheel ; as is also the inner bags of the silk pods, these being first softened in boiling water. And sometimes the floss is reel'd without twisting, being drawn out by the finger into a coarse kind of thread, serving for the woof of ordinary silks ; but this and the further management of silk, with the various manners in which it is thrown, and prepared to be woven, do not come within the scope of this Treatise.

C H A P. XI.

Some additional observations on cleaning the hurdles from the litter made by the Silkworms.

THOUGH some directions for keeping the silkworms clean, have, occasionally, been interspersed through this Treatise, yet it may not be amiss to give them a particular place here; both because the cleaning of the hurdles is absolutely necessary to the health of the worms, and also because, when they are grown large, it makes a principal part of the labour which is bestowed on them; for, as the leaves are gathered and brought home by particular persons allotted to that business, so almost the whole of their work who attend on the worms consists in feeding, cleansing, removing, and occasionally separating those which do not sicken at the same time.

Till the worms have passed their third moult, or sickness, the trouble of cleaning them is very small; for till they have pass'd their first moult, which is six or eight

days from their being hatched, they need not be cleaned at all, but may lie on the fibres which they make, without being removed from them, these form a soft warm bed, and the litter which comes from the worms, being then as fine as dust, soon dries, and, sinking among the fibres, doth not at all incommode them. This, I say, is the case provided you have fed them properly, not keeping the worms too thinly scattered, and so being obliged to throw more leaves on them than they can consume before they wither, by which means they would be buried and enveloped in the old leaves, which curl about them; this throws persons under a necessity of disengaging the worms, which, besides the endless labour of it, wounds and hurts multitudes of them: and here I must repeat what I have formerly mentioned, that slicing the leaves for the young worms greatly tends to hinder their curling about them, besides it makes the leaves go farther and produces less litter; a few handfuls of leaves are quickly sliced, which should be done more or less, in proportion to the age of the worms, till they have passed their
their

their second sickness, for then they can easily master the whole leaves.

As there is no necessity for cleaning away the fibres from under the silkworms till they have passed their first sickness, so long as it remains free from moisture or mouldness, so neither will there be any necessity to clean them again, till they have passed their second moulting, so long as you perceive it to remain tolerably dry; but if there is a large heap of fibres, and you perceive them to have grown damp and mouldy, you may thin it as much as you think proper by taking away the under fibres, which will generally come off in flakes; if you perceive many worms buried and envelop'd among these fibres as you take them off, you may conclude that you have either given too much leaves when you fed them, or that they have not been all hatched at the same time, by which means some became sick, while the rest were in a feeding state; and so the first not being in a condition to get upon the fresh leaves were buried under them and starved.

You may readily take the worms off the cake of fibres when it becomes moist, by rolling a handful of hay between your hands

till its fibres become entangled in one another; then spreading it out and flattening it, it will become a sort of net-work; lay this over your young worms, and strew the fresh leaves over it, and when they are come through it, and have fixed upon the leaves, then slide a very thin shovel of board, or paste-board, having a handle like a wool-card, under the hay, and, taking it off the cake of old fibres, slide it with the worms from off the shovel upon a clean part of the hurdle: you may very readily insinuate the shovel under the hay without incommoding the worms, if, while you raise the hay with one hand, you by degrees thrust the shovel gently under it with the other. You may let the worms be a little hungry, by fasting a little longer than ordinary, before you lay the hay over them, that they may the more quickly come up through to the fresh leaves which you give them. And therefore, that you may lose as little time as possible, when you have spread the hay and leaves over one parcel of worms, you may proceed and do the same to another, and so on to all the different parcels which you have, by which means the first which you fed will be getting

ting through to their leaves while you are managing the others ; for the hay and leaves should remain a good while on the cake of old fibres before you remove them, that you may give the worms time to get on the fresh leaves ; since it is troublesome to collect the odd scattered worms which remain after the bulk of them is taken away, for if any remain you must pick them up, with the fibres to which they stick, and so lay them among the rest.

Besides what I have already mentioned, you will find that if you, now and then open and raise the cake of fibres with a hooked wire, it will contribute to keep it dry, by giving admision to the air and causing the litter of the worms to run off. And thus to clear away their litter after each moulting may suffice for the keeping your silkworms clean until they have passed their third sickness, during which time they lie in a narrow compass and are easily managed ; for the worms necessary to produce twelve or fifteen pounds of silk may, when first hatched, lie on the space of a foot square nearly, and these, by the time they have arrived to their first moult,

may lie on a hurdle containing about six square feet, at which time they will be about eight days old ; two and an half of such hurdles may contain them at their second moulting ; eight at their third ; seventeen at their fourth moulting, and fifty when they are ready to spin : by which allowance you see they will take up about three hundred times the space which they did when first hatched.

You may continue to shift and clean the worms by means of the shovels before mentioned until they have passed their third moult ; if you keep them on the hurdle in such distinct parcels as may be taken on a shovel ; otherwise you may, shift them by the hand, the method of doing which may be thus ; when you give them fresh leaves, and they have got upon them, take away the leaves with the worms which stick to them, and place them upon loose straw spread on a clean hurdle, and if any worms remain upon the old fibres pick up the fibres to which they adhere, and place them among the rest. This I think is better than (as some advise) to scatter a few fresh leaves, and wait till the odd worms which remain have got upon

upon them, for besides the waste of time, the worms will often not get upon these fresh leaves but lie upon the hurdle while they eat them, so that you might wait a long time before you got them all shifted.

When you have a number of hurdles to clean, strew fresh leaves on as many hurdles as you think proper, and by the time that you have strewed them on the last, the worms will have got upon the leaves of the first. Then begin and take these off and place them upon a clean hurdle, and then after clearing away the litter and fibres of the hurdle from which you first removed the worms, it will be ready to put others on, and in this method proceed till they are all cleaned; by which means one supernumerary hurdle will serve for cleaning all the rest, and the last clean'd will remain empty of worms, being the supernumerary hurdle with which you are to begin your next cleaning.

For the greater ease of shifting the worms, the two hurdles should be taken from the stand, and laid near one another on a table, or square frame, which may be removed from stand to stand as you have occasion to clean them.

The

The reeds, or other materials of which the hurdles are made, are supposed to be placed so close that, after their third moulting, little or none of their litter can fall through, least it should incommode the hurdles which are placed below one another on the same stand. When the reels are placed as close as they can be it will not hinder, but that there will be sufficient crevices for the air to pass and dry the fibres; but if the worms lie upon boards, there will be always a great deal of moisture, for want of the free access of the air, and they will often require cleaning.

Before their third moulting, the litter they make is small and mostly runs down among the withered fibres, therefore till their third moulting it may suffice, as I have said, to clean away the litter and fibres once after each moulting, especially if the weather is moderately dry, and they have eaten their meals clean, leaving nothing but the fibres, which fibres you may raise up here and there with a bodkin to make them lie open, and let the litter fall down. But if it is close sultry, and moistish weather you should clean them often; for heat and moisture coming together are
the

the great causes of putrefaction, and consequently of distempers; but never offer to clean them while they are in their moulting sickness, for it is then very detrimental to disturb them; yet at other times, when you find them come lazily on the fresh leaves, and eat languidly, it will be useful to make their hurdles clean at that time in order to excite and rouse them.

But the great business of cleaning is from their fourth and last moulting, to their time of spinning containing about ten days, they will then require to be cleaned every second day, or oftener, otherwise their litter, being now in great quantity, will soon create moisture and mouldiness, and infect both the leaves and the worms.

Whatever contrivance can now be found to lighten the frequency of cleaning them would be of great use: it is very observable that at this age, their bodies being very heavy, they frequently press down and flatten great part of the fresh leaves, and that, after having lain on them, they seldom care to eat them; nor indeed can they readily get at them, while thus cover'd with worms and flattened to the hurdle: this occasions both waste of food and in-

crease of litter, therefore if any light dry materials, such as the withered fibres of rape or mustard, were spread on the hurdles (or framed in such a manner as I shall hereafter mention) so as to form a texture very loose and open, about an inch or more in thickness, which I shall call bedding, this will help to keep the leaves in such a situation as to be easily and wholly eaten, and will also prevent the worms from lying among the litter which they make; for though, when they were young and small, the fibres of the leaves formed a bedding sufficient to support them, yet at this age they scarce leave any fibres of the mulberry-leaves uneaten, and those are too weak to support their weight.

If you dress their hurdles in this manner their litter will roll down through the bedding and be received by the hurdle which, as formerly directed, is woven so close as not to let it pass, and it may be cleared away by shifting the bedding with the worms upon it, in large quantities at a time, upon a clean hurdle, and then shaking the litter off the other.

This bedding may be much improved in convenience, by fixing it in a slight square

square frame, so as that it may be all at once taken off the close hurdle when you intend to clean it: thus four reeds about the thickness of ones finger being notched and tied together, as directed in forming the rim of the close hurdle, and having some smaller twigs fastened across it, so as to divide the space into small squares of about six inches, will make a sufficient support for the bedding, which may be spread upon it so as to lie about two inches thick, but so loose and open that the worms might pass through the interstices. The outside straggling fibres may be confined within the verge of the frame by a strip of thin matting going round, which will also form a ledge, and confine the worms.

Now this bedding may either lie upon the close hurdle, so that both may be taken off the stand together when you would shake off the litter, or it may be supported on the stand by four nails of its own, while the close hurdle is likewise supported close under it by four others proper to itself, by which means you may take it away and shake off the litter without moving the worms. In order to take away the close hurdle with ease the two farthest nails
that

that support it, should have no heads, and the two supports in front may be hooks moveable on a nail, which hooks being drawn back, you can lower the front side of the close hurdle and so take it away; for, without thus lowering it, it would rub against the bottom of the bedding, and might hurt some of the worms which happened to lie low. Instead of the sticks which support the bedding in its square rim, packthread may be tied across to answer the same purpose; or nets with meshes five or six inches square may support the bedding, and may be placed on the nails in the stand by two stiff reeds run through the meshes of the opposite sides. And here, by the way, a good method occurs of taking the young worms from off their litter and fibres when there is occasion. Thus Plate I. Fig. VII. suppose you intended to remove all the worms which lie on a hurdle half a yard square, to a thin light piece of lath A. somewhat more than half a yard long, fix several small threads b. b. b. at about two inches distance, the threads should be somewhat more than half a yard long, and should have single knots tied near their extremities,

ties, which are to catch and hold them stretched in the nicks of a thin lath E. or between wires bent and fixed in a lath, as represented at C. the lath should be of the same length as the other, with as many nicks, or divisions made by the wire d. d. d. and at the same distance as there are threads fixed on the other, into these nicks slip the knotted end of each thread, and, stretching them between the two laths, lay them over the worms; then make a very thin open bed of bents or hay, and lay it over the threads and worms; upon this bed strow their leaves, and when the worms are come through the hay, and are fixed on the leaves, remove all together by means of the two sticks stretching the threads which lie under and support the bed; and when you have placed them on a clean hurdle slip the knotted ends of the threads out of the nicks, and, taking hold of the other stick, draw away the threads softly from under the bed, and use them in the same manner for removing other worms, or for dispatch you may have a good many of these threaded laths.

These things are somewhat tedious and troublesome in description, but of very
easy

easy performance ; and, according as they are found useful, may be varied and improved in discreet hands. Some might think that small nets would do as well as these threads which I have described above ; but if it is considered that the meshes of these would never allow them to be drawn away with ease, and that besides they would be liable, in drawing away, to lay hold of some of the worms and cut them, then it will easily be seen how much this method is preferable.

With regard to the bedding which I was mentioning you must take notice, that tho' stiff fibres, or perhaps straw, may serve for grown worms, yet when they are young light bents or hay is fittest, always proportioning the stiffness of the beds to the age of the worms, and making it so loose and open that they may easily pass through it. In the large hurdles, that are thus bedded with straw, you may stretch two or three strings over the straw to keep it in its place, if you should have occasion to turn the frame upside down to shake off any leaves or litter that lie on it. If you use straw for the bedding, and the weight of the worms should press the
straw

straw too close, you may now and then fork it up to make it lie loose and open.

When you use the forementioned beddings of hay or fibres, &c. you need not clean the close hurdles under them till you find the litter is so thick as to hinder the air's passing freely through their crevices, so that by this method you will be eased of a good deal of labour, and the worms will lie clean, and clear of their litter, neither will they so much crowd one another, the thickness of the bed affording them more space to lie in. It will be useful to have a broad shallow basket, made so close at bottom as not to let the litter pass through, upon which you may lay the close hurdles to beat off the litter, and so convey it out of the room; for if it were spilled on the floor, and trodden under foot, it would become very noisome; when you replace the close hurdle, after cleaning, turn the under side of it next the worms, because it will be the most dry and sweet. The more open and bushy such materials are of which you make these beds, the more they will resemble the branches of trees, among which the worm feeds in its natural state; it must however,

be remembered that at the last time of cleaning the hurdles, when the worms are ready to spin, the beds should be taken away, otherwise they will make their pods among the straw or fibres, where their litter would foul them, and there would be a loss of silk in drawing away the pods; therefore, at that time the worms must be laid on the hurdles, without any bedding under them.

Thus far it seemed to me necessary to enlarge on the subject of keeping silkworms clean in a detach'd chapter, that I might not too much interrupt the method and order of the book; and I thought it a subject too material to be omitted, even tho' only one useful rule of practise were suggested by the whole chapter.

Among such a multiplicity of precepts and observations, some things may possibly have escaped my attention; one at present occurs which is, that an equal continued degree of warmth is what silkworms best thrive in, and this degree is about the eighteenth of *Reaumur's* Thermometer, and sixty seventh of *Fahrenheit's*, for silkworms will without any detriment bear some variation above and below this degree. I shall only just mention one thing more,

more, and then with a few queries proposed upon it, put an end to this treatise.

The *Chinese* are said to give themselves no more trouble, in many places, than barely to hatch the worms after which they place them on the mulberry-trees, where they feed and make their pods without the trouble which attends keeping them in houses. It should be inquired whether this is fact, and then

How do they preserve the worms from birds, snakes, lizards, &c?

Doth the weather never injure them?

How are the injuries of the weather prevented?

Will any climate in our colonies allow of such management?

May not low shelter'd hedges of mulberry-trees answer best for a trial of this?

May not some cheap covering be found or matting formed like a pent-house to defend such hedges from perpendicular rains of?

May not the attendance of a boy be sufficient to keep off birds, lizards, &c. can dogs, or hawks be trained, or station'd for this purpose?

Will not hedges be pretty well sheltered from winds by large trees planted properly,

ly, and from rains which drive with the wind, by making them run in length parallel to the direction of the most rainy winds ?

Is it not worth while to make some trials of this sort, in our colonies, where hands are so much wanted ?



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