

# THE SILK INDUSTRY

.. OF

# ASSAM

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# THE SILK INDUSTRY OF ASSAM.

## CHAPTER I.

### GENERAL.

Out of the four species of silkworms reared in India, three are cultivated in Assam, namely, the common or mulberry silkworm, the *muga* and the *eri*. The fourth, *tusser*, is not reared in Assam at the present day, though it occurs in the wild state. *Eri* and *muga* silk are known to the outside world under the name of Assam silk. Mulberry silk which is known in Assam as *pat* is grown to such a small extent that the fact of its existence in this province is not generally known. Although the use of silk has been largely superseded by imported cotton, it still forms an integral part of the national dress of the Assamese. In no other part of India, with the exception perhaps of Burma, is the use of silk so common as among the people of the Brahmaputra Valley.

2. *Muga* silk is produced by an insect known to science as *Antheræa assamea*. This silkworm is not known to be cultivated anywhere outside Assam—a fact which gives significance to its scientific name. The *muga* insect is a polyvoltine and produces five broods of worms in the year. The chief food plants of the worm are the *sum* and the *hualu* tree. *Muga* is distinguished from the common silkworm and the *eri* by the fact that it passes the feeding stage of its existence upon the trees on the leaves of which it feeds, all other stages of its life—cocoon, moth and egg—being passed indoors. *Muga* silk is produced more or less in every district of the Assam Valley, though it has disappeared within recent years from many tracts where it used to be grown. The cultivation of this silk still continues to be an important industry in some of the less progressive parts of the valley. All castes and classes of people, with the exception of the immigrants, are permitted by social usage to rear the *muga* worm. The principal rearers are the non-Aryan castes and tribes such as the *Ahoms* of Upper Assam, the *Lalungs* of Nowgong, and the *Garos*, *Rabhas* and *Kacharis* of South Kamrup. The cocoon of the *muga* worm yields what is known as reeled or net silk, i.e., silk drawn off the cocoon in the form of a continuous thread. The silk is of a golden yellow colour and greatly esteemed for use in embroidery and artistic weaving as a substitute for gold thread. A considerable quantity of raw *muga* silk is annually exported to Bengal and other parts of India to be used for this purpose.

3. *Eri* (also called *endi*) silk is obtained from a silkworm known as *Attacus ricini*. The vernacular as well as the scientific name of the insect denote its connection with the *era* or castor plant which is its principal food-plant. The *eri* is a polyvoltine and produces 6 or 7 broods in the year. The rearing of the *eri* worm is more widely spread than that of the *muga*. There is hardly any village in the Assam Valley, barring the cool settlements, where it is not found. Custom permits every class of people to rear the *eri* worm; but as in the case of the *muga*, the principal rearers are non-Aryan tribes living on the outskirts of the valley, e.g., the *Kacharis* of North Kamrup and *Mangaldai*, and the *Mikirs*, *Kacharis*, *Rabhas* and *Garos* living among the low hills on the south bank of the river.

*Eri* silk differs from other silks in that it cannot be reeled, i.e., a single continuous filament cannot be drawn off the cocoon, as is possible with *muga* or *pat* silk. Unlike the *pat* and the *muga* cocoon, the cocoon of the *eri* insect is not formed of a long continuous thread, but is spun by the worm in distinct layers. One end of the cocoon is open so as to allow the moth to push its way out without cutting or softening the fibre. The existence of the hole is perhaps another reason for the *eri* cocoon being unreelable.

*Eri* silk is extracted by methods which resemble the carding and spinning of cotton and jute. The thread being spun by hand is more or less uneven and full of small clots of tangled fibre; it is also devoid of lustre. But the thread is soft to the touch and remarkably durable—qualities which make *eri* cloth particularly suitable for rough wear.

4. The *pat* worm is a *Bombyx* and is akin to the common silkworm of Europe, China, Japan and Bengal. It feeds exclusively on the leaves of the mulberry tree. As elsewhere, there are two distinct breeds or species of the mulberry silkworm in Assam. One, called the *bor-polu* or large worm, is a univoltine, and the other, called the *horu polu*, is a polyvoltine and produces six broods in the year.

*Pat* Silk.

The cultivation of this silk is practically confined to a section of the Katoni or Jugi caste—the *Polupohas*. The only other people in Assam who grow *pat* silk are a few Musalman families in the north of the Golaghat subdivision. The chief *pat*-growing villages are situated in the districts of Nowgong and Sibsagar and the Mangaldai subdivision of Darrang. The annual output of *pat* silk is very small, perhaps not exceeding 150 maunds. Whatever silk is produced is consumed in the country, and none of it finds its way to the market. On the other hand, there is an increasing import of Chinese raw silk into the country, to be woven up into cloth for local use. Of the three varieties of silk grown in Assam, the *pat* is the most valuable. It is only the well-to-do that can afford to wear *pat* cloth.

5. The natural history and rearing of the three kinds of silkworms grown in Assam present some common features which may be set forth at the outset.

The life history of the silkworm.

The life of every species of silkworm is divided into four well-defined stages, namely, (1) the egg or seed, (2) the worm, (3) the cocoon or rather the *chrysalis* inside the cocoon, and (4) the moth which may be either a male or a female, and which is the last or adult stage of the insect. These four stages make what is called the life-cycle of a silkworm. There may be one or more life-cycles in the course of a year. A silkworm is called uni—or bi—or multi-voltine according as it produces one, two or more broods in the year.

To start with the cocoon. In due time the *chrysalis* within the cocoon casts its pupal skin and turns into a moth, which then forces its way out of the cocoon. The moth does not feed at all; it lives only to reproduce the species, and dies within a short time after it has performed that function. The mulberry silk moth is a very sluggish creature and cannot fly. The *muga* moth is able to fly, and the female has to be tied to prevent her from escaping outside. The female of the *eri* moth can fly, but she shows little disposition to escape and may or may not be tied.

Soon after emergence, the male moths seek out and pair with the females. Sometimes, pairing has to be helped by bringing the males and females together. The male remains paired for a time, and then leaves her mate or is separated by hand and thrown away. The female moth on being fertilised lays her eggs. The process of ovi-position continues for several days. The earliest eggs produce the best worms and are preserved for breeding; those laid last produce weakly and unhealthy worms and are, as a rule, not utilised.

Tiny worms hatch out of the eggs in due time and commence to feed. *Eri* and *pat* worms are kept in the house and supplied with the leaves of their respective food plants. The *muga* worm is treated differently. It is taken out just as it has hatched out or is about to hatch out, and placed on the tree on which it feeds.

As the worm grows it becomes too large for its skin; it then ceases to eat and remains motionless for a time. Presently the skin bursts at or behind the head, and the worm slowly wriggles out of the old skin, and soon after commences to feed again. This process, known as moulting, takes place four times during the feeding stage of the worm. After the fourth or last moult, the worm feeds more voraciously than ever, grows quickly, and in a few days attains its full size. Finally it stops eating and remains motionless for a while, at the end of which it discharges the remaining contents of the stomach in the form of a semiliquid excrement, and starts moving about in search of a hiding place for making its cocoon. While in this state, the worm is said to be ripe. The ripe worm is picked off and placed in a suitable medium for spinning its cocoon.

The silky matter of which the outer shell of the cocoon is composed is elaborated in a fluid condition in two long vessels or glands, one upon each side of the alimentary canal of the worm. These glands throw out two fine filaments of silk which unite within an orifice situated under the mouth and issue apparently as a single thread. The thread is coated with a glutinous liquid or gum which hardens on exposure to the air and gives the cocoon its distinctive colour. This gum remains on the silk until it is washed off by boiling in alkali.

The worm at first throws out a loose irregularly arranged mass of fibres in order to unite the walls of its nest and thus to form a cradle for itself. It then proceeds to spin inside the cradle, laying the thread in short figure of eight loops, first in one place, then in another, thus adding layer after layer from outside inwards till the contents of the silk glands are exhausted. The process of forming the cocoon takes some days, and as soon as it has been completed, the worm sheds its skin once more and turns into a chrysalis which remains dormant until it is ready to emerge as a moth.

The cocoons, if intended to be reeled, must be reeled before the moths are due to emerge, or if they cannot be reeled before then, the insects inside must be stifled and killed by exposure to the sun or by heating with steam or over a fire, because if they are not killed in time, the moths will cut out and render the cocoons unfit for reeling.

6. There is a strong dislike among the Hindus in most parts of India against any occupation which involves the destruction of life, and it accounts for sericulture remaining restricted to limited communities usually composed of castes low down in the social scale. Assam is perhaps an exception to this rule. The culture of the *muga* and *eri* silkworms involves the taking of life just as much as that of the common silkworm; yet there are few Hindus in Assam who would object to silk growing on that account. *Eri* cocoons need not be stifled to kill the insect within, as they are not reelable; and the moths may be allowed to emerge without spoiling the cocoons for spinning. The usual objection to silkworm rearing on the score of killing life may, therefore, be avoided in the case of *eri* silk. The objection is, however, one which does not enter the mind of the ordinary Assamese Hindu. He stifles his *eri* cocoons just as he does with his *muga*. He would not allow the insects within the cocoons to mature and emerge. The moth has the habit of voiding a liquid excrement which stains the cocoon and spoils the colour of the thread. In some cocoons the insects die and melt inside causing a discolouration of the fibre. These defects are avoided by killing and drying the cocoons as soon as they have been gathered.

7. History as well as tradition are silent as to the origin and date of introduction of the culture of the *eri* and *muga* silkworms in the Assam Valley. Both are very probably of indigenous origin, since neither of them is known to be cultivated outside the province or at any greater distance than the neighbouring districts of Bengal which are ethnically as well as in respect of climate closely allied to Assam. The *eri* silkworm has never been found in the wild state, but a very near congener, *Attacus cynthia*, occurs wild in Assam and may have been the progenitor of the domesticated *eri*. The *muga* silkworm is believed to exist in the wild state in the forests of Assam and may have been the parent of the cultivated insect.

The history of the *pat* silk worm also is uncertain. The fact that the rearing of this worm is restricted by custom to a particular caste and is regarded with contempt by the rest of the population seems to point to its having been introduced from outside. In an Assamese pamphlet entitled *Jugi ba Katoni jatir itihash*, the author, Madhavram Das, claims that the Katonis of Assam are the descendants of Jogis (or Jugis as they are contemptuously called) who were driven out of Bengal by the persecutions of Ballal Sen and his successors. It is said that the ancestors of the Jugis belonged to a priestly caste, but having seceded from orthodoxy and denied the supremacy of the Brahmins, they incurred the displeasure of the King and his Brahmin advisers, and were denounced by them as out-castes. All social intercourse with the Jugis was prohibited, and they were compelled in consequence to adopt various low and degraded occupations for livelihood. Many fled from Bengal and sought refuge elsewhere. Some of them came to Assam and brought with them the knowledge of the mulberry silkworm from Bengal. Their descendants came in time to be styled Katonis or reelers. The evil reputation which the Jugis had acquired in Bengal followed them to Assam and attached also to the occupation of *pat* rearing by which they lived. The exact time when the Katonis entered Assam is not known. Madhavram Das thinks it probable that they came in the twelfth century of the Christian era. In the time of the Assamese poet Sri Chandra Bharati, a contemporary of King Nara Narayan of Cooch Behar (A. D. 1540-84), the weaving of *pat* silk was an established industry at Sualkuchi, a village which still remains the most important seat of silk weaving in Assam. That the culture of mulberry silk was introduced from Bengal seems very likely from the fact that most of the technical words used in *pat* rearing in Assam are identical with those used in Bengal.

8. The rearing of silkworms in Assam, as in other parts of the world, is a home industry which is carried on as an auxiliary to agriculture. Sericulture as a home industry. The rearers, one and all, are cultivators and the growing of silk is with them a very minor source of income. There is hardly any one who depends upon sericulture as his or her sole or principal means of livelihood. The Katonis with whom the growing of *pat* silk is a caste occupation are not an exception to this rule.

The census affords no information as to the number of persons engaged in the rearing of silkworms. In the enumeration of 1911, the silkworm rearers were all returned, very naturally, as agriculturists, and no account was taken of sericulture as a subsidiary means of livelihood. Only 13 persons were found in the whole of the Assam Valley, who were engaged in the rearing of small animals which included silkworms as well as bees, birds, etc. (page 130, Volume II of the Census Report of 1911). Possibly none of these thirteen persons were silkworm rearers.

The bulk of the silk produced in Assam is spun or reeled and woven by the people who grow it. It will be true also to say that most of the cloth so produced is woven by the producers themselves. There are others, however, who do not rear but who manufacture thread out of purchased cocoons and sell it in the raw state or after weaving it into cloth. There are others again who neither rear nor spin, but who purchase raw silk, and manufacture cloth for sale. These two classes include the professional weavers of whom there are not many in the Assam Valley, and also many women who depend upon spinning and weaving for their livelihood. The Census of 1911 returned 1,129 persons in the Assam Valley as engaged in silk spinning and weaving as their principal occupation. These were classified as follows:—

	Actual workers.		Dependents (both sexes.)	Total.
	Males.	Females.		
1	2	3	4	5
Goalpara ... ..	...	1	...	1
Kamrup ... ..	79	481	327	887
Darrang ... ..	1	...	...	1
Nowgong ... ..	2	214	13	229
Sibsagar ... ..	...	10	1	11
Lakhimpur ... ..	...	...	...	...
<b>Total</b> ... ..	<b>82</b>	<b>706</b>	<b>341</b>	<b>1,129</b>

These figures convey a very inadequate idea as to the extent to which silk spinning and weaving is carried on in the Assam Valley. The truth is disguised by the fact that most of the spinning and weaving is done by people whose main occupation is agriculture. There is a table in the Census Report to show the subsidiary occupations of agriculturists, but it furnishes no information as to the number of cultivators who were sericulturists as well. The information furnished by the Census Reports of 1891 and 1901 is equally imperfect.

The figures quoted above give, however, a fair indication as to the relative proportion of men and women engaged in the silk industry—almost 1 to 9. Men take a very minor part in the rearing of *eri* and *pat* silkworms. Their chief function is to fetch castor and mulberry leaf from a distance when the home supply of leaf fails. Nor do men participate, as a rule, in the spinning and weaving of silk. It is the women who do all or most of the work. An exception to this rule occurs in the case of the rearing of the *muga* worm which is carried on out of doors, often at a distance from the rearer's home, and is left to the male members of the family. Another exception is a community of professional weavers living at Sualkuchi, among whom weaving is done by both men and women. It is the only village in the Assam Valley where any weaving is done by males.

9A. The rearing of silkworms in Assam is surrounded by an amount of prejudice and superstition which to an outsider seems incredible and which may prove a serious obstacle to any improvement that we may try to introduce. Superstition arises from the natural tendency of the human mind to discover a cause for every effect; when it fails to find a natural cause, it is apt to attribute the effect to the influence of some supernatural power which it tries to propitiate by means as irrational as the belief itself. This will explain the large amount of superstition which has gathered round the rearing of silkworms in Assam, as well as in Bengal. The Assamese rearer has as yet no conception that the diseases of silkworms are due to natural causes and are preventible; when he sees his worms decimated by disease he is unable to account for it except by putting it down to some malign influence. He tries to avert such influence by *pujas*, *mantras* and charms some of which seem just as grotesque as the proceedings of the witches in Shakespeare's "Macbeth." I think it will need a patient and persistent course of demonstration to convince the Assamese rearer that the diseases of his silkworms are caused by the neglect of hygienic precautions and can be prevented by natural means. The comparatively civilized Hindu of the plains is no more free from superstitious beliefs bearing on the culture of silkworms than the primitive hill man; if anything, the Hindu, with his excessive predilection for ritual, seems outwardly to be more under the domination of superstition than the animist.

The most noticeable superstition or rather prejudice is one which forbids the rearing of the mulberry. (*pat*) silkworm to any Hindu outside a particular section of the Katoni caste. As rearers of the *pat* worm, the Katonis are treated with contempt by other Hindu castes who deny to them the ordinary forms of social intercourse.

All silkworms, especially the *pat* and the *muga*, are regarded as sacred beings (*dayang bostu*) which require to be handled with care and reverence and which must not be touched or even looked at except by the rearers themselves. Strangers are not admitted into the rearing house for fear of the evil mouth.\* I have visited many rearings during my recent travels in Assam, but succeeded in gaining admission into very few houses; in most places the worms were brought out for my inspection or I was allowed to peep in through the open door. The rearer herself must not touch the worms until she has washed and put on a clean cloth. This rule evidently had its origin in a sense of cleanliness, but has lost its old meaning. In Hindu houses, the worms (*pat* and *eri*) cannot get their first morning meal of leaf until the rearer has had time for a wash and change of clothes, often not till three hours after sunrise. The rearers are also enjoined to abstain from *khar* and many kinds of food, and from doing such things as are considered ceremonially impure. To avert disease the deity who presides over the destiny of silkworms requires to be propitiated by offerings. *Mantras* and charms are used to drive away or counteract the influence of evil spirits. I might have given a long list of superstitious practices and beliefs bearing on the rearing of silkworms in Assam, but refrain from doing it from fear of the report proving too lengthy.

The subject of superstition among the people possesses an especial interest for the Agricultural Department. It confronts us almost at every step which we take to introduce agricultural improvements. How to remove the existing load of superstition from the rural mind is a problem which I fear the State has not yet made any serious attempt to solve. The kind of education that is given in our rural schools does not go far to enlighten the mind. It does little more than teach the three R's. I have alluded to the root cause of superstition. What I think is most wanted is to inculcate upon the rural mind the habit of looking to nature for the causation of things and refusing to accept any supernatural explanation for material phenomena. Once the mind is trained to this habit, it will want to see and know things which lie beyond its present narrow horizon, and will at the same time acquire the power of assimilating new ideas.

9B. It is true that the Assamese raiyat is, as a rule, too lazy and at the same time too well off to exert himself for improving his lot in life. His standard of comfort may be low, but he is contented and happy. This is undoubtedly so, but at the same time it is necessary to think of the future, if not, of the immediate future. The state of isolation in which the Assamese have so long lived has disappeared and the country is being fast colonised by immigrants from other parts of India causing the pressure on the soil (a hitherto unknown factor) to increase in.

\* In Assam the fear is not from the evil eye, but from the evil mouth called *mukhlaga*. If any one sees a brood of worms and happens to utter a word of praise, it may ruin the brood!

many parts of the valley. These conditions combined with the natural increase of the population and the rapidly diminishing amount of waste land available for cultivation will, I fear, make the Assamese raiyat soon feel the inevitable struggle for existence which accompanies the march of civilisation. He should be taught how to face the struggle when it comes.

10. No form of silk is known to be grown at the present day in the Surma Valley, if we except the North Cachar Hills and a few Kachari villages in the sadr subdivision of Cachar, which ethnologically form part of Assam proper. *Eri* is the only kind of silk grown in these places, and the amount produced is very small. *Eri* silk used to be grown to a small extent within the jurisdiction of Dharampasa thana in the Sunamganj subdivision, but it appears to have completely disappeared within recent years before the rapid spread of jute cultivation. A little *eri* is still grown by a colony of Assamese settlers near Bholaganj.

There is so little silk in the Surma Valley that I did not consider it at all necessary to extend my enquiry to that part of the province. The contents of this report relate almost exclusively to the Assam Valley.



## CHAPTER II.

THE REARING OF THE *ERI* SILKWORM.

11. The culture of the *eri* or *endi* silkworm extends from one end of the valley to the other, spreading westward into North Bengal as far as Bogra and Dinajpur and southward over the North Cachar Hills to the plains of Cachar. The principal breeders of the *eri* silkworm are the animistic tribes inhabiting the sparsely cultivated country on the northern and southern outskirts of the Brahmaputra Valley.

General.

Among the Kacharis and Meches on the northern border, notably in the tract of submontane country extending from the Eastern Duars to the eastern boundary of the Mangaldai subdivision, the rearing and weaving of *eri* is a common occupation of the people. The majority of the people do more or less rearing and weaving. It is from the proceeds of this industry that much of the land revenue is paid. The bulk of *eri* silk grown by these people is sold either as thread or as cloth, mostly the latter, and very little is retained for the rearers' own use. The Meches grow *eri* largely, but sell very little of it to outsiders. The Mech women still use a great deal of *eri* cloth, though not to the same extent as before.

On the southern border of the valley, the chief *eri* growing region comprises the Mikir Hills, the Mikir mauzas of Nowgong, the North Cachar Hills and the northern slopes of the Khasi and Jaintia Hills from the Kopili river to the eastern border of the Goalpara district. The inhabitants are Mikirs, Kacharis, Tiperahs, Rabhas, Syntengs and Garos. This tract possesses a special importance, inasmuch as it supplies almost the whole quantity of *eri* cocoons exported from Assam and a great deal more besides which is sold to the weavers in the plains. A considerable quantity of *eri* thread is also exported from the area, most of it going to Manipur. The people still use *eri* to a large extent as a material for dress, though, as elsewhere, its use is being gradually superseded by imported cotton.

With the comparatively civilised people living in the centre of the valley, mostly Hindus and Hinduised tribes, the culture of the *eri* silkworm has lost its old importance. Formerly *eri* silk was worn largely by the people, but it has now been replaced by imported cotton. With the advancing civilization of the country, various new occupations have come into being to which the people can turn with greater profit than to a risky business like the growing of silkworms, and the cultivation of land has become so lucrative that other rural occupations do not find the same favour with the people as they used to do before. The result has been a great reduction in the quantity of *eri* silk grown by people living in the centre of the valley. What is grown is usually reserved for the rearer's own use, and very little of it finds its way to the market.

There is no social or religious prejudice among any class of the indigenous population against the rearing of the *eri* silkworm. But it is shunned as a low occupation by Brahmins and others who wish to stand well in society. There is no such feeling among the animistic tribes, for whom the *eri* worm possesses an additional attraction in the chrysalis which they cherish as an article of food almost as dearly as fish.

12. A full description of the *eri* insect and the stages through which it passes will be found in Messrs. Lefroy and Ghosh's Memoir on *Eri* silk published by the Agricultural Research Institute of Pusa. The mature worm may be either white or green, and either spotted or free from spots. These variations are of no practical account.

The *eri* worm and cocoon.

The *eri* cocoon is not a completely closed shell like that of the *pat* or the *muga* silkworm, the worm leaving a hole at one end of the cocoon through which the moth pushes its way out, causing very little derangement of the fibres which compose the cocoon. Unlike the *pat* and the *muga* cocoon, the cocoon of the *eri* silkworm is unreelable, for reasons which have been already stated (paragraph 3). The emergence of the moth does not, therefore, affect the value of the cocoon, though for certain reasons (paragraph 6) the Assamese rearer never allows the moth to emerge, but invariably kills the chrysalis in time to prevent emergence, except of course as regards cocoons which are kept for breeding.

The *eri* cocoon varies much in size and weight, these depending on the season, the quantity and quality of the food given to the worms, and the health and vigour of the brood. An average-sized cocoon would be about  $1\frac{1}{2}$  inches long and  $\frac{3}{4}$  inch in diameter. Empty cocoons, that is, those from which the chrysalids and moult skins have been removed, may weigh from about 2,250 to 3,600 to the seer.

Cocoons from which the moths have escaped in the ordinary course of nature and which retain the larval and pupal skins weigh about 20 per cent. heavier than those from which the exuvia of the worm have been removed.

The colour of the *eri* cocoon is either white (a creamy white) or red (light or deep brick red). One cannot tell from the worm whether it will spin a white or a red cocoon. The causation of the colour still remains obscure. It has no relation to the colour of the worm, white or green, or to the worm being spotted or free from spots, or to the nature of the food, or to the environment in which the worm spins its cocoon. Possibly it is the effect of intercrossing in the past between two distinct races or species of *Attacus*, e.g., between *A. ricini* (the *eri* worm) and the *A. cynthia* (the *Ailanthus* worm), which is said to occur wild in the forests of Assam, and which spins a red cocoon. This is the theory advanced by Messrs. Lefroy and Ghosh in their Memoir on Eri silk.

White cocoons, on being bred from, are found to produce cocoons most of which are white but a few are red; and a parallel result is obtained when red cocoons are used as seed. By continuous breeding from cocoons of any one of the two colours, the other colour can be eliminated, though not wholly, in the course of a few generations. The Assamese rearers know this well. White *eri* is preferred everywhere and commands a higher price because it gives a whiter thread than the red cocoon. In Goalpara alone, the red cocoon is in vogue. The red cocoon, on being boiled off as a preparation for spinning the thread, becomes somewhat white, though not quite so white as the white *eri*; but it is said to yield a more durable thread and is on that account liked by the rearers of Goalpara who grow *eri* not, as a rule, for sale, but for manufacturing cloths for their own use.

13. The *eri* insect is a multivoltine and produces seven or very nearly seven broods in the year, that is to say, it passes through about seven complete life-cycles in the year. The duration of each cycle varies from about six weeks in summer to as long as twelve weeks or over in winter. In the experiments made at Pusa, the duration of a cycle was found to be as short as 37 days in July and August to just three times that length of time, viz., 111 days, in November to January, but the climate of Pusa is not on all fours with that of the Assam Valley. There being seven broods in the year, the average life-time of a brood may be taken as  $7\frac{1}{2}$  weeks.

The chief broods are those grown in the autumn (September to November) and spring (February and March). The weather at these periods of the year is neither too cold nor too hot and is considered ideal for the *eri* worm, and the fly pest is least troublesome at the time. During the winter, the worm feeds slowly and does not thrive well, and during the summer, the silkworm fly is found very troublesome. Only those who wish to keep up their stock of seed attempt to rear the worm during these seasons, and the rearings are small.

14. For successful rearing and the perpetuation of the stock, it is necessary according to the conclusions of the Pusa authorities that the mean temperature of any month shall not exceed 100 nor fall below 50. These conditions are met with only in Assam, Eastern and Northern Bengal, the west coast of India, Mysore and a few other localities. The rest of India is either too hot or too cold or both in certain seasons of the year to suit the *eri* insect. The conditions of temperature and humidity are ideal in Assam except that in the upper districts of the Brahmaputra Valley, the temperature for a short period of the year (January) is somewhat too cold for the worm.

15. The castor plant (*Ricinus communis*) is *par excellence* the food plant of the *eri* silkworm, and it is from the name of the plant (*era* or *enda*) that the insect has derived its name. Next to it, but far below it in importance, is the *keseru*\*\* tree (*Heteropanax fragrans*). On the leaves of either of these trees, the *eri* worm can be fed from start to finish. There are several other trees on the leaves of which the insect can be fed during the last stage of its growth. They are unfit for feeding young worms, and even worms of the last stage when fed on them do not thrive well; many die and those which reach maturity form cocoons of poor quality. These plants are resorted to only after the supply of castor or *keseru* has run out. Among these trees, those commonly used are cassava or *simalu alu* (*Mahihot utilissima*), the papaya, the *gulancha* which is called in some places *champa* (*Plumeria acutifolia*), the *gameri* (*Gmelina arborea*), the *bhot odal* called *san-kru* by the Mikirs (*Jatropha multifida*), the *bajarani* (*Zanthoxylum rhetsa*), a species of *Dioscorea* called *thebow* (*Hodgsonia heteroclita*) and a tree known in Upper Assam as *konrha* (*Sapium eugeniaefolium*). The first three are cultivated plants, the rest are wild.

\*\* Called *horanga* or *korunga* in Lower Assam.

16. There are two varieties of the castor plant in Assam, the red and the white.

Cultivation of castor.

Both are equally good for the feeding of the *eri* silkworm, though some people prefer the red, and others the white. In some places two other varieties of castor, red and white, known as *Bengali era* are found; these grow to a much larger size and produce larger and thicker leaves than the Assamese kinds, but are not so much liked as the latter. The castor plant is a perennial and may live for 2 or 3 years and even longer; but in many places it dies out in the rains through water-logging or neglect, and springs up again from self-sown seed in the beginning of the cold weather. In the plains the plant is found growing in patches of unoccupied land round the cultivator's homestead. The only cultivation it receives consists in giving the land a ploughing or digging at the end of the rains. The soil is usually rich and needs no separate manuring. The plants usually come up very thickly and need to be thinned out. There is a popular superstition in many places against the sowing of castor seed by hand. Land which has borne castor once needs no re-sowing. But for new land the cultivator gets a few bunches of ripe capsules, and ties them at the top of a bamboo which is then stuck up in the middle of the ground. The capsules burst after a time and shed their seeds, from which the plants appear in due time. In upland tracts castor is sown in April and May in *jhum* land in mixture with a variety of other crops; the plants come up at wide intervals and grow to a large size. They yield leaves for two years, a pruning being given in March or April at the end of the first year, which makes the plants throw up a new growth of shoots as soon as the rains commence. The *jhum* is usually given up after two years; the castor plants live for a year or two longer. They soon get buried in jungle, and the leaves become smaller in size; such leaves are considered less wholesome than those from cultivated plants, and are used only when no better leaf is available.

Castor occasionally suffers from the ravages of one or more species of caterpillars, but the people, as a rule, pay little attention to these pests. The wholesale destruction of castor plants by insects is, I should think, rather uncommon, when the plant is cultivated in small patches round the cultivator's house.

The seed of the castor plant is a valuable commodity which the people till recently did not know how to utilise; and even now there are many who do not care to collect the seed. Whatever seed is obtained is sold to the Marwari shops in exchange for salt or for cash.

17. The *keseru* tree occurs both wild and cultivated. The leaves of the wild

Cultivation of the *keseru*.

tree are considered to be of inferior quality and used only when cultivated leaf is not available. The cultivated *keseru* is found in every part of the Assam plains except in Goalpara and the south bank of Kamrup. In some localities such as mauzas Dakua and Silpota in North Mangaldai, the tree is cultivated extensively and affords the chief food supply of the *eri* silkworm. It is usually planted on the embankments round the homestead; in a few places it is seen growing in regular plantations, the trees standing at intervals of 8 to 12 feet from each other.

The *keseru* is propagated either from cuttings or from seed, both being equally common. The cuttings are taken from one year old wood, about 2 feet long, and are set down where the trees are intended to grow. The seed is never sown by hand, but seedlings which spring up under the tree from dropped seed are taken up and transplanted. The young trees have to be protected from cattle and goats till they have grown tall enough to be out of their reach. When the tree is about four years old, the leading shoot is cut off to induce the tree to throw out lateral branches. The plucking of leaf may commence from the following year. The tree receives an annual pruning in the beginning of the cold weather, the new wood being cut down to within a few inches of its base. Unpruned trees do not yield well, and the leaf is considered less nutritious. If a tree is left unpruned, it produces an excessive quantity of flower and fruit, and if this be permitted to go on for 2 or 3 years, it may result in the death of the tree.

Though *keseru* leaf is available at all seasons of the year, it is only during a portion of the year (middle of August to middle of December) that it is considered suitable for feeding the *eri* silkworm. During the remainder of the year the leaves are too tender to suit the worm and are said to possess a bitter taste which the worm does not like.

18. The *keseru* tree lives to an indefinite age. A full-sized tree may yield up

Castor and *keseru* compared.

to 4 or 5 maunds of leaf, and a well grown plantation with trees standing 12' x 12' apart may yield at least 500 maunds of leaf which will be several times as much as can be expected from a similar

area of castor. At Pusa an acre of castor was found to yield 75 to 80 maunds of leaf. The *keseru* tree is also singularly free from any insect or other pest. It possesses a great advantage over the castor in respect of yield and freedom from pest; its disadvantages are that one has to wait for 4 or 5 years before the tree is fit to yield leaf, and *eri* can be reared on it only during a limited period of the year. There is also no doubt that castor leaf is more congenial to the taste of the *eri* insect than the *keseru*. One can readily shift the worm from *keseru* to castor, but if the food is changed from castor to *keseru*, the worm does not feed well for a time.

*Eri* cocoons reared on *keseru* leaf are smaller, but more compactly built and yield a stronger fibre than those grown on the castor. In practice, however, the people make no distinction between *keseru*-fed and castor-fed cocoons.

19. In many places, especially among the Kacharis of North Kamrup and Mangaldai the demand for castor and *keseru* leaf becomes so great at times that the rearers are obliged to purchase leaf from their neighbours. The price paid may vary from 2 to 4 as. a load. Patches of castor are often sold in the lump for cash or in exchange for *eri* thread or agricultural produce. *Keseru* trees are sometimes sold for the year at 2 to 8 as. each according to the quantity of leaf it is expected to yield.

20. The Assamese rearer never thinks of providing a separate house for the rearing of silkworms whether they be *eri* or *pat*. The business is far too small to allow of a separate rearing house being built. The rearer uses for the time a portion (often a compartment separated by a low partition) of his dwelling house for rearing silkworms, or if there is not enough room in the dwelling house, an out-house is used for the purpose. The house of the Assamese cultivator is a low structure, not higher than 6 feet at the eaves and 12 feet to the roof. The walls are made of split bamboo or reed, and plastered over with mud, the upper part of the wall being usually left uncoated, permitting the access of light and air. In some houses the coat of plaster is carried up to the roof, and the room within, usually the one furthest from the entrance, gets little light or air. On the other hand, there are many houses of which the walls are not plastered at all and afford little protection from wind and cold or from the parasitic fly which is the deadliest enemy of the *eri* silkworm. These defects can be remedied by making the walls air tight and providing windows fitted with fine-meshed netting to admit light and air and at the same time to prevent the ingress of the fly.

21. The *eri* rearer is not very particular about the quality of his seed cocoons. He either grows the seed himself or borrows it from a neighbour, returning to the latter the empty cocoons after the moths have emerged. In some places (Goalpara and South Kamrup) *eri* eggs are sold in the market either in the loose state or on the rolls of straw on which they have been laid. The price charged varies from 3 or 4 up to 8 or 10 layings per pice.

The seed cocoons are either spread out in a thin layer in a bamboo basket or threaded on a string, and these are kept suspended from the roof until the moths emerge and pair.

22. The paired moths are carefully removed and placed on reeds or sticks (the thin bamboo ribs of the *ugha* or warping reel being commonly used for this purpose), or on rolls of straw (*khorikas*) like those used for the raising of *muga* eggs, but larger and thicker. The female moth is tied to the reed, stick or *khorika*, as the case may be, by a ligature passing under the shoulder joint of the right-hand wing, just in the same way as the *muga* moth. Enough space is allowed between every two pairs to allow the female moth to turn round and lay her eggs without clashing with her neighbour. In many places, the female moths are not tied at all. The pairs are taken up and placed on a hanging cloth to which the moths readily adhere with their legs, and on which the females in due time lay their eggs. In other places, after pairing is over, the female moths, together with a few males, are kept inside a bamboo cage and allowed to deposit their eggs therein. The object of keeping the males in the cage is not quite clear; probably the fluttering of their wings induces the mothermoths to lay eggs quickly and readily.

On the day following the tying of the female moths, the males depart or are separated and thrown away. The females are allowed, as a rule, to lay eggs for three days after which they too are thrown away, but when they are kept in a cage, they are allowed to lay for several days, and only the first three days' hatchings are taken for the rearing.

After egg-laying has been completed, the eggs are picked off and wrapped in a piece of cloth which is kept hung up from the roof till the worms have begun to emerge.

When young worms are seen to hatch out, the cloth containing the eggs is opened out and placed on a bamboo tray (*dálá*), and tender leaves of castor or *keseru* are given to the worms to eat. The leaves are given whole or torn into shreds. The young worms soon crawl on to the leaves, and are transferred on the leaves to the feeding tray. Worms are allowed to hatch out for three days and are daily transferred to the feeding tray. Any eggs that remain unhatched after the 3rd day are rejected. Many rearers do not take the trouble of transferring the worms daily to the feeding tray, but postpone the operation till the end of the 3rd day.

The worms feed, grow and cast their skins four times and ultimately reach maturity. Leaves are supplied to them three times daily, and during the last stage as many as 4 or 5 times, that is, as fast as each lot of leaves is eaten up. As the worms grow stronger, older leaves are given to them. The worms remain on the feeding tray till the end of the fourth stage. The leaves are cleaned of insects and dirt before they are given to the worms. In hot weather the leaves are slightly moistened with water or kept outside on the roof to gather dew. The feeding tray is kept suspended from the roof, and covered with a cloth as a protection from flies. After the worms have entered the fifth or last stage, they are transferred from the feeding tray to bundles of leaf tied by their stalks and hung saddlewise on bamboo poles. The poles of which there may be 2 or more are hung one over another by passing their ends through a rope at each end. As soon as one lot of leaves is eaten bare, a fresh lot is put alongside, to which the worms transfer themselves. Many worms fall down and have to be picked up and put back on the leaves.

On attaining maturity the worms crawl up to the tops of the bundles, evidently in search of a hiding place to spin their cocoons in. They are then picked off and placed in a suitable medium (*jáli*) for spinning. It is usual to examine each worm by the sound test (paragraph 44) to see if it is ripe.

Some rearers do not use the foregoing mode of feeding worms in the last stage. They feed the worms all through on trays or mats, providing more and more space as the worms grow in size.

The rearing of the *eri* silkworm is, as a rule, carried on in a very slovenly fashion. The worms are not sorted out according to age till they have passed the fourth moult. I examined many lots of young worms and did not see one in which all the insects were of equal growth; every lot showed worms in different stages of growth, some feeding and others resting for moult. Then, again, there is much neglect in the matter of cleaning the feeding trays. During the first two stages of growth, the excreta and dead worms of which many are often found on the feeding tray are not removed at all. Later on, the trays are cleaned not oftener than once in 3 or 4 days. Only during the last stage is the litter removed regularly once a day.

The *jáli* on which the ripe worms are placed for spinning consists usually of dry plantain leaves. These are tied to form a bundle which is suspended from the roof within doors. Twigs of various kinds of trees such as mango, jack, etc., with the withered leaves attached are also similarly used. Sometimes, worms are made to spin in a basket filled with plantain or other leaves. The worms begin to spin as soon as they are placed on the *jáli* and complete the cocoons in three to six days, at the end of which the cocoons are ready to be gathered in.

23. The great pest of the *eri* silkworm is the tachinid fly (*Tricolyla bombycis*) which attacks every species of silkworm grown in Assam.

Diseases and enemies. The life history of this parasitic fly is as follows. The female fly punctures the body of the silkworm and deposits one or more eggs; the wound is shown by a black mark. The egg gives rise in 3 or 4 days to a maggot which bores into the tissues of the silkworm and feeds there till it matures. It then leaves the body of the worm (which by the time is killed) and in a few hours turns into a pupa from which in due time (12 to 14 days) emerges a new fly. The fly breeds 7 or 8 times in the year. A female fly may lay as many as 350 eggs, and cause the death of as many silkworms. If the silkworm is attacked at an early age, it dies before maturity; but if the wound has been inflicted after the last moult the worm spins a cocoon, and may even form a chrysalis inside, but the insect will have been killed before the time for the emergence of the moth has arrived. In the case of the *eri* cocoon, the maggot after cutting out of the chrysalis pupates inside the cocoon, and the fly comes out through the hole in the cocoon which the worm left for the emergence of its own moth. The cocoon is spoiled for purpose of breeding, the

chrysalis inside having been killed; but it does not lose value for spinning. With mulberry and *muga* silkworms, on the other hand, once the maggot has cut through the cocoon, it is rendered valueless for reeling.

Flies are most numerous and troublesome during the hot weather months (April to June); with the advent of the rains, they become less numerous, but they continue to cause great loss all through the rainy season. From September to March, there is not much fear from this pest, though it does not wholly disappear at any time of the year. There is no rearing house in Assam which is wholly safe from the invasion of the fly. There are always sufficient openings in the walls to admit the fly; and whenever the door of the house is opened, it allows the fly to enter. Young worms are protected from the fly by being covered with a piece of cloth, but older worms cannot be protected in this way. Smoke is used to keep away flies from the rearing house. But none of these measures proves sufficient to ward off the pest. Whole broods of worms are occasionally lost through the ravages of the fly. I examined a large number of broods in the course of my enquiry and did not find one which was wholly free from its attack; in some broods more than half the worms exhibited the black marks characteristic of the sting of the fly.

Another destructive enemy of the *eri* worm is the rat which often destroys worms in large numbers. The rearers try to keep down the pest by using traps and by keeping the receptacles containing eggs, cocoons and worms suspended from the roof of the house. Cats are also encouraged to visit the house.

The *eri* silkworm is subject to several bacterial diseases which are identical with or very akin to the diseases which affect the mulberry silkworm. The researches at Pusa have revealed the existence of pebrine, flacherie and muscardine in the *eri* silkworm, and the examinations of diseased specimens by my assistant have shown that the first two diseases as well as grasserie occur to some extent among *eri* worms in Assam (*vide* Appendix I). The disease most commonly met with is flacherie; it is characterised by the same symptoms as flacherie in the *muga* silkworm (paragraph 50). The disease generally occurs when the supply of castor or *keseru* leaf having run out, the leaves of other trees are used as a substitute. The worms do not feed well on leaves to which they have not been accustomed from early life. The result is indigestion which brings on the disease. It may be cured by changing the diet to what it was in the beginning, but the remedy is one which under ordinary conditions is hardly practicable. The other two diseases, pebrine and grasserie, do not seem to be of much importance. At Pusa, it has not been found necessary to examine the breeding moths as a precaution against pebrine.

The Assamese rearer pays little heed to disease among his *eri* worms. He is always prepared to lose a part of his worms through one cause or another, and such a thing as the total destruction of a brood is rather uncommon. I have heard people say that so long as they possess a plentiful supply of castor leaf, they can count with confidence upon getting a good crop of cocoons. It speaks well for the hardiness of the *eri* silkworm as compared with the *muga* or the *pat*, in the case of which the success of the rearing is dependent upon many other factors besides an adequate supply of food for the worms.

24. As soon as the cocoons have been plucked from the *jali*, it is the custom of the animistic tribes to remove the chrysalids for eating by widening the natural opening in the cocoon; the moult skins are shaken out at the same time. Cocoons so treated are thoroughly clean. But all men are not equally careful in cleaning the cocoons. Many cocoons are left with the chrysalids, and others contain dead worms which, being useless for eating, are not removed. Most lots of so-called empty cocoons, on being examined, are found to contain a proportion (which may vary from 5 to 15 per cent.) of cocoons with the insects left inside. Cocoons coming from South-west Kamrup and the adjoining parts of Goalpara are usually free from insects and considered the best in the market. Those coming from Chaparmukh contain more or less insects and fetch a lower price. It is suspected that some rearers deliberately mix empty cocoons with a small proportion of cocoons with the insects inside, and pass off the whole as empty cocoons. The insects get so dried and crushed inside that their presence cannot be easily detected. It is a form of adulteration which seriously interferes with the export of *eri* cocoons from Assam to Europe and Bombay. It not only increases the cost of the cocoons, but what is more serious, the dry remains of the insect cause injury to the spinning machinery and also spoil the quality of the yarn.

The Hindus and Muhammadans have no use for the chrysalids. Those who have Kachari neighbours get their cocoons cleaned free of charge, the cleaners taking the chrysalids as their fee. But most people stiffen the cocoons by exposure to the sun.

The cocoons are kept in store till such time as they are wanted for spinning. When kept long in store, the cocoons are occasionally exposed to the sun to prevent mildew.

25. We do not possess any reliable data for estimating the total production of *eri* silk in Assam with accuracy. Such information as is available in regard to the exports of *eri* silk in the shape of cocoons, thread or cloth will be found in Appendix II(c) and paragraph 26 of this report, but it does not go far enough to enable the total production to be estimated with any degree of accuracy. In the centre of the Valley, the proportion of people who grow *eri* silk may not exceed 10 to 20 per cent. of the population (in Goalpara the proportion may be still less), and the quantity grown annually by a single family may not amount to even one seer of cocoons in the year. The Kacharis of North Kamrup and Mangaldai rear on a larger scale; the proportion of families rearing the worm may be fully 50 per cent. on the total, perhaps more, and individual rearings are larger, usually yielding enough cocoons for weaving one or two pieces of *borkapor*, i.e., 2 to 4 seers of cocoons, in the year. Among the hill tribes on the southern border of the valley, almost every family breeds the *eri* worm and the average production per house is certainly greater than among the Hindus or Kacharis of the Assam plains; as much as 20 seers of cocoons may be grown by a single family in a year, though the average may not be even as high as 4 or 5 seers. The total Hindu and Muhammadan population of the Assam Valley (excluding the immigrants and their descendants who do not rear) may be taken as 16 lakhs, and if we take a family to consist of five persons, and 15 per cent. of the above population as engaged in the rearing of the *eri* silkworm, and the average annual outturn per family to be one seer of cocoons, we get a total annual production, so far as this population is concerned, of 1,200 maunds. Then as to the animistic tribes their number in the Assam Valley and the North Cachar Hills may be taken at 5½ lakhs; if we allow that one out of every two families rears the worm and the average outturn per family is 3 seers, the total annual production would be 4,125 maunds. Putting the foregoing figures of production together, the total annual outturn of cocoons in the whole of Assam (excluding a fringe of country on the northern slopes of the Khasi and Jaintia Hills, where a certain amount of *eri* silk is produced) would appear to be 5,325 maunds, which, at Rs. 100 per maund, would be worth Rs. 5,32,500. This estimate must not, however, be accepted as very trustworthy. It merely serves to embody in a concrete form the general impression I have gathered in the course of my enquiry.

26. The greater portion of the *eri* silk grown in the country is spun and woven by the rearers themselves. Only a small portion of the cocoon crop is destined for the market, and almost the whole of it is derived from the hilly country on the South Bank, embracing the Mikir Hills, the North Cachar Hills and the northern slopes of the Khasi and Jaintia Hills extending into the adjoining districts of Nowgong and Kamrup. Small quantities of cocoons for export are obtained from the neighbourhood of Hajo and Ramdia in the Kamrup district. These contain insects and sell at a little over half the price for empty cocoons.

The eastern half of the hilly country mentioned above is tapped by a section of the Assam-Bengal Railway extending from Haflong on the south and Barpathar on the east to Gauhati on the west. There are numerous weekly markets in this area, mostly situated at the foot of the hills, to which cocoons and agricultural produce are brought by the hillmen and disposed of to the traders (mostly Marwaris) who send these down to the nearest point on the railway. The principal markets are Boithalungso, Amreng and Lengri on the Borpani river, Karikhana and Panimur on the Kopili, Doboka on the Jamuna, Haflong, Maibong, Langting, Lunding, Dimapur and Barpathar on the railway, and Nahorjan, Rangalu and Chapanala at the foot of the Mikir Hills. The chief exporting stations are Jamunamukh and Chaparmukh. Most part of the cocoons is exported to Gauhati and thence to the silk mills in Bombay or to Calcutta for shipment to Europe. Small quantities are purchased by traders in the interior for retail sale to village spinners. From a statement which was kindly furnished by the Chief Auditor of the Assam-Bengal Railway, it appears that during the twelve months ending with the 20th September 1913, the total export of *eri* cocoons from the stations situated within this producing area amounted to 919½ mds. out of which about 30 mds. went direct to Calcutta, and 750 mds. to Gauhati, the remainder (140 mds.) being consigned to other places inside the province.

The western half of the hilly country which supplies *eri* cocoons for export lies west of Gauhati and extends as far as Dhophdhara on the eastern border of the Goalpara district. It is coincident with one of the most important *muga* growing tracts in

Assam. There are several weekly *hâts* in this area (the chief of these being Dhopdhara, Boko, and Borduar), where the villagers bring their *eri* cocoons for sale, and dispose of them to Marwari traders who consign most of the cocoons to Palasbari. Some cocoons also come to Palasbari from Chaparmukh and Jamunamukh. A part of the cocoons is retailed to the villagers of the country round Palasbari, with whom the weaving of *eri* cloth is an important industry, and the rest is shipped to Calcutta. The transactions of the Palasbari merchants may amount to between 200 and 400 mds. of cocoons in the year.

Cocoons are shown in our annual trade reports as an article of provincial importance. In the Imperial tables of import and export by rail and river, cocoons are included under raw silk which also includes silk thread and waste. In Appendix II (a) of this report, will be found a statement which exhibits the export of silk by rail and river from Assam for every year since 1881. The export of cocoons is also shown in the statement for every year since 1886, before which year they were not separately registered. The cocoons exported from Assam went almost wholly from the Brahmaputra Valley, and presumably they were all *eri* cocoons, as no other form of silk cocoons is known to leave the province. It will be seen that the trade has been very fitful. The exports reached their maximum (3,544 maunds) in the year 1889 when there was a sort of a boom in *eri* cocoons in consequence of a great demand from Europe. The price of cocoons went up to about Rs. 140 per maund\* in the local market. But the boom did not last long. The villagers, I am credibly informed, soon learned the trick of adulterating empty cocoons (which was what the home spinners wanted) with cocoons in which the insects were allowed to remain, and as soon as this was discovered, the demand from Europe ceased and the price of cocoons fell to the old level of Rs. 70 or thereabout. The exports gradually dwindled down to nil, and remained so for many years. Since 1910-11, the export trade in cocoons has again revived; a fresh demand for *eri* cocoons from European spinners has again arisen and it seems to be at present on the increase, as evidenced by the sudden increase in exports from 323 maunds in 1911-12 to 1,081 maunds in 1912-13. The price of cocoons has advanced at the same time from about Rs. 75 to over Rs. 100 per maund. But I greatly fear that it is in danger of another collapse. The spinners of Bombay and Europe insist upon getting cocoons free from insects, but they are not getting what they want. With the rise in price, has reappeared the temptation to adulterate empty cocoons with cocoons which retain the insects. I have received a communication on the subject from the agents of the Chhoi silk mills of Bombay. The following is an extract from the letter:—

“We, however, venture to enclose herein two samples of *eri* cocoons recently purchased by us from Assam, from which you will see that they contain chrysalids to some extent. We beg, therefore, to suggest to you to impress upon the cultivators to remove from the cocoons the chrysalids or their remains completely, for by using cocoons containing chrysalids, our machinery is spoiled and the quality and colour of the yarn are deteriorated considerably.\*\*\*\*\* It is consequently essential that the cocoons should be cut open at either end and the chrysalids removed therefrom completely. This can be easily done by child labour.”

An English firm of spinners has also written to the authorities of Pusa very much to the same effect. It is a matter for the consideration of Government whether any steps should be taken to stop the evil which, if allowed to continue, may ruin the reviving trade in *eri* cocoons. The growers of the cocoons are primitive hillmen who are comparatively easy to deal with, but who at the same time are apt to take fright and give up *eri* rearing or at least the selling of cocoons, if interfered with in any serious manner. All that can be done is to impress on them through the village elders the importance of preparing the cocoons for the market in such a way as to make them acceptable to the spinners, and the Marwari merchants in the interior may be advised to avoid purchasing cocoons which are not completely free from insects.

The method of cleaning cocoons suggested in the extract given above is very simple and inexpensive. A machine known as the reversing machine, costing Rs. 16, has been invented by an engineer in Tirhut, by means of which *eri* cocoons can be thoroughly freed from insect remains. The chrysalis is removed by widening the natural hole in the cocoon which is then placed on the reversing machine which turn it inside out, thereby removing all dirt that remained inside. The cost of cleaning with the machine amounts to from 6 to 8 annas per seer of reversed cocoons, with

\* In the trade reports, the value of *eri* cocoons was taken every year at the uniform rate of Rs. 70 per maund, which is not correct.



wages of adult labour at 3 annas per day. I do not think the machine is wanted in Assam, since cocoons can be cleaned at much less cost and trouble by the simple expedient of cutting them open with a knife.

27. It is not usual for the hillmen who sell their produce to traders in the interior to take advances from them. Many live far away and can not be trusted with advances. The transactions are, therefore, mostly for cash. But the practice of giving advances on *eri* cocoons as well as on other kinds of produce exists to a small extent in some places. When money is given out in advance, the price paid at the time of delivery is considerably less than the market price at the time. At Lumding I found that Mikirs and Kacharis who had taken advances from the Marwari shopkeepers were paid at Re. 1 per seer of cocoons, while the cash price at the time stood at Rs. 2. The case was similar with lac, cotton and every other kind of agricultural produce.

One would think that a co-operative society might be able to save these people from the cruel usury to which they are at present compelled by poverty to submit. But the people are wholly illiterate, and are too primitive and ignorant to understand and manage any form of co-operation in which cash is concerned. The rudest people are used to many forms of friendly and social co-operation, but it is co-operation in which labour alone, and no money or at least very little of it, is required. I do not think that there is the least chance of any co-operative scheme being successful in promoting the production of, or trade in *eri* cocoons. I have considered the possibilities of co-operation in relation to every aspect of the silk industry in Assam; and the conclusion I have formed is that the only branch of the industry in which it does possess some chance of success at present is the manufacture and sale of *eri* cloth and possibly also of *muga* thread in certain parts of the Kamrup and Lakhimpur districts (see also paragraph 103).

28. The earliest attempt at growing *eri* silk on a commercial scale was made in 1873 by one Mr. C. H. Lepper, an agent of Messrs. Lister & Co., of Bradford. He at first tried to get the Assamese to extend the cultivation of the *eri* worm, by promising to buy all the cocoons at a fixed rate, but as no one came forward, he took up some land in the south of the Lakhimpur district and planted some 30 acres with *keseru*. His first experiments at growing the *eri* worm were very promising, but eventually he found great difficulty in procuring labour which also proved costly, and was obliged to abandon the experiment. Between the years 1884 and 1889, numerous experiments were made by European capitalists to test the possibility of growing *eri* on a commercial scale, but none of them met with success. A short account of these is given below.\* In 1884, a tea planter of Nowgong tried an experiment which failed owing to blight and too severe plucking of the castor plant. In 1886 the Local Government offered to pay half the cost of any experiment in growing *eri* on a commercial basis. Several tea planters made the experiment, but none were able to carry it to completion. Mr. Crowe of Pathalipam in the North Lakhimpur sub-division put down two acres of castor, but the plantation was washed away by the Subansiri river which flowed by.

In the same year, an experiment made at his own expense by the late Mr. A. C. Campbell, Deputy Commissioner of Kamrup, gave a promising result. He did not grow any castor himself, but relied on supplies procured at great expense and trouble from outside. The success of the experiment induced him to repeat it on an extended scale in the following year. He planted 20 acres of land with castor, but the crop came up unsatisfactorily, and he was again compelled to procure leaf from outside. The result was disastrous; almost the whole brood of worms was carried off by disease which on microscopic examination was found to be pebrine.

The next and most important experiment was made in the year 1889 by Mr. F. Mackenzie, a tea planter of Cachar, and with results equally disastrous. Mr. Mackenzie had been making experiments in *eri* rearing for some years past, and was very sanguine of success. He estimated the cost of production to be Rs. 216 per acre, which included cost of cultivation, rearing sheds, and all expenses incidental to rearing, and expected a return of 200 lbs. of cocoons valued at Rs. 140 per maund = Rs. 350. These estimates appear, in the light of the experience gained at Pusa, to have been much too over-sanguine. At Pusa, under careful field cultivation, an acre of land yielded about 80 maunds of leaf after leaving enough leaf on the trees to mature the seed; this quantity of leaf is just enough to produce one maund of pierced cocoons; that is to say, from one acre of castor plants, only one maund of *eri* cocoons is to be expected, and not  $2\frac{1}{2}$  maunds as in Mr. Mackenzie's estimate. This is by the way. An arrangement was concluded

\* For a fuller account of these experiments, the reader is referred to Mr. H. Z. Darrah's Note on *Eri* silk in Assam, published in 1890.

between Mr. Mackenzie and Government under which the latter was to pay him half the cost of the experiment up to Rs. 1,500. The experiment was started in January 1889 by cleaning some 30 acres of land on a spur of the Jaintia Hills about 8 miles from Mr. Mackenzie's house at Kalineecherra. The jungle which was principally bamboo and long grass was cut and burnt in the usual way, and in the following month, some 20 acres were sown partly with Patna and partly with Cachar castor seed. The plants looked most healthy and grew up well in the beginning, but from April they, especially the Patna variety, began to die from excessive rainfall which is natural to the place. The catastrophe came in July when millions of caterpillars emerged from the bamboo jungle around and ate up within two days every leaf throughout the area. All efforts to check the insect invasion proved fruitless. The supply of castor leaves having failed, the worms, about 100,000 in number, had to be fed upon the leaves of wild *keseru* and other trees, and they seemed to get on well until just before they were ready to spin their cocoons, when almost *all of them* displayed the symptoms which were described by Mr. Mackenzie as follows:—The worms stretched back their heads and necks, retched several times, and with a good deal of difficulty, vomited a thick slimy fluid (of a dirty white colour). Their bodies becoming limp and flaccid, they either fell from the leaves on which they had been feeding, or remained hanging caught on some projection. Decomposition was exceedingly rapid, diseased worms, almost before death, emitting a most horrible putrid smell. The disease undoubtedly was flacherie, and was in all likelihood caused by the worms having been shifted from a soft easily digested diet of castor to an indigestible diet of *keseru* and other jungle leaves. Another lot of 100,000 worms were kept in a separate house and attended by a separate set of coolies and reared from the beginning on *keseru* leaves; these grew well till they were about to ripen, when they too fell a prey to the same disease. It is difficult to account for the failure of these worms, unless it was that the leaves which were obtained from wild trees were wanting in nutrition and of an unhealthy character.

To sum up, the causes of the failure of the experiments related above were—first the destruction of castor plants by caterpillars, secondly disease, and thirdly the want and costliness of labour. To grow a large area of castor without the risk of its being occasionally eaten up by insects seems almost hopeless. A small patch of castor may be easily protected, and its loss will not matter much, but when a thickly sown plantation of tall castor plants is infested with insects, it is impossible to rid it of the pest. At Pusa it has been found a hopeless task to check the pest once it appears in a serious form, and all such measures as hand-picking and spraying with insecticides prove more or less fruitless. The *keseru* plant seems quite safe in this respect, but then with the *keseru* one can rear only during a limited period of the year, and there will be little or no work for the rest of the year—a condition which is incompatible with the economical employment of labour.

Moreover, if we can rely upon the experience gained at Pusa, the rearing of the *eri* silkworm involves an amount of labour for which the cocoons obtained do not yield an adequate return. For instance, in an experiment in which a record of the labour employed was kept, it was found that to procure one maund of cocoons (of which the value may be Rs. 100), 300 cooly days (a cooly day = one cooly employed for a day) were absolutely necessary. Three hundred cooly days in Assam would mean at least  $300 \times 6$  annas = Rs. 112-8. The above included the cost of gathering leaves, but not the cost of cultivating the castor crop, it having been assumed that it would be repaid by the value of the seed. In another experiment, 19 seers of cocoons, valued say at Rs. 47-8 were produced at an expenditure of 210 cooly days which would cost Rs. 90 in Assam. It is evident from these considerations that *eri* rearing under present conditions cannot be profitably undertaken by a capitalist. The business is far too risky to be attractive as an investment. It has always been a cottager's industry and is likely to remain as such as long as it will last. Moreover, if any one wished to make money by growing silk, he would much sooner grow mulberry silk than the *eri*; the former is at least three times as valuable as the latter. The cost of rearing mulberry silk may not be much higher than that of *eri* silk, and if the rearing be conducted under proper hygienic conditions, there will be as little risk of failure with the one as with the other.

## CHAPTER III.

THE REARING OF THE *MUGA* SILKWORM.

29. The *muga* silkworm (*Antheræa assamea*) belongs to the same genus as the Indian tusser (*A. paphia*), the Chinese tusser (*A. pernyi*) and the *yammamai* silkworm of Japan (*A. yammamai*). It exists in a more complete state of domestication than any of the latter, the worm passing only its feeding stage on the trees in the open air, while it spins its cocoon, pairs and lays eggs indoors. *Muga* silk surpasses tusser in brilliancy and possesses the valuable merit of a natural golden yellow colour which makes it useful for purposes of embroidery and artistic weaving, a merit possessed by no other silk in the natural or undyed state. The rearing of the *muga* silkworm is confined to the Brahmaputra Valley, and not known anywhere outside this limited area, although it is said to occur wild in other parts of India. The Salvation Army has been experimenting with this worm at Moradabad in the United Provinces and at Paradeniya in Ceylon, but so far without success.

30. There is no record or tradition of any attempt at rearing the *muga* worm wholly indoors. Rearers occasionally bring home the last few worms of a brood and feed them in the house for a day or two to get them to mature. It is said to be a difficult task to keep the worm confined. This difficulty is by no means an insuperable one. It would be a great advantage for more reasons than one to be able to rear *muga* indoors.

31. For a description of the *muga* worm and cocoon, I would refer the reader to Mr. Stack's Note on Silk in Assam, 1884.

The cocoon is in size about 1½ inch, long by 1 inch in diameter. Mr. Stack describes the colour of the cocoon as a golden yellow, but this is scarcely correct. The loose outer lining of the cocoon is of a brown or brownish yellow colour. The harder core inside is of a much paler colour, very nearly white. It is after the cocoon has been boiled in alkali for reeling that the silk assumes the amber or golden yellow colour characteristic of it. With the living chrysalis inside, the cocoon weighs about 66 grains, and the empty cocoon from which the moth has made its escape weighs about 6 grains only. The size and silk content of the cocoon varies a good deal, depending upon the season of the year, the species of tree on which the worm has been fed and the vigour of the worm.

32. There are two varieties of the *muga* silkworm, namely, the *Borbhagiá* and the *Horubhagiá*, known in the south-western parts of Kamrup as the *Borjhukiá* and the *Horujhukiá* respectively. The former is distinguished by its worm and cocoon being somewhat larger than those of the latter. The smaller breed seems to be preferred as being the hardier of the two. In Sibsagar and Nowgong the *Horubhagiá* is also known as the *Kukurbáhi*, so called from a small bird of this name which it resembles in its habit of feeding in clusters and building its cocoons close to one another. These distinctions are not, however, considered to be of much importance, and many rearers refuse to recognise the existence of more than one breed.

According to Rati Kanta Borah, who has written a small book on the *muga* silk of Assam, there is a third breed of the *muga* silkworm which he calls *Bor* or *Labang*. It is said to be larger in size than either of the above kinds, but it is soft and tender and liable to fall off the tree. I have not met with this kind, and few people seem to know it.

33. The *muga* worm feeds on the leaves of several species of trees. Of these the *sum* (*Machilus odoratissima*) and the *húlu* called *háonlá* in Lower Assam (*Tetranthera monopetala*) are the only two on which the worm is commonly reared. The other trees on which it feeds are the *digloti* (*Tetranthera glauca*), the *páti honda* (*Cinnamomum obtusifolium*), the *bomrati* (*Symplocos grandiflora*), the *champa* (*Michelia oblonga*), and the *ádákuri*, also called *mezankuri* (*Litsea citrata*). *Digloti*, *pátihondá* and *bomrati* are utilise

only when they occur in a *sum* plantation; by themselves they are never used. *Champá* and *mezankuri* are used for producing two special forms of silk which are distinguished under the name of *Champá patiyá* and *Mezankuri muga* from the common or *Sumpatiya muga* which is raised on the *sum* and the *huálu* tree. But the extent to which these two trees are used at the present day is extremely small; in fact the growing of *Mezankuri* silk is practically extinct, and the total production of *Champátiyá muga* may not amount to more than a few pounds in the year. The latter is to be met with only in mauzas Lahing and Holongapar in the Jorhat subdivision (*vide* paragraph 52).

34. In Upper Assam, *muga* is reared almost exclusively on the *sum* tree, the *huálu* being seldom used. The reverse is the case in Lower Assam, except that in Mangaldai and North Kamrup, the *sum* is the more commonly used of the two. Both trees are rarely used in the same locality.

*Huálu* leaf is said to be more tender and easier for the worms to digest. It is considered an advantage in Upper Assam to have a few *huálu* trees in a *sum* plantation, as they are held to be better suited than *sum* for the feeding of young or weakly worms. Cocoons from *huálu*-fed worms are larger, but not so hard and compact as those bred on the *sum*. They are also more difficult to reel and yield less silk than the latter.

Both *sum* and *huálu* occur in the wild state as well as in cultivation. In Upper Assam, there are large areas covered with a spontaneous growth of *sum* trees. Only a fraction of these forests is utilised for rearing. The *huálu* tree is equally plentiful in Lower Assam, but it does not possess the gregarious habit of the *sum* and occurs scattered through the forest and in village waste lands.

35. *Muga* silk is grown more or less in almost every mauza in Assam proper barring those on the extreme North-east Frontier and the pure Kachari mauzas stretching along the north of the Kamrup district and the Mangaldai subdivision of Darrang. Pargana Habraghat (Bijni) on the eastern border of the Goalpara district is the extreme western limit of the *muga* growing area. Beyond Habraghat, there is no part of Goalpara where this silk is grown.

The following statement shows the area under *sum* trees in each district of the Assam Valley for the 10 years ending with 1912-13. It includes the area occupied by *huálu* trees as well:—

Statement showing the area under *sum* trees in each Assam Valley District for 10 years ending with 1912-13.

Year.	Goalpara.	Kamrup.	Darrang.	Nowgong.	Sibsagar.	Lakhimpur.	Total.
1	2	3	4	5	6	7	8
	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.
1903-04	...	1,221	291	263	13,807	4,498	20,020
1904-05	...	1,412	706	190	15,077	4,761	22,146
1905-06	...	1,369	706	222	14,092	3,993	20,382
1906-07	...	1,497	706	222	14,378	4,077	20,880
1907-08	...	1,512	709	222	14,857	4,123	21,423
1908-09	...	1,509	709	222	15,090	4,123	21,653
1909-10	...	1,572	504	189	15,066	4,100	21,431
1910-11	...	1,535	574	202	15,149	4,100	21,560
1911-12	...	1,539	546	237	15,986	4,100	22,408
1912-13	350*	1,604	589	231	17,216	4,364	24,334

\* The area under *sum* (including *huálu*) was not returned in previous years.

Plate I.



*A Sum. Plantation.*

These figures should be accepted as approximate, being largely based on estimates. A large proportion of the trees occurs scattered or growing on embankments round the raiyats' homesteads, and the areas occupied by them had to be ascertained by guess.

The total area in 1912-13 was 24,334 acres of which the bulk was situated in the Sibsagar district. These figures merely show the area assessed to revenue which bore the trees, but give no indication of the area actually used for rearing. In an unfavourable season, when the worms die off prematurely, the bulk of the trees remains unused, and even in a favourable year much of the area is left uncropped. A great deal of *sum* bearing land is held with little idea of rearing, but chiefly as fuel reserves. I believe that even in a favourable season, at least a quarter, and in places one-third or even one-half of the *sum* bearing area may remain unused.

The figures quoted above bring out the relative importance of the several districts of the Valley as producers of *muga* silk. Goalpara did not return any area under *sum* before 1912-13. The small area of 330 acres returned for that year is situated in Pargana Habraghat which is part of the permanently-settled estate of Bijni, and I presume it is only a rough estimate. This Pargana and the southwestern mauzas of Kamrup—Luki, Bongaon and Boko,—constitute one of the most important *muga* growing areas in Assam, and in one sense it is certainly the most important, since it is this limited area which directly or indirectly supplies seed *muga* to all parts of the Valley. The population of this area is composed mainly of Kacharis, Rabhas and Garos. These people are unacquainted with the art of reeling and dispose of the whole of their cocoons to traders coming from Palasbari and its neighbourhood.

In the Darrang district the more important *muga* growing areas lie around Sipajhar a few miles to the west of Mangaldai. Nowgong grows very little *muga* at the present day. *Kala-azar* is mainly responsible for the great decline in *muga* culture in that district. The little that is grown now is intended primarily for sale as seed to rearers from the upper districts.

The Sibsagar district has always been the most important *muga* breeding area in the Valley, and still retains its predominance, containing as it does about three fourths of the total area under *sum* trees. The chief *muga* growing areas in that district are the comparatively backward mauzas inhabited chiefly by Ahoms in the south of the Jorhat and south-east of the Sibsagar sub-division. The Lakhimpur district, though far behind its sister district in point of the total *sum* bearing area, contains two very important *muga* breeding tracts. One of these is popularly known as Jamira and comprises a group of villages within the mauzas of Jamira and Lorua, not far from the Sibsagar frontier. It returned, in 1912-13, a total area of nearly 1,600 acres under *sum*. The other tract is mauza Dhemaji in the Sadr sub-division on the right bank of the Brahmaputra. In this district too, the rearing of *muga* is chiefly in the hands of Ahoms.

It is currently believed that the cultivation of *muga* silk has greatly declined in recent years. The foregoing figures do not countenance this belief, but it should be remembered that the area under *sum* is no index to the extent to which the trees are actually used for *muga* rearing. It is very possible that a larger proportion of the trees now remains unused than before. I am led to believe from the enquiries I have made that the culture of the *muga* worm has greatly declined within the last twenty years in North Kamrup, Darrang and Nowgong. *Kala-azar* and the great earthquake of 1897 are held responsible for the result. In Golaghat and also in parts of Jorhat, the people do not seem as keen on *muga* cultivation as they were before. Many occupations which did not exist before have come into being and proved more attractive than *muga* rearing which entails a great deal of hardship and gives a precarious return. On the other hand, the high price of the silk has acted as an incentive to rearers of Lakhimpur and the eastern parts of the Sibsagar district and possibly also to those of South Kamrup. In these places, the growing of *muga* silk appears to be on the increase.

36. Mr. Thomas Hugon\* reported the area planted with food trees for the *muga* in 1834 in the Assam Valley to be 5,000 acres of which 2,000 acres was situated in the Nowgong district. Thirty-six years later, Colonel Hopkinson, then Commissioner of Assam, reported 18,000 acres as the area under *sum* which was assessed to revenue. I do not know

\*Mr. Hugon held the office of Sub-Assistant at Nowgong and contributed a paper up on the silkworms of Assam to the Proceedings of the Asiatic Society for 1837.

how these figures were obtained and whether they are strictly comparable to our present day returns. But after making all allowances, they seem to indicate that the cultivation of *muga* has gone on steadily increasing from what it was in the early days of British rule, though in individual areas the culture of this silkworm has declined from local causes within recent years.

37. As a cultivated tree, the *sum* occurs either in groves or simply on the *dháps* or embankments which ordinarily enclose the cultivator's homestead. The seedlings spring up in village waste lands from seeds cast by birds, and are either left to grow *in situ* or transplanted in new sites, when about a year old. The usual distance at which the trees are planted in a grove varies from 12 to 18 feet. The plantation is protected by a fence for two or three years, that is, until the trees have grown high enough to be out of the reach of cattle and goats. The land is in the meantime utilised for growing such crops as rice seedlings, pulse and sugarcane. Beyond this, the plantation receives little or no care. Very few people ever take the trouble of manuring a *sum* tree, though it is admitted that it is greatly benefited thereby. The tree is never pruned. The *sum* tree lives to an indefinite age. Old trees are found to be grown with moss and parasitic vegetation and infested with ants. They are also liable to be shaken too much by the wind and it is difficult to protect worms on high trees from birds. To overcome these difficulties, old trees are sometimes lopped down to a convenient height and left to grow anew.

Theoretically, a *sum* grove, planted 15' x 15', may contain nearly 200 trees per acre, but there are always many vacancies, and in most groves, many of the trees being self-sown stand at wide and irregular intervals. The average number of *sum* trees per acre may not exceed one hundred. An actual enumeration of trees in 51 *sum* groves in the Sibsagar district gave an average of 96 trees to the acre.\*

Unlike the *sum*, the *huálu* is seldom found in the cultivated state. It is one of the trees commonly found in village waste lands in the lower districts. It also comes up spontaneously from seeds scattered by birds on the embankments round the raiyats' homestead, and is taken care of when found, and as such it may be said to be a cultivated tree. The *huálu* tree has a soft wood and soon gets bored through and through by ants and other insects. It is only when the tree is comparatively young that *muga* worms can be safely placed on them. Trees more than 15 or 20 years old become unsuitable for further rearing of account of their harbouring too many ants.

Both the *sum* and the *huálu* tree become fit for use when a year or two old, but in practice they are seldom used before 3 or 4 years, often not for a year or two longer. It is on the younger trees that the rearer places his newly-hatched worms, and he is careful to see that each tree should have enough leaf to carry the worms at least to the completion of the third stage, when they can be safely transferred to new trees. Younger worms cannot be handled except at the risk of many getting hurt or killed. This accounts for the reluctance of the rearers to use young trees until they have acquired a good covering of leaves.

A well grown *sum* or *huálu* tree may be used twice a year for feeding *muga* worms, but as a rule, trees are seldom used more than once a year.

38. The *muga* silkworm produces five broods in the year. The insect may be found in every stage of growth at all times of the year at some place or other, but five principal cocoon crops are recognised in practice, these following one another in the order given below and bearing the vernacular names of the months or seasons in which they are gathered in:—

- 1st—The *Katia* or autumn crop gathered in during October and November;
- 2nd—The *Jarua* or winter crop, which remains on the tree during the greater part of the cold weather and is harvested early in spring (February-March),
- 3rd—The *Jethua* or hot weather crop which ripens in May-June;
- 4th—The *Aherua* or early rains crop, which is harvested in July; and
- 5th—The *Bhadia* or late rains crop, which is harvested in August-September and which again is followed by the *Katia* crop, and so on.

Of these five broods, the *Katia* or autumn brood is by far the most important, and furnishes the bulk of cocoons used for reeling. The autumn season being neither too hot nor too cold and there being little rain at the time is considered the best

\*The enumeration was done by some Mandals under the direction of Baba Grish Kumar Sen, Sub-Deputy Collector, to whom I am greatly indebted for information regarding the culture of *muga* and *pat* silkworms in the Sibsagar district.

time in the year for rearing the *muga* worm; the worms feed well at the time and produce the best cocoons in the year, judging from the yield of silk and the comparative ease with which the thread is reeled off. A thousand *Katia* cocoons may yield 20 to 25 tolas of reeled silk and about 10 to 15 tolas of waste.

The *Jarua* or winter brood is perhaps the least important of the five. It is grown only for seed. The worms feed very slowly during the winter, continuing to feed on the trees for two months or longer according to the severity of the weather; and the cocoons are of the poorest quality, yielding 10 to 15 tolas of net silk per thousand.

The *Jethua* or hot weather crop is an important brood in the Lakhimpur district, where it fills the position which the *Katia* crop occupies elsewhere. The hot weather in Upper Assam, with its mild temperatures and frequent showers, is favourable to the *muga* worm, but in the lower districts the weather is hot and dry at the time and proves trying to the insect. The cocoons of the *Jethua* brood yield thread of a lighter colour than the *Katia* and rank about equal in quality to the latter, but the yield of thread is somewhat less.

The next brood, the *Aherua*, which comes to maturity in the early part of the rainy season is of minor importance, though in Lakhimpur district, it is grown to a large extent and is probably equal in importance to the local *Katia* crop. Elsewhere it is grown mainly for seed.

The *Bhadia* or late rains crop is of great importance on account of its supplying seed cocoons for the *Katia* crop. It is extensively reared for this purpose in the Kamrup and Nowgong districts whence the breeders of Upper Assam draw their annual supplies of seed. The produce of the *Bhadia* brood, after satisfying the requirements for seed, is used for reeling. *Aherua* and *Bhadia* cocoons are difficult to reel, and yield silk of inferior quality; the yield of reeled thread per 1,000 cocoons may be about 16 tolas.

39. A complete cycle of the insect, according to Mr. Stack, lasts about 54 days in the warm months and 81 days in the cold season and is distributed over the several stages of its existence as below:—

	Minimum days.	Maximum days.
Hatching	7	10
As a worm	25	40
Spinning cocoons	4	7
In the cocoon	14	21
As a moth (up to laying eggs)	8	8
	54	81

The maximum number of days has not, I fear, been correctly stated above. The winter brood in the colder districts of Upper Assam often spends almost three months in feeding on the trees and a brood ripens so slowly at this time of the year that a fortnight often elapses between the ripening of the earliest and the last worms.

40. The *muga* silk worm quickly degenerates in the plains of Assam and it is seldom possible to keep up the same stock for more than a year. In every cycle, the brood becomes more and more diseased, resulting in the ultimate extinction of the stock. This makes it necessary to import a fresh supply of seed (*honch*) after every three to six broods. The deterioration is quicker in Upper Assam than in the lower districts. In Lakhimpur and Sibsagar, three or at the most four generations of worms are all that can be expected out of any stock of seed, and most rearers content themselves with raising only one or two crops of cocoons in the year. The only part of the *muga* producing area in which the insect can be bred perpetually is a small tract of hilly and jungle country lying near the southern junction of the Kamrup and Goalpara districts. It comprises the hilly mauzas of Luki, Bongaon and Boko in Kamrup and a part of Pargana Habraghat in Goalpara. This limited area is the primary source from which the rest of Assam derives its supply of *muga* seed. People who want seed either go there and make their purchases direct from the seed-rearers or they purchase it from others who have previously obtained seed from there and raised one or two broods for sale as seed. The latter course is the more common of the two. In Kamrup and Nowgong there are many rearers who make it a business to rear *muga* for the express purpose of selling the cocoons as seed to the breeders of the upper districts; and in Upper Assam itself many grow *muga* from seed imported from the lower districts and sell it as seed to



their neighbours. The brood which is in great demand for this purpose is the *Bhadia* which ripens in August-September. It supplies seed for the *Katia* crop which is by far the most important brood in the year and yields the bulk of cocoons intended for reeling.

It may be asked why the *muga* insect should gradually degenerate and ultimately die out in the plains of Assam, while it suffers no such deterioration in the hilly tract mentioned above. The character of the soil and climate may account for the difference. In the plains, the soil becomes more or less water-logged during the rains and when in this unhealthy condition it is bound to affect the quality of the vegetation growing on it. This cannot be the case where the land is high and dry as in the hilly tract mentioned above. Then as to the climate, humidity and cold are both injurious to the *muga* worm and in both these respects, the upper districts of Assam are at a decided disadvantage as compared with the south-western parts of the Kamrup district.

It is believed by many, though not by all, that the hardiness of the *muga* insect grown in the jungly parts of the Kamrup district is due to an occasional interbreeding between the wild and the domesticated insect. It is also said that the Nagas in Upper Assam occasionally come across wild *muga* cocoons in the forests and bring these for sale to Assamese rearers. Such *muga* is spoken of as Naga *muga*. It is said to be more hardy and resistant to disease than the common worm. I am not sure if there is any real ground for either of these beliefs, though Mr. Stack asserts it as a fact that the wild moth is sometimes allowed (like the wild buffalo) to improve the strain of the domestic breed. I have questioned many people on this point; some do not share the belief in wild *muga* interbreeding with the house insect, and others have never heard of any such thing, while none of those who hold the belief could testify to its truth from personal experience. The *muga* rearers of Boko and Luki whom I questioned closely on this subject thought that there was little chance of such interbreeding and they seemed unaware of any such phenomenon.

Another reason which is alleged for the superior hardiness of the *muga* grown in the Kamrup district is the fact that the insect is bred there on the *huálu* tree, and not on the *sum* which is the tree used in Upper Assam. I cannot say if this reason is a sufficient one. There are places in Kamrup where both *sum* and *huálu* trees are found and there the breeders seem to prefer for seed cocoons that have been grown on *sum* trees to those grown on the *huálu*.

The *muga* rearer is very particular about the quality of the seed-cocoons. He makes long journeys for procuring his seed. People from the furthest corners of Upper Assam visit the remote and somewhat inaccessible parts of the Kamrup and Goalpara districts in search of seed. Seed cocoons are usually purchased in advance while the worms are still feeding on the tree. The purchaser carefully examines the worms and assures himself that the brood is of even growth and free from disease and the worms are strong and healthy. The price of the seed cocoons is fixed in advance and the purchaser waits till the worms have completed their cocoons. The demand for seed is often so keen that the purchasers do not wait till the cocoons are spun, but take away the mature worms after placing these on bundles of twigs in which the worms spin their cocoons while being carried along.

All the worms in a brood do not ripen on the same day. A period of several days—from 5 or 6 to as many as 12 days or more,—elapses between the time when the first worms ripen and spin their cocoons and the time when the last worms of the brood come to maturity. The earlier cocoons produce an excessive proportion of male moths and the later ones produce too many females. Early and late cocoons are consequently rejected as unfit for seed. The cocoons which are formed during the middle of the ripening period (*bhorpok*) when the largest number of worms attain maturity, produce an equal proportion of male and female moths and these are accordingly selected for use as seed.

In former days before the country was opened up by steamers and railways, seed purchasers from the upper districts used to go down in boats to Lower Assam for fetching their annual supplies of *muga* seed-cocoons; they can now get up their seed in much shorter time. Formerly the rearer brought his own seed or got it through a neighbour. This is still the practice to a great extent, but since the opening of the Assam-Bengal Railway a new class of traders has arisen, who take seed cocoons, from Lower Assam and retail them to breeders in the upper districts. The seed sold by these people is not always reliable and causes frequent disappointment. Those who use this seed have no means of knowing whence it came or whether it was derived from a healthy brood.

Seed-cocoons sell always dearer than reeling cocoons, usually at about double the price of the latter. During the last 2 or 3 years the price of seed-cocoons has ranged generally from 120 to 150 per rupee, against 300 to 400 per rupee for reeling cocoons. At times, however, the price of seed-cocoons rises as high as 40 to 50 per rupee.

41. The seed-cocoons are kept in a closed bamboo basket, spread out thinly so as just to touch each other. The basket is hung up in a place out of the reach of rats. In the cold weather the basket is kept near the kitchen fire to quicken the emergence of moths. The moths usually emerge in the evening, and pair shortly after. The paired moths are taken out on the following morning and the females which are recognisable at once by their bulky body are tied to a roll of straw, called a *khoriká*, the males being left free but remaining adhering to their mates. The tying of the female moth is done by means of a cotton string passed round the base of the right hind wing. The string is about a foot long; it is doubled up, and the two ends are brought together and tied to the *khoriká*, leaving a length of 3 or 4 inches between it and the moth so as to permit her to turn freely round the straw.

*Khorikás* are made out of fine thatch grass. Grass taken out of an old thatch that has got blackened by smoke is preferred for the purpose from a notion that it promotes the laying of eggs. Usually only one pair of moths is placed on each *khoriká*, but in some places as many as four are tied to the same roll of straw. The size of a *khoriká* may vary from 9 to 18 inches in length and from the thickness of the little finger to about an inch in diameter. It is made with a hook at one end to permit of its being easily hung up.

If any female moths are left unpaired, they are induced to pair with any surplus males that may be found in the basket. But if the males be fewer than the females, the surplus moths are tied to *khorikás*, and these are taken out and placed outside the house in the evening to attract males to come and pair with them. Eggs from moths fertilised in this way hatch imperfectly and give an indifferent result.

The *khorikás* bearing the paired moths are hooked on to a string stretched across a room in the rearer's house. From the same lot of cocoons, moths continue to emerge usually for three days; any appearing after 3 days are rejected. Each day's moths are kept separate on the string.

The male moth remains attached to the female for about 24 hours at the end of which it leaves its mate and flies away. The female moth then commences to deposit its eggs and continues to do it for several days. Eggs laid after the first three days are calculated to produce feeble worms. The female moths are therefore removed from the *khorikás* on the morning following the fourth day after their emergence from the cocoons. Each moth lays on the average about 250 eggs. It is a common practice to take a light once or twice every night and pass it along the line of *khorikás*; it is supposed to have the effect of making the moths lay an abundance of eggs.

As soon as egg-laying is completed, the female moths are removed and the *khorikás* are taken down and placed in a round cylindrical frame made out of a bamboo or cane mat. A number of parallel strings are stretched across the open top of the frame and the *khorikás* are hooked on to these strings. The object of using such a frame is to keep the eggs out of the reach of rats and mice. The frame is kept covered with a piece of cloth to prevent the access of ants and mosquitoes which prey upon the eggs. In the cold weather the frame is placed near the kitchen fire to enable the worms to hatch out early.

When the eggs are due to hatch, they are examined daily, and as soon as hatching has begun, the *khorikás* are taken out to be placed on the trees which have been previously selected for the purpose. A rearer having more *khorikás* than he has use for sells off the surplus, the usual price being double the price of seed-cocoons at the time.

42. About the time that the moths are emerging, the ground under the *sum* or *hudlu* trees is cleared of jungle and the trees themselves are cleared of ants, dead wood and parasitic vegetation as far as practicable. All underwood is cut down and removed, so as to facilitate the picking up of any worms that may accidentally fall down. Ants on the trees are killed off by fire or hot water and nests of the common nest-building ant (*ámroli*) are pulled down and destroyed. Gur, fish entrails, flesh and other baits are placed on the tree to attract ants from the top of the tree. To prevent ants from reaching the worms from outside, a bandage of twisted paddy straw is tied round the trunk of the tree at a height of about four feet from the ground and a quantity of sand or ashes is placed over the bandage.

43. Young trees carrying a good covering of succulent leaves are selected for placing the *khoriás* on. On young trees the worms are not liable to be shaken too much by the wind, and they are easily seen and protected from ants and birds. Old trees are avoided as they harbour too many ants, and the moss on their branches gets slippery after rain, and renders the worms liable to fall off. It is considered desirable in Upper Assam to have a few *huálu* trees in a *sum* plantation. The leaves of the *huálu* are more succulent than those of the *sum* and considered more suitable for the feeding of young *muga*. Weakly worms are said to improve by transfer from a *sum* to a *huálu* tree. The *digloti* tree is also valued for a similar reason.

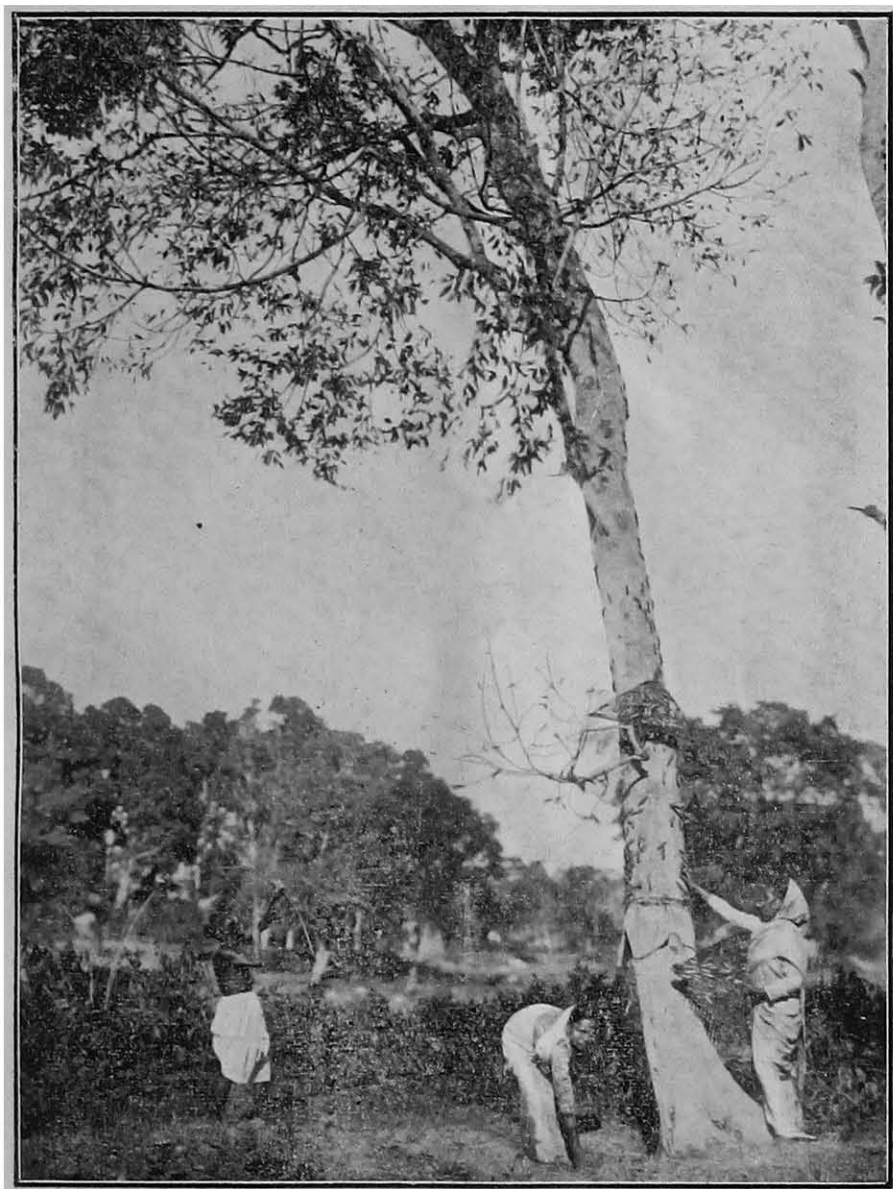
44. The *khoriás* with the newly hatched worms and with some of the eggs still unhatched are suspended from the branches of the selected trees, either by hand or by means of a bamboo pole. Loose eggs that have fallen off the *khoriás* are placed in a small basket lined with cloth, and the basket is tied to a branch of the tree. It takes three days for all eggs on a *khoriá* to hatch. The young worms soon crawl up to the leaves and commence to feed. The number of *khoriás* placed on a tree depends upon the quantity of leaf which it bears. There should be sufficient leaf on the first trees to feed the worms till they have at least passed the third moult. If too many worms are placed on a tree, they become lean, weak and uneven in size and it becomes necessary to transfer the worms too early to a fresh tree. Worms before they have cast the third moult are too small in size and are difficult to handle without the risk of many getting hurt or killed. On the other hand, if the right number of *khoriás* has been placed on a tree and the leaf is of good quality, the worms feed and grow well and to an even size. The success of the rearing depends much upon the quality of the leaf on which the young worms are made to feed and upon placing the right number of *khoriás* upon each tree. It often happens that the rearer has not got his seed ready when his trees are in a fit condition for the worms, and by the time his seed is ready, the leaf has become hard and unsuitable. The overcrowding of worms too is also a potent cause of disease. I shall revert to these points when dealing with the diseases of the insect. In a plantation containing (say) thirty good sized trees two or three hundred *khoriás*, each bearing the eggs of one moth, may be used and if there is no excessive loss through disease or other causes, a yield of some twelve *khons* of cocoons (a *khon* in the language of the *muga* rearer means one thousand) may be counted upon. For placing the *khoriás* on, perhaps half a dozen trees would be used, the remaining trees being brought into requisition one after another as those first used get exhausted of leaf.

After most of the leaves have been eaten, the worms descend along the trunk of the tree, evidently in search of food. The first bandage of straw is now removed and a fresh bandage of plantain or pine-apple leaves is put on with the object of preventing the worms from reaching the ground. The worms are unable to crawl over the smooth surface of these leaves; and as they gather above the bandage they are carefully picked up by hand and transferred to a fresh tree. This may be done either by placing the worms by hand on the trunk of the new tree and leaving them to crawl up, or, as is more commonly done, by gathering them on a triangular bamboo sieve, and hooking it on to a branch or to a bamboo nail driven into the trunk of the tree. Worms in different stages of growth are placed on different trees, and on each tree only just as many worms are put as will have food enough to attain full development. Towards the end of the feeding period, the worms eat with such voracity that it becomes necessary to shift them more than once to new trees. Another reason for repeated transfers is the reluctance of the rearer to use more trees at one time than he can conveniently watch.

The worms feed all day and night in summer and rest only during intervals of feeding and in midday when the sun is too hot. In winter they remain quiet at night and are able to eat after the air has been warmed up by the sun. A dropping sound like that of light hail is heard under the tree at feeding time; it is caused by the pea-like excrement of the worms which is constantly falling to the ground.

Like most other silkworms the *muga* worm undergoes four moults. They remain motionless for about 33 hours at each moult. These moults are known in Upper Assam respectively as *chhái-urá*, *duir-chhái kátá*, *tinir chháikátá* and *máiki chháikátá* or *bor chháikátá*. Somewhat different names are used in Lower Assam. The name of the first moult refers to the ashy or dark grey colour of the skin cast off at this moult. The names of the second and third moults explain themselves. Nobody could tell me the meaning of one of the two names for the fourth moult; it literally means the cutting of the female skin.

Plate II.

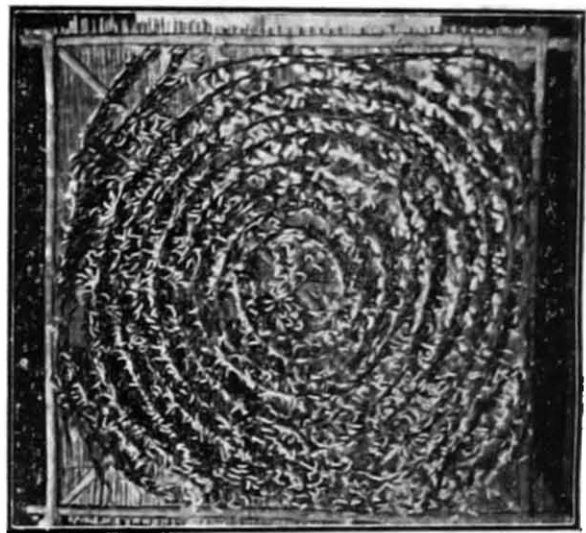


*Transferring Muga Worms.*

Plate III.



*Jali for Muga Worms.*  
(PARA. 45)



*Spinning Tray.*  
(PARA. 60.)

At the end of the fourth moult the worm exhibits a voracious appetite and grows rapidly. Before it attains maturity it wanders about for nearly a whole day and night; then it remains motionless for a few hours in which condition it is known as a *jumoa* (which means dozing or sleeping) worm; then it voids a semi-liquid excreta which is of a fast yellow colour; finally it begins to move again and descend the tree in search of a hiding place for spinning its cocoon. It is then known as a ripe or *paká* worm. On its way to the ground the mature worm is arrested by the bandage of plantain or pine-apple leaf which has been tied round the trunk of the tree. It is then gathered and brought home. The ripe *muga* is now full of the gelatinous matter with which the worm spins its silken cocoon. The body now assumes a bright translucent hue and makes a rustling sound when held close to the ear and rubbed with the fingers. Ripe worms begin to come down the trunk of the tree at night fall and continue to do so for three hours. They are collected by hand, placed in a basket and carried home. If the bandage of leaves is not sufficiently large and tight or if a large number of ripe *muga* assemble on the trunk and begin biting each other, many may fall down to the bottom of the tree, die or get lost; the ground below is therefore kept clear of grass and jungle to make easy the picking of such worms as may fall down. If the fallen worms are not picked up quickly they may wander away and spin their cocoons under clods of earth or dry twigs wherever they may find a place to hide in.

It is a happy instinct of the *muga* worm to descend from the tree as soon as it becomes mature. Other species of *Antheraea* are not possessed of this instinct and they spin their cocoons on the trees on which they feed, rendering the collection of the cocoons a difficult and tedious task.

45. A bundle of leafy twigs (*jáli*) is provided for the worms to spin their cocoons in. The leaves on the twigs should not be too dry and

Cocoon spinning.

crisp so as to break or be shaken off; nor should they be too green, as the worms do not like the damp feel and do not spin well on such leaves. The twigs are therefore cut 5 or 6 days before the worms are due to ripen, and dried in the sun. Such leaves as have a somewhat rough surface so as to permit the worms to crawl over them easily and at the same time are tough enough not to break when the cocoons are plucked are preferred for making the *jáli*. Many kinds of trees are used for furnishing twigs for the *jáli*; those commonly used are the mango, jack, bamboo and *singuri*. The usual way of putting the ripe worms on the *jáli* is to place the worms on a mat and to stand the *jáli* over it when the worms climb up to the twigs and seek out suitable spots for themselves. When all the worms have entered the *jáli*, it is taken up and suspended from the roof of a house.

A counted number of worms, usually four to six hundred, is placed in each *jáli*. Worms which are intended to produce breeding cocoons are kept separate from the rest.

The worm spins its cocoon in the manner already described. It then casts its skin for the fifth time (the skin remaining inside the cocoon) and metamorphoses itself into a pupa or chrysalis. These processes take from 4 to 7 days according to the temperature of the air. The completion of the cocoon is ascertained by shaking it; the pupa is free and rolls about on shaking, but if the insect is still in the caterpillar stage, it does not move.

46. The cocoons are plucked from the *jáli* some time before the moths are due to emerge; and if they are intended for reeling, the

Stifing cocoons.

chrysalids inside are stifled by placing the cocoons over a fire. If some of the cocoons are found to be fly-blown the whole lot of cocoons must be stifled at once. The maggots of the fly pierce the cocoons and render them useless for reeling.

Unlike the *eri* or the *pat* cocoon, the cocoon of the *muga* silk worm cannot be killed by mere exposure to the sun. The use of artificial heat is, therefore, necessary. The usual method of stifling is as follows:—

A bamboo platform is erected at a height of about four feet from the ground and is covered with a thick layer of green plantain leaves. The cocoons are placed on the leaves and covered over with a second layer of plantain leaves in such a way as to exclude air. A fire is started with bamboo or wood fuel and kept up for 2 or 3 hours. The process may have to be repeated once or twice more to make sure that all the chrysalids have been killed. The stifled cocoons are afterwards dried in the sun for two or three days and then stored till such time as they are wanted for reeling.

47. The *muga* insect is exposed to the attacks of various enemies while in the rearer's house. The seed-cocoons, moths and eggs have to be carefully guarded against rats, mice and ants. Enemies of the *muga* worm. Mosquitoes are also said to be very injurious to moths and eggs. In the open air the worms are constantly preyed upon by various species of birds and the flying fox or bat (*baduli*). Among the birds which cause most damage are the crow, the kite, a species of small bird called *bhadrokoli* which resembles the house sparrow, the *saksakia* or wandering pie and the little downy owl (*pesa*) which last feeds at night. The insect enemies are not less numerous. The chief of these are several species of ants [the three commonest being the nest building ant called *amroli*, the *majarali* and the *dálbindhá* or *gandhúti* (a very small ant which lives in burrows inside the twigs of the tree)], the common red wasp (*baral*), an ichneumon fly called the *sohoni* and at least two species of large hornets one of which, the *dinkaná*, preys by night and is said to be most destructive to *muga* worms in certain localities. The common ricebug is also said to cause great injury at times to the *bhadia* brood. Among mammals, monkeys and jackals are reckoned as enemies of the ripe *muga* worm.

Bows and pellets are used against birds which prey by day. It needs constant watching by the rearer to keep out these enemies. The watching begins on the day that the *khorikás* are placed on the trees and does not cease for a moment during the day hours till the last worms have ripened and come down the tree. Watching at night too is commonly necessary during the later stages of rearing, especially in places which are infested by bats. One or more tall clappers of split bamboo or empty kerosine tins tied to the top of a bamboo, are pulled by a string from within the watcher's hut to frighten away nightly marauders. These are also used by day to scare away birds. Various other devices are used to the same end. This constant watching is found a very troublesome task, especially in inclement weather and is usually left to old men and children where there are any in the family.

Ants do great damage to young worms which quickly succumb to their bites. Older worms bitten by ants are able to grow and spin cocoons. The measures taken against ants have already been described.

Wasps and hornets are beaten down and killed, whenever found. The *dinkana* comes at night and carries away the worms bodily to its nest. The rearer is quite helpless against this dreaded nocturnal enemy. Fortunately it occurs only in places near forests. The depredations of this insect are said to have rendered *muga* rearing extremely precarious in some villages in the south of the Jorhat subdivision, and I have heard that some people of mauza Khorikatiya have had to give up *muga* rearing altogether on that account.

Mention should be made here of the common silkworm fly (*Tricolyza bombycia*) which is a dreaded pest of the mulberry as well as of the *eri* silkworm. The life history of this parasitic fly has been described in Chapter II (paragraph 23). This fly attacks the *muga* worm as well, but fortunately not to anything like the extent to which it victimises the *eri* and *pat* worms. The comparative immunity of the *muga* worm may be due to the fact that the worm is armed with numerous tufts of hair on its body which help to keep out the silkworm fly, or it may be due to the fact that the fly itself has its own natural enemies which prevent it from multiplying fast. In and near human dwellings the fly is comparatively safe from its enemies and is, therefore, able to increase without check. Hence it proves more injurious to the *eri* and *pat* worms which are reared indoors than to the *muga* which lives in the open air.

48. Continued heavy rain causes more or less injury to the *muga* worm, especially to the autumn and winter broods. Once in a few years, a long spell of rain and cold known in Assam as the *katiáhota* comes towards the end of October when the *Katia* worms are feeding on the trees, and causes great loss. Many worms are washed off the trees, others die from wet and cold and the cocoons spun in such weather do not reel well on account of the gum on the silk not being able to dry up quickly enough. High wind is apt to blow down worms from the branches. Hail storms are another, though fortunately a rare, source of danger and, if severe, may kill a whole brood of worms. Dry hot weather is also regarded as unfavourable; eggs do not hatch well in such weather and many young worms die from the scorching rays of the sun.

49. The *muga* worm is highly subject to a disease which often occurs in an epidemic form and destroys the insect wholesale. It attacks the worm in all stages of its life but is most marked in the last two stages, sometimes carrying off whole broods when they are about to ripen.

The disease is characterised by the worm losing its usual bright colour, gradually ceasing to feed and passing a semi-liquid excrement and sometimes a liquid discharge from the mouth. The dead worms fall off the tree or remain hanging on by the tail. The body becomes flaccid and turns black after death. Curiously enough the Assamese do not seem to possess a distinctive name for this disease of the silkworm; when it occurs, they invariably attribute it to the evil eye or rather as they say to the evil mouth (*mukh-lagá*).

Weak and unhealthy worms are known as *hahoya*; they are smaller in size than the rest of the brood, do not eat well, have a dry and rough skin and wander about on the tree. If such worms are transferred to a tree having good succulent leaves, they may recover, grow and spin cocoons, but most *hahoya* worms fail to reach maturity, and those which spin at all form cocoons with a light covering of silk (*leeta* cocoons).

Worms showing black spots on the body are known as *photukia* (literally spotted). In Upper Assam two kinds of *photukia* worms are distinguished, namely the *batiphotukia* which are very much like the *hahoya* worms but with black spots; and the *hatiphotukia* which grow to an abnormally large size and are said to moult five times instead of the usual four. Neither kind is able to spin cocoons. Worms which have matured but failed to spin cocoons or encased themselves in thin cocoons through which they can be seen are known as *jagiori* or *akará* worms.

*Bisá* or *Bisakatá* is the name given in Upper Assam to a *muga* worm which exhibits a most singular affection. Small maggots are seen to come out through the spiracles on the body of the worm and turn into minute silken cocoons which remain attached to the body of the worm. Such worms never ripen and are destroyed when found. Fortunately the disease is not a common one and in the lower districts it is wholly unknown.

There is another disease of the *muga* worm which in Upper Assam is known as the *phulá rog* (swelling); the body of the worm becomes swollen; a dark reddish juice exudes from the body and the skin is sometimes burst. The contents of the body are black. It usually occurs in the *Jethua* brood. The disease is evidently grasserie.\*

50. The diseases of the *muga* insect have never been the subject of scientific investigation. My Sericultural Assistant, Babu S. C. Saraswati, and I have, I believe, been the first to take up this investigation. Our enquiry was, however, limited to an examination under the microscope of diseased and dead specimens of worms, chrysalids and moths. In all we examined some 250 specimens which had been collected by us from different broods, and we got many of these re-examined by the Imperial Entomologist of Pusa to whom my sincere acknowledgments are due for the assistance he ungrudgingly gave me in this work. A list of the specimens examined will be found in Appendix I. The specimens we examined included many *hahoya* and *photukia* worms and worms that had died from the epidemic disease described in the first part of the last paragraph. We found, as indeed we had suspected, that the disease in all these cases was one and the same and that it was identical with that well-known disease of the common silkworm which is known as flacherie. A few specimens were found affected with grasserie and pebrine. Our investigation left no doubt that flacherie is the disease which is primarily responsible for the great destruction of *muga* worms which happens far too often in Assam and causes serious losses of time, labour and money to the *muga* rearer.

The flacherie disease of the common silkworm is analogous to indigestion in man. It is caused by an excessive accumulation of undigested and fermenting food in the intestinal canal of the worm. Coarse hard leaf given to young worms, wet or fermented leaf, leaf covered with mud or dust, want of cleanliness and ventilation and sudden changes in weather or temperature are held to be the chief causes which induce the disease in the mulberry silkworm. As the *muga* worm lives and feeds in the open air, some of these causes are inoperative in its case, and some are not preventible. We, however, believe that in the *muga* worm, the quality of the leaf is probably the main cause of the disease. We have seen that the food trees receive no pruning or manuring and the ground under them is seldom tilled. Such trees cannot be expected to yield healthy and nutritious leaf. It may also happen that the leaves of the tree on which hatching worms are placed are too old and hard to suit their digestion. Then again, to avoid the trouble of having to watch too many trees at one time, there is a tendency on the part of the rearer to place too many young

\* I am indebted for this description of the disease to Mr. M. N. De of the Pusa Research Institute who lately visited Assam. Since writing the above, I have received from Mr. De a note on the grasserie disease of the *muga* silkworm, which I append to this report (Appendix V).



worms on a tree with the result of overcrowding and compelling many of the insects to eat hard leaves unsuited to their age. If these really be the causes of the excessive prevalence of disease in the *muga* silkworm, they at least can be mitigated, if not wholly prevented, by due care and trouble taken in cultivating the food plants, in selecting the right kind of trees with which to start feeding and in avoiding the overcrowding of the worms.

The *sum* tree bears coppicing well and may be found to bear pruning equally well. I am not quite so sure about the *hualu* tree. I should like to see an experiment made in cultivating these trees carefully in the same way as the tree mulberry. By tilling and manuring the ground, the trees can be made to yield more leaf and of a better quality and to carry proportionately more worms. If the trees are kept down to a moderate height, the handling of the worms and protecting them from birds and other enemies would be easier; and by pruning in advance they could be made to produce leaves of the right degree of hardness about the time that the newly-hatched worms are to be placed on them. Planted 10' x 10', an acre of land may bear over 400 trees and yield a much larger harvest of cocoons than at present. To each tree should be assigned as many worms as it is considered able to carry to maturity. The worms will start by feeding on the young leaf, and as they grow, the leaves too will grow so that the insects will get suitable food at each stage of growth.

Flacherie in the mulberry silkworm is caused by two microscopic organisms which are regarded by some authorities as distinct and by others as only two different stages of one and the same organism. It is not certain that the germs of this disease are transmitted like those of pebrine from one generation to another. But it is admitted that the disease produces a constitutional debility which causes the worms of the next generation predisposed to contract the disease. The "cellular" system of growing seed is adopted against this disease as well as against pebrine in all advanced silk-growing countries. The same system may prove useful in reducing disease in the *muga* silkworm.

The Imperial Entomologist, Mr. T. Bainbrigge Fletcher, whom I consulted as to the possible measures for combating the disease favoured me with certain suggestions, among which those which seemed to me feasible have been embodied above. The remedial measures which have been suggested are based on mere *a priori* considerations and must be fully tested and proved practicable before they can be brought to the notice of the rearers.

51. One acre of *sum* contains on the average 100 trees and may produce a maximum outturn of one hundred thousand (or to use the language of the Assamese rearer one hundred *khons* of) cocoons. But such heavy outturn are rare and, as a rule, a rearer is quite content if he can get 30 to 40 *khons* of cocoons from one hundred trees. The average yield per acre must be less, perhaps not more than half of the above, say 15 to 20 thousands.

52. These two forms of *muga* silk are greatly esteemed by the Assamese, but are possessed of no economic importance. The silk is of a creamy white colour and said to be more lustrous than the common *Sumpatiya muga*. When procurable it sells at fancy prices—Rs. 60 or more per seer against Rs. 16 to 20 for the best *Sumpatiya* silk. I have seen both the kinds, but failed to see any special merit in them except the merit of being rare. *Mezankuri muga* used to be grown in recent years in some of the southern mauzas of the Jorhat sub-division, but within the last two years its cultivation has become wholly extinct. The *champá patiyá* variety is still grown by a few people, but the total production may not exceed a few pounds of silk in the year.

The insect which produces these two varieties of silk is the same as the common *muga*; the difference arises wholly from the nature of the leaf on which the worm is fed. In one case it is the *mezankuri* or *ádákuri* tree (*Litsea citrata*) and in the other the *champá* (*pán champá*) tree (*Michelia oblonga*). The *ádákuri* tree comes up spontaneously in newly-cleared land, and it is in the early shrub-like stage of the tree that it is capable of producing *mezankuri* silk. The tree can be used from the 2nd year to the 4th year, i.e., for 3 years. Two-year old trees produce the best silk. The quality of the silk gradually deteriorates, and if the tree be used in the 5th year, the silk produced would not be distinguishable from the ordinary *muga*. The extinction of *mezankuri* silk is attributed to the people having had to give up *jhuming* for want of waste land which has disappeared before the spread of tea and ordinary cultivation. The *pán champá* tree is a large forest tree which I do not think is ever planted.

The leaves of the *adākuri* as well as of the *pārchampā*, have a pungent taste which is not liked by the *muga* worm, and only strong and healthy worms are able to feed on them. The *adākuri* tree has the additional disadvantage of having a slippery bark and a scanty covering of leaf, which cause many worms to fall down or get scorched by the sun.

53. The data for calculating the average annual yield of *muga* cocoons are very uncertain. The area under *sum* trees in the last ten years has varied from 20,000 acres to 24,000 acres, the average being about 22,000 acres and this is the only reliable datum we possess. For the purpose of the calculation we want also to know what proportion of the area is utilized on the average of good and bad years for the rearing of the *muga* worm, how many crops of worms are on the average taken off the same trees, and the average yield per acre taking good and bad seasons together. The information I have been able to gather on these points is not very reliable. If we assume that the year has been a favourable one over the whole of the *muga* growing area, we may perhaps be justified in adopting the following data. Area of *sum* cropped with *muga* =  $\frac{2}{3}$  yds. of the total area or say 15,300 acres; only one brood of worms is raised in the year; the average yield of cocoons in a favourable season is 30,000, or 30 *khons* as the rearer would say. On these data the total production of *muga* cocoons would work out to  $15,000 \times 30 = 450,000$  *khons*. This must be taken as a hypothetical figures, since it can very rarely happen, if ever at all, that the season has been equally favourable over the whole of the *muga* producing area or that every brood of worms during the year has turned out equally well. The actual average, taking good and bad seasons together and for the whole country, may not exceed half of the foregoing figure. But even then it would mean a considerable amount of wealth. One half of 450,000 *khons* is 2½ lakhs of *khons*. The usual price of *muga* cocoons has varied in the past two or three years between 300 and 400 per rupee or say Rs. 3 per *khon* (thousand). At this price, the 2½ lakhs of *khons* of cocoons would be valued at 6½ lakhs of rupees which is more than the total estimated value of the *eri* cocoons grown in the province.

54. The bulk of the *muga* cocoons grown in Assam is reeled by the rearers themselves or sold to neighbouring villagers who reel them for their own weaving. The only part of the country where *muga* cocoons are an article of trade lies on the South Bank between Khunamukh on the east and Dhopdhara on the west. The chief *muga* growers in the area are the Kacharis, Rabhas and Garos living in the south-west corner of the Kamrup district and pargana Habraghat in the east of the Goalpara district. These people do not reel the silk, but dispose of their cocoons at the weekly *hāts* or to petty traders who visit their homes. The principal markets for *muga* cocoons in this tract are Dhopdhara and Damra in Goalpara and Boko, Singra, Habima, Borduar, Chhaigaon and Palasbari in Kamrup. Most of the cocoons eventually find their way to the bi-weekly *hāt* at Palasbari and smaller quantities to the Chhaigaon *hāt*. The cocoons are bought off by people coming from Sualkuchi and other villages lying for some miles round Palasbari. The reeling of *muga* cocoons is an important industry with these people. The thread is either disposed of in the raw state at Palasbari and Gauhati or locally woven into cloth. The principal season for *muga* cocoons extends from the end of October to the end of January. During these three months about three-quarters of a lakh of rupees worth of *muga* cocoons is believed to change hands at the Palasbari market. On one *hāt* day (December 6th, 1913), we counted 328 baskets of cocoons, each holding about 3,000 valued at Rs. 10, the whole being worth about Rs. 3,280. The traders are all Assamese; the Marwaris do not deal in *muga* cocoons, as they contain insects and are regarded by them as impure. The transactions are wholly cash.

The price of *muga* cocoons has been very high since two years past. It rose in places to 200 per rupee. The present price December 1913 is between three and four hundred per rupee. Three years ago the price was 5 to 6 hundred for the rupee. The growing dearness of the silk is ascribed to disease which caused great losses of worms in Upper Assam in 1911-12 and 1912-13. In the present year the *muga* crop has given a good outturn and prices of *muga* cocoons and silk have sensibly decreased.

There is no export of *muga* cocoons from Assam, either whole or pierced.

## CHAPTER IV.

THE REARING OF THE *PAT* SILKWORM.

55. Mulberry silk or *pat*, as it is called by the Assamese, is grown to a small extent in certain parts of the Brahmaputra Valley. The rearing of the *pat* worm is restricted by custom to one particular caste of Hindus, the Katonis who also call themselves Jugis (*vide* paragraph 4). The only other people who rear this silkworm are a few Muhammadan families living in mauzas Nahorani, Gurjugonia, and Dergaon in the Golaghat sub-division. In Appendix III will be found a table showing the names of the mauzas in each sub-division of the Assam Valley in which *pat* silk is grown at the present day and the approximate number of families in each mauza who rear the worm. I collected the information with the aid of the local officers. Mr. Stack stated in his note on silk in Assam that the *pat* rearing industry was hardly known out of the district of Sibsagar, the ancient centre of Ahom rule; but it will be seen from the table that the number of rearers in the Nowgong district is far greater than that in Sibsagar or in the rest of Assam put together. There are many villages in Nowgong such as Digholdari and Kakotigaon in mauza Baropujia, Jamuguri in mauza Hatichong, Choraibahi and Morangia in mauza Choraibahi, where the industry still retains a considerable importance. I visited some of these villages and was somewhat astonished to see the keen interest, which the Katonis evinced in the maintenance of the industry which is their hereditary calling. But taking the Assam Valley as a whole, the growing of mulberry silk has become less attractive than before and has long been in a state of slow decline. The industry was never of any great magnitude even in the days of the Ahom kings. The wearing of *pat* silk was severely restricted to the members of the royal family and high officials of state, and only enough was produced to supply their requirements. On the annexation of Assam, this restriction ceased to exist, but the high price of the silk was a bar to its general use. In recent years, several unfavourable causes have been at work to depress the industry. The *kala-azar* epidemic not only caused a great loss of population in Lower and Central Assam, but at the same time put a check upon every form of rural occupation, not excepting agriculture. Another serious cause of decline of the *pat* rearing industry is the growing competition of imported mulberry silk which is able to undersell the native product. Over and above these causes, there is a social movement, as yet in its infancy, which threatens to lead to further curtailment of the rearing of *pat* silk. The Katonis are at present animated, in common with other depressed castes, by a desire to improve their social status. They have begun to resent being looked down upon as low and untouchable by other Hindu castes. They are being advised that if they give up the rearing of the *pat polu*, and undergo a prescribed course of religious purification, they will be allowed to enter into social intercourse with the better classes of Hindus. This movement is not yet widely spread, and all Katonis do not share the feeling which lies at the root of it. The Katonis of Mangaldai enjoy almost as good a social status as the Kalitas, though they still adhere to their hereditary calling, and elsewhere, even in Nowgong where the movement is more in evidence than in any other district, many of the Katonis are opposed to the abandonment of *pat* rearing, though they are anxious like others to raise themselves in the eyes of the Hindu society. Nevertheless, the movement has been exercising a disturbing effect upon the growing of mulberry silk. I was told that some 300 families of Dhoom Dhoomia, a large Katoni village in mauza Dhing in the Nowgong district, have given up *pat* rearing within the last year or two as the result of this movement, and I should not be at all surprised if others follow in their wake.

56. The quantity of *pat* silk annually grown by a family is very small. It varies from a quarter of a seer to three seers at the most. The annual average outturn per family may not exceed one or one and a half seers. Most people I have consulted put it at one seer, but I am inclined to take a somewhat higher average, say  $1\frac{1}{2}$  seers, in view of the general tendency to underestimate in such cases. On reference to the table mentioned above (Appendix III), the total approximate number of *pat* rearers will be seen to be 4,026 or roundly 4,000. At  $1\frac{1}{2}$  seers per family, the total annual production of *pat* silk may amount to 150 maunds. And if we take the value of one seer of Assamese *pat* silk at Rs. 16 = Rs. 6.20 per maund, the total value of the silk annually produced would be Rs. 96,000 or roundly Rs. 1,00,000. This estimate is admittedly rough, but it is the best I am able to offer.

57. Two distinct species of the *pat* worm are cultivated, namely, the *bor polu* and the *horu polu*, the silk obtained from them being respectively known as *bor pat* and *horu pat*. The *bor polu* is a univoltine insect and is in all probability identical with the *bor polu* of Bengal.

(*Bombyx textor*). There are two varieties of it, one producing a yellow cocoon and the other a white or rather greenish white cocoon. The latter is the more common of the two. The *horu polu* is a smaller worm and produces several broods in the year. It is commonly stated to be the same as the *nistari* worm of Bengal (*B. croesi*), but this is very doubtful. The *nistari* worm is characterised by black markings on the body, while the *horu polu* of Assam shows no markings, and in appearance is almost like the *chhota polu* or *desi* worm of Bengal (*B. fortunatus*), though the colour of the cocoon is different. The *horu polu* cocoon is of a greenish white colour, and the Bengal *desi* cocoon is a golden yellow. The Head Master of the Government Sericultural School at Rajshahi to whom I submitted some specimens of the *horu polu* worm for identification pronounced it to be the same as the *chhota polu*. There is only one variety of the *horu polu* now grown; it produces a greenish white cocoon like the white variety of the *bor polu*, but smaller in size.

Most rearers grow both the species of mulberry silk. In the Golaghat sub-division, most of the silk is derived from the multivoltine kind. In Mangaldai, on the other hand, the rearing of this species has wholly disappeared since the earthquake of 1897. The rearers of the place attribute the extinction of the *horu polu* to the earthquake itself, but it was in all likelihood due to disease. A new race of *horu polu* known as the *moria* was introduced a few years ago, but that too, has almost disappeared. The only kind of *pat* now reared in Mangaldai is the univoltine *bor polu*. It is also the only kind grown in North Kamrup.

Both species yield silk of almost equal value, except that the yellow *bor polu* fetches a slightly lower price than the silk obtained from the white varieties of *bor* or *horu pat*. On being washed yellow silk becomes almost white, though not quite so white as silk from the white cocoons. *Bor pat* is said to be stronger and softer than *horu pat*, but less lustrous, and is in some places held in greater esteem than the latter; in other places the case is just the reverse.

A sample of *horu polu* cocoons was tested by me; the cocoon was found to measure on the average just under one inch, in length and about two-fifths of an inch in diameter, and the silk content weighed five-sixteenths of a tola to one *pon* of cocoons (1 *pon*=80 is the unit of counting *pat* and *eri* cocoons). One *pon* of *horu pat* cocoons is usually reckoned to yield  $\frac{1}{2}$  tola of reeled silk and the same number of *bor pat* cocoons  $\frac{1}{3}$  tola. This means that to obtain one seer (80 tolas) of silk,  $80 \times 4$  or 320 *pons* or 25,600 *horu pat* or  $80 \times 3$  or 240 *pons* or 19,200 *bor pat* cocoons would be required. In Bengal 16 *kahons*=256 *pons* of *chhota polu* or *nistari* cocoons are reckoned to produce one seer of reeled silk, against 320 *pons* in Assam as indicated above.

58. The *bor polu*, as already mentioned, breeds only once a year. The eggs hatch about the time of the Magh Bihu festival or shortly after, (usually about the end of January), the worms feed for about forty days and spin cocoons about the middle of March (beginning of *Chey*); the moths emerge in 15 to 20 days, then pair and lay eggs. All these stages are completed by the time of the *Baihang Bihu* festival which occurs on the last day of *Chey* (middle of April). The eggs are then stored away for nine months, that is to say, till the arrival of the next *Magh Bihu* festival.

The *horu polu* produces several broods in the year variously stated at 4 to 6. My enquiries lead me to believe that if the same stock be continuously bred from, it will pass through six successive life-cycles in the course of a year, the average duration of a cycle being two months. Few breeders attempt to rear more than two or three broods in a year. Many limit themselves to the chief or autumn brood which is reared in the month of *Kati* (October-November) and known, therefore, as the *Katia bah*. The autumn crop of *horu polu* and the spring crop of *bor polu* produce most of the *pat* silk grown in Assam.

59. The rearers either save their own seed-cocoons or procure them from their neighbours. The usual price of seed-cocoons is one anna per *pon* of 80. Very few people breed the *horu polu* all through the year; most rearers of this worm have consequently to depend upon purchased seed. A prevalent custom in Bengal is to procure seed from a distant locality (*joar*) having a different soil and climate from that of the rearer's own place. The rearers often go long distances from home in search of good seed; they carefully examine the brood from which the seed is to come, to make sure that it is free from disease, as far as they are able to judge from its external appearance. Such examination often fails to ensure good healthy seed, but it undoubtedly helps to keep down

disease. This custom does not obtain in Assam. Here the seed is very frequently changed, but it is always obtained from a place near by, and no outsiders being allowed to enter the rearing house, purchasers of seed-cocoons have no means of examining the parent brood and are obliged in consequence to depend upon such information as to the health of the worms as the owners are willing to furnish or they can obtain by enquiry in the neighbourhood.

The process of breeding is somewhat different with the *bor polu* from that for the *horu polu*. In each case, the seed-cocoons are placed on a bamboo tray (*dálá*); the moths emerge from the cocoons and pair in the morning, and the male moths are separated and thrown away in the evening. In the case of the *bor polu*, the female moths after being fertilised are removed from the tray and placed on a cloth suspended in a quiet corner of the house, where they deposit their eggs. The cloth with the eggs on it is neatly folded up and stored in a small earthen pot or bamboo or cane basket which is kept suspended from the roof and is not allowed to be touched before the next *Magh-Bihu* festival. With the *horu polu*, on the other hand, the female moths are allowed to remain on the tray on which they deposit their eggs, and the eggs remain there till they hatch, a few days later.

60. No separate house is provided in Assam for the rearing of the *pat* silkworm.

Rearing house and appliances. Like the *eri*, it is reared in a compartment of the dwelling house, usually the compartment furthest from the entrance of the house. The rearing room is kept scrupulously neat and clean, though very dark; and but for the chinks in the upper unplastered portion of the *ikra* walls, it is bereft of any means of ventilation. Inside the room, a bamboo structure called a *ghará* is erected. It consists of four stout posts and a series of thin horizontal bars tied across the front and back posts at intervals of 6 to 9 inches from each other and serving the purpose of shelves on which the feeding trays are placed. A *ghará* may contain 10 to 16 of these shelves, and there may be more than one such *ghará* in a rearing house. To protect the worms from ants, the bottom of each post is enclosed with a low earthen embankment and the basin thus formed is kept filled with water. The posts are made to stop short of the roof so as to prevent the access of rats. In some places, the vertical posts carrying the *ghará* are not placed on the ground, but are suspended by ropes from the roof of the house, and each rope is passed through an inverted funnel made out of a sheath of the betel nut tree, to prevent the passage of rats from the roof.

Young worms are fed on small circular trays (*dálás*) of woven bamboo, which are plastered over with mud. The *dálás* are either kept suspended from the roof or placed piled one over another on a bamboo pole of which the top is split and spread out in the form of a cone, and the bottom is enclosed with a low earthen embankment filled with water for protection against ants. Older worms are fed in larger bamboo trays called *khalopás* which may be either of circular or of an oblong shape and which are not usually plastered with earth like the *dálás* for younger worms. A *khalopá* may carry as many as one *kahon* or 16 *pons* (1,280) of worms and a *ghará* containing 10 such *khalopás* may yield 10 *kahons* of cocoons which would produce 40 tolas or half a seer of silk.

Another very necessary appliance is the spinning tray called *chándeli*, *chandrakí* or *phuljálí* (Plate III). It consists of an oblong bamboo mat on to one side of which a long roll of woven bamboo, about 2 inches wide, is sewn in the form of a gradually widening spiral, leaving a continuous interspace about two inches wide between the walls of the spiral. The worms, when ripe, are placed on the tray and spin their cocoons between the walls.

61. The mulberry tree is called *nuni* in Upper and Central Assam and *meskuri* in the lower districts. The bush form of mulberry which is the only kind grown in Bengal is unknown in Assam.

The mulberry tree. Here it is always grown as a tree, the practice in this respect being the same as in Europe. The tree is commonly grown on the hedge round the homestead and occasionally in the form of a regular plantation, with the trees planted about ten feet apart. Mulberry trees are grown in Assam exclusively from cuttings, propagation from seedlings or by budding and grafting being wholly unknown. Cuttings are planted at all times of the year except in the winter, but the usual time of planting is the beginning or the end of the rainy season. The slips are about a cubit long and are buried flat in holes dug in the soil and manured with cow dung. The shoots appear in a few weeks and allowed to grow at will without any attempt to regulate the shape of the tree. Sometimes three or four shoots are allowed to grow together into as many trunks and produce an irregular shaped tree. The plants begin to yield leaf after a year, but leaves from a young tree are considered soft and wanting in nutriment.

and usually the plucking of leaf is deferred till the tree is two years old. When mulberry trees are grown in a plantation, the land is given an annual digging with the spade and manured with cowdung and the refuse from the rearing house. Trees grown on the hedge receive no cultivation except what is given to the crops grown in the *basti* land on the borders of which they stand. The cultivation of the mulberry tree is on the whole very careless. The rearers are somewhat particular in the matter of giving the trees an annual pruning. The tree is pruned either at the time of gathering leaf for the *katia* brood of the *horu polu* in the autumn, or in the spring when leaf is taken for the *bor polu*. The new wood is cut off to within a few inches of the base; a fresh growth of young shoots appears from the stump so left. Trees pruned in the autumn cannot yield leaf for the *bor polu* crop which is reared in the spring, but those pruned in the spring may be utilised for the autumn brood of the polyvoltine worm.

There are several varieties of mulberry grown in Assam for feeding the *pat* worm. The commonest variety is called the *horu nuni*, a small tree with small entire or lobed leaves, apparently identical with the form of *Morus indica* which is grown as a bush in Bengal. There are local sub-varieties of the *horu nuni* which are distinguished from one another by slightly different characters. The tree flowers and fruits scantily, and the fruit is small and black, when ripe. One sub-variety known as the *jeskuri* in Mangaldai produces a copious amount of flower and fruit and its leaves are smaller than those of the common *meskuri* and are less liked by the worm. Another variety of mulberry is the *bor nuni* which is a larger tree than the *horu nuni*; its leaves are entire, and thicker, larger and more succulent than those of the latter. It is to be found only in the Nowgong district, and I am told also in the Majuli of the Sibsagar district. Its leaf is considered more nourishing than that of the *horu nuni*, but less congenial to the worm, and it is, as a rule, used only for feeding the older worms. The *bor nuni* greatly resembles the "small leaf" variety of mulberry found in Shillong, which also is a form of *Morus indica*. A third variety, or rather a distinct species, of mulberry which I saw in a village in Nowgong is the *M. laevigata* which is a common forest tree of Assam. It grows to a large size and yields a valuable timber, and is known to the Assamese as the *bola* tree. The cultivation of this tree as a food plant for the *pat* worm is, I believe, of very recent introduction and is not yet known beyond some villages of Nowgong.

Numerous varieties of mulberry are in existence, and many of these are under trial at Pusa. Among these the Phillipine mulberry (*M. alba*, var *multicaulis*), the Japanese mulberry (*M. japonica*), and the Italian variety (*M. atropurpurea*) which is the same as the "big leaf" mulberry of Shillong are recommended as the best. But it is a subject on which any general recommendation should not be accepted without a trial. A variety which may suit one race of worm may not prove equally congenial to another, and the soil and climate may cause a difference in the quality of the leaf. If Government decide on establishing an experimental station for the improvement of sericulture, one of the experiments I would suggest would be to plant and test new and improved varieties of mulberry, among others the three kinds mentioned above. They might prove more suitable than the indigenous varieties of Assam.

The mulberry tree in Assam suffers very badly from the attack of a borer which tunnels through the trunk of the tree and kills it in a few years. I have not seen a single full-grown tree which is free from the borer. It is rare to see trees more than 20 or 25 years old. The people do not know how to combat this pest. I have not seen the insect, but it is likely to be very similar to the grub of a large beetle which attacks orange and other fruit trees; and like the latter it may be destroyed by such means as inserting a bent wire in the burrow in which the grub lives, injecting carbon bisulphide, kerosene or some other acrid fluid into the burrow and closing it up with clay or tar. The attention of the Provincial Entomologist may be drawn to this pest.

*Pat* rearers have often to rely upon purchased leaf for feeding their worms. There are many people who do not rear the *pat* worms, but who grow mulberry leaf for sale. Leaf is sold either by the load or by the tree at 2 to 8 annas per load or tree according to the demand at the time and the size of the tree.

62. It has been seen that the eggs of the *bor polu* worm are laid on a cloth and stored till the eggs are due to hatch about the latter part of January. The cloth is brought out, and such worms as have emerged from the eggs are transferred to a new earthen pot either with the help of a feather or by holding the cloth turned upside down over the pot and gently tapping on its back with the fingers. The young worms are given some tender mulberry leaves torn into fine shreds, and when they have risen to eat them, they are removed with the leaves to the feeding tray. More worms hatch out

on the second and third day, and these too are removed in the same way as above. Only the first three days' hatchings are reared; the eggs which remain unhatched after three days are [seldom used, as they generally produce weak unhealthy worms. Each day's hatching is kept separate on the feeding tray.

In the case of the *horu polu*, the eggs, as already stated, are deposited on a bamboo tray on which they remain till the worms hatch out. As soon as the worms appear, they are given finely chopped leaf to eat, and when they have risen on the leaf, they are transferred with it to the feeding tray. The process of hatching out and removal of the worms continue for three days, at the end of which the remaining eggs are thrown away. Each day's worms are kept separate. All rearers, however, are not equally careful in this matter. Some do not transfer the worms daily to the feeding tray, but continue to feed them on the breeding tray for several days, with the result that early and late worms feed together and get mixed up.

The worms are given harder and older leaves as they grow. Leaf is supplied usually twice a day, young worms are sometimes fed thrice. Three or four feeds a day is the rule in Bengal, and in some countries leaf is supplied oftener. The leaf dries up less quickly in our moist climate and hence fewer meals are found enough. When the weather is dry, it is usual to sprinkle water over the leaves and to keep them on a wet floor or in a basket lined and covered with plantain leaves to prevent the leaves from drying too quickly. It has been mentioned that the worms which hatch out on a particular day are fed separately from those which appear earlier or later. By giving more food to the late worms than to the early ones, the different lots of worms are brought in the course of a few days to the same stage of growth, and thereafter they are kept and fed together.

The litter consisting of the remains of the leaves and the excreta of the worm is not removed before the second moult. Thereafter it is removed once in three or four days. The cleaning of the feeding trays is a very tedious operation, the worms having to be carried to a fresh tray, a few at a time, with the leaves on which they are feeding. The result is that the trays are not cleaned as often as they should be. During the last two stages of feeding, the litter which accumulates fast ought to be removed once daily, otherwise the tray gets covered with a thick mass of fermenting leaves, excreta and dead worms, upon the top of which the live worms will be feeding—a condition which cannot fail to induce disease. The Assamese rearer is fairly alive to the importance of cleaning the litter, but he is not energetic enough to do it in a thorough manner.

The cleaning of the litter can be greatly simplified by using nets or perforated paper as are used in Europe and Japan. The use of nets is also becoming common in Bengal. One pair of nets is provided for each feeding tray. One of the two nets is spread over the tray from which the litter is to be removed. Some fresh leaves are scattered over the net, the hungry worms soon crawl up to the leaves, and are then lifted with the net and removed to a fresh tray. They continue to feed on this tray with the net spread under them till the time for the next cleaning arrives, when the second net is used in the way above described, and the litter is lifted off with the first net and thrown away. I think the Assamese rearer will readily adopt the use of nets for cleaning. Old fishing nets cut to the size of the feeding trays will serve the purpose very well. Most people possess a stock of fishing nets which are woven by themselves and cost nothing in cash beyond the cost of the thread.

The worms on attaining maturity assume a translucent colour like that of mother of pearl, cease to feed and remain with their heads thrown up in the air. Some wander about and come to the edge of the feeding tray. The mature worms are picked off and placed in the spinning tray. During the cold weather, the spinning tray is kept out in the sun, resting on a stick which supports it with its face turned slightly down wards. The object of placing the tray in a slanting position is to avoid the full heat of the sun and also to allow the last liquid discharge of the worms to fall clear of the tray.

The spinning of cocoons is completed in three days; another two or three days is usually allowed to allow the cocoons to harden. The cocoons are then removed from the spinning tray. Those selected for breeding are treated in the manner already described. Those intended for reeling are reeled off before the moths have had time to emerge. It is not usual in Assam to stifle the cocoons of the *pat* silkworm. The common practice is to reel them off almost as fast as they are plucked off the spinning tray. This is possible because the outturn of cocoons obtained by an individual rearer is so small that the whole lot can be reeled off within the short time that elapses between the gathering of the cocoons and the appearance of the moths. With larger rearings, the cocoons must be stifled to destroy the chrysalids which would otherwise turn to moths and spoil the cocoons for reeling.

63. The chief enemies of the *pat* worms are ants, rats, and the silkworm fly (*Trypoxyna bombycis*). Some of the measures taken by rearers to protect the worm from ants and rats have been already mentioned. Ants could be prevented from reaching the feeding trays by smearing the posts of the bamboo frame with a stick-fast, e.g., crude petroleum or a mixture of castor or mustard oil and resin boiled together.\* The use of any such substance is at present unknown. Painting the posts with common kerosine oil may also prove useful against ants.

The silkworm fly (*bor mákhi*) is perhaps the greatest pest of the *pat* worm, as it is also of the *eri* insect. It is most common from April to September, and on this account, very little rearing is done during the hot and rainy season. It occurs, however, more or less at all times of the year, but are much less numerous during the autumn and winter months. The fly is kept in check by keeping the rearing room dark and by smoking from a smouldering fire to which resin (*dhuna*) is added from time to time. Young worms are protected by being kept covered with cloth, and some rearers cover the feeding frame with a mosquito curtain to keep out the fly. None of these measures is fully effective. The fly can be wholly prevented by using fine wire-netting or perforated zinc sheets in the way already described in Chapter II (paragraph 20).

In Assam the mulberry silkworm is probably as much subject to disease as it is in Bengal.† We have examined a large number of diseased specimens under the microscope (*vide* Appendix I) and found abundant evidence of *pebrine* and *flacherie* which are the two worst diseases of the mulberry silkworm. We have also seen specimens attacked with *grasserie*. Many of the specimens were re-examined in the laboratory of the Imperial Entomologist with very much the same results as we found. The only disease of the mulberry silkworm of which we have found no evidence as yet is muscardine which next to pebrine is the most dreaded disease of the silkworm in Bengal.

Science has placed within the reach of the silk grower means of successfully combating the diseases mentioned above. The chief means are the use of cellular seed, the regulation of the temperature, humidity and ventilation of the rearing house, and the disinfection of the house and all appliances used in the feeding and handling of the worms. These measures do not cost much, but to be effective they must be carried out in a thorough and systematic manner. They are in regular use in every advanced silk-growing country in the world, and are gradually becoming popular in Bengal. Whether they will appeal to the Assamese rearer, one cannot very well tell beforehand. Any improvements we may suggest to him must be proved by actual demonstration before he can be expected to adopt them. At present he is not aware that the diseases from which his silkworms perish are at all preventible. He often sees entire broods being carried off by disease, but he is content to ascribe the loss to malign influence and ill-luck. Such is his ignorance in the matter that he does not yet possess a distinctive name for any silkworm disease, and is unable when asked to give a consistent account of the symptoms which characterise each disease.

64. No attempt has been made by Government to develop the culture of the mulberry silkworm in the Assam Valley. Writing to the Government of India in 1877, Colonel Keatinge observed that the question of extending the *pat* silk industry need not be seriously discussed. The industry has perhaps undergone a decline since then; and new conditions (*vide* paragraph 55) have arisen which tend to depress it still further. The question now is—should we let the industry die a slow death or should we make an effort to revive it and, if possible, to extend it? The climate of the Assam Valley is well suited to the culture of the mulberry silkworm, and it would have been quite feasible to improve and extend the industry if the people were possessed of the requisite intelligence and enterprise. But unfortunately the mass of the people are extremely conservative and slow to move, and they are too well off to make any special exertion for the betterment of their material condition. Apart from this difficulty, a special odium attaches to the rearing of the *pat* worm which makes it impossible for any Hindu outside the Katoni caste (rather a particular section of that caste, the *Polupohas*) to rear this silkworm. The *Polupohas* are a numerous class in Assam, and if any attempt is made to improve or extend the culture of the *pat* worm, it is proper that it should begin with these people. Among the Mussalmans and the

\* Boil castor oil 1 seer and *dhuna* (sdl resin)  $\frac{1}{2}$  seer together for 8 or 10 minutes, and add a little water and keep the paste for application when wanted.

† Mr. M. N. De, Sericulturist of the Pusa Research Institute, who was lately on a visit to Assam, thinks there is less disease among mulberry silkworms in Assam than in Bengal, probably due to the disinfecting action of smoke from the household fire which is kept up all day in the dwelling house of every Assamese cultivator.



animists there is no social or religious bar against the rearing of the *pat* worm. An attempt may be made to introduce it among these classes. I have some hope from the Muhammadans of the Assam Valley who, generally speaking, possess more enterprise than the Hindus. We have seen that some Muhammadans are already engaged in the rearing of the *pat* worm (paragraph 55). A Muhammadan gentleman of Gauhati has, at my advice, put out a small area of mulberry and intends to commence rearing shortly. It is to be hoped that he will succeed and his success may lead others to follow him. During my visit to the Mech country in Goalpara, the leaders of the community expressed to me a strong desire to be taught the art of growing mulberry silk, and I was told that they had submitted a petition to this effect to the Chief Commissioner. These Meches, some 45,000 in number, have been converted within the last decade to a liberal form of Hinduism under the spiritual guidance of a Hindu ascetic, and are now actuated by a keen desire for social and material improvement. I think these people ought to be encouraged. It may prove easier to teach them modern methods of sericulture than to introduce these among the existing rearers who will be naturally reluctant to change their old methods.

It would be idle to mention here the many improvements in the rearing of the *pat* worm which could be introduced if the social and economic conditions of the country were favourable. Some of these improvements have been already indicated. There is one, however, which I have not yet mentioned and which seems to me fairly easy to introduce. I mean the introduction of improved races of the mulberry silkworm. The European univoltine silkworm is expected to thrive well in the climate of the Assam Valley. Like the native *bor polu* it should be reared in the early spring (middle of January to middle of March). The European silkworm has been grown successfully at Shillong for many years in succession. The weather conditions at Shillong during the rearing season (April-May) are very similar to those which prevail in the Assam plains during the earlier months of the spring. Moreover, the European silkworm has been successfully grown at Pusa and in the plains of the Punjab and the United Provinces. There is, therefore, every reason to believe that it will take kindly to the climate of the Assam plains. On this point, I was able to consult Mr. Goodman, of the firm of Messrs. Anderson Wright & Co., who is regarded as an authority on sericulture in India. He is of opinion that the native races of silkworms are hopelessly degenerate, and no improvement is possible with them. He advises that all future efforts to revive the mulberry silk industry in Assam should be restricted to one crop of the European univoltine in the year. Mr. Goodman has no faith in the native multivoltine races, though he believes that crosses between them and foreign univoltines may be found to thrive well. A very interesting experiment in this line is now in progress at the Government Sericultural Station at Berhampur in Bengal.

I have already initiated some experiments to test the suitability of the European univoltine worm to the conditions of Assam. For this purpose two ounces of eggs of a French univoltine silkworm have been distributed among a number of Katoni rearers in Mangaldai, Jorhat and Nowgong. The results of the trials will be embodied in the report if they are received by me in time.\* It will be comparatively easy, I think, to introduce this new breed if found successful. I have shown cocoons of the French worm grown at Shillong to many rearers in Assam; they yield three times as much silk as the native *bor polu*. They all expressed a desire to be supplied with seed of this new worm. The new breed will have this disadvantage that it will entail upon the rearers the necessity of importing fresh seed every year. The eggs of all foreign univoltines must be exposed for several weeks to a certain degree of cold (below 50°F.), otherwise they fail to hatch evenly and the worms suffer in vigour and health. This degree of cold is never reached in the Assam plains. Consequently the seed must be obtained annually from a cold country. This will be a difficulty, but it can be met by making arrangements with some private firms for the supply of eggs.

65. I have already alluded to the experimental rearing of the European silkworm at Shillong. The experiment was started in 1904 at the instance of Sir Bampfylde Fuller, then Chief Commissioner of Assam, and has been repeated annually since that year with almost uniform success. In 1912, the experiment together with the Fruit Garden at Umyngka where the rearing house is located, passed into the hands of the local Roman Catholic Mission and is being continued by them on a somewhat extended

\* The results of the trials have since been received. The French worms grew well till they were about to ripen when most of the insects died with symptoms characteristic of flacherie. It seems the worms did not feed well on the local mulberry. Some of the worms ripened and formed cocoons which were of excellent quality. Some of the experimenters have expressed an earnest wish to repeat the trial and to be supplied with seed or cuttings of the kind of mulberry suited to foreign silkworms. I have arranged to obtain cuttings for them from Pusa and Shillong.

scale. The rearings have been made with seed annually imported from France and Italy. For some years, locally raised seed has also been used. It was at first feared that the winter temperatures of Shillong might not be sufficiently low for the proper hibernation of the eggs of the European moth, but experience has shown that eggs hibernated at Shillong hatch with perfect regularity and the worms do not suffer from deficient vigour or health. The cocoons produced from locally raised eggs have been found to be just as good as those obtained from imported seed. Samples of Shillong grown cocoons have been sent at different times to a French expert, M. De L'Arbousset, for valuation and pronounced by him to be as good as the average of French cocoons, and some to be equal in point of quality to first class cocoons, selling in the French market. The cocoon crop of 1906, amounting to 7·980 kilograms (dry) was sent to M. De L'Arbousset for sale; he got the cocoons reeled and the silk which weighed 2·270 kilos was sold for 113·50 francs, which, after deducting 13·60 francs as cost of reeling, left 99·90 francs as the value of the cocoons. In Indian weight and money, this meant Rs. 7 per seer of cocoons, and as the cocoons had been dried to one-third of their original weight, it meant one-third of Rs. 7, i.e., Rs. 2·5-4 per seer of green cocoons—a price which is almost three times what is paid for *desi* cocoons in Bengal.

65A. We have been endeavouring for some years past to introduce the culture of the European silkworm in the Khasi and Jaintia Hills, but so far with little visible success. Three Khasia youths have received a training at Government expense at the Rajshahi Sericultural School, and two of them have been helped with a subsidy of Rs. 250 each for the erection of a rearing house and with the free gift of a microscope. Both these men are now rearing silkworms on a small scale. Large quantities of mulberry plants have been distributed to Khasia cultivators. For two or three years we purchased at a fixed price (Rs. 2-8 per seer) whatever cocoons were brought to us for sale, and we also gave prizes for mulberry plantations. But all these measures failed to produce any tangible result. No steps were, however, taken to teach the people how to rear silkworms, and to bring its advantages home to them by actual demonstration. Our efforts were confined to the immediate neighbourhood of Shillong where the people are well off and can always count upon getting various kinds of lucrative employment.

The Roman Catholic Mission to whom the sericultural experiment was transferred three years ago has not only continued the experiment on the lines which we had initiated, but has given it a wider scope than before. The Mission has erected a large rearing house at a cost of Rs. 3,000, of which one-half has been contributed by the Government. A number of orphan boys have been taught the rearing of silkworms, and two of them have returned home after undergoing a course of practical instruction in reeling silk at a European filature in Bengal. The Mission has built a reeling station at the Fruit Garden and is now prepared to purchase any cocoons that may be brought to them for sale, thus creating a demand and facilities for sale which hitherto did not exist. So far the prospects seem hopeful, and I think the time has now come for making a fresh and vigorous move. I do not think the efforts of the Mission will bear much fruit without the active co-operation and financial support of Government. For this purpose, a much more vigorous policy of encouragement is necessary than we have pursued in the past. The hill districts of Assam appear to me well adapted for the rearing of the mulberry silkworm, and there is very little in the way of minor industries in those districts to occupy the spare time of the people who, as a rule, are very poor. It will not be unreasonable, therefore, to expect that Government should lay out a few thousand rupees annually in introducing a new, easy and profitable cottage industry in the hill districts of Assam. If an annual grant of, say, Rs. 5,000 were available, I would employ a special sericultural officer for the hill districts, and a suitable number of itinerant assistants, all being natives of the hills and able to move about and mix freely with the people. I would establish a number of small demonstration centres, each with a small plantation and rearing house, at which these men might give practical lessons to the villagers in the rearing of silkworms. A part of the grant might be set apart for awarding a premium on each pound of cocoons offered for sale. Without some such measures to supplement the work of the Roman Catholic Mission, it will be idle I fear to look for the speedy introduction of sericulture in the hills. It may be quite feasible to enter into some arrangement with the authorities of the Roman Catholic Mission whereby they might take charge of the whole of the sericultural propaganda in the hill districts on receipt of an annual subsidy from Government. It would certainly be a cheaper and perhaps more effective arrangement than if Government were to pursue a wholly independent line of action:

I am fully aware that the foregoing recommendations run somewhat counter to observations made by the Director of Agriculture in paragraph 32 of the Annual Report of the Agricultural Department for 1912-13. He considers that our efforts to introduce exotic silk in the hills are a needless diversion of energy and observes that if anything in the way of sericulture is to be undertaken, we should, in the first place, improve and place on a sound basis the existing silk industry in the Brahmaputra Valley rather than strive to create in the hills a new industry which is perhaps not wanted. In my humble view the two problems are wholly unconnected, and both of them deserve the attention of the State. I have given some reasons why the introduction of sericulture should be encouraged in the hill districts, and it seems to me that it may prove an easier task to introduce silk in a new country than to improve an old industry carried on under conditions and by rules which have become stereotyped by age.

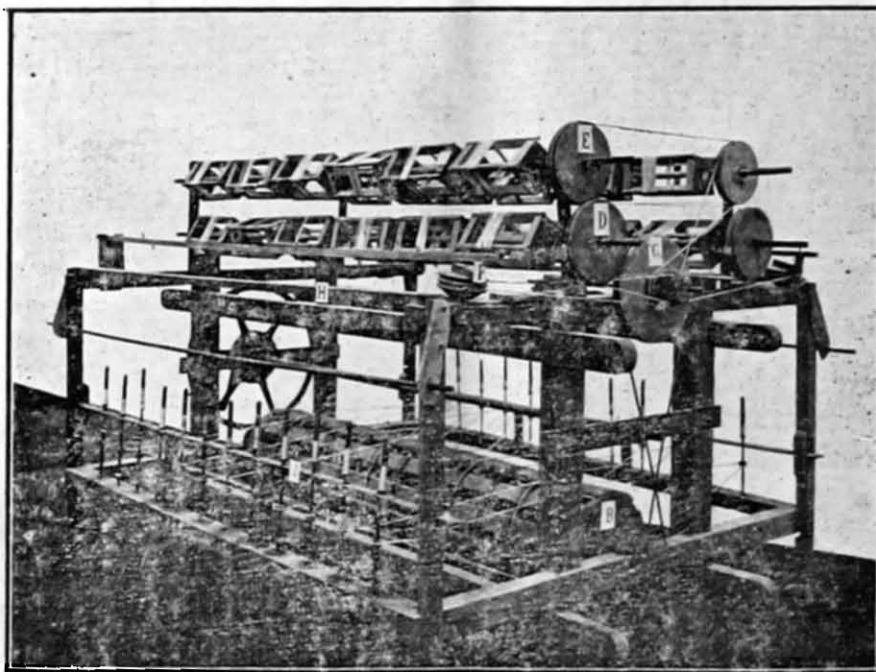
Plate IV



*Reeling of Pat.*



*Re-reeling.*



*The Surat Twisting Machine.*

## CHAPTER V.

## THE REELING AND SPINNING OF SILK.

66. The fibre of silk cocoons is extracted either by reeling or by spinning. Reeling consists in drawing out the natural single filaments of a number of cocoons and uniting them into a single thread which is taken up and wound round a revolving frame, called a reel or, as in Assam, round a wooden roller which is made to revolve like a reel. Reeled silk is known in the trade as *thrown* or *net* silk. For the purpose of reeling the requisite conditions are :—

(1) The natural filament should come off easily on being drawn out. In the cocoon the filament is bound together by a natural gum which must be softened or removed to permit of the fibre being pulled out without breaking. The cocoon of the *muga* silk worm contains a tenacious gum which has to be washed out by boiling the cocoon in alkali water. In the cocoon of the *pat* worm the gum is merely softened by boiling in plain water for a few minutes. (2) The filament of the cocoon should be capable of being drawn out in a continuous line and not in broken lengths which cannot be conveniently dealt with in reeling. Pierced cocoons, *e.g.*, those from which the moth has emerged in the ordinary course of nature or cocoons that have been pierced by the maggot of the silkworm fly are unreelable on account of the fibre having been torn at the hole which the moth or the maggot made for its escape. The *eri* cocoon also cannot be reeled, partly because the filament is not continuous, being laid in short lengths of a few yards, and partly perhaps on account of the entangled manner in which the worm lays the fibre round the natural aperture which it leaves for the exit of the moth. *Eri* cocoons being unreelable are treated as a form of silk waste.\* And (3) the filament should come off without getting entangled. Every cocoon has an outer covering of silk in which the fibre is so loosely and irregularly arranged that in trying to draw off, it gets entangled into knots. This loose outer silk, known as floss, is consequently unreelable. The floss of the *muga* cocoon is known as *jothá* (literally waste) or *dhahá*. The *pat* cocoon yields very little floss, and what little floss is obtained is usually thrown away.

Underneath the floss, the silk filament lies arranged in a continuous line in the shape of innumerable figure of eight loops which are laid over one another in such a way as to form a more or less compact layer. It is from this portion of the cocoon that reeled silk is obtained. The aim of the reeler is to get hold of this filament as near to its upper end as he can. In careful reeling, not only is the floss pulled off but with it a portion of the inner layer of the fibre is taken out, until what is known as the true end of the filament is found, that is to say, until the filament comes off in a single line.

Much of the reeling done in Assam is of a most careless nature. The true ends are never thought of, and even much of the floss is deliberately taken up with the reeled thread. All *pat* silk and the low grades of *muga* silk which are exported for the purpose of embroidery are reeled in this rough and ready fashion. This explains why very little waste is obtained from *pat* cocoons in Assam. In Bengal, the waste, known there as *chasam*, from mulberry silkworm cocoons amounts to a considerable percentage on the yield of net silk. The better kinds of *muga* thread are reeled with the greatest care, and in spite of the crude nature of the reeling apparatus the thread obtained is of a decidedly good quality.

The inner part of a cocoon (called in Assam *koli* or *bari*) is unreelable, because the cocoon which floats in water during reeling gets heavier (relatively to water) as it parts with its silk coating, and ultimately becomes so heavy as to break the filament. The *koli*, therefore, ranks as waste. Some *muga* reelers take the trouble of unwinding the *koli* by hand, but as a rule, they are spun along with other silk waste. The *koli* of the *pat* cocoon is so thin and contains so little silk as to be of little or no account. No use is, therefore, made of it. In *muga* cocoons, however, the *koli* contains a fair amount of silk which is spun like any other form of silk waste and yields a superior quality of spun yarn.

67. The different forms of silk waste mentioned above are (1) *eri* cocoons, (2) pierced *muga* cocoons, (3) pierced *pat* cocoons, (4) floss (*jotha*) of *muga* cocoons, and (5) inner layers (*koli*) of *muga* cocoons. All these kinds of waste are treated more or less alike, being spun

\* Mr. E. Stack, in his Note on Silk in Assam, mentions that the *eri* cocoon has been successfully reeled in Italy and experiments have shown that it can be reeled in India. This can perhaps be done only by using some automatic device by which the short filaments of a number of cocoons can be taken up and united without having to search for their ends as is necessary in ordinary reeling. The Jette-bou reeling machine may be able to do this, but I do not know if it has been tried with *eri* cocoons.

into thread in somewhat the same fashion as cotton. Hand-spun silk is almost devoid of lustre. The lustre of silk is due to the reflection of light from its smooth surface. In net silk a number of filaments are arranged in a more or less parallel or at least a regular order, with the result of intensifying the reflected light, while in hand-spun silk the filaments are twisted without order, and the light being diffused from innumerable little reflecting spots is not strong enough to make the silk shine. In machine-spinning, the silk fibres are made to undergo a process of combing which results in their being arranged in parallel order. Mill-spun silk consequently possesses more or less lustre, though not to the same extent as reeled silk. The machinery for spinning silk waste has reached such perfection that the superior grades of spun silk are not much inferior to reeled silk in point of fineness or lustre.

Mill-spun silk, though ever so superior to hand-spun silk in point of appearance, cannot be expected to possess the same strength and durability as the hand-made article. As yet, it has attracted very little attention in Assam, though it has come into extensive use in other parts of India. Several persons have been, at my instance, trying mill-spun silk to see whether it can be woven on the Assamese loom and what kind of cloth it will make.

68. For reeling as well as spinning, *eri* and *muga* cocoons need to be previously boiled in an alkaline solution in order to wash out the natural gum of the silk. *Pat* cocoons do not need this preliminary treatment.

The alkaline solution is prepared as follows. A quantity of ash is placed in a closely woven bamboo funnel, and water poured over it to leach out the alkali in the ash. The filtrate is caught in a vessel placed below the funnel and is known as *kharoni* (*khár* or alkali water). *Khár* water is extensively used all over the Assam Valley in cooking, in washing, bleaching and dyeing yarn and cloth and in degumming silk. Ashes of various plants are used for these purposes. Those obtained from plantain stems, castor stems and leaves\*, *keseru* wood, mustard and *mati-kalai* plants are considered best suited for degumming silk. The quantity of ashes used is about half as much as the cocoons to be boiled. The cocoons are boiled in the alkali water usually for two or three hours, and taken off when the fibre is found to come off easily on pulling.

In degumming *muga* cocoons some slimy substance is sometimes added to the boiling liquor with a view to make the filaments come off readily and to reduce the abrasion on the reeler's arm which is caused by the rubbing action of the thread. The substances ordinarily used for this purpose are the core of the *owtenga* fruit (*Dillenia indica*), *simul* bark (*Bombax malabaricum*, and leaves of the *ageru* (*Sida sp.*) and *láfa-ság* (*Malva arvensis*).

*Eri* cocoons after they have been boiled in alkali water are kept wrapped in green arum or plantain leaves for 3 or 4 days. The object is to soften the inner core of the cocoons which takes longer time to loosen than the outer layers of the fibre. Sometimes the cocoons have to be boiled in alkali a second time, if the foregoing treatment is found insufficient. When the fibre is found thoroughly loosened, the cocoons are washed in water, and any insect remains, they may contain, are removed. For the latter purpose, the cocoons, while floating in water, are gently stroked with the fingers which cause them to flatten out in the form of thin circular discs. The cleaned and washed cocoons are then dried and stored till required for spinning.

69. The Assamese reeling apparatus (Plate IV) known as the *hál* or *bheer* is a very simple contrivance. Its component parts are (1) an earthen basin for holding water in which the cocoons to be reeled are placed; the basin is mounted over an open fire place for boiling or heating the water. (2) A thin stick (usually a fern stem) supported on (3) two bamboo uprights and placed across and a few inches above the basin; the thread is passed over the stick on its way from the basin to the reel. *Pat* cocoons are very light in weight and apt, therefore, to leap out of the water when the thread is pulled on to the reel. In reeling them a pair of sticks is used instead of one.

\* Castor ash was analysed at Pusa and found to be a mixture of the sulphates and chlorides of Magnesium and Potassium together with 28.3 per cent. of Potassium carbonate, which latter is the saponifying agent. Ash can be easily replaced by washing-soda used to the extent of 25 per cent. of the weight of the cocoons. Boil for 45 minutes; remove the cocoons and wash; then, if desired, boil for a few minutes in a soap solution (using soap equivalent to 10 per cent. of the weight of silk), wash in water till clean. Cocoons so treated will be quite clean and white. I have found this recipe quite good, except that the boiling needs to be longer than 45 minutes for loosening the fibre thoroughly.

The thread is carried between the sticks which keep back any cocoons that happen to leave the basin. In some places the cross stick and uprights are replaced by a thin bamboo stick placed slantingly over the rim of the basin on that side of it on which the reel stands. The top of the stick is split and held apart by a short stick bent to the shape of a bow, over which the thread is carried.

(4) Two more bamboo uprights placed about 2 feet from the basin.

(5) A horizontal wooden shaft with pivots at the ends which rest in notches on the inner sides of the two uprights just mentioned; this shaft constitutes the reel on to which the thread is wound. Sometimes, a hollow bamboo joint is fitted over the shaft to permit of the thread being removed from the reel, whenever desired. And (6) a wooden wheel about 7 inches in diameter or a piece of wood cut to the shape of a figure of 8. It is mounted on the left hand side of the shaft and serves the purpose of a fly wheel.

Process of reeling *pat* silk.

70. Two women\* are required for working the apparatus, one to draw the silk from the cocoons, the other to wind it on the reel.

Plate IV shows the method of reeling *pat* silk. The basin is filled with water which is brought to the boil. The women sitting near by throws a handful (some 20 or more) of fresh cocoons in the water and keeps them stirring with a stick. Within a minute or two the cocoons are found adhering by their filaments to the lower end of the stick which is then lifted with the left hand, while with the right hand she pulls down the cocoons so as to unite the several filaments into a single strand or thread. She then nips off the thread, separating it from the floss adhering to the stick, and passes the end of the thread through the pair of cross sticks on to her companion sitting on the far side of the reel. The latter ties the end of the thread on to the shaft, pulls out a fresh length of thread with her right hand, lets it pass down the underside of her forearm from the elbow to the thumb, and then gathers it on to the reel by giving the shaft a rub with the palm of her right hand or by giving an occasional push to the wheel or piece of wood which acts as the fly wheel. As soon as one length of thread has been wound, another is pulled out and treated in the same way. The woman sitting near the pot continues to add handfuls of fresh cocoons from time to time, treating them in the manner above described and taking care that the cocoons which are being reeled at one time may not be too many or too few. As the filaments are being drawn out, the cocoons keep on moving and turning in the water, and when fairly exhausted of their silk content, they break away from the thread and sink. Such cocoons as break away prematurely are brought back with a stick and kept on moving among the reeling cocoons in order to help their filaments to be caught up by those of the latter.

The object of letting the thread pass down the forearm is to twist the individual filaments into a single thread. The twist is very slight perhaps not more than two to the inch. In other reeling machines such as those used in Europe and Bengal, the filaments are consolidated by what is known as *croisures*, *i.e.*, by crossing two threads upon each other or the same thread upon itself a number of times during its or their passage from the basin to the reel. The *croisures* not only help to bind the filaments together, but give the thread a rounded shape.

The process of reeling *pat* silk, as described above, is very defective in two respects—First, there is no fixity in the number of cocoons reeled together; it remains a matter of chance, though the reeler takes some pains to regulate the number. Secondly, no attempt is made to find the true ends of the filaments, and a great deal of floss is left in the thread. The result of these defects is that the thread is thick in some places and thin in others, and must be sorted into lengths of even thickness before it can be used for weaving. These defects are not inherent in the reeling apparatus, but in the mode of manipulating the cocoons. They do not occur in the reeling of the better qualities of *muga* thread, in which the reelers carefully keep to a fixed number of cocoons, and the true end of each filament is found before it is joined on to the thread.

*Pat* cocoons being much smaller in size, it is perhaps found slow and inconvenient to deal with each individual cocoon as is done with the *muga*.

71. The process of reeling *muga* silk is almost the same as for *pat*: the only differences are as follow:—(1) The water in the basin is not heated to boiling, but is either cold or kept luke-worm over a slow fire. Good cocoons can be reeled in cold water; for inferior

Process of reeling *muga* silk.

\* Reeling is principally a female occupation, though it is not uncommon to see men taking part in the work.

cocoons which do not readily part with their filaments, the water has to be heated, but must not be so hot as to scorch the hand. (2) The cocoons are taken up one by one; the floss is plucked off and the inner filament drawn out until the true end is found. A number of these filaments, varying according to desired thickness from 6 to 20, are put together to form a thread which is then passed over the cross stick (single in this case) on to the reel. But all *muga* reeling is not done with equal regard to the quality of the thread. As already mentioned, a great deal of *muga* thread of inferior quality is prepared for purpose of export. Being used for embroidery, the quality of the thread is of little account. In reeling such thread a great deal of the floss is deliberately put into the thread.

72. Two women can reel 1 to  $1\frac{1}{2}$  totals of thread (*pat* or *muga*) per hour, according to the care with which the reeling is done. In the reeling of *pat* cocoons, the floss amounts to very little and is of no account. With the *muga* the proportion of waste to reeled silk is variable, amounting in careful reeling from 60 to 80 per cent. on the outturn of reeled thread, but very much less in case of inferior thread.

73. Mention may be made here of a reeling apparatus known as the *uni*, which is used for reeling *pat* silk in a few villages round Sipajhar in the Mangaldai subdivision. It consists of the usual basin, a forked stick through which the thread is carried from the basin to the *uni*, and the *uni* itself which is nothing but a double cross made by tying two short sticks across another stick of wood about 18" long. The thread is wound round the cross sticks in the shape of a double triangle and crossing upon itself at the common apex. The apparatus is worked by a single woman. She holds the *uni* in her left hand; with her right hand she pulls out the thread, lets it down her left forearm, and then lays it on the *uni* in the manner mentioned above. She has also to attend to the boiling and manipulating of the cocoons, following exactly the same process as with the common reeling apparatus. While attending to the cocoons she lays aside the *uni* which she takes up again after joining the ends of the cocoons to the thread. The reeling, therefore, goes on in an intermittent fashion, and is necessarily very slow. It is claimed, however, for the *uni* that it produces a better quality of thread than the *hāl*, inasmuch as the reeler, having the thread always before her eyes, is in a better position to regulate its thickness, and she can remove any clots of silk or debris of the cocoons that may accidentally come up with the thread.

74. The Bengal reeling machine which was introduced by the East India Company some 150 years ago is decidedly superior to the crude apparatus used in Assam, in point of the outturn of silk that can be obtained in a given time. It may produce from 6 to 12 chataks of silk in a day of 10 hours, that is, at least twice as much as can be turned out by the Assamese reel. It must, however, be remembered that in Bengal, the reelers are professional men who work for a wage, while in Assam reeling, like rearing and weaving, is for the most part a domestic occupation in which the workers are mostly women working during leisure hours, often as a pastime and not for a living. As to the quality of the thread, the Bengal machine, as it is worked in the villages, does not seem to possess any very decided advantage over the Assamese reel. The quality in either case depends upon the skill and care of the reelers. The Bengal reeling machine, when used in a filature, is capable of producing silk of superior quality with which neither Bengal *khamru* (village reeled) nor Assamese reeled silk can compare. But a filature is equipped with machinery and appliances which are out of the question in village reeling. These considerations make me doubt whether the Bengal reeling machine or any other type of improved reel will be an advantage to the Assamese silk reeler. There is, however, one class of people, *viz.*, the professional *muga* reelers of Sualkuchi, to whom an improved reeling machine may commend itself. They are well-to-do people who may not object to spend a little money on a reeling machine (the Bengal machine costs about Rs. 8), if they can obtain a greatly increased outturn of silk from its use. I would strongly recommend a trial of the Bengal reeling machine being made at Sualkuchi to test this point.

There is one little improvement which can be easily introduced in the Assamese reel. We have seen that the thread is carried over a cross stick or between a pair of cross sticks on its way from the basin to the reel. In the Bengal machine as well as in all other improved types of reeling apparatus, the thread is passed through a minute hole in a glass or porcelain button, which serves to



keep back (1) any cocoons that may leap out of the basin, and (2) any clots of thread or fragments of cocoons that may come up with the thread. The cross sticks in the Assamese machine fail to keep out the latter and may be replaced with great advantage by a button.

75. As soon as reeling is over, the wooden roller on which the silk has been wound is detached from the reeling apparatus, and the thread is transferred with the help of a spinning wheel to a *nátái* or bamboo reel in the manner shown in the accompanying illustration (Plate IV).

The *nátái* takes the place of the spindle and made to revolve by turning the handle of the wheel. As it revolves, it takes up the thread from the roller which is set at a slight angle to the ground and with one end facing the *nátái*. As much thread is taken up at a time as will form a skein about a *tola* or less in weight. The skein of silk is slipped off the *nátái* and kept hanging in shade, till thoroughly dry.

The re-reeling is done, as a rule, by the reeler herself and generally as soon as the reeling of the cocoons has been finished. A curious departure from the rule is found in a tract of country popularly known as Jamira in the Dibrugarh subdivision. The rearers of this place sell the bulk of the *muga* thread they produce not in skeins as elsewhere, but on the *konrhás* or wooden shafts on which it has been wound in the process of reeling and in a more or less moist condition. The *konrhás* are bought up by Marwari traders who have to re-reel the thread and form it into skeins before it can be sold. Deductions have to be made for the weight of wood and for moisture and give rise to much higgling between the sellers and the buyers. The practice of selling *muga* on *konrhás* is said to be of very recent origin and is characterized by fraud and deceit.

76. *Pat* cocoons are reeled by those who grow them and all of whom, with the exception of a few Muhammadans, belong to the Katoni caste. No other class of people in Assam will have anything to do with the rearing or reeling of mulberry silk. *Muga* silk, on the other hand, is reeled by every class of people from the lowest to the highest. Much of the reeling is done by the rearers themselves, but perhaps the greater part of the cocoon crop is sold to house-holders who reel thread for their own use or to people with whom reeling of *muga* is a profession. *Muga* reeling is carried on a fairly extensive scale as a profession in the villages lying for some miles round Palasbari and at Sualkuchi on the opposite bank of the river. The animistic tribes—Kacharis, Rabhas, Garos and Mikirs—living in South Kamrup are still unacquainted with the art of reeling, though they grow *muga* on a considerable scale. The cocoons grown by them mostly find their way to the Palasbari and Chhaigaon *hátis* and are there bought up by the professional reelers of Sualkuchi and the country round Palasbari. Another tract where *muga* reeling is carried on as a profession is a group of villages including and adjoining Sipajhar in the Mangaldai subdivision. Sualkuchi and Sipajhar enjoy a reputation for the excellent quality of the *muga* thread they produce.

77. There are three distinct processes of spinning *eri* silk and other kinds of silk waste, each with slight local variations in different parts of the country. In two of these, the spindle (*tokorá* or *tákuri*) is used for twisting the thread; in the third, the twisting is done by means of the spinning wheel (*jator*). In the first process a number of cocoons are arranged one over another in the form of a cap on the top of a short stick which may be called the distaff and moistened with water. The distaff is held in the left hand and a thin wisp of fibre is pulled out by the right hand and attached to the top of the spindle which is then given a sharp spin with the fingers and let to hang down. While the spindle is turning round, the spinner draws out a fresh length of thread and as soon as she finds it has received enough twist, she takes up the spindle and gathers the thread on to it. In drawing off the fibre she endeavours to keep it to an even thickness by stretching with her fingers any portion where the wisp of fibre appears too thick or adding more fibre when it looks too thin. In the second process, the spindle is used but not the distaff and the cocoons are spun dry. A number of cocoons are taken and carded by hand so as to thoroughly loosen the fibre which then looks almost like a mass of cotton wool. The carded *eri* is then arranged into a bunch which is tied to a post. The fibre is then drawn off and spun with the spindle in the same way as in the first process. In some places, the cocoons are taken one at a time; the fibre is loosened and wrapped round the palm of the left hand and then spun in the usual way.

The two processes of spinning described above, in both of which the spindle is used, are in vogue among the animistic tribes and to a large extent among the people in the plains. Thread spun with the spindle is known as *tokorá-kátá*, *tákuri-kátá*, etc. (literally spindle-spun), and is of better quality than thread spun on the wheel.

In the third process, the cocoons are placed on a distaff and moistened with water, as in the first process; the fibre is drawn off as a long continuous strand which is allowed to fall into a cup of water in which it accumulates and forms a clod (*chápuri* or *chaporá*). The clod of thread, as yet untwisted, is removed from the water, and twisted by means of a spinning wheel. Thread prepared by this process is known as *chápuri-kátá*. This process is in common use among people living in the centre of the valley. *Chápuri-kátá* thread is usually too thick and uneven, and is used in the manufacture of inferior goods. A good quality of thread can, however, be prepared by this process, if care be taken to ensure evenness of the strand as it is being drawn off the cocoons.

78. Spinning is a very slow process, especially with the spindle. Usually a woman, in addition to her household work, can spin only 2 tolas of thread in a day. If she were to spin the whole day, she might turn out about twice that quantity. When the spinning wheel is used as in the third process, the outturn of thread is considerably increased, though the thread is of inferior quality. One seer of clean *eri* cocoons yields about  $\frac{3}{4}$  of a seer of spun thread, the remainder being gum washed out by boiling.

79. I procured two pairs of hand combs (such as are used in the combing of wool) from the Salvation Army and made some experiments to see if they would be of any advantage in the spinning of *eri* silk. Only one pair is used at a time. The combs tear up the long filaments into lengths of 4 to 8 inches, and arrange them in parallel order. The fibres are then removed and rolled into slivers for spinning. I found it difficult to spin with the spindle out of a sliver prepared as above; the fibres being straight and slippery, and there being no entanglement, are pulled off every now and again by the weight of the spindle, causing the thread to break. With the spinning wheel, however, the spinning was found to be much easier and a much larger outturn of thread could be obtained than by any of the processes used in Assam. I am not sure about the quality of the thread. My trials could not be continued long enough for want of time, but I was led to believe that the use of hand combs in combination with the spinning wheel might be an advantage in the spinning of *eri* silk.

80. Appendix II(a) contains a statement showing the exports of raw and manufactured silk from Assam for every year since 1882. The second and third columns of the statement show the exports of raw silk the principal components of which are *muga* thread and *eri* cocoons. No other form of raw silk is known to be exported from Assam, except a trifling quantity of *eri* thread sent from the Assam Valley to the Buxa Duars. Almost the whole of the raw silk shown in the statement was exported from the Brahmaputra Valley. If we deduct the quantity and value of the cocoons, as shown in columns 6 and 7, from the quantity and value of raw silk shown in columns 2 and 3 of the statement, the difference will represent the quantity and value of *muga* silk exported from the Brahmaputra Valley: I would not attach any importance to the figures of value shown in the statement, since the rates adopted in calculating them were simple arithmetical averages of the reported prices of *muga* silk and *eri* cocoons—articles which are of widely different value—without reference to the quantity of each class of goods exported. Restricting ourselves to a consideration of the quantities of raw silk exported, we find that the exports of *muga* silk (column 2 minus column 6) fluctuated between 1,437 maunds in 1890 to *nil* or very nearly *nil* in the three years 1899 to 1901. The average annual exports for the 26 years between 1883 and 1911-12\* amounted to 542 maunds which, taking the price of *muga* silk at Rs. 400 per maund, would be worth Rs. 2,16,800.

The actual exports of *muga* silk are believed to be much greater than those shown in our trade returns. Considerable quantities of *muga* silk as well as *eri* cloth leave the country by post or are booked by passenger train, and fail to be registered; and I am also told that consignors of silk do not always declare the nature of goods for fear of its being stolen. That a great part of the silk exported from Assam escapes registration will be at once evident from statistics of export of manufactured silk during the past seven years. It will be seen that in six out of the seven years, the exports amounted to *nil* and in the remaining year to

\* The figures in columns 2 and 6 for 1912-13 are evidently wrong. See column of remarks.

only one maund! But this could never be the case. We all know that large quantities of *eri* cloth annually leave the province for Bengal and other parts of India; the reason for its not appearing in our trade returns is that the whole or almost the whole of the manufactured silk sent out of Assam is carried by post and passenger train, both of which are outside the scope of our present system of trade registration.

Gauhati, Palasbari, Sibsagar, Nazira and Dibrugarh are the principal places in Assam from which *muga* silk is exported. Most of the silk is sent to Calcutta and Dacca and smaller quantities are sent direct to Hyderabad, Madras and other places in India. The chief use of *muga* silk outside Assam is in embroidery and also to some extent as yarn for making ornamental side and cross-borders of *dhuties* and *saris*. A species of embroidered cotton, known as *kasida* cloth, is largely manufactured in the town of Dacca; the embroidering material used is wholly *muga* silk. *Muga* silk is also in demand for the making of fishing lines. The trade in *muga* silk is almost exclusively in the hands of the Marwari community. There are some Bengali and Assamese firms who deal in this article as well as manufactured silk, but their dealings are mostly of a retail nature. Most of the *muga* silk exported from Assam is of an inferior quality, being intended for purpose of embroidery in which the quality of the thread used is not of much importance.

I have described in paragraph 75 the condition in which *muga* silk is brought to the market by the villagers of Dibrugarh. In the country round Palasbari, which is another important centre of production, the common practice with inferior grades of thread, is to tie together a number of skeins with a stout rope of jute or some other fibre, and to send the silk in that condition to the market. Water is also added to increase the weight. The fraud is so evident that no buyer is likely to be deceived, much less the Marwaris who possess a practical monopoly of the trade. The purchasers deduct the estimated weight of water and the rope, and pay for the estimated weight of dry silk. The chances in a transaction like this must be generally in favour of the buyers who are shrewd business men not easily to be out-witted by the simple country folk. I am unable to account for the continued existence of this extremely crude method of doing business. The transactions in *muga* silk are mostly for cash. The system of payment in advance is, however, not wholly unknown; it is said to be common enough in mauzas Jamira and Dhemaji in the Dibrugarh subdivision. I did not see any evidence of it in the villages near Palasbari where many poor people earn a livelihood by reeling *muga* cocoons.

81. The usual price of *muga* thread in recent years has varied between Rs. 7 and Rs. 16 per seer according to quality. But during the last three years, on account of the continued failure of the *muga* crops in Upper Assam, the price of the thread has been exceptionally high, best qualities having gone up to the neighbourhood of Rs. 30 per seer, and the lowest selling at about Rs. 12. The last autumn brood having turned out well, prices have recently gone down to some extent, but have not yet reached their usual level. The high price at which *muga* silk has been selling of late has induced many people to discard its use in favour of mulberry silk.

The present average price of *muga* thread may be taken at Rs. 20 per seer. In the thirties of the last century, according to the statements of Mr. Thomas Hugon and General Jenkins, the price of *muga* thread was Rs. 3 to Rs. 5; and in 1884 according to Mr. E. Stack, it varied from Rs. 8 to Rs. 12. In those days, *pat* silk used to sell much dearer (Rs. 16 to Rs. 24 per seer) than any other form of native silk (excepting perhaps *mezankuri* and *champá-paliyá muga* which were rare articles), but the position of the *muga* and *pat* silks has been reversed since then.

82. The total quantity of mulberry silk produced in Assam is very small, and there is little or no trade in the article. The Katonis who grow this silk use a part of it in their own weaving and sell the rest to their neighbours or to petty traders who take it elsewhere for sale. There is, however, a growing import trade in mulberry silk. It comes from China through Bombay. There is no means of ascertaining with accuracy the quantity of Chinese silk imported into Assam. It comes either by post or by passenger train and so escapes registration. Appendix II(b) purports to show the imports of silk by rail and river into Assam, but for reasons which have been stated in paragraph 80, the statistics are imperfect and almost valueless, as regards the more valuable classes of silk imported into, and exported from, Assam. I was told at Sualkuchi that some 40 to 50 maunds of Chinese silk is annually used by the weavers of that place. Smaller quantities are imported into other places in Assam. The total quantity of Chinese silk imported into the Valley may not be less than 100 maunds. The usual price of this silk is about Rs. 14 per seer or Rs. 560 per maund. The use of imported

mulberry silk is increasing fast in Assam. The competition of this silk has brought down the price of the indigenous mulberry silk from over Rs. 20 to about Rs. 16 per seer, and as previously stated it is being used as a substitute for *muga* silk.

83. The spinning of *eri* thread is not a regular profession with any class of people.

Trade in *eri* thread. In many localities, however, the women spin small quantities of thread for sale. The aggregate quantity so produced must be considerable. A great deal of *eri* thread is produced by the hill tribes of Nowgong, Kamrup and the North Cachar Hills. Most of the thread produced in the North Cachar Hills and Nowgong is exported to Manipur. This trade is of recent growth, and I am unable to estimate what it may amount to in the year, the trade between Assam and Manipur having ceased to be registered since 1909. The Kacharis of North Kamrup and Mangaldai supply considerable quantities of *eri* cloth and thread to the Bhutias who visit their villages during the cold weather. A great deal of *eri* thread is also sold to the Bhutias at the annual fairs at Darranga and Udalguri. Much of the thread sold at these fairs is imported from Bogra and Rangpur. In Appendix II(c) will be found a statement showing the exports of raw silk from Assam to Bhutan and other trans-frontier countries for the last twenty years. The raw silk exported to these countries is wholly *eri* thread. The quantity of thread exported to Bhutan used to be quite insignificant, but the trade underwent a tremendous expansion in 1911-12, when as much as 4,186 maunds of *eri* thread valued at Rs. 8,37,000 was exported to Bhutan. The accuracy of the figure has been doubted. The increase is attributed to the visit of the Raja of Bhutan to the Darranga fair on his way back from the Delhi Durbar, and to the influx of wealthy Bhutia traders who came down from Bhutan to meet the Raja at the fair. It may be also due to the introduction in that year of a paid agency for the registration of the traffic with Bhutan. In the following year, the export of raw silk fell to 1,096 maunds worth Rs. 2,09,000.

A great part of the thread exported to Bhutan is imported into Assam from Northern Bengal (Bogra and Rungpur) and is known to the trade as Bogra thread. I was told at the Darranga fair that about 100 maunds of Bogra thread had been taken away by the Bhutias this year. This thread is of a very coarse quality and dark in colour; it sells at between Rs. 4 and Rs. 5 per seer. A portion of the Bogra thread imported into Assam is used up locally in the manufacture of coarse *eri* cloth. There is no means of ascertaining the quantity of *eri* thread coming to Assam from Northern Bengal. According to the information I have received from Marwari dealers, it may amount to about 150 maunds in the year worth, say, about Rs. 30,000. Appendix II(b) purports to show the imports of raw and manufactured silk into Assam, but for reasons similar to those stated in paragraph 80, the statistics given are devoid of value.

84. The ordinary qualities of *eri* thread produced in Assam sell between Rs. 5 and

Price of *Eri* thread. Rs. 7 per seer, which is very much the same as the price quoted for *eri* thread by General Jenkins in 1833 and by Mr. E. Stack in 1884. About the beginning of the last century, Dr. Buchanan, writing about the culture of *eri* silk in Bengal, stated the price of the thread to be 12 annas to Re. 1 per seer of 96 sicca weight (nearly 2½ lbs.) (*vide* page 116 of Geoghegan's report on the silk industry in India). Superior qualities of *eri* thread sell at present at very much higher prices than those paid for the ordinary kinds, and fetch as much as Rs. 8-8 per quarter of a seer (equivalent to Rs. 14 per seer). But only a very small quantity of such thread is offered for sale, most of it being reserved for weaving at home. The best *eri* thread is produced in the country between Palasbari and Chhaigaon, which also produces the best quality of *eri* cloth.

85. There is a general impression that cotton is fraudulently mixed with *eri* in

Adulteration of *eri* with cotton. the making of much of the *eri* cloth sold at the Palasbari market. It is believed that either raw cotton is mixed with the *eri* fibre in the act of spinning the thread, or cotton yarn is substituted for part of the *eri* yarn in weaving the cloth. I have visited many villages near Palasbari and have nowhere found any evidence of such adulteration. In a village near Baihata in North Kamrup, my Assistant came across a villager who admitted that he did occasionally spin cotton with *eri* silk, and explained to him the process of treating cotton so as to make it resemble *eri* in appearance. I believe the practice of adulterating *eri* with cotton is as yet far from being general. If it is allowed to spread, it may give a set-back to the present prosperous trade in *eri* cloth. The presence of cotton in silk can be easily detected by smell on burning fragments of thread taken from the cloth, if the cotton and silk yarns are distinct. But if the two fibres have been spun together, it is impossible to detect the adulteration without a chemical test.

## CHAPTER VI.

## THE PREPARATION OF YARN FOR WEAVING.

Preparatory processes.

86. The various processes through all or some of which the yarn has to pass before it is fit for weaving are the following :—

Sorting.		Dyeing.
Doubling.		Sizing.
Twisting.		Warping.
Degumming.		Pirning.
Washing and Bleaching.		

These processes are shortly described below.

87. Sorting is necessary when the thread is of unequal thickness. Imported mulberry silk is extremely uneven and needs to be sorted into 3 or 4 grades according to thickness. Indigenous *pat* silk is also of a very uneven quality and must be sorted. *Muga* thread purchased in the bazar also needs a similar treatment. It is not usual to sort spun silk. Sorting is done by placing the skein or hank of thread on a swift (*chereki*) and transferring the thread from it to a number of reels, each carrying thread of a particular thickness as judged by the eye. Such portions of the thread as appear too coarse are rejected at the same time.

88. Doubling consists in putting together a number of threads—2, 3 or 4—and uniting them into a single thread. This is necessary in the case of much of the mulberry silk which comes from China as it is too fine to be used in Assamese weaving. *Muga* thread is sometimes doubled, but not as a rule. *Bri* thread is rarely doubled, the only instances of using doubled *eri* yarn being found among the Kacharis of North Kamrup. Doubling is done by placing 2, 3 or 4 skeins of thread on an equal number of revolving reels planted in the ground and gathering the ends from them into a single thread. The united thread is taken up on another reel, which is held in and turned by the hands. The thread is then twisted by one or other of the processes described below.

89. Reeled silk is twisted either singly or doubled. The object of twisting or throwsting as it is also called is to bind together the loose ends of the filaments which combine to make the thread, and in case of doubled thread to bind its component parts together. It also equalises the thickness of the resulting yarn. There are two methods of twisting silk in use in Assam, one for warp yarn and the other for weft which needs much less twist than thread intended for the warp. It must not be supposed that all cloths made in Assam out of net silk are made of twisted (*pakoá*) warp. The bulk of *pat* and *muga* cloths made is woven with un-twisted (*káchá*) thread and it is only for the better classes of goods that twisted yarn is used for the warp. The weft is slightly twisted in case of both classes of fabric, except that *muga* and indigenous *pat* silk, when used for weft, needs no additional twisting beyond what it received in the act of reeling.

The twisting of warp yarn is carried out on an apparatus known as the *bán*. The work as carried on at Sualkuchi is described below. The apparatus consists of two bamboo frames erected at a suitable distance from each other. Each frame consists of a cross bar of bamboo at the top, and two bamboo posts to which the cross bar is tied. The yarn, single or doubled, which is to be twisted is wound on a swift planted on the ground. The loose end is carried over the top of the nearest frame to the top of the furthest one and under the cross bar of the latter back to the top of the first frame. The top and bottom portions of the thread which lie side by side are kept apart by little bamboo pegs inserted along the tops of the cross bar at each end. The thread is then broken off and the two ends are made to hang down to the same level by two small spindles attached to them. The same process is repeated with other similar lengths of yarn to be twisted, the total number of lengths treated at one time being usually 8. As each length is arranged, the two spindles are given a spin by rubbing the axes between the palms of the hands and repeating the same action at

regular intervals while the twisting is in progress. The required twist is ascertained by the height to which the spindles have risen owing to contraction of the yarn in consequence of the twisting. As soon as each length is found sufficiently twisted, the spindles are detached from the two ends of each length of yarn; one end is then knotted on to the loose end of the swift containing the supply yarn and the other end to the loose end of a reel which takes up the twisted material. As the twisted yarn is taken up on the latter, a fresh length of untwisted yarn comes off the swift and takes the place of the twisted yarn on the frames. The process of attaching the ends to the spindles and spinning the spindles is repeated as before. The several lengths of yarn are treated exactly alike in regular succession to permit of continuous work. The number of twists may be about 15 to 20 per inch. In the case of long lengths say 180 feet as is usual at Sualkuchi and other places where weaving is carried on as a profession, guide frames at intervals of 30 feet or so are interposed between the two frames in order to prevent entanglement. The guide frames are made of bamboo splints and contain 16 square holes through which the top and bottom portions of the 8 lengths are carried. The spinning of the spindles is usually done by one or two boys who assist the throwster in his work. The duty of the latter consists in letting out the fresh untwisted yarn from a swift and winding the twisted material on to a reel. The winding is done by rubbing the axis of the reel between the palm of the right hand and the instep of the right foot. To prevent abrasion of the skin, a piece of leather is placed over the instep.

The *bán* being 180 feet or 120 cubits long, each length of thread is twice that length, *viz.*, 240 cubits, and 8 such lengths treated at one time  $= 8 \times 240$  or 1,920 cubits make a *sari* of yarn, and 16 *saris*  $= 30,720$  cubits of yarn make one *bihá*, which is just enough to furnish warp for a piece of cloth,  $10 \times 2$  cubits, which is the usual size of *pat* and *muga* cloths woven at Sualkuchi for the use of Khasia women.

A great deal of twisted warp yarn is bought and sold among the weavers of Sualkuchi; none is offered in the market. The usual price of twisted *muga* is Rs. 3 per *bihá* weighing about 8 tolas, *i.e.*, Rs. 30 per seer and of twisted *pat* about Rs. 3-12 per *biha* weighing about 13 tolas, *i.e.*, about Rs. 23 per seer.

The twisting of silk as done by non-professional weavers is performed in very much the same manner as described above for Sualkuchi; only the *bán* is much shorter in length.

Weft yarn is twisted with the help of a simple instrument which is known at Sualkuchi as the *bolondiyá*.\* It consists of two short upright sticks set about  $1\frac{1}{2}$  feet apart on a board. The yarn to be twisted is carried on a revolving reel which is stuck in the ground. The loose end of the yarn is drawn out and tied to one of the uprights. A loop of yarn is pulled off the reel and let to pass down the left forearm in exactly the same fashion as in the reeling of silk. In going down the arm, the yarn receives a certain amount of twist (which may not be more than 5 to the inch). It is then placed by the right hand over the two uprights, but in the form of a figure of 8, the intersection being at the middle point between the uprights. A fresh loop of yarn is again drawn out and treated as above, and the process goes on until the whole of the supply has been worked off.

There is a special object in arranging the yarn so as to repeatedly cross upon itself *viz.*, yarn so arranged can be subjected to washing, dyeing or sizing without any fear of entanglement. Should it get broken at any point in handling, the broken ends can be easily detected. The *bolondiyá* is often used solely for cross winding yarn before subjecting it to any of the operations mentioned above. The cross winding of twisted yarn, as done at Sualkuchi and perhaps at other places, is performed in a somewhat different manner. The end of the yarn is drawn through a hollow bamboo and attached to one of the uprights (the one nearest the right hand of the operator). The operator holds the bamboo in his right hand and gives it a sharp pull with the effect of drawing off a loop from the supply reel; with the fore-finger of his left hand he guides the loop diagonally and slips it over the left hand upright, thus forming one-half of the figure of 8, and with the bamboo held in his right hand, he throws a loop over the right hand post, thus completing the figure. This process is carried on repeatedly to the end.

Another instrument used for cross winding yarn (usually *eri* thread) is either a double cross like the *uni* used in the reeling of *pat* silk at Sipajbar (paragraph 73) or a stick of wood with a natural fork at the upper end and a short bar tied across at the lower end, leaving a few inches projecting below the cross bar to serve as a handle. The instrument is held in the left hand and the yarn is arranged over it in the form of a figure of eight as with the *bolondiyá* described above.

\*This term is applied elsewhere to a very different appliance, *viz.*, to a large conical-shaped reel resembling the *ndá*, but much bigger in size. It is used for re-winding yarn after it has been sized.

I saw at Pusa a machine which is used by the silk weavers of Surat for twisting and doubling yarn. It costs about Rs. 110; if made locally, it might cost less. The machine occupies a space of 7' x 5'-6" and stands 5' 4" high. It carries 24 bobbins which hold the untwisted yarn and 24 reels to correspond, which take up the twisted material, 12 of each being in the front of the machine and 12 at the back. The bobbins (which are each set on the top of a spindle) and the reels are made to revolve at differential speeds by means of a large cylinder or drum which is connected at one end to a pair of iron cog-wheels and at the other to a series of wooden wheels. The accompanying illustration (Plate IV) will show the arrangement by which the several parts of the machine are geared to each other. On its way from a bobbin to its corresponding reel, the thread passes through one of a row of eyelets inserted along the top of a long wooden shaft which is made to move slowly in a lateral direction by means of an eccentric wheel to which it is attached. This device enables the thread to spread evenly on the reel as it is being gathered up. This machine has a great advantage over the Assamese apparatus inasmuch as it can be worked in-doors, whereas the latter takes up an enormous amount of space and can be used only in fine weather and out of doors. The Surat twisting machine may be tried in Assam. It is likely to find favour with the professional weavers of Sualkuchi.

90. *Muga* and *eri* thread is degummed before it is reeled or spun. But mulberry silk, whether indigenous or imported, retains its natural gum which has to be washed out at some stage or other. In weaving *káchá pat* cloth of inferior kinds, yarn is sometimes used undegummed; but for *pakóá pat* cloth (*i. e.* in which twisted yarn is used) and also for better kinds of *táchá* fabric the yarn is degummed before the warp is made. Weft yarn of *pat* silk is always degummed. It is the weft thread that shows on the cloth. By degumming it acquires a white colour and gives the cloth a better look than it would otherwise have. The degumming of *pat* silk is performed by boiling it for a few minutes in an alkaline solution (*khároni*) prepared from the ashes of rice-straw or plantain leaf. Sualkuchi weavers have begun to use washing soda in place of *khároni*, 15 tolas of soda being used for every seer or 80 tolas of yarn. The loss of weight on degumming *pat* silk amounts to from 20 to 25 per cent. on its original weight.

91. All yarn needs to be washed before dyeing to remove grease and dirt which prevent the yarn from taking the dye well. Except for dyeing it is not usual to wash the yarn. A few *eri* weavers wash the yarn before weaving in order to improve the whiteness of the cloth. Various materials are used in Assam for washing silk yarn. Those in common use are the pulp of the green papaya fruit or of the white gourd and the soap-nut (*ritha*). The use of soap for washing yarn is barely known. The pulp of the white gourd, when pounded up forms a watery mass in which the yarn is soaked for a night; it is then taken out and washed in clean water. In using papaya, the green fruit is cut up into slices and boiled with water in which the yarn is placed. The thick skin on the soap-nut, when soaked and kneaded in water, forms a lather very much like that of soap. The yarn is kept soaked in the lather for a night and then washed clean in water.

The art of bleaching silk, whether yarn or cloth, is barely known in Assam. *Eri* and *pat* silk can be easily bleached by boiling in a solution of olein soap and soda.\* One would think that *muga* thread which is valued for its natural bright yellow colour needs no bleaching. The Sualkuchi weavers, however, bleach small quantities of *muga* thread for the weaving of a special fabric, called the *tel kapor*, in which a few ends of white *muga* are inserted for forming stripes. The process is very simple. The *muga* yarn is first washed by soaking it in the watery pulp of the white gourd in the manner already mentioned, and then soaked again for a night in gruel prepared from powdered rice and *akhoi* (a preparation of rice). By this treatment the yellow colour of the silk is changed into a creamy white. The bleaching is not very perfect, but it serves the purpose for which it is intended.

92. The dyeing of cotton and, to a less extent, of silk was at one time very common throughout the Assam Valley. The importation of dyed cotton yarn has made the dyeing of cotton obsolete. Silk is still dyed to some extent. Most of the silk cloths manufactured in the plains is woven out of un-dyed yarn, except that a little coloured thread is placed in the cross-borders which are an almost invariable feature of the usual descriptions of cloth worn

\*I obtained the following formula from Pusa. For mulberry silk, take 20 per cent. W. S. of soap and 1 per cent. W. S. of soda (W. S. means on weight of silk); for *eri* 10 per cent. W. S. of soap and 5 per cent. W. S. of soda. Boil yarn for 2 or 3 hours; take out and rinse in hot, then in cold water. For mulberry silk, dip yarn so treated in 3 per cent. W. S. of acetic acid to restore lustre and seroop.

by the Assamese. The coloured yarn so used may be either cotton, in which case it is procured from the bazar, or silk which is dyed at home. But there are special fabrics in which dyed silk forms the body of the cloth, e.g., the *bhât-kâpor* used by Assamese Hindus when cooking or eating food, the *eri sari* or *chârkhând* woven in South Kamrup for Synteng women, and two descriptions of cloth known as the *dhuni* and the *tel-kapor* which are largely manufactured at Sualkuchi for the use of Khasia and Garo women.

The dyeing of *eri* silk is fairly common among the animistic tribes, such as the Meches of Goalpara, the Kacharis, Rabhas and Mikirs of Nowgong and South Kamrup and the Syntengs of the Jaintia Hills. Among the large Kachari population in North Kamrup and Mangaldai, the dyeing of *eri* silk (the only kind of silk they know) is gone almost out of fashion; it survives, as far as I have been able to gather, in a few villages near Udalguri where a special kind of cloth known as *dorgkhu lepa* is prepared with dyed *eri* yarn for sale to the Bhutias. Another tribe who enjoy a local reputation for their skill in dyeing *muga* are the Phakials of the Dibrugarh subdivision.

There are no professional dyers in the Assam Valley; what little dyeing there is done by the weavers themselves. The dye is applied as a rule to the yarn, and very seldom to the cloth.

93. The dyes formerly used were all natural dyes of indigenous origin. They are still used among the non-Hinduised tribes living in the backward parts of the country and a little is still used among the Hindus. A short account of the natural dyes used in dyeing silk is given below, so far as my information goes. Much information will be found on the subject in Mr. W. A. M. Duncan's *Monograph on Dyes and Dyeing in Assam*, published in 1896.

*The Hindus.*—Lac is practically the only natural dye used; it gives a fast red colour, but is expensive. Ten to 12 seers of stick lac are required for dyeing one seer of silk. The use of lac as a dyeing material was very general at one time. Very few people use it now-a-days, its place having been taken by magenta which is very cheap though it produces a fugitive colour. Lac dye is still used to some extent at Sualkuchi. In spite of its being costly, it is preferred to chemical dyes on account of its great fastness. Various mordants are used with the lac dye, such as the leaves of the *bomrati* tree (*Symplocos grandiflora*), *thakera tenga* (*Garcinia pedunculata*) and alum. The Sualkuchi weavers obtain a fast black dye for *pat* and *muga* silk by pounding a quantity of *hilika* nuts (myrobolans) and boiling them in water in an iron pan, some iron nails being put in at the same time. The black liquid is strained and the yarn is boiled in it until it has acquired the right tint. The dye practically costs nothing, but is said to be very effective. It produces a black colour with a slight reddish sheen, which no chemical dye has yet been found to imitate.

*The Meches of North Goalpara.*—These people know only three dyes—red, yellow and black; but red is the only colour used for dyeing *eri* yarn. It is obtained from madder which is purchased from Bhutias at 6 to 8 annas the seer.

*The Kacharis and Rabhas of South Kamrup.*—Only two colours are used—red and yellow—both for *eri* yarn. The red dye is obtained from lac and the yellow from the heart-wood of the jack tree or from *asukat* (*Morinda* sp.). The mordants used for both are the acid leaves of one or other of two species of jungle trees locally called the *garchiri* and the *bhabokuri* (also called *katora*). I regret I am unable to give the botanical names of these plants.

*The Mikirs and Kacharis of Nowgong.*—The dyes used are red, black and blue black, all for *eri* yarn. The red is obtained from lac mordanted with *leteku* leaves (*Baccaurea sapida*); the black from iron flakes (from a blacksmith's shop) boiled with the leaves of the *uriam* tree (*Coscinium fenestratum*), and blue black from the leaves of the indigo or of a plant known as *buthi* to the Mikirs and *gesemlai* to the Kacharis, which they cultivate. The last two dyes are prepared by pounding the leaves and letting them ferment for a few days; the fermented material is steeped in alkali water and left in it for 3 or 4 days, after which the dye is ready.

*The Kacharis of North Mangaldai.*—*Eri* is dyed red with lac and madder in a few villages near Udalguri.

*The Phakials of Dibrugarh subdivision.*—The Phakials are reputed for their skill in dyeing *muga* silk. The colours used are red, yellow, blue and green. The red is obtained from the lac dye boiled with the *thakera* fruit (*Garcinia pedunculata*); the yellow from the bark of the *tepor tenga* tree (*Garcinia xanthochymus*) in combination



with the leaves of the *bomrati* (*Symplocos grandiflora*), the blue from an infusion of *rom* leaves (*Strobilanthes flaccidifolius*) which is boiled with the ingredients mentioned above for the yellow dye; and the green from the leaves of the *bomrati*, the silk in this case being previously treated with lime and then washed clean in hot water. The colours obtained are fast and the dyeing does not diminish the natural lustre of the silk.

94. Synthetic dyes have come into use everywhere in the plains, though, as already noted, the use of dyes among the Assamese is very limited. The only place in the Brahmaputra Valley where a considerable amount of dyed silk is used is Sualkuchi. The only colours in vogue here are red, black, yellow, blue and green, all in deep shades. Dyeing in pale colours is unknown in Assam, and is not perhaps liked by the people. The dye stuffs used are as follow :—

Red.—Mostly with magenta; for superior cloth, with lac (as already noted).

Black.—With *hilika* (myrobolans) as previously mentioned.

Yellow

Blue

Green

} —With chemical dyes.

Intermediate colours are produced by mixing two or more colours together, but they are not generally used. In using any synthetic dye, a small quantity is boiled in water and the yarn is dipped and kept moving in the boiling solution till it is seen to have acquired the right shade. The dye is never weighed; everything is done by guess. The cost of dyeing with a synthetic dye is nominal—perhaps not more than 2 annas per seer of yarn dyed. But the result is unsatisfactory, inasmuch as none of the chemical dyes which have come to the notice of the Sualkuchi weavers has been found to produce a fast colour—not even fast to ordinary washing. The dyes are all of German make and are sold in small tins of  $\frac{1}{4}$  to  $\frac{1}{2}$  lb. No directions are furnished with the dyes as to the mode of using them and the dyers are left to use them as best they can. The people use soda, alum and other materials with a view to improve the fastness of the dyes, but with uncertain and generally unsatisfactory results. The Sualkuchi weavers are very keen on dyeing and they are eager for instruction in the use of artificial dyes. Government might help the weavers in this matter. I have talked to many of them and given them the addresses of the leading German firms in Bombay and Calcutta who deal in chemical dyes. These firms, at all events some of them, are willing to send out their agents to any locality where there is a sufficient demand for their goods, for training people in the mode of using their dyes. I believe they will readily do it if advised by Government.

95. The most important class of *eri* cloth manufactured in Assam, namely, the *bor kapor* which may be used either as a body-sheet or as suiting material, is a plain white cloth. Dyed *bor kapor* is as yet unknown. It has been found at Pusa that *eri* thread can be dyed in any desired shade of colour with artificial dyes; excellent suiting material in desired patterns can be produced out of such dyed yarn. A note on the dyeing of *eri* yarn based on materials furnished to me by Mr. M. N. De, Assistant to the Imperial Entomologist, who is in immediate charge of the sericultural work at Pusa, is appended to this report (Appendix IV.) The note gives the particular chemical dyes which have been found suitable for use in the dyeing of *eri* thread, and the manner in which they should be used. It will not be enough for us to tell the people to use these dyes. They must be shown how to use them, and a demand which does not at present exist must be created for dyed *eri* goods before the weavers at large can be expected to manufacture them. All this will require continued experiment and demonstration—work which will come naturally on the programme of an experimental weaving station if one is established in Assam.

96. For most silk cloths, whether *muga*, *pat* or *eri*, the yarn which is to form the warp has to be sized in order to bind all floating or loose fibres into the body of the thread and also to strengthen the thread. Badly reeled or spun thread requires more sizing than thread which is even and smooth. *Muga* yarn, especially such as is reeled by the weaver herself, is usually even, smooth and strong and needs little sizing, sometimes none. But *eri* and mulberry silk is full of loose fibres sticking out of the thread and these must be smoothed down and bound into the body of the yarn before conversion into warp.

Weft yarn is less heavily sized than warp yarn, and often not at all.

The materials used in sizing yarn are *akhoi*, rice and paddy. Sizing from *akhoi* (a preparation of rice) is prepared by boiling it in water to form a thin gruel; the yarn is dipped in the gruel and dried. This kind of sizing is used at Sualkuchi for *pat* and *muga* silk. The sizing most commonly used is prepared from rice. Very white rice is preferred for the purpose. It is boiled quite soft and then kneaded into a gruel in which the yarn is placed and kneaded for a few minutes with the hands. It is then taken out, washed and dried. Many people object to using this sizing because touching boiled rice (*bhát*) is supposed to make one unclean—a belief which is common to Hindus in all parts of India. They accordingly use paddy instead. The paddy is boiled till soft and kneaded in water; the starchy liquid so obtained is strained through cloth. The yarn is then treated in the same way as with the sizing prepared from cleaned rice.

The foregoing account relates to the method of sizing the yarn before it is put on the loom. The sizing of yarn-in-the warp (*i.e.*, after the warp has been prepared, but before it is placed on the loom) is not known in the Valley, but at the far end of it, in the Dhubri subdivision, I found an instance in which the sizing is applied to the warp. It occurs among the Muhammadan cultivators who do not weave, but who prepare the warp and give it to a professional weaver who weaves the cloth at a fixed charge. Along with the warp sufficient materials for sizing are supplied to the weaver. The materials used for a piece of *eri* cloth 6 cubits long are oil-cake 1 seer, mustard oil  $\frac{1}{2}$  seer, a handful of turmeric and some dry *suktáni* (jute) leaves. The oil-cake is steeped in water till soft, and then mixed with it to form a thin paste; the warp is dipped in the paste, taken out and dried. When dry, the warp is stretched out, and a decoction prepared by boiling the turmeric, jute leaves and oil together is applied to the warp with a brush (*kuchi*.)

Sizing is sometimes applied to the warp to counteract the fraying of the ends on account of constant shaking caused by the movements of the healds. A thin solution of starch, usually rice-water (*már*) from the cooking pot, or some mucilaginous substance like the rotted pulp of the pumello fruit is used for this purpose. It is applied with a brush (*kuchi*) which is made out of the flower stalks of a long grass called *kuchi-phul*.

An additional sizing may be applied to the cloth after it is taken off the loom. It is usual only with inferior descriptions of *eri* cloth which are meant for sale. The object is to fill-in the inter spaces between the threads and to give the cloth a smooth and finished appearance. The cloth is washed and while still wet, it is stretched full length between two rollers and a number of flat bamboo sticks having pointed ends which are fixed to the selvages are placed over the cloth, about a foot apart, to keep it well spread out. The sizing is then spread and well worked in, on both sides of the cloth, by means of a flat bamboo knife. The cloth is then dried. The sizing is prepared by boiling a quantity of arum roots (*kochur mukhi*) and kneading it into a paste to the consistency of thick cream. A variation of this process, in which the sizing is much less heavy, is as follows. The cloth is stretched between two rollers, but only for a foot or two at a time. The sizing, usually rice gruel, is applied over successive portions of the cloth with a rag, the cloth being unrolled from one roller and taken up on the other as the work of applying the size proceeds.

97. The common method of preparing the silk warp is exactly the same as for cotton. It has been very fully described by Mr. Samman in his Monograph on the Cotton Fabrics of Assam. I consider it unnecessary to go over the same ground again. There is, however, a special method of warping which is followed by professional weavers like those of Sualkuchi and Tantigaon in Jorhat. It is used in preparing warp of twisted silk yarn. The differences between this and the common process are as follow:—(1) only two warping reels (*ughas*) are used, instead of 4 to 8 as in the common process; (2) the warping reels are not set in the ground as in the ordinary process, but are carried in the hands of the operators; (3) the leasing of the ends is done as they are being laid against the warping sticks and not as a separate operation which is necessary when a series of ends are being carried and laid together. The subsequent operations of drawing the ends through the reed and of tying the healds are the same with silk as with cotton.

98. The mode of preparing pirns or spools for the shuttle is exactly the same as with cotton (*vide* Mr. Samman's Monograph.)

Pirning.

## CHAPTER VII.

## FINAL.

99. I have submitted in the preceding chapters estimates, admittedly very rough, of the quantity and value of each class of silk produced in the Assam Valley. These estimates put together might give us some idea of the total monetary value of the silk products of the Valley. The Surma Valley and Hill Districts (barring the North Cachar Hills) do not enter into the calculation, because none of them produce silk in any appreciable quantity. In the consolidated estimate which I submit below, I have taken the value of each kind of silk in the shape in which it is used in, or exported from, Assam. In calculating the value of silk cloth, I have assumed that it is twice the value of the yarn of which it is made—an assumption which may be accepted as not far from the truth—and which in fact is used by professional weavers as a basis for fixing the price of silk cloth.

## ESTIMATE OF THE TOTAL VALUE OF THE SILK PRODUCTS OF ASSAM.

<i>Eri.</i>	Rs.
A.—Total outturn, of cocoons : 5,325 maunds (paragraph 25)	
B.—Cocoons exported in 1,912-13 : 1,080 maunds valued at Rs 100 per maund [Appendix II(a)] ... ..	1,08,000
C.—Cocoons spun in the country = A—B=4,245 maunds.	
D.—Outturn of thread from C = $\frac{3}{4}$ ths of C=3,180 maunds.	
E.—Imported <i>eri</i> thread : 150 maunds (paragraph 83) valued at Rs. 200 per maund=Rs. 30,000.	
F.—Total quantity of <i>eri</i> thread available = D + E=3,330 maunds.	
G.—Thread exported to Bhutan in 1912-13 : 1,096 maunds [Appendix II(c)], valued at ... ..	2,09,000
H.—Thread remaining in the country to be woven = F—G = 2,234 maunds valued at Rs. 240 per maund = Rs. 5,36,000.	
I.—Value of cloth woven out of H = 2 × H ... ..	10,72,000
Total value of <i>eri</i> silk ... ..	13,89,000

*Muga.*

J.—Total outturn of cocoons : 2½ lakhs of thousands (paragraph 53).	
K.—Yield of reeled thread from J = (J+160) maunds (one thousand cocoons yield $\frac{1}{4}$ seer = $\frac{1}{160}$ maund) = 1,400 maunds.	
L.—Thread exported in 1911-12* [Appendix II(a)—column 2 minus column 6]. = 592 maunds, valued at Rs. 400 per maund. ... ..	2,37,000
M.—Thread remaining in the country to be woven = K—L = 808 maunds, valued at Rs. 600 per maund† = Rs. 4,85,000	
N.—Value of cloth woven out of M = 2 × M ... ..	9,70,000
O.—Yield of <i>muga</i> waste = 40 per cent. on reeled thread (K) = 560 maunds, which would yield $\frac{1}{4}$ ths of it in thread = 420 maunds valued at Rs. 200 per maund = Rs. 98,000.	
P.—Value of cloth woven out of O = 2 × O ... ..	1,96,000
Total value of <i>muga</i> silk ... ..	14,03,000

*Pat.*

Q.—Total outturn of <i>pat</i> silk : 150 maunds (paragraph 56) valued at Rs. 640 per maund = Rs. 1,00,000 (roundly).	
R.—Imported mulberry silk 100 maunds (paragraph 82) valued at Rs. 560 per maund = Rs. 56,000.	
S.—Value of cloth woven out of Q and R = 2 × (Q + R) ... ..	3,12,000
Grand total of the value of silk products ... ..	31,04,000

\* Figures of export for 1912-13 are wrong; therefore, those of the preceding year have been adopted for the calculation.

† The value rate for thread remaining in the country has been taken at 50 per cent. more than the value of exported thread (Rs. 600 against Rs. 400). Both rates are lower than actual prices of *muga* thread during the past three years.

The total value of the silk products is estimated above at thirty-one lakhs of rupees. The estimate is a very rough one, but I believe it is not an exaggeration. The estimate in any case brings out the importance of the silk industry which, if the figures are anywhere near the truth, brings in some 5½ lakhs of rupees as value of raw silk and cocoons exported out of the Valley, and saves to the country some Rs. 25½ lakhs which would have to be spent in purchasing cloth if the local silk industry ceased to exist. The total value of the silk products probably exceeds the value of the sugarcane crop in the whole of the Assam Valley and amounts to nearly two-thirds of the total land revenue demand.

The value of the *muga* silk produced in Assam would appear to be slightly in excess of that of the *eri* silk. This may seem strange, but in all likelihood it is actually so. It is true that the culture of the *eri* silkworm is much more widely spread than that of the *muga*, but it is to be remembered that individual rearings of the *muga* worm are larger than those of the *eri* and weight for weight, *muga* silk is three times as valuable as the produce of the *eri* worm. Among the people of Assam proper, especially of Upper and Central Assam, the use of *eri* silk is very limited at the present day, whereas *muga* silk is very largely worn by the females. Almost the whole of the *muga* cloth woven in Assam is retained in the country and very little of it is exported out of it; with *eri* silk on the other hand, there is a considerable export trade in cocoons, thread and cloth. *Eri* silk is consequently more in evidence than *muga* and is, therefore, apt to be regarded as the more important of the two.

100. There are two distinct branches of the silk industry, one is concerned with the rearing of the silkworm and includes the reeling and spinning of silk; the other with the weaving of silk. I propose to deal with weaving in a supplementary chapter of this report, and to confine my present observations to that branch of the industry which deals with the rearing of silkworms.

The rearing of the *muga* silkworm is in a stationary condition, and does not seem capable of much development. There is some demand for *muga* silk from other parts of India principally as material for embroidery, but the demand is limited and is not likely to expand much. Practically, there is no demand for this silk from outside India; it is far too costly to suit the European market. The cultivation of this silk is attended by constant losses from disease. If some means could be discovered for preventing disease, it might help to put a new life into the industry, and *muga* silk may become cheap enough again to hold its ground against other kinds of silk. The present high price of this silk has caused many to give it up and use imported mulberry silk instead; and I fear that unless it becomes cheap again, it may before long succumb to the competition of imported silk.

The rearing of the mulberry silkworm (*pat*), has long been in a state of decadence and is of little importance at the present day. It is in danger of further decay from the social movement which I have mentioned in paragraph 55. We may perhaps be able to give it a new lease of life by introducing improved races of the silkworm, by teaching the rearers how to combat disease and by introducing its culture among such people as have no social or religious prejudice against the industry. But I admit that the task will be an uphill one and the chances of success, considering the nature of the people concerned, somewhat doubtful. The Agricultural Department made a beginning in these directions some years ago at Shillong, but their efforts to popularise sericulture among the Khasias have not as yet met with visible success. The work is now being carried on by the Roman Catholic Missionaries of Shillong. I have some hope that with due co-operation and financial assistance from Government, the efforts of the Mission to spread sericulture in the Khasi and Jaintia Hills will prove successful.

Lastly, as to the rearing of *eri* silk. The prospects of this branch of the silk industry seem hopeful. There is a demand for *eri* cocoons from silk spinners of Europe and Bombay. *Eri* silk is probably in greater favour for power spinning than any other class of waste silk. The export of *eri* cocoons is showing a marked tendency to increase, but there is a danger ahead which must be removed to enable the trade to expand. I refer to the adulteration of cocoons with insects (paragraph 26). The export trade in *eri* cloth and thread is also in a flourishing condition. The export of *eri* silk to Bhutan has enormously increased within the past three years, and there is a brisk demand for *eri* cloth from Bengal and other parts of India.

101. Sericulture has to face the competition of other occupations just as much as any other form of employment. It is said that the rearing of silkworms does not cost much and being a cottage industry and principally the occupation of females, it causes no interference with agricultural work or other kinds of rural labour. This is

not exactly true; silk growing may not cost much in money, but it costs labour and is more risky than any other occupation. It often clashes with other kinds of employment. In most parts of Assam the women take an active part in the cultivation of crops which are more profitable than the rearing of silk worms and are becoming more remunerative every year with the steady rise in the price of agricultural staples. Then again, the attention of the people is being diverted to many occupations which did not exist before. All this must tell on the popularity of silk rearing. It is not possible to forecast the effect of this growing factor on the future of the sericultural industry in Assam. In the open thickly populated parts of the Brahmaputra Valley, the rearing of silkworms is losing favour with the people; away in the hills and in the backward parts of the valley, the people have got nothing to attend to beyond their hereditary callings of which silk growing is one, and it is in these parts that sericulture still retains its former importance, and has, at least in some places, gained in importance in comparison with former times.

Suggested experiments and improvements.

102. A number of experiments and improvements have been suggested in the course of this report. These are briefly mentioned below.

#### EXPERIMENTS AND IMPROVEMENTS SUGGESTED IN THE COURSE OF THE REPORT.

##### *Rearing.*

(1) Provision of windows fitted with wire netting or perforated zinc sheet to prevent the entrance of the silkworm fly into the rearing house. This would make easier and less risky the rearing of *pat* and *eri* silkworms during summer when the fly is very troublesome. (Paragraphs 23 and 63.)

(2) The use of nets for cleaning the trays in which *pat* and *eri* worms are fed. This would be particularly beneficial in the case of the *pat* worm. (Paragraph 62.)

(3) The introduction of the European univoltine mulberry silkworm. There is a reasonable prospect of this improved race of silkworms proving successful in the climate of the Assam plains. Should it prove successful, some arrangement would have to be devised for supplying the rearers with fresh hibernated seed every year. This could be easily done by private agency. (Paragraph 64)

(3a) Encouragement of sericulture in the hill districts. [Paragraph 65(a).]

(4) An experiment may be made to rear the *muga* silkworm indoors. (Paragraph 30).

##### *Prevention of disease.*

(5) The diseases of the *muga* silkworm will need further investigation. The work is of a difficult scientific nature, and will demand the employment of a competent sericulturist well-skilled in bacteriological work. Certain suggestions based on the recommendations of Mr. E. Fletcher, the Imperial Entomologist of Pusa, have been submitted in paragraph 50 for the prevention of the epidemic disease (flacherie) of the *muga* worm. The measures which have been suggested are: (1) the use of cellular eggs, (2) the manuring and pruning of the food plants of the worm and (3) the prevention of over crowding of the worms on the food trees. All these measures and any others that future experience may suggest will have to be tried and proved before they can be safely brought to the notice of the *muga* breeders. (Paragraph 50.)

(6) The diseases of the *eri* silkworm are not so serious as those of the *muga* worm, but if a bacteriologist be available, these too should demand a part of his attention and time. (Paragraph 23.)

(7) The diseases of the mulberry silkworm in Assam are identical with those which occur elsewhere, and can be prevented by the use of disease-free seed and careful attention to cleanliness and feeding. The efficacy of these measures will need to be demonstrated. (Paragraph 63.)

##### *Food plants.*

(8) The testing and introduction of new varieties of mulberry. (Paragraph 61.)

(9) Growing *sum* and *hudlu* trees on the same system as mulberry, *i.e.*, under a well-regulated system of tillage, manuring and pruning. (Paragraph 50.)

##### *Spinning and reeling of silk.*

10. The use of hand combs for preparing *eri* and other kinds of silk waste for spinning. (Paragraph 79.)

(11) The introduction of an improved reeling machine and of improvements in the existing reeling apparatus. (Paragraph 74.)

(12) Testing of the Surat twisting machine. (Paragraph 89).

*Dyeing.*

(13) Teaching silk weavers the methods of using synthetic dyes so as to get fast colours. (Paragraph 94.)

(14) Dyeing of *eri* yarn in fast synthetic colours for the manufacture of suitings. (Paragraph 95.)

*Export trade in Eri cocoons.*

(15) Measures for preventing the adulteration of *eri* cocoons with insects. (Paragraph 26.)

Among the experiments and improvements suggested above, those numbered 10 to 14 may come on the programme of the experimental weaving station which has been proposed by Mr. Hoogewerf. No. 15 is matter of mere administrative action. As to the remaining suggestions I venture to think that the silk industry of the province is possessed of sufficient importance to justify some expenditure of public money for its promotion. If this view be accepted, it will be necessary to establish a silk station in order to test the suitability to local conditions of the measures of improvement which I have suggested or which may be suggested by others in future, and to popularise such improvements as prove feasible. The silk station should be placed in charge of a competent sericulturist who should also possess an adequate knowledge of bacteriological work, and located at a central place like Jorhat.

103. I was specially desired to consider the possibility of developing *eri* silk by applying co-operative principles to its production and sale. So far as the production and sale of cocoons is concerned, I do not think it is at all possible under present conditions to develop it by co-operative methods. The rearers who grow cocoons for sale are mostly illiterate hillmen who are too ignorant to understand the principles of co-operation or to manage a society based on those principles. They live in little hamlets isolated from each other, and are wanting in that cohesion and solidarity of interest which are essential for the existence and working of a co-operative society. Moreover, the business of cocoon-growing is of such a petty nature and so inexpensive that it is not likely to receive any material benefit from co-operation.

The only branch of the silk industry to which co-operative methods may be applied with some chance of success is the manufacture and sale of cloth. There are certain localities where the weaving of *eri* cloth is an industry of considerable magnitude, and the weavers belong to the ordinary class of Assamese cultivators among whom co-operative credit societies have been working with more or less success for some years past. One such tract—no doubt the one most important—is the country in the neighbourhood of Palasbari between Khanamukh on the east and Chhaigaon on the west. The village of Sualkuchi is another important seat of silk manufacture. The co-operative movement may be able to promote the weaving industry in these places. Some advance in this direction has already been made in four groups of villages within a few miles of Palasbari, in each of which a co-operative credit society had been at work for sometime. I visited these villages in December last in the company of the Assistant Registrar of Co-operative Societies and we succeeded in persuading the societies to add co-operative methods of production and sale to their present business which is limited to the lending of cash. The societies are (1) to purchase raw materials required in the weaving trade such as cocoons, yarn, looms and other appliances, etc., where these can be had cheapest and sell these to the members slightly over cost price, and (2) to help the members in disposing of the cloths manufactured by them in the dearest market, *e.g.*, by advertising the goods in the papers and bringing the producers and consumers together and thus doing away with the middlemen who at present intercept a share of the profits. The societies will need constant advice and guidance from the Registrar and his staff, who will have to find for them at the outset the best markets for buying and selling the commodities with which they will have to deal. A co-operative credit society has also been recently established at Sualkuchi. All the members are weavers, and although the society is empowered to deal only in cash, it is expected it will be able to do some good in the way of promoting the local weaving industry.

The societies mentioned above will soon show if the weaving industry in Assam is capable of being fostered by co-operative methods. Personally I am not very sanguine. Some success has no doubt been achieved in popularising co-operative credit in the province, but I venture to remark that very few of them have as yet reached that stage at which they are able to manage their own affairs without constant check

and supervision from Government. It is also to be remembered that the management of an industry or trade on co-operative lines calls for a much greater amount of business capacity than is requisite for the successful management of a purely credit society.

104. It was my intention to add a chapter on the weaving of silk, but I have been obliged to omit it owing to the non-receipt of a report on *Silk weaving.* weaving in Assam from Mr. E. Hoogewerf, Principal of the Government Weaving Institute, Serampore, who visited Assam early in the year 1914 to enquire into the weaving industry of this province.

## APPENDIX I.

Statement showing diseases in specimens of silkworms examined in the laboratory of the Imperial Entomologist and by Babu S. C. Saraswati, Temporary Sericulturist Assistant of the Agricultural Department.

N.B.—(1) The specimens which were examined by Babu S. C. Saraswati alone are marked with asterisks.

(2) P denotes pebrine, F flacherie, G grasserie, H healthy. For example, 1F means one specimen affected with flacherie, 3G means 3 specimens affected with grasserie.

Lot No.	Sub-division whence obtained.	Description.	Diseases found.	Remarks.
1	2	3	4	5
		I.—Muga silkworms.		
1	Gauhati ...	1 worm from unhealthy brood	1F.	
2	Ditto ...	1 moth from unhealthy brood	1F.	
3	Ditto ...	1 unhealthy cocoon ...	1F.	
4	Ditto ...	Ditto ...	1F.	
5	Ditto ...	1 worm from a cocoon ...	1F.	
6	Golaghat ...	1 worm ...	1F.	
7	Gauhati ...	23 moths and worms from inside of cocoons (from a lot kept for breeding).	2P, 4F, 16H.	Result of examination of one of the 23 specimens is not known.
8	Jorhat ...	91 cocoons from healthy brood	10F, 5G, 76H.	
9	Mangaldai ...	32 cocoons from unhealthy brood.	21F, 9G. ...	Two specimens were not reported on.
10	Ditto ...	10 cocoons from unhealthy brood.	3F, 7G.	
11	Ditto ...	14 cocoons from unhealthy brood.	2F. ...	12 specimens were not reported on.
12	Jorhat ...	6 worms from unhealthy brood.	3F, 1G, 1F+G, 1H.	One was a <i>bali photukia</i> and another a <i>hiti photukia</i> worm. Both showed flacherie.
13	Ditto ...	1 worm from unhealthy brood	1F.	
14	Dibrugarh ...	2 worms from unhealthy brood.	2F.	
15	Jorhat ...	6 worms from unhealthy brood.	5F. ...	One specimen was spoiled for examination.
16	Ditto ...	22 worms from unhealthy brood.	12F, 2G. ..	Eight specimens were spoiled for examination.
17	Ditto ...	5 worms from unhealthy brood.	4F, 1G.	
18	Ditto ...	6 worms from an unsuccessful rearing.	5F, 1G.	
19	Sibsagar ...	4 moths ...	1P, 3F. ...	} These were received from Babu Srish Kumar Sen, Sub-Deputy Collector, Sibsaagar.
20	Ditto ...	1 unhealthy worm ...	1F. ...	
21	Ditto ...	Ditto ...	1F. ...	
22	Nowgong ...	1 worm from unhealthy brood	1G.	
23	Ditto ...	7 worms from same ...	5F, 2G.	
24	Ditto ...	3 ditto ...	3F.	
25	Gauhati ...	2 worms from unhealthy brood.	2F.	
*26	Sibsagar ...	23 worms from unhealthy brood.	23F.	
27	Nowgong ...	3 unhealthy worms ...	3F. ...	} Remaining two specimens of Lot 29 showed muscardine. The three lots 27, 28 and 29 were examined by Mr. M. N. De, during his visit to Assam.
28	Ditto ...	5 ditto ...	3P, 1F, 1H.	
29	Ditto ...	6 dead chrysalids ...	2F, 1P + F, 1G.	



Lot No.	Subdivision whence obtained.	Description.	Diseases found.	Remarks.
1	2	3	4	5
<i>II.—Eri silkworms.</i>				
1	Mangaldai ...	2 worms from unhealthy brood.	2F.	
2	Nowgong ...	20 mother moths from healthy brood.	1P, 5F, 14H.	
3	Jorhat ...	16 living worms from a fairly healthy brood.	4F, 12H.	
		44 dead worms of 3rd stage from same.	19F, 1G, 2F + G, 9H.	13 dead worms were spoiled for examination.
4	Ditto ...	75 living worms of 3rd, 4th and 5th stages from a fairly healthy brood.	32F, 2G, 4F + G, 32H.	5 specimens were spoiled for examination.
5	Ditto ...	35 living worms of 3rd stage from apparently healthy brood.	14F, 21H.	
6	Sibsagar ...	39 living worms of 3rd stage from healthy brood.	39H.	All were sound.
7	Mangaldai ...	5 dead chrysalids from a lot of seed cocoons.	3F, 1G, 1F + P.	
8	Nowgong ...	5 chrysalids from seed cocoons which failed to eclose.	3F, 1P.	One chrysalis of lot 8 died from attack of fly. Lots 7, 8, 9 and 10 were examined by Mr. M. N. De during his visit to Assam.
9	Ditto ...	5 weak worms of 5th stage from a healthy brood.	3F, 1G, 1H.	
10	Ditto ...	5 worms from healthy brood...	4F, 1G.	
<i>III.—Pat silkworms.</i>				
1	Nowgong ...	12 pupae from apparently healthy brood.	10P.	Two contained fly maggots; others fly pupae.
2	Ditto ...	1 worm ...	1G.	
3	Golaghat ...	20 moths and 5 cocoons that failed to eclose.	8F, 17H.	
4	Nowgong ...	17 mother moths from a lot of 50 cocoons (apparently healthy brood).	16P, 1F, 1H.	Out of 17 mother moths only 3 had laid good eggs; 5 had laid 50 or 60 each; rest failed to lay altogether.
5	Jorhat ...	7 mother moths from 20 seed cocoons; healthy brood.	1P, 6H.	
6	Nowgong ...	52 moths from same stock as Lot 4.	24P, 13F, 1G, 14P + F.	
7	Golaghat ...	18 moths and 5 pupae from cocoons that failed to eclose (same brood as Lot 3).	2P, 13F, 7H.	One specimen was not reported on by I. E.
8	Jorhat ...	164 worms of 1st stage mostly dead.	3P, 107F, 54H.	
9	Nowgong ...	5 weakly worms of 3rd stage	5F.	Examined by Mr. M. N. De.

*N.B.*—(1) All specimens of *pat-polu* were of the *horu polu* variety.

(2) In dead worms, flacherie germs are produced by natural putrefaction of the contents of the stomach. The results of examination of dead *muga*, *eri* and *pat* worms, so far as flacherie is concerned, must not be accepted as a true index to disease. In most cases, specimens of living worms were taken and placed at once in a preserving fluid which prevented putrefaction.

## APPENDIX II(a).

*Exports of silk by rail and river from Assam.*

N.B.—The exports were almost exclusively from the Brahmaputra Valley; small quantities were exported in some years from the Surma Valley and are noted in column of remarks.

Year.	Raw.		Manufactured.		Cocoons included in raw silk.		Remarks.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
1	2	3	4	5	6	7	8
	Mds.	Rs.	Mds.	Rs.	Mds.	Rs.	
1881 ...	538	1,18,300	...	8,900			
1882 ...	648	2,24,000	...	1,500			
1883 ...	614	...	...	...			Not registered before 1886.
1884 ...	532	66,910	...	...			
1885 ...	728	1,20,100	...	...			
1886 ...	1,548	1,54,300	...	...	1,290	20,200	
1887 ...	948	2,25,840	18	24,000	62	4,340	
1888 ...	2,102	2,76,760	143	85,900	1,488	1,04,920	Included 1 Mds. cocoons from Surma Valley.
1889 ...	4,302	4,37,728	281	1,64,947	3,044	2,49,020	Included 22 Mds. raw from Surma Valley.
1890 ...	2,897	4,33,671	219	1,51,400	280	64,400	
1891 ...	1,404	1,71,810	222	1,29,500	1,120	78,400	
1892 ...	1,790	2,03,305	155	98,000	1,249	93,940	Included 2 Mds. raw from Surma Valley.
1893 ...	1,576	5,25,444	107	69,893	409	43,210	Included 12 Mds. raw and 6 Mds. manufactured from Surma Valley.
1894 ...	1,351	3,16,124	140	84,000	196	13,720	Included 9 Mds. raw from Surma Valley.
1895 ...	1,201	3,52,210	61	29,478	278	19,460	Included 5 Mds. raw and 3 Mds. manufactured from Surma Valley.
1896 ...	530	1,27,780	306	1,53,000	53	3,410	
1897 ...	116	19,720	681	4,61,544	21	1,470	Included 4 Mds. manufactured from Surma Valley.
1898 ...	448	1,12,000	6	3,114	NH	NH	
1899 ...	7	1,230	244	2,35,144	6	220	
1900 ...	NH	NH	285	2,71,228	NH	NH	
1901 ...	5	1,230	218	95,122	NH	NH	
1902 ...	384	94,000	468	2,15,200	NH	NH	
1903 ...	659	1,30,760	491	2,30,770	NH	NH	
1904 ...	791	1,97,760	193	90,710	870	40,400	
1905 ...	739	1,97,280	179	84,000	NH	NH	
1906-07 ...	643		NH	NH	8	560	
1907-08 ...	644		NH	NH	NH	NH	
1908-09 ...	483		NH	NH	NH	NH	
1909-10 ...	429		NH	NH	NH	NH	Included 11 Mds. raw from Surma Valley.
1910-11 ...	963		NH	NH	4824	Value not known	Included 4 Mds. raw from Surma Valley.
1911-12 ...	915	2,69,608	1	1,540	323	10,228	Value rate for cocoons evidently wrong having been taken as same for Bengal mulberry cocoons which are much cheaper than etc.
1912-13 ...	1,000(a)	2,94,076	NH	NH	1,081(b)	68,110	Included 7 Mds. raw from Surma Valley. (a) Ought to be larger than (b); evidently there is a mistake.



APPENDIX II(c).

*Exports of silk, raw and manufactured, to Bhutan and other trans-frontier countries.*

Year.	Raw.						Manufactured.						Remarks.
	Bhutan.		Other countries.		Total.		Bhutan.		Other countries.		Total.		
1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Mds.	Rs.	Mds.	Rs.	Mds.	Rs.	Mds.	Rs.	Mds.	Rs.	Mds.	Rs.	
1893-94	90	15,290	14	3,583	104	18,878	59	11,685	78	16,990	197	28,675	Other trans-frontier countries include Towang, Aka and Dafia, and Abor and Mishmi Hills; also Manipur and Hill Tippera, trade with which last two countries ceased to be registered from 1909.
1894-95	104	18,160	...	...	104	18,160	48	11,481	23	11,102	78	22,583	
1895-96	862	60,305	...	...	862	60,305	36	13,846	154	40,624	190	56,470	
1896-97	41	7,321	4	1,159	45	8,980	18	5,545	53	20,535	71	26,080	
1897-98	29	5,424	...	...	29	5,424	16	3,518	49	21,087	95	24,605	
1898-99	35	6,221	...	...	35	6,221	42	10,472	195	51,932	238	62,404	
1899-00	83	13,267	...	...	83	13,267	55	12,678	66	20,505	121	33,183	
1900-01	75	13,213	...	...	75	13,213	36	9,464	73	14,604	109	24,068	
1901-02	581	93,391	3	563	584	93,956	61	14,721	20	5,383	81	20,104	
1902-03	314	23,468	...	...	314	23,468	111	20,693	39	9,602	150	30,295	
1903-04	94	17,385	...	...	94	17,385	97	22,713	69	16,716	166	39,429	
1904-05	103	15,403	...	...	103	15,403	56	15,674	77	20,053	133	35,727	
1905-06	42	7,450	...	...	42	7,450	36	8,633	25	5,336	61	13,969	
1906-07	65	14,022	...	...	65	14,022	158	25,459	30	6,160	189	31,619	
1907-08	54	11,319	...	...	54	11,319	108	30,231	9	2,065	117	32,296	
1908-09	88	17,519	...	...	88	17,519	144	38,952	7	3,603	151	40,555	
1909-10	68	9,266	...	...	68	9,266	61	11,762	7	2,616	68	14,378	
1910-11	34	7,560	...	...	34	7,560	51	8,433	44	9,777	95	18,210	
1911-12	4,186	8,36,901	...	...	4,186	8,36,901	3,103	2,43,588	25	3,409	3,128	2,46,997	
1912-13	1,096	2,09,021	...	...	1,096	2,09,021	1,017	2,77,679	13	2,488	1,030	2,80,167	

## APPENDIX III.

*Estimated number of mulberry silkworm rearers in each mauza of the Assam Valley.*

						Number of families rearing mulberry silk.
<b>Sibsagar district—</b>						
<b>Jorhat subdivision—</b>						
Mauza	Kotohagar	...	...	...	...	84
"	Parbatia	...	...	...	...	4
"	Khangia	...	...	...	...	15
"	Salmora	...	...	...	...	117
"	Simaloguri	...	...	...	...	62
"	Katonigaon	...	...	...	...	44
<b>Total</b>						<b>326</b>
<b>Golaghat subdivision—</b>						
Mauza	Dakhiuhengra	...	...	...	...	1
"	Kacharihat	...	...	...	...	2
"	Athgaon	...	...	...	...	59
"	Dhekial	...	...	...	...	53
"	Gurjugonia	...	...	...	...	54
"	Nahorani	...	...	...	...	54
"	Dergaon	...	...	...	...	2
"	Kumargaon	...	...	...	...	8
"	Misamara	...	...	...	...	13
<b>Total</b>						<b>248</b>
<b>Sibsagar subdivision—</b>						
Mauza	Jukaichuk	...	...	...	...	3
"	Morabazar	...	...	...	...	124
"	Solaguri	...	...	...	...	5
"	Bakota	...	...	...	...	36
"	Joktoli	...	...	...	...	26
"	Athkhel	...	...	...	...	3
<b>Total</b>						<b>197</b>
<b>Total for Sibsaagar district</b>						<b>769</b>
<b>Darrang district—</b>						
<b>Tezpur subdivision—</b>						
Mauza	Behaguri	...	...	...	...	35
"	Borchula	...	...	...	...	6
"	Chatia	...	...	...	...	17
<b>Total</b>						<b>58</b>
<b>Mangaldai subdivision—</b>						
Mauza	Hindughopa	...	...	...	...	140
"	Lokrai	...	...	...	...	180
"	Sipajhar	...	...	...	...	64
"	Rangamati	...	...	...	...	32
"	Kalaigaon	...	...	...	...	11
<b>Total</b>						<b>427</b>
<b>Total for Darrang district</b>						<b>485</b>

Number of families rearing  
mulberry silk.

## Nowgong district—

Mauza Pubghoria	...	...	...	...	...	110
„ Bhelowguri	...	...	...	...	...	12
„ Khatowal	...	...	...	...	...	23
„ Singhiapaton	...	...	...	...	...	82
„ Juria ...	...	...	...	...	...	44
„ Borkondoli	...	...	...	...	...	72
„ Kampur	...	...	...	...	...	96
„ Garubat ...	...	...	...	...	...	32
„ Pakhimora	...	...	...	...	...	14
„ Kachomari	...	...	...	...	...	140
„ Hatichong	...	...	...	...	...	263
„ Jagial	...	...	...	...	...	140
„ Baropuja	...	...	...	...	...	704
„ Mikirbheta	...	...	...	...	...	175
„ Charaibahi	...	...	...	...	...	417
„ Dandua	...	...	...	...	...	181
„ Ghagua	...	...	...	...	...	72
„ Mayang	...	...	...	...	...	42
„ Uttarmesa	...	...	...	...	...	42
„ Sohori	...	...	...	...	...	86
						<hr/>
				Total...	...	2,752
				Total for Nowgong district	...	<hr/> 2,752 <hr/>

## Kamrup district—

## Gaubati subdivision—

Mauza Borbangshar	...	...	...	...	...	10
„ Karara	...	...	...	...	...	6
„ Pubkachari mahal ...	...	...	...	...	...	2
„ Pub Barigag	...	...	...	...	...	2
						<hr/>
				Total for Kamrup district	...	20
				Total for Assam Valley	...	<hr/> 4,026 <hr/>

N. B.—Mulberry silk is not grown at present in the districts of Goalpara and Lakhimpur, nor in the Barpeta sub-division of Kamrup.

## APPENDIX IV.

*Note on the Synthetic Dyes used at the Agricultural Research Institute, Pusa, for dyeing Eri silk.*

The synthetic dyes used at Pusa are acid dyes, basic dyes and alizarine. They are the following :—

1. Acid yellow G. R.
2. Cyprus Green B.
3. Water Blue.
4. Silk Black 4 B. F.
5. Brilliant Congo R. G.
6. Columbia Yellow.
7. Indocyanine B.
8. Micado Orange 4 R. O.
9. Salmon Red.
10. Sorbine Red G.
11. Thiazine Brown G. R.
12. Naphthol Red S. G.
13. Silk Blue B.
14. Rhodamine B.
15. Diamond Green G.
16. Janus Black D.
17. Brilliant Orange.
18. Alizarine 40 %.

Nos. 1 to 9 are manufactured and sold by the Berlin Aniline & Co. (1 Rampart Row, Bombay); Nos. 10 to 15 by the Badische Anilin Soda-Fabrik & Co. (3, Elphinstone Circle, Bombay) and Nos. 16 to 18 by Meister Lucius and Bruning, Ltd. (Post Box 127, Bombay). All except No. 18 are acid dyes; Nos. 2 and 15 may also be used as basic dyes.

The method of using each of the three classes of dyes is described below :—

*I. Acid dyes.*—Acid colours are generally used in a bath of boiled-off soap liquor. The quantity of liquor should be about  $\frac{1}{4}$ th or  $\frac{1}{5}$ th of the amount of water in the dye-bath, and the water should be 50 to 60 times the weight of the silk to be dyed. In the absence of boiled-off liquor, fresh solution of soap (4 or 5 % W. S.) or Glauber's salt (5 % W. S.) may be used.

Weigh the silk and soak it in cold water; take the required quantity of water and liquor. Dissolve the dye (1 to 7 % W. S. according to depth of shade required) in hot water and strain it; add acetic acid (2 % to 5 % W. S. according to desired shade). Warm up the bath until it is luke-warm, add the dye and acid solution to the bath, stir up well and put the silk in; work the silk about in the bath; warm up to 195°F. After one hour or as soon as the desired shade has been obtained, take out the silk, rinse well in cold water; then "scoop" or brighten with 4 % W. S. acetic acid or 2 % W. S. sulphuric acid added to 40 times W. S. of water.

*II. Basic dyes.*—Basic dyes are not quite fast. They are generally used for "topping" other dyes (acid or alizarine), that is, the silk may be first dyed with an acid or alizarine dye, and then dipped in a basic dye to brighten or change the colour.

Weigh the silk and wet it out; dissolve the required quantity of dye in hot water and then put the liquid in a vessel containing 50 to 60 times W. S. of water. If boiled-off liquor is used, add 7 to 8 % W. S. acetic acid. Stir the bath well, put the silk in; heat to 160°F and dye in the bath for 20 to 30 minutes. Take out the silk and wash it in cold water. For fixing the dye which makes the colour tolerably fast, the dyed silk is placed in 15 % W. S. tannic acid added to 40 to 50 times W. S. of water for 4 or 5 hours at a temperature of about 170°F.

Instead of tannic acid, extract of myrobolans, sumac, divi-divi, gall or chestnut or catechu may be used, taking for 10lbs. of tannic acid, 34lbs. of myrobolans, or 40lbs. of sumac leaves or 14lbs. of divi-divi, gall or chestnuts; crush the material, boil for 2 hours in sufficient water to prepare the extract and strain the liquid.

*III. Alizarine dyes.*—The use of alizarine dye of 40 % purity is recommended. It will give the following colours, the mordant being different in each case.

*Red.*—The yarn is mordanted with 6 % W. S. aluminium sulphate and 5 % W. S. cream of tartar. The mordanted yarn is dyed with 5 % W. S. alizarine and 4 % W. S. acetate of lime. To get brighter shades, add 1—4 % stannous chloride and as much more of cream of tartar.

*Orange.*—The mordant used is 5 % W. S. stannous chloride and 5 % W. S. cream of tartar. Mordant, and then dye with 5 % W. S. alizarine. To get redder orange, 4—5 % W. S. acetate of lime should be added to the bath.

*Brown.*—The mordant used is 3—4 % W. S. pot. bichromate and 1 % W. S. sulphuric acid. Dye with 5 % W. S. alizarine only.

*Brown.*—Another mordant for brown colour is 5 % W. S. chrome alum and 5 % W. S. cream of tartar. Dye with 5 % W. S. alizarine.

*Purple.*—The mordant used is 6 % W. S. ferrous sulphate and 6 % W. S. pot. bitartarate. Dye with 5 % W. S. alizarine and 5 % W. S. carbonate of lime.

*Red purple.*—Mordant with 6 % W. S. copper sulphate and 6 % W. S. pot. bitartarate. Dye with 5 % W. S. alizarine.

The process of mordanting is as follows:—Weigh the silk; take the exact quantities of mordants as given above, powder the chemicals carefully and dissolve them in hot water; and put them in 60 to 70 times W. S. of water. Wet out the silk, put it in the water, working it about all the time. Bring the bath to nearly boiling point, and leave all night to cool. In the morning take out the silk, wash smoothly in cold water, wring out and let it get nearly dry.

The mordanted silk is now dyed as follows:—Heat 60 to 70 times W. S. of water; add the required quantities of alizarine and any other "assistant" required, after dissolving these well in hot water; put in the wet mordanted silk in the bath at about 130°F.; stir and work about the silk; bring the bath to the boil and keep it boiling for one hour; take out the silk and wash in clean cold water.

The dyed silk receives an after-treatment as follows:—Put the dyed silk in 5 % W. S. boiling soap solution, turning it round till well soaped; take out, wash 2 or 3 times in clean cold water, wring and dry in shade.

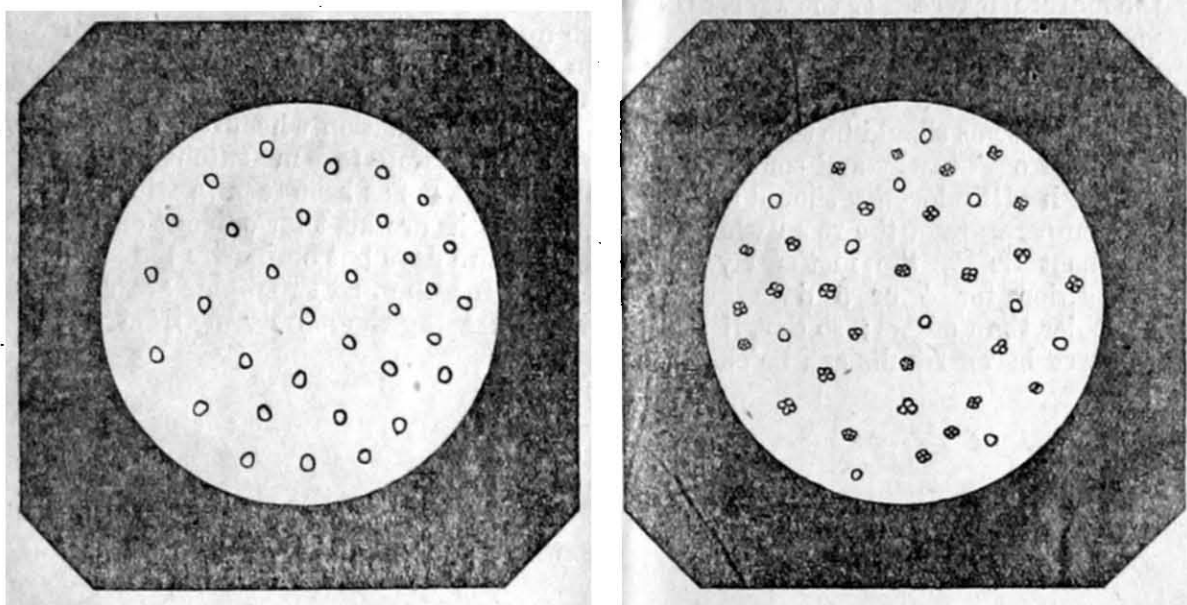


## APPENDIX V.

## NOTE ON THE GRASSERIE DISEASE OF THE MUGA SILK WORM BY MR. M. N. DE.

*Grasserie in muga worms.*

Grasserie is a disease of silkworms causing great damage to rearers. Ordinarily the mortality of the *muga* worms from this disease is about 4 %, but when it rains for some days after a long drought the mortality is very great. The disease appears in all the stages of the caterpillars but specially in the fifth stage. The acutely-diseased worms die before spinning cocoons, but if mildly attacked they spin thin and flimsy cocoons, die in the pupa stage and can seldom change into moths. In Assam among the rearers, it is known as *foolá rog* (swelling disease); it corresponds to *Rasá* disease in mulberry silkworms. The disease appears most in May and June. The external symptoms of the disease when the worms are affected with it are the following:—The body of the worms swells up, and the skin becomes a little shiny; the worms cease to take food, crawl about and seem to be distressed, later on they remain motionless, hang with the head downwards and finally die; the bodies begin to decompose gradually and fall down to the earth with the slightest wind, the skin bursts into pieces and a deep black juice comes out.



The internal symptoms of the disease are the following:—

The blood of the diseased worm becomes cloudy: ordinarily the blood of the healthy worm is transparent; the shiny appearance of the skin is due to this. In this cloudy fluid (if examined under the microscope of 700 magnifications), there are visible innumerable oval shaped and slightly angular bodies (*vide* Fig. I) which should not be confused with fatty globules which are round and very shiny looking. Besides, the oval bodies can be crushed easily by placing a little of the juice on a slide and pressing with a cover glass by means of the thumb (*vide* Fig. II), whereas the fatty globules remain unchanged. These oval bodies are stained blue by osmic acid, whereas the fat bodies are stained black; fat bodies are dissolved by ether, absolute alcohol, caustic potash, etc., but the oval bodies remain unchanged. The grasserie bodies in *muga* worms are quite different from the grasserie bodies in *Bombyx mori*, *Antheraea yamamai* of Japan, *Antheraea pernyi* of China and *Attacus ricini* of Assam (*vide* my article on grasserie in silkworms, Agricultural journal of India, Volume VI, Part III, July 1911). The oval bodies peculiar to the disease are found not only in the blood, but also in the fatty tissues, tracheal membrane, muscles and cells. The disease is contagious but not hereditary.

The causes which produce grasserie in silkworms are not well-known. The following causes may generally be attributed:—

- (1) Rain after a long drought in the rearing season as the worms are compelled to eat very juicy leaves.
- (2) Continuous and persistent rain.
- (3) Tender leaves if eaten by grown-up worms.
- (4) Worms fed on mature leaf first and tender leaf afterwards.

- (5) Leaves eaten from a big and tall tree first and then from a small and dwarf tree (as the leaves from the latter contain more juice).
- (6) Leaves from wet and moist ground.
- (7) Leaves of shady place.
- (8) Damp air.
- (9) Sudden change from dry and hot temperature to cold and damp.

*Remedy and prevention.*—Some of the causes which give rise to the disease are beyond our control. I have noticed during my last tour in Assam that the rearers are ignorant of the causes which give rise to the disease. In most cases too many *khorikas* (straws on which *muga* moths have been allowed to deposit eggs) are tied on a single branch so that when the caterpillars hatch they are forced to eat mature leaves and when all the leaves in the branch are exhausted, they crawl to a new branch and begin to feed upon comparatively tender leaves and so get the disease. In Dibrugarh the rearers tie the *khorikas* on trees containing mature leaves with the notion that the worms will grow quickly on those leaves. Now the worms may thrive better on those leaves, if they survive, but many of them will die of flacherie or grasserie as the young worms can hardly digest the mature leaves. If the *khorikas* are distributed judiciously to all the branches of young trees containing tender leaves a large number of worms can be saved from this disease. The disease may be prevented to a great extent if the time of the rearing season is changed when the natural causes enumerated above do not exist. The diseased worms should be thrown away far from the plantation whenever they are seen. Worms from healthy and sound eggs can resist the disease to some extent so that eggs from a healthy locality should always be obtained. It has been seen in winter that if the temperature of the room where the mother moths are kept for oviposition is raised to about 80°F., the moths lay their eggs in two days but ordinarily they continue oviposition for 4 or 5 days. Now the eggs of the first two nights are better and healthier than others; so that if the practice of keeping the mother moths at 80°F. is followed better results can be obtained.