Life Cycle of Muga Silkworm

Compiled by Dr NIDHI GARG

Introduction

- The golden silk Muga is the pride of Assam which is associated with Assamese culture and tradition
- Muga culture is the monopoly of Assam
- Muga is an endemic silkworm species prevalent in the Brahmaputra valley and adjoining hills by virtue of its typical agro-climatic condition
- Assam alone contributes 95% of the total Muga raw silk production
- The precious glittering golden yellow silk-Muga is exclusive and endemic to Assam and the North Eastern Region of India since nowhere in the world Muga silk can be produced
- Assam is the state producing all types of natural silk fibre
- Assam state contributing highest production of two types of silk i.e. Muga & Eri
- Assam received Geographical Indication (GI) tag for Muga silk and its products in the year 2007
- Though the climatic condition of Assam is almost favourable for producing all the four varieties of silk but it is very much suitable for Muga silkworm rearing

Introduction

- Muga silkworm having least number of chromosome (n=15) among saturnid moths
- Muga silkworm feeds on Som (*Persea bombycina* Kost.) and Soalu (*Litsea polyantha* Juss.) as primary food plant and few other plants as secondary and tertiary.
- Since Muga is reared outdoor, it suffers from a large number of problems such as unfavourable weather, infection from other creatures and outbreak of various diseases
- Huge potentials of Muga silk sector as one of the most promising economic activities for employment generation in the rural sector of Assam
- The export market for Muga silk are USA, Japan, UK, Germany, Malaysia, Italy etc.
- Production of Vanya silk, i.e. Muga, Eri and Tasar raw silk during the year 2011-12 were 126 MT, 3072 MT and 1590 MT respectively,where 1.6% increase in Muga over the previous year 2010-2011 (124 MT)
- The popularity of Muga silk has been spreading to different parts of India as well as to other countries because of its uniqueness

Uniqueness of Muga Silk

- Natural shining golden colour
- Muga silk is a stain free fabric
- Muga silk fabric is the second costliest fabric in the world next to Pashmina
- Muga silk is precious, durable, lustrous, strongest silk among the all types of natural Silk
- No artificial dye is required
- Everlasting colour stability. The golden colour is increased after every wash instead of decay of shine
- Muga silk fabric can be washed by all the washing material. There is no washing restriction
- It can absorb Ultra Violet radiation up to 85%
- Moisture regain capacity up to 30%
- Resistant to Acid
- It has the highest tensile strength amongst all other natural fabrics
- Muga silk is comfort to wear over the year due to its thermostatic nature

Evidence of Origin

- Muga silk is native of Assam and named after Assamese word "Muga" which indicates the amber (brown) colour of cocoon. The scientific name of Muga *Antherea assamensis* itself shows its Assam origin .
- In Kautilya's Arthasastra (321 B.C), it is mentioned that the varieties of textile commodities known as dukula, was the product of the country of Suvarnakudya/Sonkudhia (Modern Assam) which was as red as sun, as soft as the surface of gem. There are various species of insect found in Northern Myanmar to South of Tripura which produce different varieties of silk but the variety of worm found in Assam only produce golden coloured yarn, from which the pure muga fabric is produced.
- Historical records reveal that the exquisite varieties of Muga silk were sent by the king Bhaskara of Kamrupa (Assam) as gift to king Harshavardana by 1,300 years ago.
- It is mentioned in P.C. Choudhury's book *"The History Civilization of the People of Assam to the Twelfth Century A.D."*, that at least with 1st century A. D. the production of silk and the silk trade was in Assam and the manufacture of Muga silk has been confined to Assam alone.

Evidence of Origin

- He also mentioned that the art of sericulture and rearing of cocoons for the manufacture of various silk cloths were known to the Assamese as early as the Ramayana and the Arthasastra.
- Gait, Sir Edward in his book "A History of Assam" (1st Edn. 1905, *Pp.217)* reported that the custom house at Hadira opposite Goalpara fixed a duty of 10% according to the terms of commercial treaty executed with Gaurinath Singha, the Ahom king and Welson of East India company in 1793 where 224 maunds value of Rs.53899/- during that period.
- In the book *"Facts about Assam Silk"* refers Chinese records dating as far back as 248 A.D. mention about the trade route from the south through the Shan states, Brahmaputra river and Kamrupa to Pataliputra (Patna). The ancient trade in silk with Bhutan and Tibet through Udalguri in the Darrang district of Assam still exists.
- The silk Industry of Assam was first made known to the world by famous European traveller Jean Joseph Tavernier in 1662 and refers that silkworm in Assam remained on trees all round the year and confirms that the stuff made of them was very brilliant.

GI Certification for Muga Silk of Assam

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भारत सरकार

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in class 23, 24, 25, 27, 31 under no. 55 as of the date 20.07.2006

in respect of MUGA SILK OF ASSAM
Falling in Class, 23,24,25,27,31.
Raw silk yarns and threads for textile use, Textile and Textile goods including Mekhela-Chadar, Shawls, dress materials, Sarees, wall hangings, clothings/garments, foot wears, Head gear, Made ups, Ties, motifs, fashion wears, Quilt, furnishings & upholstery, Cocoon.

आज दिनांक 13 मास 20 07 को चेन्नई में मेरे निदेश पर मुद्रांकित किया गया।

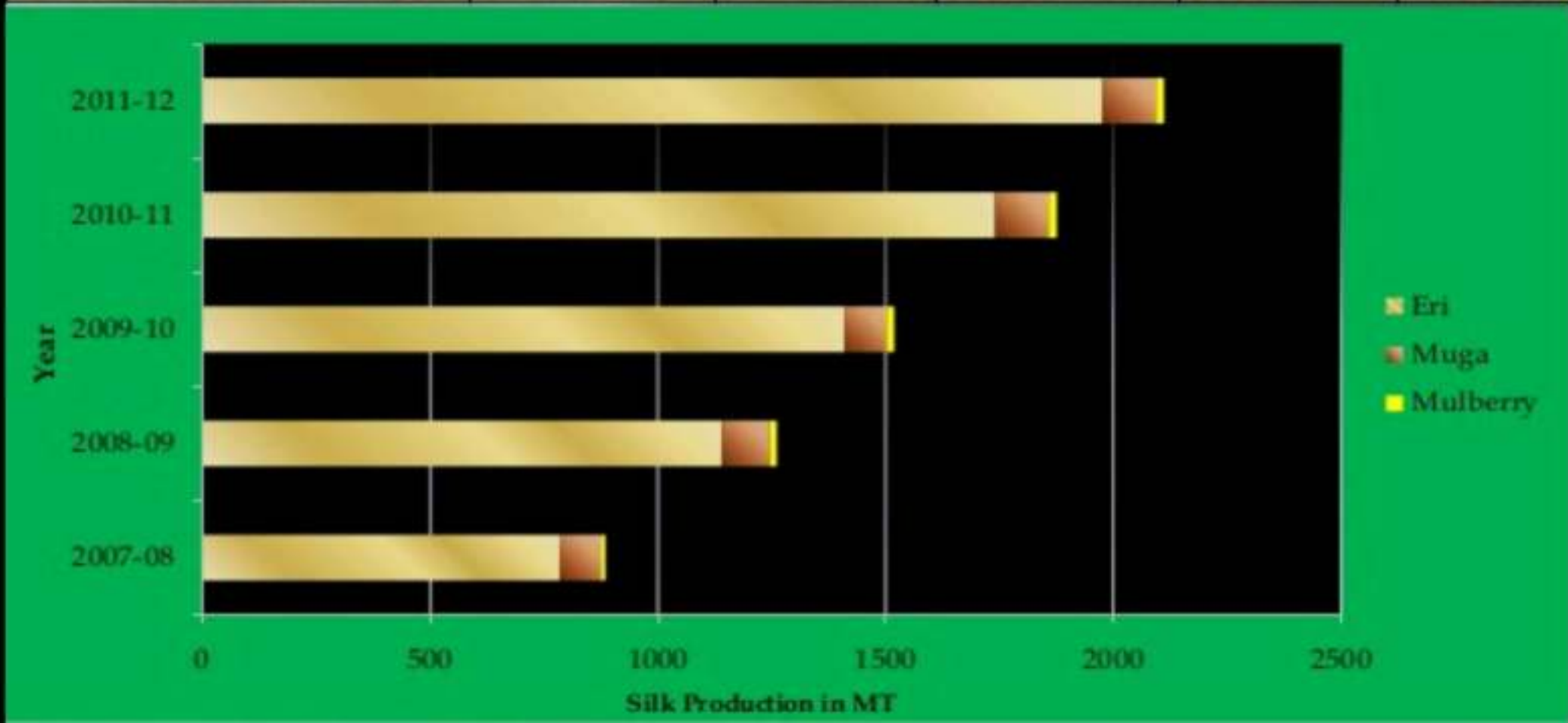
Sealed at my direction this 13 day of July 20 07 at Chennai.

रजिस्ट्रार, भौगोलिक उपदर्शन
Registrar of Geographical Indication.

Geographical Location of Assam

Raw Silk Production in Assam (MT)

Sl. No	Variety	Production (MT)				
		2007-08	2008-09	2009-10	2010-11	2011-12
1	Eri	784.26	1141	1410	1741	1976
2	Muga	91.07	105	93	117	118.76
3	Mulberry	9.48	15	16	18	16.75
	Total	884.81	1261	1519	1876	2111.51

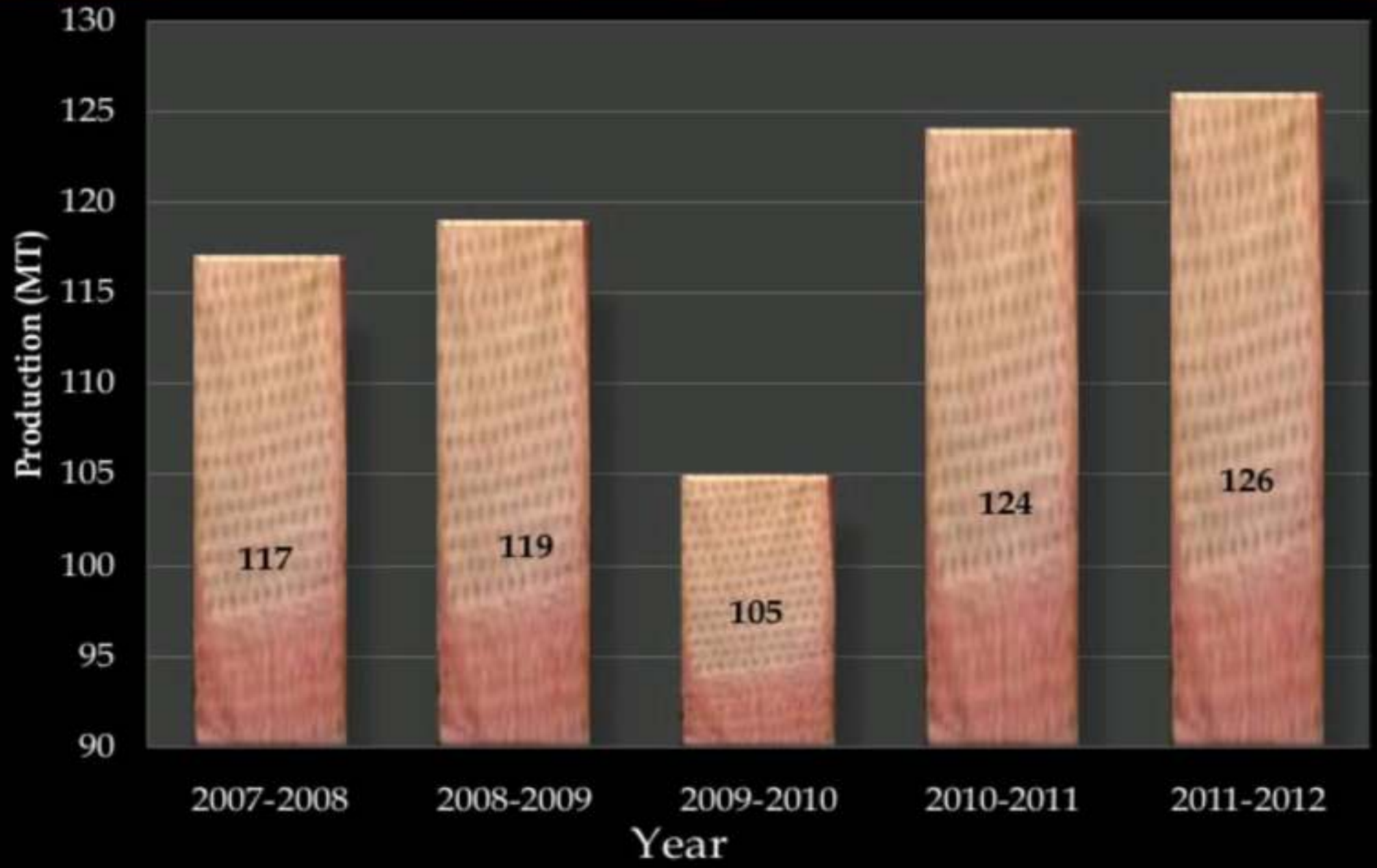


Present Status of Muga Raw Silk Production

Sl. No	State	2010-11	% Share	2011-12	% Share
1	**Assam**	**117.00**	**94.35**	**118.76**	**94.25**
2	Arunachal Pradesh	1.2	0.97	1.60	1.27
3	Manipur	0.50	0.40	0.50	0.40
4	Meghalaya	3.25	2.62	3.31	2.63
5	Mizoram	0.40	0.32	1.17	0.93
6	Nagaland	1.40	1.13	0.66	0.52
7	West Bengal	0.25	0.20	0.23	0.18
	Total	**124.00**		**126.00**	

Source: Annual Reports CSB & DOS, Assam

Production Muga of Raw Silk



Trend of Muga Silk Production in Assam

Sl. No	Period	Production of Raw Silk (MT)
1	1997-1998	60
2	1998-1999	70
3	1999-2000	82
4	2000-2001	94
5	2001-2002	92
6	2002-2003	94
7	2003-2004	99
8	2004-2005	98
9	2005-2006	98.5
10	2006-2007	96.45
11	2007-2008	86.05
12	1998-2009	101.00
13	2009- 2010	93.00
14	2010- 2011	117.00
15	2011-2012	118.76

Source: Annual Reports CSB & DOS, Assam

Growth Trend of Muga Raw Silk Production in Assam

Present Scenario of Muga culture

Sl. No	Particular	Status
1	Area under Muga Food Plantation in Hectors	9241
2	Effective Plantation under use in hectors	6000-65000
3	Rearing Capacity/Hector/Annum(DFL)	1500-2000
4	DFL Cocoon in average	1:50
5	Cocoon production/Hector/Annum in number	75000-10000
6	Cocoon requirement/Kg yarn (No)	45000-50000
7	Raw Silk production Kg/Hector/Annum	15-20
8	Silk recovery in percentage	40-45
9	Rearing capacity per family/per Annum(DFLs)	400-500

Source: Central Muga and Eri Research & Training Institute, Lahdaigarh, Jorhat, Assam (2010-2011)

Distribution

- **The native place of this moth is Assam.**
- **Its production was confined to Assam, border areas of neighboring north-eastern states and Cooch Bihar in West Bengal.**
- **Now it is reared in Nagaland, Meghalaya and Andhra Pradesh also.**

Host plants

- **The muga worm feeds on aromatic leaves of Som [Fig. 3.27(i)] and Soalu [Fig. 3.27(ii)].**

- **It can also be reared on host plants similar to that of tasar worms.**

Fig. 3.27. Host plants of muga worm — (i) Som tree and (ii) Soalu tree

Figure 1.2 Som plantation

Process of Muga Culture - *Soil to Silk*

Food Plants


Som


Soalu

Traditional Morphotypes of Som


Nahorpotia


Jampotia


Belpotia

Food Plant Diseases

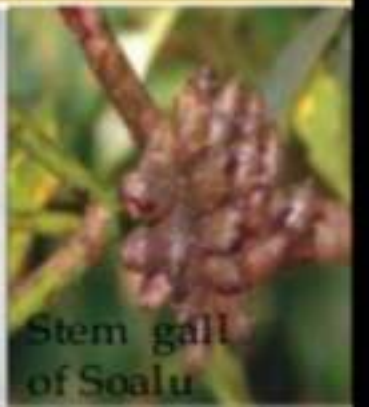

Leaf rust of Som


Leaf spot of Som


Grey blight of Som


Leaf gall of Som


Leaf gall of Soalu


Stem gall of Soalu

Antheraea assamensis Helfer (Muga Silkworm)

Kingdom : Animalia

Phylum : Arthropoda

Class : Insecta

Order : Lepidoptera

Family : Saturniidae

Sub Family: Saturniinae

Genus : *Antheraea*

Species : *assamensis*

Life history

- **The moth is multivoltine the entire life cycle lasts for about 50 days in summer and 120 days in winter.**

- **This moth is semi-domesticated and can be raised outdoor.**

- **Muga moth (“Muga Polu’ in Assamese) also has the same life cycle as other silkworms, i.e., egg, larva, pupa and adult.**

Life history: Adult muga moth

- **The wings and body of the male moth are copper brown to dark brown, while those of female is yellowish to brown.**

- **Besides colouration, the male moth can be distinguished from the female by its**

1. **Slightly smaller size**
2. **Slender abdomen**
3. **Bushy antennae**
4. **Sharply curved forewing tips**

Life history

- **The *Antheraea assamensis* can be identified by the orange eye-spots, the pale leading edge of the forewing, and a black spot in the rear wing eye- spot located towards the body [Fig. 3.28(a)].**

- **Typically, the males find the females upon emergence and copulate immediately.**

Figure 1.1 a: Male moth b: Female moth

Life Cycle of Muga Silkworm

Male moth

Female moth

Eggs

1st instar

2nd instar

3rd instar

4th instar

5th instar

Cocoon

Pupa

Yarn

Febric

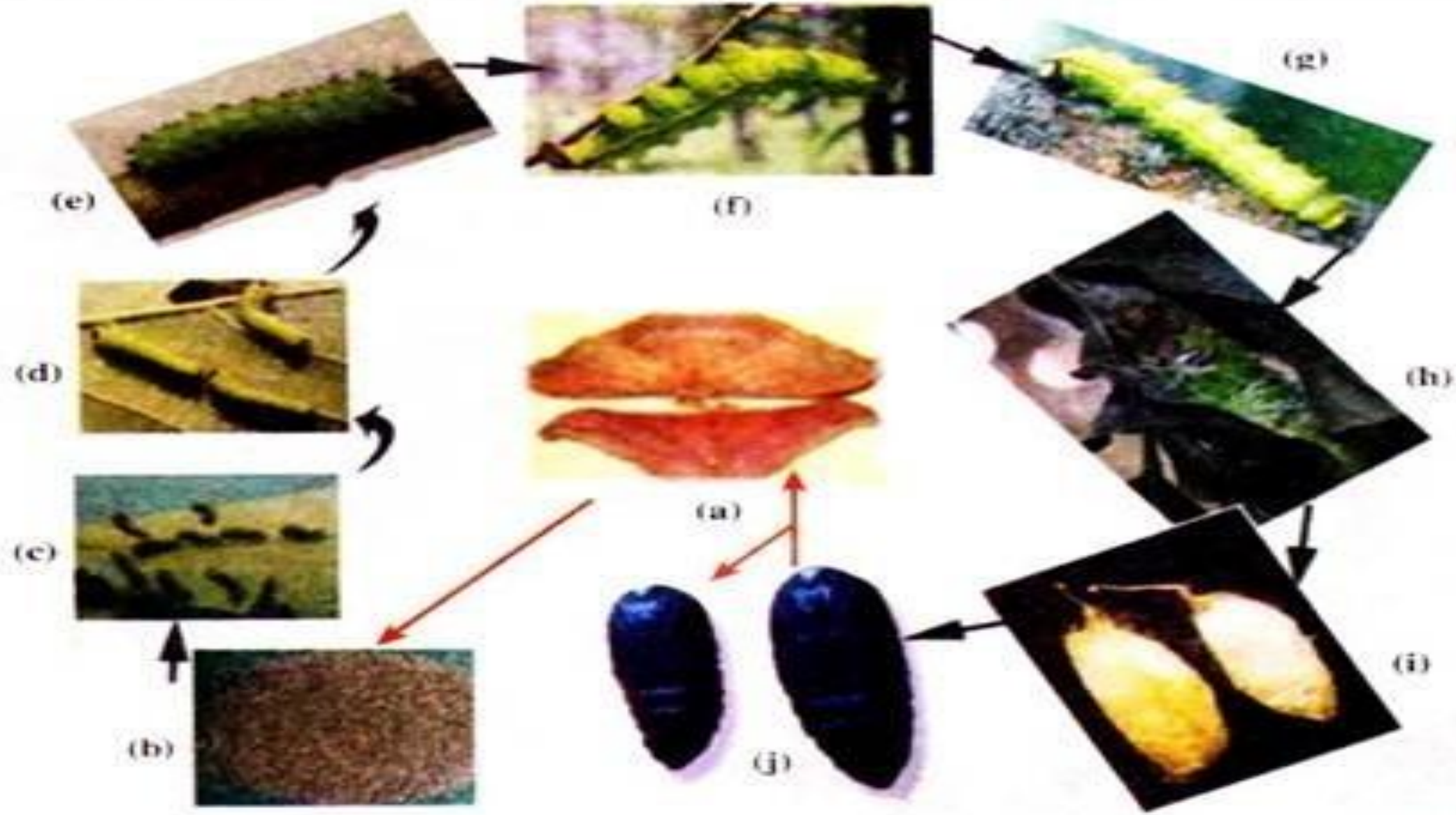


Fig. 3.28. Life cycle of muga moth : (a) Adult muga moth; (b) egg; (c) 1st instar; (d) 2nd instar; (e) 3rd instar; (f) 4th instar; (g) 5th instar; (h) pupating larva; (i) cocoon and (j) pupa

Life history

- **Egg:**

- **The female moth's eggs (popularly known as seeds) are laid on the Som and Soalu leaves.**

- **Larvae:**

- **Eggs are hatched into larvae of about 2 mm long.**
- **They grow rapidly, eat voraciously and end up about 30 mm long after 4-5 weeks.**
- **During this time, they moult four times. At the end, they search suitable place for cocooning.**

Figure 1-19 (all Fotos by the author): 1 - Eggs of muga silkworm *Antheraea assamensis* (Helfer) (Lepidoptera: Saturniidae), 2 - *A. assamensis* -First Instar, 3 - Second Instar, 4 - Third Instar, 5 - Fourth Instar, 6 - Fifth Instar, 7 - First Instar feeding on egg shell, 8-12 - Coulour variation instar wise (Ist

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STAGES OF MUGA SILKWORM
Egg
(7-14 days)
1st stage worm
(3-6 days)
2nd stage worm
(3-5 days)
3rd stage worm
(4-8 days)
4th stage worm
(5-11 days)
5th stage worm
(7-15 days)
Mounting on Jali
(3-7 days)
Cocooning
(7-10 days)
Cocoon
(12 days)
Moth
**Duration ranges indicates stage wise duration in summer and winter crops

Life history

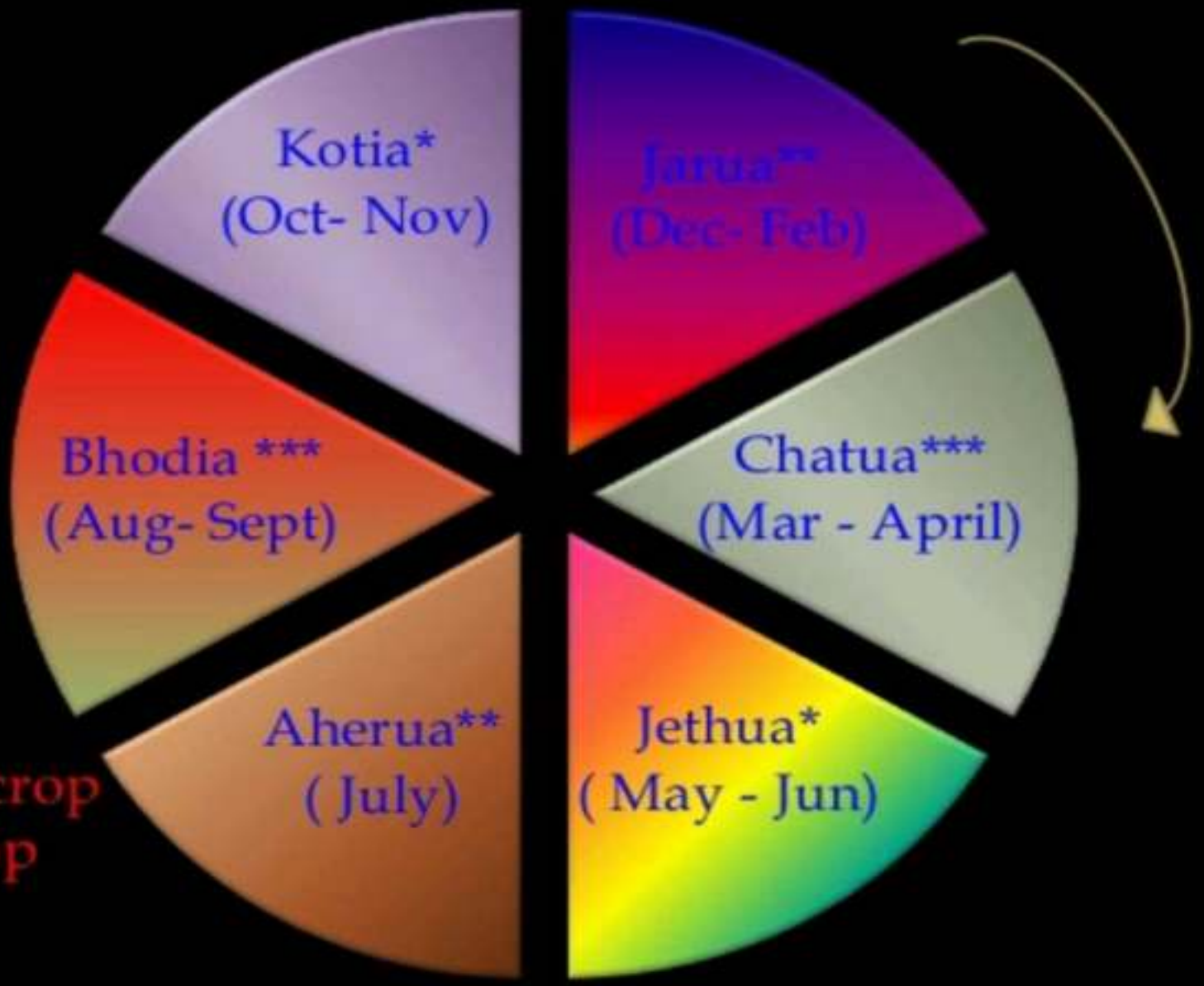
Duration of different stages of muga silkworm

Stages of life cycle	No. of days in summer (Minimum)	No. of days in winter (Maximum)
Egg laying and hatching	7	15
Larval stage	24	70
Cocooning stage	3	7
Pupal stage	14	55
Moth and egg laying stage	2	3
Total number of days	50	150

Source: Thangavelu K et al. (1988): Handbook of Muga Culture, CSB, Bangalore, p2

Choudhury S N (1982): Muga Silk Industry, Directorate of Sericulture, Assam, p34

Crop Cycle of Muga Silkworm



* Commercial crop
** Pre-seed crop
*** Seed crop

Name of Muga crops & their characteristics

Sl No	Assamese name of crops.	Month	Season	Cocoon characteristics.	Quantity of silk per 1000 cocoons	Remarks
1	Katia	Oct-Nov.	Autumn	Best cocoon, good for reeling, 612 mtr per cocoon.	250 gm reeled silk, 125 gm silk waste.	Main commercial crop
2	Jarua	Nov, Dec,Jan	Winter	Poorest cocoon, 265 mtr thread per cocoon.	150 gm reeled silk.	Pre seed crop
3	Chotua	March-April	Early Spring	Used for seed		Seed crop
4	Jethua	April-May	Spring	Good cocoon, next to Katia, 546 mtr thread per cocoon.	200 gm reeled silk.	Second commercial crop.

5	Aherua	June-July	Early Summer	Poor cocoon, not suitable for reeling, 460 mtr thread per cocoon.	180 gm reeled silk	Pre seed crop
6	Bhodia	Aug.-Sept	Late summer	Poor cocoon, difficult for reeling, 448 mtr thread per cocoon.	150 gm reeled silk	Seed crop.

Source: Thangavelu K et al. (1988): Handbook of Muga Culture, CSB, Bangalore, p2

Choudhury S N (1982): Muga Silk Industry, Directorate of Sericulture, Assam, p35

Optimum Temperature and Humidity Required for Muga Silkworm

Sl. No	Stage	Temperature (° C)	RH (%)
1	Incubation of eggs	25-26	80-85
2	Larval Stage	24-26	75-80
3	Spinning of cocoon	24-25	75-80
4	Storage of cocoon	25-28	70-80
5	Pairing of moth	25-28	75-80

Physical characteristics of Muga cocoon

Parameters	Characteristics
Colour	Golden brown
Shape	Oval (with small peduncle)
Size	4.5 - 5.5 cm (L) X 2.1 - 2.7 cm (B)
SCW (gm)	5.50 – 6.8
SSW (gm)	0.50 – 0.60
SR %	8.80 - 9.09
Rendita	4500 – 6500
Single cocoon filament length	350-450 m
Filament size	4.5-5.0 Denier
Tenacity	4.53 gm/dr.

Process of Muga Culture - *Soil to Silk*

- Muga Silkworm is wild in nature and it is reared in outdoor
- Pre & Post rearing operations are done in indoor hence it is considered as semi-domesticated
- Muga silkworm is polyvoltine in nature, having 6 broods in a year
- Muga food plants thrive well in slightly acidic (P^H ranging 4.0 to 6.8) alluvial, sandy loamy, clay and laterite red loam soil
- The newly hatched larva is characterized by prominent black inter-segmental markings over the yellowish body with brown head
- During the larval period the worm changes their skin (Moult) four times
- The larval period having five Instars and four moults
- The matured worms are mounted on *Jali* for cocooning
- After 7 days during summer and 10 days during winter cocoons are harvested
- The pupa is copper brown, weighs about 5 – 6g
- After harvesting good, flimsy, Mute and Uzi-infested cocoons are sorted out

Process of Muga Culture - *Soil to Silk*

- Only well-formed good cocoons are selected for seed production as well as for reeling purpose
- Seed cocoons are preserved in single layer to facilitate proper aeration and easy emergence
- Seed cocoons are allowed to emerge for coupling to produce seeds (DFL)
- After 17 days during summer and 35 days during winter Moths are emerged from cocoon
- The approximate body length of male moth is 3 cm and the female is 3.5 cm
- The adult does not eat during the short period of its mature existence
- Commercial cocoons are oven or sun dried subjected to kill the pupa and preserved for reeling
- The CPC (Cut & pierced cocoons) are used to spin muga yarn with traditional *Takli*
- The commercial cocoons are reeled with traditional *Hand Bhir* reeling device and improvised reeling machines

Rearing of muga moth

- **The seed cocoons intended for preparation of eggs are obtained from commercial rearers or from Government grainages.**
- **These are then laid in a single layer in trays to facilitate the emergence of moths.**
- **Emergence starts from dusk and continues till morning.**
- **The emerging adults are allowed to mate and in the coupled state, the pair is tied with a piece of cotton thread to 1.5-2 feet long stick made of dried straw which is known as Kharika.**

Rearing of muga moth

- **After overnight mating, the couples separate in the morning and if they do not decouple naturally they are made to do so by heat of fire lighted some distance away.**

- **The female moth lays about 150-250 eggs on Kharika.**

Fig. 3.29. Female muga moth laying eggs on Kharika

Rearing of muga moth

- **During the rearing period, farmers restrict entry of people to the rearing plot as they believe that the evil sight of outsider may cause Mukhloga disease (Flacherie, a bacterial disease of muga).**

- **During summer, the worms hatch out in the morning in about 8 days.**

- **The Kharikas with the hatched worms are hanged on the host plants.**

Rearing of muga moth

- **The larvae immediately crawl and start feeding on leaves. When the leaves are exhausted, the larvae crawl down and are collected on triangular bamboo sieves with long handles (Chaloni) Fig. 3.30, which are again hanged on a fresh tree.**

Fig. 3.30. Muga larvae are collected on chaloni

Fig. 3.31. Muga larvae crawling down the tree trunk

Rearing of muga moth

- **A band of straw with a little sand or ash is tied around the tree trunk 1-1.2 m above the ground to prevent the worms from crawling down the ground.**
- **The larvae feed voraciously, pass through 4 moults and reach the mature stage.**
- **In the final stage, larvae become greenish blue with prominent tubercles.**
- **Larval period lasts for 30-35 days. The ripeworms come down the trees searching for a suitable place for spinning of cocoon.**
- **They are then collected by rearers and put in baskets containing mango twigs and leaves, which are set as cocoonages (Jali) for the spinning of cocoons.**

Rearing of muga moth

- **The jalies are then hung (Fig. 3.32) and left undisturbed in separate rooms or at some shady place till cocoons are formed.**
- **Dry leaves of singari, bhomloti, azar, etc. are utilised for preparation of jali by the farmers.**
- **It is believed that cocooning in singari leaves produces shining and compact cocoons.**
- **Spinning takes about 2-3 days in summer and 7 days in winter.**
- **Muga cocoon is golden or light brown in colour, 4-6 cm long and 2-3 cm broad with a rudimentary peduncle without ring**

Rearing of muga moth

- **The**

Fig. 3.32: Jali cocoonage for muga larvae

Process of Muga Culture - *Soil to Silk*

Seed Production (Grainage)


Sorting of seed cocoons


Preservation/Storage of seed cocoons


Emergence of moth


Coupling


Moths on Kharika


Egg Laying


Egg drying


Loose Egg (DFL)

Process of Muga Culture - *Soil to Silk*

Rearing

Brushing of worms

Matured worms

Rearing of Muga Silkworm

Colourmorphs of Muga Silkworm

Green

Blue

Orange

Yellow

Spinning of Cocoon

Traditional Mountage 'Jali'

Box type Mountage

Harvesting Cocoons

Post Cocoon Processing

- **The muga cocoon is compact and leathery in structure.**
- **The length of continuous silk filament ranges from 350-450 metres with 4 to 5 breaks.**
- **Immediately after removal from the mountages, cocoons are spread on bamboo mats in the sun during hot hours of the day that partially kills the chrysalis.**
- **These are then subjected to heating in oven that kills the chrysalis completely, and thus the cocoons are stifled.**
- **For degumming of cocoon, local people use alkali (khar) made by burning banana peel/pseudo- stem or paddy straw/husk. Cocoons are boiled in such mild alkaline solutions for about 15-20 minutes.**

Post Cocoon Processing

- **Almost entire reeling of muga is done with a primitive machine, called Bhir or Bhawri, operated by two persons (Fig, 3.33). The cocoons are kept in basin with warm water.**

Fig. 3.33. Muga reeling by Bhir

Post Cocoon Processing

- **The Reeling requires two persons:**

- **One person releases the filaments from cocoons while the other twists the filament into one thread and wind it on Bhir.**

- **Two persons can reel around 100 gm raw silk per day on an average.**

- **Only 40-45% silk filament is reeled and rest is rejected as waste.**

Process of Muga Culture - *Soil to Silk*

Reeling & Spinning

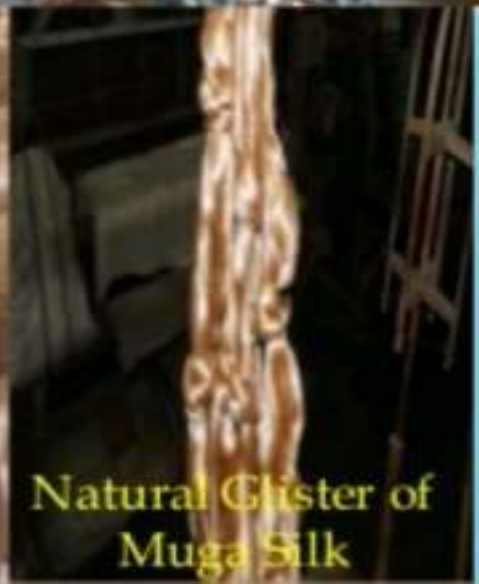

Reeling with traditional Bihir


Reeling with Improvised Reeling Machine


Spinning with traditional Takli


Re-Reeling


Reeled Muga Silk Yarn


Natural Gluster of Muga Silk


Standard hank of Muga Silk

Diseases of Muga Silkworm

1. Protozoan Disease: Pebrine

2. Viral Disease: Grasserie

3. Bacterial Disease: Flacherie

4. Fungal Disease: Muscardine

Pest and Predators of Muga

Food Plant Pest

Silkworm Pest

Predators

Traditional Rearing Equipments


Chakaripera
(Moth cage)


Brushing Cage


Kharika


Ketepa


Triangular bamboo
Chalani


Khora(Bamboo basket
used to collect mature
worms)


Dhanu(Bow)

Traditional Product of Muga Silk

Mekhela

Mekhela – Saadar Set

Saree

Multi color Muga

Pure Muga cloth piece

Royal Silk Dress

Dress of Sukapha, The First Ahom King of Assam

Fancy Dress of Muga Silk

Men's Jacket

Men's Shirt

Men's Kurta

Ladies Shirt

Ladies Hand Knitted Silk blended Sweater

Ladies Muga Embroidered

Stole

Diversify Products of Muga Silk

Ladies Bag

Muga Curtain

UV Protected Umbrella

Muga Tie

Wall Hanging

Cushions with Fine Silk Designs

Bed Spread with Pillow Cover

Other Uses of Muga Silk

- In Aircraft Tire

- In Parachute Rope

- In Bullet Proof Jackets

Muga Silk in Assamese Culture


WHEN YOU GO HOME
TELL THEM OF US AND SAY
FOR YOUR TOMORROW
WE GAVE OUR TODAY


I HOPE NO WORMS WERE HURT IN THE PRODUCTION OF THESE!
SILK SHIRTS
THANK YOU