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Review Article
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"South Asian Ways of Silk - A Patchwork of Biology, Manufacture, Culture and History"

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Abstract

This note reviews the biological aspects of the book "South Asian Ways of Silk - A Patchwork of Biology, Manufacture, Culture and History", covering the different species of silk moths and their management. The review centers on the Mulberry Silk Moth but also other silk moths (the Eri Silk Moth and wild silk moths) are covered in detail. Considerable research has taken place in most South Asian countries, which now has to be carried out to the rearers of silk moths, who are the backbone of sericulture. Obstacles to this are mentioned.

Keywords: Moth; Silk; Cocoons

Introduction

November 2015, the book "South Asian Ways of Silk. A Patchwork of Biology, Manufacture, Culture and History" was published by BOOKBELL in Guwahati, Assam, India [1]. The book was written by 12 authors from Bangladesh, Bhutan, India, Myanmar (Burma), Nepal, Pakistan, Sri Lanka and from Denmark (see under references below). The book is the first of its kind and comprises most aspects of silk: biology of the silk moths, rearing of cocoons, manufacturing of silk threads and fabrics, designs, marketing of fabrics and the history of silk.

In this note, the biological aspects of the book are reviewed, in particular the research efforts to improve sericulture in South Asia (Figure 1).

Silk Moth Species

The silk moth species in South India are described in details in the book [1].

The mulberry silk moth

The Mulberry Silk Moth (*Bombyx mori* (L.), family Bombycidae) originated in China and has been a domesticated for almost 5,000 years. Since the first century A.D., the species has been reared in South Asia and is now cultivated in India, Bangladesh, Pakistan, Nepal, and Myanmar and until recently in Sri Lanka. The species is not found in the wild any more, and has been cultivated in the region since the first century A.D. The larvae are fed on leaves of White Mulberry (*Morus alba*, family Moridae), placed upon shelves inside houses, mainly by rural women (Figure 2).

The eri silk moth

The eri silk moth (*Samia ricini* (Boisduval), family Saturnidae) is the other domesticated silk moth species, cultured for centuries in north-eastern India and a few other countries. Larvae of the moth are reared mainly by rural women on leaves of Castor (*Ricinus communis,* family Eurphorbiaceae), Kesseru (*Heteropanas fragrans*, family Araliaceae), Cassava (*Manihot execulenta*, family Euphorbiaceae) and a few other host plants (Figure 3).

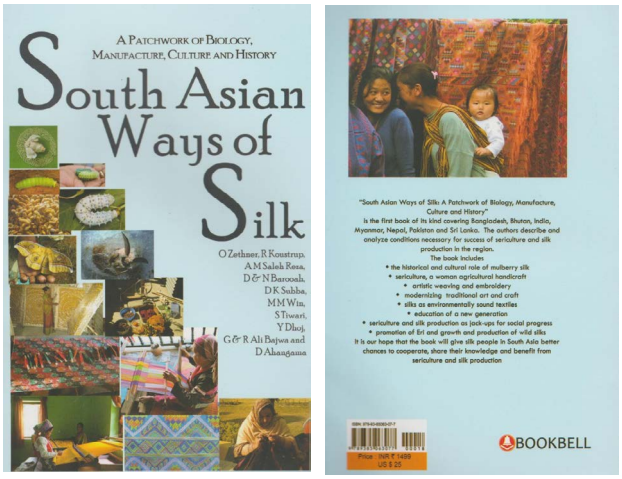
The host plants of the eri silk moth can be grown without irrigation, in contrast to cotton, which requires real much water to grow. This environmental advantage and the fact that eri silk is regarded as the most comfortable of all textiles, puts eri in a good position for the future.

Because of its open cocoons, the adult eri moth emerges easily from the cocoon. One cannot harvest the more than one kilometer long threads, but only short pieces of threads. So, the rearer does not have to kill the pupae, which makes the rearing of eri-larvae acceptable even for orthodox Buddhists, who are not allowed to kill any living creature.

Hindus in northeastern India regard eri-pupae as a gastronomic delicacy and can obtain high prices for the pupae in India and other Asian markets (China, Japan).

The wild silk moths

South Asia is rich in wild silk moth species and three species are



a) b)

Figure 1: a) Front b) back cover of the book reviewed.

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Figure 2: The mulberry silk moth: a) adults mating, b) eggs and small larva, c) Plucking of mulberry leaves, Myanmar, d) big larvae feeding on mulberry leaves, e) rearing larvae on shelves, f) cocoons.

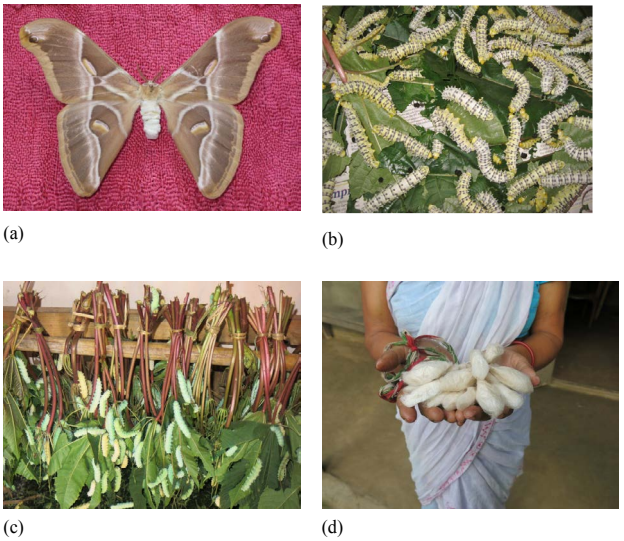

Figure 3: a) The eri silk moth adult b) Eri silk moth larvae feeding on castor leaf, Jorhat, Assam, India c) Bunch rearing of eri silk moth larvae feeding on Kesseru leaves, village near Shillong, Meghalaya, India d) Eri silk moth cocoons, village near Guwahati, Assam, India.

used by man. For historical, cultural, and economic reasons India is clearly the foremost country in the production of wild silks (3). The management of wild silk cocoons in India is mainly carried out by men.

Larvae of the tropical tasar (or Tussah) silk moth (*Antheraea mylitta* (Drury) or *A. paphia* (L.), both Saturnidae) feed on leaves of plantations of forest tree species: Arjun (*Terminalia arjuna* (Roxb.) Wight and Arn, Asan (*T. tomentosa* Wight and Arn), Sal (*Shorea robusta* Roth, family Dipterocarpeaceae) are the main host species. Larvae raised from adults of cocoons of tasar silk moths are placed on leaves of the host tree, where they move from tree to tree, often helped by bending trees towards each other (Figure 4) [2].

Larvae of the temperate tasar silk Moth (*Antheraea roylei* Moore, family Saturnidae) feed on leaves of various Oak species (*Quercus* spp.) of the Himalayas. The temperate tasar moth planted in India has been reported to be a hybrid between *A. roylei* and *A. pernyi* Gyérin-Meneville (The Chinese Oak Silk Moth), which is more productive than *A. roylei*. The management of the temperate tasar silk moth is very similar to that of the tropical tasar moth.

The muga silk moth larvae (*Antheraea assamensis* (Westwood), family Saturnidae) feed on leaves of trees of the family Lauraceae, in particular the Som tree (*Persea bombycina* (King ex. Hork. f) and the Sualu tree (*Litsea monopetala* (Roxb.) Pers). The management of larvae is exclusively carried out by men with a deep biological knowledge surrounded of mystery and taboos. Larvae are moved from tree to tree and finally collected when they crawl down the stem to spin their cocoon among dry leaves on the ground (Figure 5).

As shown by findings in the Indus Valley Civilization tasar and muga silk have been used by man since about 2400 B.C., almost as long time as mulberry silk has been known [3].

The qualities of silks from a number of other wild silk moths have been or are being tested. The malda silk moth (*Cricula trifenestata* Helfer, family Saturnidae), the Indian Moon Moth (*Actias selene* Hübner, family Saturnidae) and the Atlas Spinner (*Attacus atlas* L.,

Figure 4: The tropical tasar silk moth: a) adult, c) larvae in tree, d) cocoons. Odisha, India.

Figure 5a: The Muga silk moth. Adults, female bound to straws Jorhat, Assam, India.

Figure 5b: Muga silk moth larvae crawling down tree stem, Guwahati, Assam, India.

Figure 5c: Muga silk moth cocoons on shelf, Jorhat, Assam, India.

family Saturnidae) have shown promises, and cocoons of many other wild species may provide silks of unknown beauties.

Research Issues

Development of mulberry silk moth races and mulberry varieties

Even during the colonial time efforts were made to create races of mulberry silk moth and varieties of mulberry that are suitable to specific edaphic and climatic conditions for cultivation. When United Kingdom was the colonial power in most of the countries of South Asia, British scientists, with a few exceptions, played a major role in the research [4-6].

After independence of India research institutions were established under the umbrella of the Central Silk Board, India. Much of the research on rearing of silk moth species and their host plants took place in these institutes and their stations and in universities, by Indian researchers with the occasional assistance from foreign scientists.

The pattern in the other countries was much different from that in India. Researchers had to be trained, programmes made and research carried out with the assistance from researchers from other countries (Japan, China, South Korea and India). The references refer to two Nepalese examples of publications, but dozens of other sources could have been mentioned [7,8].

By 2015, all countries, except for Bhutan, had developed hundreds of Mulberry silk moth races and Mulberry varieties, adapted to the various edaphic and climatic conditions existing in their countries.

It should be possible to establish lists of the existing races and varieties, which could be utilized in the most relevant localities of the region. In this way one would not have to duplicate expensive research efforts, made in other countries and restrict the efforts to carry out less expensive trials with already certified Mulberry Silk Moth races and Mulberry varieties from other countries (Figure 6).

Sericulture

The health of eggs and larvae is of pertinent importance for successful sericulture.

Protecting silk moths against insect pests and diseases play a significant role for producing good quality cocoons. The worst insect pest is the parasitic Uzi fly (*Exorista sorbillans* (Wiedemann), which kills young silk moth larvae and causes the old larvae to spin flimsy cocoons. Other pests are the ichneumon fly *Xanthopimpla predator* Fabricius, praying mantis and bugs. These attacks are greatly reduced by using net in doors and windows and ventilation channels of the rearing house (Figures 7-9).

Diseases are, however, far more important than insect pests. These include diseases caused by fungi (*muscardine* and others), bacteria (*flacherie*), nucleopolyhedrosis virus (*grasserie*) and protozoan *Nosema* spp. (*pébrine*). Keeping a general high standard of hygiene is a must in sericulture. *Pébrine* has been, and still is, far the most dangerous

Figure 6: Mating of two different strains of mulberry silk moth in order to create a new race. One strain is dyed. Khopasi station, Nepal.

Figure 7: Mulberry silk moth egg lay under funnels. Khopasi station, Nepal.

Figure 8: Eggs being checked for pébrine disease, Bursa, Turkey.

Figure 9: Female larvae rearer thanking Louis Pasteur, Statue, Alès, Les Cevenness, France.

Figure 10: 3rd instar larvae during ´transport farmers, Bangladesh.

silk moth disease, hampering sericulture over long periods of time. It is interesting to note that Louis Pasteur' s simple control method from the late part of the 19th century, which allowed farmers to check silk moth eggs for *pébrine* under microscope thus avoiding using eggs from infected female moths, has survived as the best control method in large parts of South Asia and elsewhere. Over time women have been the most careful and best rearers of mulberry silk larvae, as seen in the numerous illustrations and descriptions of the process in China, India and Europe [9].

It has been shown that the best and safest start of sericulture is done when rearing of the first two larval instars takes place in *Chawky* centers by particularly trained staff. From the *Chawky* centers young third instar larvae are distributed to farmers. The *Chawky* system is abundantly used in India and well underway in Bangladesh and Pakistan (Figure 10).

The growth of larvae, naturally, depends on the quantity and quality of Mulberry leaves fed to the larvae. Here the selection of Mulberry variety is pertinent. Fast growing and varieties with large leaves provide the possibilities for a good cocoon harvest. The size of the cocoons indicates the conditions under which the cocoons have been reared.

Although the details of planting and management of Mulberry trees is not part of this paper it should be mentioned that a good supply of Mulberry trees and leaves is a prerequisite for fast growing and healthy silk larvae, are subsequently big cocoons.

Silk Production Figures over Time

The commercial production of mulberry silk in India was considerable by the end of the 18th century, when huge amounts of silk fabrics were produced for local consumption and export to other Asian countries and to Europe. Thus, the annual silk production in Bengal, which was the main silk producing part of India at the time, reached around 1,000 MT around 1870. The total silk production in India had not increase significantly in 1938. Between independence in 1947 and 2012 the production of silk in India has increased almost thirty times due to research efforts a.o., and about 17% of the world production was produced in South Asia, in particular India (China is still by far the largest silk producing country). The annual production in each of the other South Asian countries is less than 100 MT, which relatively is far below the production in India, taking into account the large size of the populations in Bangladesh and Pakistan.

The production of eri-silk and wild silks (Vanya silks) does now comprise some 20% of the total silk production in India and has increased rapidly over the past decade. There is a scope in cultivating especially eri silk in all countries of South Asia (Figure 11).

Reasons to differences in silk production figures

As seen above the relatively small silk production in countries other than India cannot be explained by lack of technical knowledge and research in those countries. Other factors are even more important today:

- Less cocoon productivity (kg cocoons per 100 disease-free egg laying) today about half of that in India. Regional cooperation by researchers and institutions could lead to an increase of the cocoon productivity. The cocoon productivity is a result of size of mulberry plantations (food supply), care of rearers and more factors.
- Poor extension of knowledge to farmers, in particular women farmers. Extension by addressing groups of farmers instead of individuals, in a farmer field school (FFS) approach instead of individually. This together with education and employment of more female extension staff would go a long way to increase the production considerably.
- Too little and unstable payment for cocoons to farmers has been hampering farmers to produce raw silk.

INDIA

Silk Statistics of India 2002-2011

	Unit	2002-3	2004-5	2006-7	2007-8	2008-9	2009-10	2010-11	2011-12
Production									
Mulberry area	Ha	194,463	171,069	191,183	178,000	187,000			282,000
Mulberry raw silk	MT	14,617	14,520	16,525	16,245	14,360	15,149	16,270	18,272
Eri raw Silk	MT	1,316	1,448	1,485	1,530	2,038	2,460	2,761	3,071
Tasar raw silk	MT	284	315	350	428	603	720	1,165	1,588
Muga raw silk	MT	102	105	115	117	117	105	123	127
Total raw silk	MT	16,319	16,500	18,475	18,320	18,370	19,600	20,410	23,057

DGCIS, Ministry of Commerce, Government of India, and Statistics of India Central Board , Bangalore

Figure 11: Silk statistics of India.

- Organization and coordination of efforts by government and foreign donors has often been lacking.
- Religious factors when training farmers, in particular the prohibition of Buddhist believers to kill the silk moths, has been an obstacle to sericulture of the mulberry silk moth. Culturing eri silk moth might have been more successful.
- The most serious factor is probably the rapid urbanization taking place all over South Asia, where also silk rearers move to towns and cities, where there are few opportunities for culturing in silk moths.

Conclusion

Since independence much research on sericulture has been done in South Asia, not only in India but also in the other countries except Bhutan. Literature and reports form this research should be made easily available in all countries of the region. In the future, instead of duplicate research, the existing research results (mulberry silk moth races, mulberry varieties) should be shared. The countries should the resources to extend the existing knowledge to farmers, in particular women, who are the most important persons for continuing and increasing the production of cocoons and raw silk.

Cultivation of Sericulture should be promoted in all South Asian countries with suitable conditions. In particular in Sri Lanka and Myanmar, where orthodox Buddhist belief prohibits the killing of mulberry silk moth larvae and pupae in the cocoons. This is not a problem in the open cocoons of the eri silk moth, where the adults are permitted to emerge alive.

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