REVIEW ARTICLE

Seribiodiversity and their Role in Sustainable Development in India

Ashmita Ghosh, Mrinal Ray, Debnirmalya Gangopadhyay*

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Abstract

India is one of the mega biodiversity centers of the world, housing around 10% of world's species. Indian biodiversity is intricately related to the socio-cultural practices of the inhabitants of this land. The north eastern and sub-Himalayan regions and other parts of the country are abundant in several wild sericigenous insects and their host plants. In India, only 5 types of sericigenous insects are commercially exploited from different species of silkworm's *viz*., mulberry silk and non-mulberries or vanya silk, which feed on a number of host plants. Sericulture is an eco-friendly agro-based labor intensive rural cottage industry and provides subsidiary employment and supplementing income to the rural farmers especially the economically weaker section of the society. In order to preserve the natural biodiversity, the systematic attempts are required to conserve the seribiodiversity for ecological balance and sustainable economic viability. The cocoons and pupae are not only used to harvest silk but also an alternative source of protein, fat and minerals for human food and animal feed. The ethnic people also use these insects for treating different ailments. The host plant leaves are being used for many other purposes such as animal feed, nutritional and medicinal uses, in addition to the utilization as silkworm feed. Therefore, the sericulture has gained a new paradigm to increase farmers' income keeping a well balance of ecology and biodiversity. The paper discusses about the significance of sericulture for rural development and the strategies to be taken up to revive the development of sericulture industry in India.

Key words: Agro-based industry, Biodiversity, Seribiodiversity, Sustainable development.

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Introduction

The art of silk production is called sericulture that comprises cultivation of silkworm rearing and post cocoon activities leading to production of silk yarn. India is one of the world's most biologically and culturally diverse countries. India is one of the world's 'mega diversity' countries containing four hotspots zones viz. the Eastern Himalayas, the Western Ghats and Sri Lanka, Indo-Burma and the Sundaland. This region harbours a wide range of biodiversity The region is home to about 7.6% of all mammalian, 12.6% of all avian, 6.2% of all reptilian, 4.4% of all amphibian, 11.7% of all fish, and 6.0% of all flowering plant species. India has 6.13 percent of total arthopodan species recorded so far in the world (60,383 species out of 98,3744) (Ghosh, 1991). These arthopodan species also includes the sericigenous insects which are distributed throughout the Indian sub continent. Diversity of silkworm at the genetic level is critical to success in any crop breeding as it serves a platform for specific breeding programs. Genetic diversity is a particular concern because greater genetic uniformity in silkworm can increase vulnerability to pests and diseases. Hence, maintenance of genetic diversity is a fundamental component in long-term management strategies for genetic improvement of silk worm which is cultivated by millions of people around the globe for its lusture silk. Seri-biodiversity refers to the viability in sericigenous insects and their host plats, which are economically and ecologically important biodiversity. The silk thread and the allied produces from these sericigenous insects are used for textiles, fertilizer, animal feed, food material, and medicine etc. Silk is the way of life in India, making it an inseperable part of Indian culture and tradition. The sericulture industry provides employment opportunities to the rural areas and its economy securing the livelihood of 70% of the people who depends on this sector. In the recent times, the genetic resources of sericigenous insects are facing threats like deforestation, habitat destruction etc due to different anthropogenic pressures and little importance on their managements. Sustainable development is required to meet human needs while preserving the environment so that while preserving the environment and genetic resources the economy is not hampered (Verma and Dwivedi, 2011). Therefore, the conservation of seri-genetic resources especially, the food plants of sericigenous insects has become very much essential to meet the desired objective for long term utilization and crop improvement programme.

Department of Sericulture, Raiganj University, Raiganj-733134, Uttar Dinajpur, West Bengal, INDIA

Corresponding author: Dr. Debnirmalya Gangopadhyay, Assistant Professor, Department of Sericulture, Raiganj University, Raiganj-733134, West Bengal, India; Mob.: +91 9873359143; Email: debn4u@gmail.com, deb_ganguly2003@yahoo.com

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Sericigenous Diversity of India

Silks are produced solely by arthropods and only by animals in the classes Insecta, Arachnida, and Myriapoda. Nearly 400-500 species are known to produce silk but only very few are commercially exploited. There are several wild sericigenous insects and their host plants which are abundant in the Notheastern and Sub-Himalayan regions and other parts of the country (Kalita and Dutta, 2014). However only five types of sericigenous insects are commercially exploited in India. They are mulberry silk, Tasar silk, Muga silk, Eri silk, Anaphe silk, Fagara silk, Coan silk, Mussel silk and spider silk (Gupta *et al*., 1999). Spiders also produce a variety of silks, but in contrast to insects, an individual spider may produce as many as eight different types of silk thread. Nevertheless, the purposes for which insects and spiders use silks are similar. The silks produced by myriapods are uncharacterized. One the basis of this, the silk

is categorized into two types: mulberry silk and non-mulberry or vanya silk.

India is the only country in the world which is producing all the four varieties of silk viz., Mulberry, Tasar, Eri and Muga. It has the world monopoly for Muga, a golden yellow silk, produced mainly in the state of Assam. Singh *et al*. (2000) reported on the exploration of wild sericigenous or silk producing insects from North-eastern India (Table 1).

Vanya or Non-Mulberry Silk

Tasar silk

The tasar silk constitutes nearly 95 per cent of the global production and is produced in China, India and Japan. The Indian Tasar worm is polyphagous and feeds on Asan, Sal and Oak (Table 2).

- *Temperate or oak tasar:* The oak tract extending from Jammu and Kashmir in the West to Manipur in the east, embracing Himachal Pradesh, Uttar Pradesh, West Bengal, Sikkim, Assam, Arunachal Pradesh, Meghalaya, Mizoram and Nagaland inhabits the temperate tasar silkworm. The food plant is oak plant. There are five species in temperate tasar *A. proylei*, Jolly; *A. roylei*, Moore; *A. pernyii*, *A. yamamai*, Guerin Meneville and *A. polyphemus*, Cramer.
- *Tropical tasar:* These are found in dense, humid tropical forest of central and southern plateau of India. The major cocoon-producing districts are Singhbhum and Santhal Pargana in Bihar, Raigarh and Jagdalpur in Madya Pradesh; Mayurbhanji and Keonjhar in Orissa; Purulia and Bankura in West Bengal; Bhandra in Maharashtra; Adilabad, Warangal, Karimnagar, Khammam, Mahaboobnagar, Visakapatnam of Andhra Pradesh; Belgaum in Karnataka. *A. mylitta* feeds on *Terminalia* and produces a special type of silk.

Muga silk

The Muga silkworm is present only in the North-Eastern region of India. Muga silk is obtained from the cocoon of silk insect belong to the species of *A. assamensis* (India). The host plants play an important role in production of quality silk (Borgohain, 2015). The Muga silkworm primarily feeds on Som (*Persea bombycina*) which is an aromatic non deciduous tree with alternate leaves; besides this Soalu (*Litsea polyantha*) also the primary host plants while Dighloti (*Litsea salicifolia*) and Mejankori (*Litsea citrata*) is the secondary host plants of this silkworm (Bhattacharya *et al*., 1993; Tikader and Rajan, 2012). These plants are abundantly distributed in Assam, Meghalaya, Arunachal Pradesh, Nagaland, Manipur, Mizoram and Tripura due to availability of favourable climate.

Eri silk

Eri silk is obtained from the silk insect *Samia ricini* Eri is also produced in India and to a lesser extent in some parts of Burma and Africa. The eri silkworm feeds mainly on *Ricinus communis* (Caster oil plant) having other important secondary food plants like *Heteropanax fragrans* Seem; *Manihot utilissima* Phol; *Carica papaya* L.; *Evodia faxinifolia* Hook; *Ailanthus excelsa* Roxb.

Mulberry silk

Nearly 95 per cent of the commercial silk comes from the mulberry silkworms *Bombyx mori*. Mulberry silkworm is a monophagous insect. There are over 20 species of mulberry, of which four are common: *Morus alba, M. indica, M. serrata* and *M. latifolia*.

Other silk

Silk is also produced by some sericigenous organisms other than the commercially exploited varieties of silkworms. These are:

- Fagara silk, produced from the pedunculate cocoons of the giant silk moth *Attacus atlas* inhabiting in the Indo-Australian bio-geographic region, China and Sudan. Ahmed (2013) recorded the natural incidence of the saturniid wild silk moth, *Attacus atlas* L. feeding on "Tree of Heaven", *Ailanthus excelsa* Roxb. plantations at Jorhat, Assam, India.
- Indian moon moth, *Actias selene* (Hubner) a wild sericigenous insect is widely distributed in western Maharashtra having a total of 29 species of host food plant from India.

Sericigenous insects for industrial resources

Silk the 'Queen of Textiles' is the most precious and beautiful textile fiber. India, being producer of all the five commercially traded varieties of natural silks, occupies the second position in the world raw silk production next to China and the largest consumer of silk. India produced 19,070 MT of raw silk in during the year 2015-16 in which, mulberry and Vanya raw silk output amounts to 12,954 MT and 6,116 MT, respectively (CSB Report, 2015-16).

Table 1: Types of silk.

Common name	*Scientific name*	*Origin*
Mulberry Silkworm	*Bombyx mori*	China
Tropical Tasar Silkworm	*Antheraea mylitta*	India
Oak Tasar Silkworm	*Antheraea proylei*	India
Eri Silkworm	Philosamia ricini	India
Muga Silkworm	*Antheraea assama*	India
Oak Tasar Silkworm	*Antheraea yamamal*	Japan
Oak Tasar Silkworm	*Antheraea pernyi*	China

Table 2: Raw silk production in India.

Sl. No.	*Particulars*	*2017-18 (Target)*	*2017-18*	*2016-17*	*% increase over 2016-17*
A	Mulberry Plantation (ha)	242140	223926	216810	3.3
B	Mulberry Raw Silk (MT)				
	Bivoltine	6200	5874	5266	11.5
	Cross Breed	17276	16192	16007	1.2
	Sub-Total (B)	23476	22066	21273	3.7
C	Vanya Silk (MT)				
	Tasar	3450	2988	3268	-8.6
	Eri spun silk	6675	6661	5637	18.2
	Muga	240	192	170	12.8
	Sub-Total (C)	10364	9840	9075	8.4
	Total (B+C)	33840	31906	30348	5.1

Source: Compiled from the reports received from the State Sericulture Department

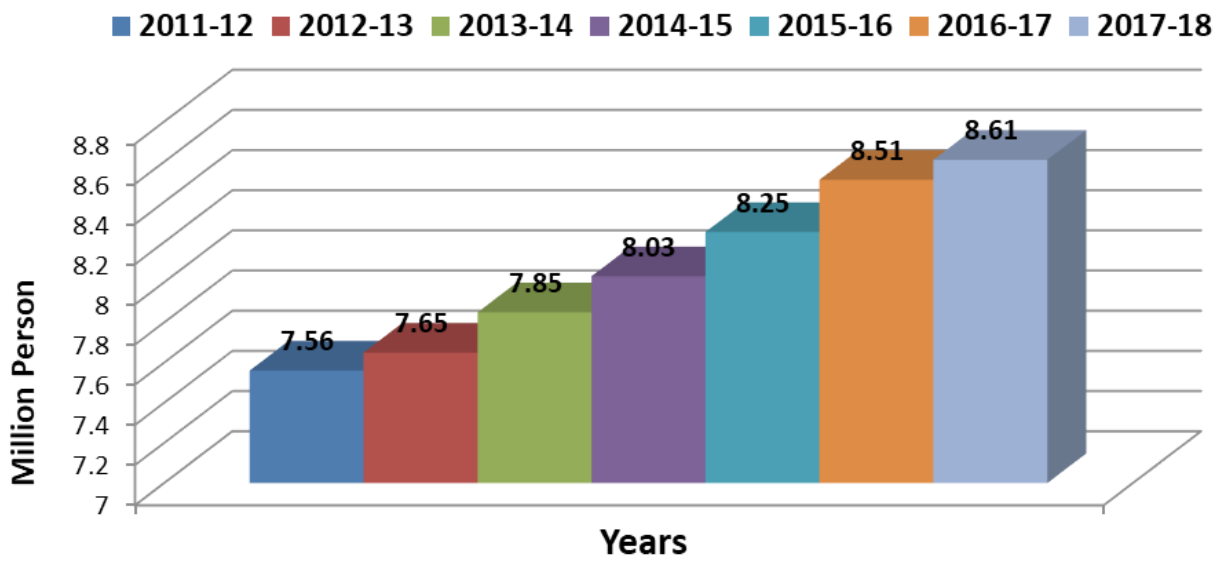

Fig. 1: Employment generation in sericulture sector.

Sericigenous insects in allied purposes

Apart from silk, there are several others by products from these insects which can be utilized as commercial input in many fields. Silkworm pupae were used as fertilizer, animal feed, food material, and medicine in some countries, such as China, Japan, Korea, India, and Thailand (Zhou *et al*., 1996; Mishra *et al*., 2003; Zhu, 2004). In China (Cao *et al*., 1996) and India, by many tribal communities, silkworm pupae are consumed as human food (Nagaraju, 2008). Recently by Ministry of Health PR China, silkworm pupae have been put in the list of "Novel food resources managed as common food" (Zhu, 2004). The silkworm pupae contain 55-60% protein, 25-30% lipid, 4.96% fibre (Yang *et al*., 2002). Silkworm pupae (*Bombyx mori*) contains high level of essential amino acids such as valine, methionine and phenylalanine and 28.8% saturated fatty acids, 2.7% monounsaturated fatty acid and 43.6% polyunsaturated fatty acid; predominantly linolenic acid (Tomotake *et al*., 2010). Sericin powder, which is yielded through process of the degumming of silk fiber, is used in a variety of industries as a raw material in production of food, cosmetic, medicine, and so forth (Gulrajini, 2008). Thus sericulture not only provides silk for fashionable clothing, it also offers several useful by products to the human society (FAO, 2009).

Sericigenous insects in aesthetic purposes

The moths of sericigenous insects having a beautiful and attractive looks and wing patterns that attracts people to use them as models for different designs of variety of textiles, decorative items etc (Subramanian, 2008). They are also used as mode of amusement in different butterfly-moth parks. Butterfly and moth farms like Brinckerhoffs, all the pupae are captives reared exclusively for sale as live insects, which yield $100,000,000 annually (Anonymous, 1983).

Sericigenous insects in employment generation with sustainable development

These insects have an extensive role in rural employment generation as it is a labor extensive industry. In a report, the industry can engage about 11 workers per kg of raw silk production throughout the year (Gangopadhyay, 2008). The industry engages about 53% of women in different activities of sericulture. In 2015-16 more than 85 lakhs persons are associated with the industry to earn their livelihoods. It is the agro-based enterprise having urban rich and middle-class as consumers. The primary producers in rural areas regain about 57% of the final value of silk fabrics, making a key factor in removing the rural poverty due to its high work participation rate and can check the migration from rural to urban areas. The in-situ and ex-situ conservation of the sericigenous insects can be achieved by planned and collaborative efforts of government, entrepreneurs and farmers to preserve the diversity and genetic resource of the sericigenous insects. The conservation strategies can help the farmers and others by providing a natural seed bank for the sericulture. This will play an important role in employment generation for the people getting associated the protection and conservation of seridiversity (Fig. 1).

Conservation of Seribiodiversity

The main aim of Seri-biodiversity conservation is to protect the available different ecotypes from extinction and use them in future breeding programmes. The extinction of traditional Indian silkworm races (Kashmir race, Chotopolu etc.) had only been due to lack of conservation / management systems. The scientifically maintained, characterized and evaluated germplasm is therefore, of utmost importance to have specific breeding plans for upgrading the productivity and production stability.

Human society depends on biodiversity for its values, viz., food, fibre, fuel, shelter, medicines and several other day-to-day necessities without which sustenance of mankind on this earth is impossible. It is therefore, important to enhance understanding, augmentation, conservation and sustainable use of bio-diversity with appropriate human interventions. The importance of conservation of breeds is compulsory not only for initiating new breeding programmes but also for conserving the important races which have gone out of culture. Special emphasis need to be given on saving the genetically important trends from extinction and exploring new strains for the development and progress of countries silk industry. The plan for conservation and

improvement of seribiodiversity therefore, should be based on the biotechnological interventions like biochemical marker genes for disease resistance, QTL based molecular characterization and genome analysis using molecular markers. Conservation without effective utilization is useless. There is urgent need for increased utilization of seribiodiversity both for commercial use and experimental use to increase the silk production and to evolve better yielding breeds.

Conclusion

Thus, the seridiversity and its exploitation have potential in upgrading the socio-economic conditions of the rural folks and preferred enterprise in the Indian sub-continent. There is a lot of scope to develop the industry in India due to its availability of wide range of biological resources. But, developing and strengthening of mechanisms of conservation of seribiodiversity of India is the urgent need of hour. Moreover, there is a need to popularize new technologies among the farmers for the wide spread adoption in the field to change the image from its traditional cottage industry to a modern high tech industrial activity through research and development with an objective of poverty alleviation and sustainable socio economic development.

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