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Biodiversity of Sericigenous insects in Assam and their role in employment generation

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Abstract
Seribiodiversity refers to the variability in silk producing insects and their host plants. The North – Eastern region of India is considered as the ideal home for a number of sericigenous insects. However, no detailed information is available on seribiodiversity of Assam. In the recent times, many important genetic resources are facing threats due to forest destruction and little importance on their management. Therefore, the present study was carried out in different regions of the state during the year 2012-2013 covering all the seasons. A total of 12 species belonging to 8 genera and 2 families were recorded during the survey. The paper also provides knowledge on taxonomy, biology and economic parameters of the sericigenous insects in Assam. Such knowledge is important for the *in situ* and *ex- situ* conservation program as well as for sustainable socio economic development and employment generation.

Keywords: Conservation, Employment, Seribiodiversity

1. Introduction
The insects that produce silk of economic value are termed as sericigenous insects. The natural silk producing insects are broadly classified as mulberry and wild or non-mulberry. The mulberry silk moths are represented by domesticated *Bombyx mori. L.* Non-mulberry sericulture is universally known as forest or wild sericulture that provides an important source of employment for the native population in forest areas. North east region of India is considered as the floral and faunal gate way for Asian main land to Indian Peninsula. The region is also considered as one of the 25 biodiversity hot spots of the world [1] and makes an ideal home for a number of sericigenous insects. For the people of Assam sericulture is the part of their culture and tradition, rather than a profitable business. Since, time immemorial muga and ericulture have been practiced in different pockets of this region. Fairly good reports on seribiodiversity of North East India are available [2, 3, 4, 5, 6]. However, no detailed information is found on sericigenous insects of Assam. At the present time many important genetic resources of silkmoths are facing threats due to indiscriminate destruction of forests. On the other hand, in the backdrop of growing unemployment and slow industrialization, in places like Assam, development strategies focusing on traditional seri cottage industry may help in improving socio economic status generating employment opportunities.
Therefore, considering the importance of sericigenous insects a detailed survey study was carried out on the diversity of sericigenous insects in Assam and their role in employment generation.

2. Materials and Methods
2.1 Study area: (Fig 2)
Assam, the largest state of NE India is located between $93^0$03’48.06’’ East latitude and $25^0$28’50.94’’ North longitude, covering an area of 78,438 km^2. Assam is surrounded by six of the other seven sister states: Arunachal Pradesh in north, Nagaland and Manipur in east, Tripura and Mizoram in south and Meghalaya in west. The topography of this land is uneven, full of hills, plains and rivers. The Brahmaputra valley in Assam is approximately 80-100 km in width and 1000 km in length. The southern Barak valley is separated by the Karbi Anglong and North Cachar Hills from the Brahmaputra valley in Assam. Barak valley in Assam is a small valley with an average width and length of approximately 40-50 km. The land of Assam has an average elevation of 2909 feet above the sea level.


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Fig 1: A-R represents various species of sericigenous insects found in Assam
A=Larva of *B. mori*, B= Larvae of *A. assamensis*, C=Larvae of *A. pernyi*, D=Larva of *A. proylei*, E=Larva of *A. frithi*, F=Larva of *Actias selene*, G= Larva of *Attacus atlas*, H=Larvae of *Cricula trifenestrata*, I=Larvae of *Samia ricini*, J=Moth of *B. mori*, K= Moth of *A. assamensis*, L=Moth of *A. pernyi*, M=Moth of *A. roylei*, N=Moth of *Attacus atlas*, O=Moth of *Actias selene*, P= Moth of *Cricula trifenestrata*, Q=Moth of *A. frithi*, R=Moth of *Samia ricini*,

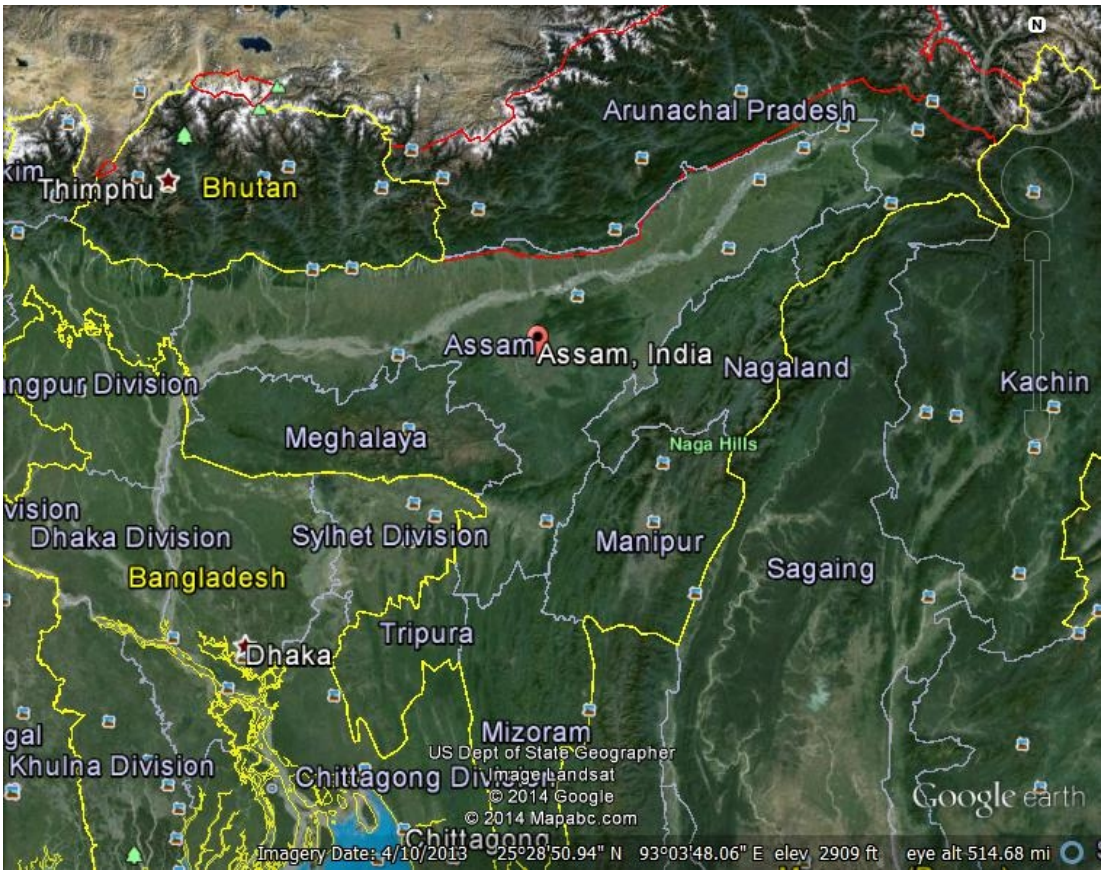

Fig 2: Assam—the study area (Source: Google earth)

2.2 Survey and data collection

Extreme surveys were conducted throughout the state covering various seasons during the year 2012-2013. The main objective of the study was to document the diversity of sericigenous insects and to record their distribution as well as host plants. During the survey, officials of the state and central sericulture department as well as private rearers were interviewed for collection of primary data and other information. The specimen of egg, larvae, cocoon and moths were collected for morphological characterization of various sericigenous insects found in Assam [4].

3. Results and Discussion

A total of 12 species belonging to 8 genera and 2 families were recorded from the state of Assam during the survey period. The species along with their host plants and distribution are given in Table 1. The genera *Antheraea* represented the highest five number of species of which *Antheraea assamensis* is most predominant from commercial point of view. The species produces the famous golden muga silk and is found to

be available nowhere in the world except in North Eastern India in general and the Brahmaputra valley of Assam in particular. The study also revealed that in Assam more than 60 crore number of muga cocoons are produced every year, of which only 10% is used for multiplication of eggs and breeding and remaining 90% is used for commercial reeling (source: Information bulletin, Directorate of sericulture, Government of Assam, India) . Next to muga, *Samia ricini*, the eri silk producing insect is the most widely cultured and popular silk insect in Assam. According to sericulture department of Assam, the state ranks 3rd among the eri silk producing states in India. Assam contributes 65 percent of the total eri silk produced in the country every year. *Samia caniggia* is the wild eri silk producing insect found in Assam but is not commercially exploited to a great extent. The other wild sericigenous insects in Assam are found to be distributed in the forest of foothills of Himalaya and Barak Valley. According to state profile data of Directorate of Sericulture, Government of Assam, shows that the state occupies the 3rd position in the country for the production of wild silk. During the study period a total of 9 wild silk insect species were recorded from different parts of the state. Another important variety of sericulture in Assam is the culture of mulberry silk worm. Assam possesses two indigenous breeds of mulberry silkworm as Sarupat (Multivoltine) and Barpat (Univoltine).

The present investigation clearly indicates that in the global sericulture map Assam has unique distinction of being the homeland of all four varieties of silk viz. mulberry, eri, muga and tasar along with a good number of wild sericigenous insects. This may be due to the favorable geographical locations, diversified topography and ideal climatic conditions that have made Assam a region of rich seribiodiversity. Earlier workers [7, 8, 9] recorded 19, 9 and 10 sericigenous insects from North eastern region of India. The present study recorded 12 sericigenous insects from the state of Assam only. The Muga silk worm has already granted Geographical Indication registration as the insect is confined to only Assam and few places of North east India due to its peculiar insect's behavior adaptation and requisite climatic condition [6]. But the present status of muga culture has been very deteriorating. The declining trend set during the British period and is being continued due to combined effect of forest destruction, use of excessive pesticides in tea gardens, impact of oil industries on environment and change of climate due to pollution. Recently, on 5th June of 2013, considering the importance of conservation of muga silkworm in the wild for future exploration, the sericulture department of BTC (Bodoland Territorial Council) and department of Forest has set up the world's first muga wild life sanctuary in a fringe village under Manas National Park (Times of India, Calcutta, India, 12th June 2013). Eri culture is one of the traditional practices of tribal communities in Assam and entire North east India. Although the people consider eri culture as a subsidiary occupational venture; pre pupae and pupae have great demand due to rich protein content and delicious nature among the tribal communities. As the eri silk worm is fully domesticated women play a significant role during rearing and post rearing activities. Tasar culture is new introduction in the sericulture of Assam. However, the strength of this region lies in muga and eri culture.

The survey also showed that the diversified forest types of Assam hold a good number of wild sericigenous insects. Thangavelu [9] revealed that Saturniids exhibit genetic diversity and natural variation in the wild population indicating natural adaptations to specific niches. Wild silk moth population comprising diverse gene pool holds great potential utility for mankind. Gogoi & Goswami [10] revealed that genetically useful and important traits of wild silk moths may be a sound basis for future breeding programmes of other domesticated silk worms in evolving commercially and improving economically desirable improved strains of species. Culture of wild silk moths not only provides economic gain to the local communities but also helps in conservation of forest ecosystem. But in the recent time particularly in Karbi Anglong and N.C. Hills which is the rich pocket of wild silk insects, shifting agriculture cultivation has created a major threat to not only wild seri insects but for other floral and faunal diversity too.

Therefore, efforts should be made for enhancing *ex-situ* and *in –situ* conservation, protection and proliferation of wild silk moths along with other semi domesticated and domesticated silk insects through planned and collaborative efforts of state and central government industries. Seed production centressss should be established in different areas of the state and attempts of cloning of food plants may help to conserve maximum diversity at species level. Knowledge of breeding system, biology and biological characters of the species is the pre –requisite for *ex-situ* conservation. Hence, characterization of seribiodiversity in Assam is the most essential need for conservation purpose.

Sericulture as an enterprise offers tremendous opportunity for sustainable employment and economic growth in states like Assam. It is estimated that sericulture can engage at the rate of 11 workers per kg of raw silk production (in on farm and off farm activities) throughout the year. This potential is par excellence and no other industry generates this kind of employment, especially in rural areas. Besides, it is an ideal program for the weaker sections of the society because of its unique features such as low gestation and high return. Sericulture is also a women friendly occupation. Post harvesting activities and rearing of domesticated silkworms are mostly performed by women and therefore, it can be used as an important tool for economic empowerment of women. But technology and skills need to be improved for scientific and systemic exploration of seri industry in Assam.

Thus, it can be stated that there is a lot of scope to develop this agro based industry in Assam due to availability of wide range of biological resources. But, developing and strengthening of *ex-situ* and *in-situ* mechanisms of conservation of seri biodiversity of Assam is the urgent need of hour. Moreover, there is a need to popularize new technologies among the farmers for wide spread adoption in the field. The image of industry also needs to be changed 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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Table 1: Shows the diversity of sercigenous insects, their places of occurrence in Assam and their host plants

Family	Name of silk insect	Host plant		Places of occurrence of silk insect
		Common Name	Scientific name	
Bombycidae	*Bombyx croesi. Linnaeus*	Nuni	*Morus indicus* L.	Throughout the state
Saturniidae	*Antheraea assamensis. Helfer*	Som	*Persea bombycina Kost*	Brahmaputra valley
		Sualu	*Litsea polyantha Juss*	
		Dighloti	*Litsea salicifolia Roxb. Ex Wall*	
		Patihonda	*Actinodaphne obovata Blume*	
		Mezankori	*Litsea cubeba (Lour.) Pers.*	
		Kordoi	*Averrhoa carambola L.*	
	Antheraea pernyi. Guerin-Menevelli	*sawtooth oak*	*Quercus acutissima Carr.*	Karbi Anglong, N.C. Hills
	Antheraea roylei. Moore	*sawtooth oak*	*Quercus acutissima Carr.*	Karbi Anglong, N.C. Hills
		Saiha(Whitewash stone fruit)	*Lithocarpus dealbatus Hook.f. & Thomson ex Miq.*	
	Antheraea proylei. Jolly	Sal	*Shorea robusta (Roxb.)*	Karbi Anglong, N.C. Hills
	Antheraea frithi. Moore	Sal	*Shorea robusta (Roxb.)*	South Kamrup, Lakhimpur,Goalpara
	Actias selene. Hubner	Arjun	*Terminalia arjuna*	Garbhanga, Sonari
		Som	*Persea bombycina Kost.*	
		Payam	*Evodia fraxinifolia Hook*	
	Attacus atlas. Linnaeus	Awuapat	*Maesa indica (Roxb.) Wall*	Jorhat, Nameri National Park, Rongjuli
		Dighloti	*Litsea salicifolia Roxb*	
	Cricula trifenestrata. Helfer	Som	*Persea bombycina Kost.*	Lakhimpur, Sivsagar, South Kamrup
		Mezankori	*Litsea cubeba Pers.*	
		Aam goch	*Mangifera indica L.*	
	Samia ricini Donovan	Era goch	*Ricinus communis L.*	Throughout the state
		Keseru	*Heteropanax fragrans (Roxb.)Seem*	
		Payam	*Evodia fraxinifolia Hook.*	
		Korha	*Sapium tenuifolium Buch-Ham*	
		Borpat	*Ailanthus grandis Prain*	
	Samia canningi. Hutton	Era goch Keseru Payam	*Ricinus communis L* *Heteropanax fragrans (Roxb.)Seem* *Evodia fraxinifolia Hook.* *Manihot esculenta Crantz.* *Litsea salicifolia Roxb.* *Litsea cubeba Pers.* *Psidium guajava L.*	Kokrahjar, Mangaldoi, Jorhat
	Andraea bipunctata	Chah goch	*Camellia assamica*	Jorhat, Golaghat

Table 2: Shows morphological features of some of the sericigenous insects found in Assam

Morphological Parameters		*B. mori*	*Antheraea assamensis*	*A. pernyi*	*A. roylei*	*A. proylei*	*A. frithi*	*Actias selene*	*Attacas atlas*	*Cricula trifenestrata*	*Samia ricini*	*Samia canningi*
Egg	Colour	Whitish	Reddish brown	Brown	Brown	Brown	Brown	Grey	Light brown	Ivory white	White	Brownish to creamy white
	Size (LX B)	2.3-3x2.0-2.3 mm	2.5-3.0X2.0-2.5 mm	2.6x2.1 mm	2.8x2.3 mm	2.8x2.4 mm	2.8x2.3 mm	3.04x2.8 mm	3.04X 2.5 mm	1.8x1.2 mm	2.7x2.3mm	1.6x1.2 mm
	Shape	oval	Oval/ellipsoid	Oval	oval	oval	oval	Oval dorsoventrally compressed	Oval dorsoventrally compressed	Oval	Oval	oval
Larva	Colour	White	Green, blue, yellow, orange	Green	Dark green	Light green	Dark green	Dark green	Dark green	Yellowish brown	Yellow,cream, green, blue , white and spotted	Yellowish
	Body weight of mature worm	2.78 g	10.40 g	14-21 g	12-21 g	13-18 g	9.21-11.41 g	18.6 g	22.6 g	2.56 g	15 g	5.5-6.1 g
	Body length of mature worm	4 cm	6.88 cm	9 cm	9-12 cm	8-10 cm	5-8 cm	7.56 cm	11.14 cm	5.6 cm	7-8 cm	6.9-7.2 cm
Pupa	Colour	black	Light metallic	Black metallic	Light metallic	Light metallic	Brownish black	Brown	brown	Brown	black	Blackish brown
	Weight	1.00-1.34 g	4.4-6.5 g	4.40-7.8 g	3.5-8.1 g	4.1-6.4 g	2.59-4.37 g	7.6 g	7.6 g	1.78 g	2.6 g	1.41-2.38 g
Coc-oon	Shape	oval	oval	Oval	oval	oval	oval	Oval	oval	Oval	oval	Oval
	Colour	white	Bright golden colour	Golden brown	Greenish	Light Golden	Light Golden	Whitish grey	Grayish brown	Whitish	White and brick red	Gray, orange brown brick red
	weight	1.85-2.00 g	4.9-7.2 g	5.4-8.44 g	4.8-7.45 g	5.87 g	3.39 g	8.65 g	8.1 g	2.01 g	3.45 g	3.23 g
Adult mot-h	colour											
	Male	White	Deep brown	Camel brown	Greenish grey	Grrenish brown	Yellow	Pale green	Red brown	Orange brown	Black	Dark brown to pinkish white
	Female	White	Light brown	Camel brown	Reddish brown	Greenish brown	Yellow	Pale green	Red brown	Orange brown	Black	Dark brown to pinkish white

Table 3: shows the economic characters of some sericigenous insects found in Assam

Economic characters ↓	***B. mori***	***A. assamensis***	***A. roylei***	***A. proylei***	***A. pernyi***	***A. frithi***	***A. selene***	***A. atlas***	***C. trifenestrata***	***S. ricini***	***S. cannigii***
Fecundity	310	146	282	185-230	114	199	221	180	83	350	300
Larval duration (days)	25-31	22-45	35-40	35-40	35-40	35-45	32-53	39-42	44-51	19-25	27-29
Cocoon weight	1.85-2.00 g	4.9-7.2 g	4.8-7.45 g	5.87 g	5.4-8.44 g	3.39 g	8.65 g	8.1 g	2.01 g	3.45 g	3.23g
Shell weight	0.15 g	0.7 g	1.3 g	1.77 g	0.64 g	0.8 g	1.05 g	0.5 g	0.23 g	0.85	1.82g
Shell ratio (%)	19.14	9.5	11-13	10-11	12-13	7-9	4.15-6.23	19-20	8.0%-13.33%	13.33-13.75	13.33-14.00
Filament length(m)	614	300-355	175-210	470-630	750-810	520-595	7.52-8.57	---	----	300-400	300-400
Voltinism	Bivoltine/ univoltine	Multivoltine	Bivoltine	Bivoltine	Bivoltine/ univoltine	multivoltine	Trivoltine	univoltine	multivoltine	Multivoltine	Bivoltine

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