

CHECKLIST OF WILD SILK MOTHS OF NORTH EAST INDIA (LEPIDOPTERA: SATURNIIDAE, BOMBYCIDAE)

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ABSTRACT: More than 200 specimens were collected from six states of North East India (Arunachal Pradesh, Assam, Meghalaya, Nagaland, Manipur and Mizoram) and 41 species were identified belongs to Saturniidae (31 species) and 9 species (Bombycidae). The identification is validated through taxonomic treated male genitalia of all sericigenous moths. Two new subspecies have been described of genus *Loepa* from Nagaland and Arunachal Pradesh. One new report of *Antheraea* sp. is reported from Nagaland. All illustration including morphological features, external genitalic characters along with field photographs and description of illustrated characters have been completed. Color photographic plates are being prepared along with description, which will be published soon. According to conservation point of view, the species are to be recorded from the places, which can be explored and documented for future references. All the specimens have to be preserved for future references, so that other scientists can quote and refer for identification of species from voucher collection. All silk moths along with cocoons and plant's leave from where it was collected have been preserved at Insect Repository, CMERTI, Lahdoigarh. This will be utilized for correct identification of silk moth species of North East India. There were many misidentifications among *A. compta*, *A. pernyi*, *A. helferi*, *A. royali*, *A. frithii*, *A. mylitta* and *A. andamana (platessa)* (new record), which have been corrected through illustration of genitalic structure. According to genitalic structure of *A. assamensis*, it is found that this species does not match with any other species of genus *Antheraea*, because of it special characters of labidae in valvae of male genitalia. In evolutionary stage, *A. assamensis* is the oldest species among all species of *Antheraea*. A further study may be conducted for DNA barcoding for the species. *Antheraea compta*, *Attacus atlas*, *Cricula trifenestrata* have been reared for continuing the generation, but *Antheraea compta* cocoons are under diapauses and *Attacus atlas* only one generation was successful. North Eastern region is one of the biodiversity hotspots for flora and fauna among 34 biodiversity hotspots of world.

KEY WORDS: Saturniidae, Bombycidae, checklist, Arunachal Pradesh, Assam, Meghalaya, Nagaland, Manipur and Mizoram

North East region of India is considered as the floral and faunal gateway for main Asian land to Indian peninsula. The region is having a dense spectrum of species and considered as a rich reservoir of natural resources. The North East India is one of the major and important hot spot among 35 biodiversity hotspots of the world, which is known for the "Endemism". Due to the unique climatic conditions and varied topography, North East India occupies as a distinct and diversified ecosystem and it becomes the natural abode for lepidopterous insects. Seitz (1933) recorded 19 species of wild sericigenous lepidopterans from the entire North Eastern India including Sikkim. Arora and Gupta (1979) described 17 species of wild silk moth belongs to the family Saturniidae. Singh and Chakaravorty (2006) recorded 24 species from North East India. Recently, Kakati and Chutia (2009) recorded 14 species of wild sericigenous moths from Nagaland.

Antheraea assamensis, *A. mylitta* and *Samia ricini* are commercialized for obtaining silk in North East India. According to literature, there are only 24 silk moth species (Singh & Chakaravorty, 2006) available in North East India, but there may be more silk moth species. In the current study 29 species have been collected and identified, in which 2 new subspecies described and one species (*Antheraea platessa platessa*) new record to North Eastern India.

MATERIALS AND METHODS

The adults of Lepidoptera were collected from Oct. 2011 – Sept. 2014 during night with the help of light traps (200 watt mercury vapour light) and some collections were also made by hanging a makeshift source of light (200 watt mercury vapour light) on a white sheet or white washed wall. The collected insects were sacrificed by using tetra benzene. These were stretched, pinned, labelled, identified, preserved in the wooden collection boxes at Entomology Laboratory, CMERTI, Lahdoigarh. Eggs and larvae were also collected from forest and only few reared in the rearing chamber. The specimens collected from various localities were processed as per methodology discussed by workers such as Lindquist (1956), Zimmerman (1978), Landry and Landry (1994). For studying the wing venation the standard techniques given by Zimmerman (1978) and for genitalia Robinson (1976) had been followed.

The entomological pins of different sizes (10 x .20mm to 15 x .30mm; 38mm x .40mm; 38mm x .55mm) were used depending upon the size of the specimen. The pinned specimens were either stretched in spreading board boxes or on plastazole pasted/fixed at the bottom of a slide box. In order to accommodate the abdomen of dead specimens, triangular groves were made on the plastazole. After properly spreading, the wings were held in position with the help of translucent paper strips, the latter fixed with ordinary pins. The specimens were allowed to dry in the spreading boxes for about 4 hours at 70°C. The label having information such as locality, date of collection, altitude and name of the collector etc. was tagged to each specimen. During preservation of wild silk moths in insect storage boxes in all the four corners naphthalene bolls were kept to avoid infestation on preserved insects by other insects *i.e.* mites and silver fish (*Lepisma* sp.). All the specimens were deposited at Entomology Laboratory, CMERTI, Lahdoigarh. During the course of present study, dissections of the male and female genitalia have been made as per methodology given by Kumar & Ramamurthy (2010).

As per procedure, the male abdomen was detached from the insect (moth) body with the help of forceps by exerting a pressure on the thorax dorsally and raising the abdomen upward simultaneously. Before this, the abdomen was wetted by applying 100% per cent ethanol. Then it was shifted to 10 per cent potassium hydroxide (KOH) solution and boiled in beaker at electric hot plate for 10 min. After boiling, the abdomen transferred to glacial acetic acid in petridish for cleaning. After cleaning in acetic acid, the abdomen shifted to ethanol for taking photographs by using a 5.0 digital camera attached with RSMr 10 stereoscopic zoom microscope and finalized in plates (prepared in 300 pixels/inch) species wise using Adobe photoshop 7.0, ACDSee 9 Photo Manager.

RESULTS AND DISCUSSION

Twenty nine species of wild silk moths have been collected from Manipur, Arunachal Pradesh, Meghalaya, Mizoram, Nagaland and Assam states of North East India (Table 1, 2). All twenty nine species' name were updated from

LEPINDEX and in one species, there was confusion according to LEPINDEX for the species *Samia pryeri*, but Dr. Ian Kitching, Lepidoptera Leader, NHM, London informed that this is still in *Samia ricini*, by mistake it was entered in the LEPINDEX database.

Among all six states (Fig. 1), highest number of species (28) was recorded from Arunachal Pradesh state (Table 2). If this programme will continue, many more species will be recorded from Arunachal Pradesh. Some areas of Arunachal Pradesh are still unexplored.

The details of all the species will be presented through illustrated genitalic atlas and other morphological feature, which are part of classical taxonomy.

All the species' name updated from LEPINDEX and in one species, there is confusion according to LEPINDEX, the name is *Samia pryeri*, but Dr. Ian Kitching, Lepidoptera Leader, NHM, London informed that this is still in *Samia ricini* by mistake it entered in the Lepindex database.

DISCUSSION

All the species have been collected from Arunachal Pradesh, Nagaland, Assam, Manipur and Meghalaya. All the species' name updated from LEPINDEX and in one species, there is confusion according to LEPINDEX, the name is *Samia pryeri*, but Dr. Ian Kitching, Lepidoptera Leader, NHM, London informed that this is still in *Samia ricini*. Now, it is clarified and corrected in LEPINDEX database, which is approved by ICZN for current name of the species of order Lepidoptera.

In India, still researcher using names *Samia cynthia ricini* / *Samia cynthia* / *Philosamia ricini* / *Philosamia cynthia ricini*, which are incorrect and the correct name is *Samia ricini* for domesticated species and *Samia canningi* for wild species. Both the species have peculiar characters in size, color, wing venation and genitalic features. According to recent survey, only three species are found in North Eastern India viz., *Samia ricini*, *Samia canningi* and *Samia kohlii*. During study, complexity was faced to identify the *Antheraea pernyi*, *A. compta*, *A. frithii* and *A. roylei*. But, now it is clarified with the help of male genitalic features. In all these species the labide of each species have different shape and size, which is used for identification of *Antheraea* spp.

It is recommended that researcher should use current scientific and valid name of *Samia ricini* for domesticated species and for wild species *Samia canningi*. Complexity of *Antheraea compta* and *A. frithii* is also solved, the correct identification of these two species have been verified and corrected, which will be utilized by researchers and scientists. The current scientific name of muga silkworm should be named as *Antheraea assamensis* not as *Antheraea assama*.

All the information can be utilized for conservation of wild silk moths of North East India. Utilization of some species for obtaining silk may be tried and also may be collected some wild population from reported locations for breeding purpose.

The collection made under the project is preserved at Insect Repository, Entomology Section, CMERTI, Lahdoigarh, which can be utilized as reference collection in future for clarification and identification of wild silk moths. As, Thailand people are producing silk from *C. trifinistrata*, so, five species can be commercialized viz., *Samia canningi*, *Attacus atlas*, *Cricula trifenistrata*, *Antheraea roylei*, *A. compta*.

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Table 1. Localities surveyed in four states of North Eastern India.

S. No.	States	Location of collection
1	Arunachal Pradesh	Pashighat, Ziro Valley, Roing and adjoining forest areas
2	Assam	BTC, Lakhimpur, Tejpur, Tinisukia, Jorhat, Golaghat, Kaziranga forest areas, Dibrugarh, BTC, Darrang
3	Manipur	Imphal, Urkhul
4	Meghalaya	Barapani, Shillong, Mawlong, Nongpoh (Khasi Hills); Tura, Damalgiri, Silsela, Balpakram National Park, Bagmara, Kanai, Dalu (Garro Hills),
5	Mizoram	Aizawl and adjoining forest areas
6.	Nagaland	Mokockchung, Zuniboto districts and adjoining forest areas

Conducted Survey at 6 States of North East India

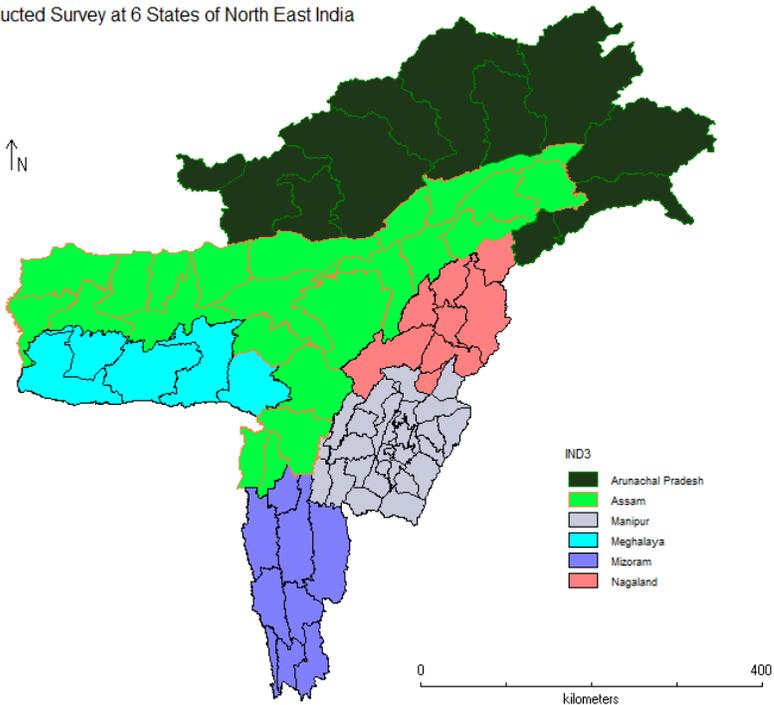


Figure 1. Covered States of North East India.

Table 2. Distribution list of all collected species.

S. No.	Scientific Name	AP	As	Man	Meg	Miz	Nag
Family Saturniidae							
1.	<i>Actias selene</i> Hübner, 1806	+	+	+	+	+	+
2.	<i>Antheraea assamensis</i> Helfer, 1837	+	+	+	+	+	+
3.	<i>Antheraea compta</i> Rothschild, 1899	+	+	+	-	+	+
4.	<i>Antheraea frithi</i> Moore, 1858	+	+	+	-	+	+
5.	<i>Antheraea mylitta</i> Drury, 1773	-	+	-	+	-	+
6.	<i>Antheraea pernyi</i> Guérin-Meneville, 1855	+	-	+	+	-	-
7.	<i>Antheraea roylei</i> Moore, 1858	+	-	+	-	-	+
8.	<i>Antheraea helferi</i> Moore, 1858	+	-	+	-	-	+
9.	<i>Antehraea andamana</i> Moore, 1877	-	-	-	-	-	+
10.	<i>Archaeoattacus edwardsii</i> White, 1859	+	-	+	+	+	+
11.	<i>Archaeoattacus staudingeri</i> Rothschild, 1895	+	-	+	+	+	+
12.	<i>Argema maenas</i> Doubleday, 1847	+	-	+	+	+	+
13.	<i>Argema sinensis</i> Walker, 1855	+	-	-	-	-	-
14.	<i>Attacus atlas</i> Linnaeus, 1758	+	+	+	+	+	+
15.	<i>Cricula andrei</i> Jordan, 1909	+	-	-	+	+	-
16.	<i>Cricula trifenestrata</i> Helfer, 1837	+	+	+	+	-	-
17.	<i>Loepa katinka</i> Westwood, 1848	+	-	+	+	-	+
18.	<i>Loepa megacore</i> Jordan, 1911	+	-	-	-	-	-
19.	<i>Loepa sikkima</i> Moore, 1865	+	-	-	-	-	-
20.	<i>Loepa</i> subsp. nov.	-	-	-	-	-	+
21.	<i>Loepa</i> subsp. nov.	+	-	-	-	-	-
22.	<i>Loepa miranda</i> Moore, 1865	-	-	-	+	-	-
23.	<i>Rhodinia newara</i> moo, 1872	+	-	-	+	-	-
24.	<i>Salasa tonkiniana</i> Le Moult, 1933	+	-	-	-	+	-
25.	<i>Samia canningii</i> Hutton, 1860	+	+	+	+	+	+
26.	<i>Samia kohlli</i>	+	-	+	-	-	-
27.	<i>Samia ricini</i> Boisduval, 1854	+	+	+	+	+	+
28.	<i>Satrunia pyretorum</i> Westwood, 1847	+	-	-	-	-	-
29.	<i>Saturnia simlaensis</i> Westwood, 1847	+	-	+	-	-	-
30.	<i>Saturnia thibeta</i> Westwood	+	-	+	-	-	-
31.	<i>Saturnia</i> sp.	+	-	+	-	-	-
Family Bombycidae							
32.	<i>Andraca</i> sp.	+	-	-	+	-	-
33.	<i>Bombyx mori</i> Linnaeus, 1758	+	+	+	+	+	+
34.	<i>Bombyx incomposita</i> van Eecke, 1929	+	-	-	+	-	-
35.	<i>Norasuma javanica</i> Moore, 1872	+	-	-	+	-	-
36.	<i>Gunda ochracea</i> Walker, 1862	+	-	-	+	-	-
37.	<i>Gunda</i> sp.	+	-	-	+	-	-
38.	<i>Ocinara bifurcula</i> Dierl, 1978	+	-	-	+	-	-
39.	<i>Triuncina reliquiosae</i> Helfer, 1837	+	+	+	+	+	+
40.	<i>Triuncina</i> sp.	+	-	-	+	-	-
41.	<i>Trilocha varians</i> walk, 1855	+	+	+	+	+	+

Abb: AP-Arunachal Pradesh, As-Assam, Man-Manipur, Meg-Meghalaya, Miz-Mizoram and Nag-Nagaland.

Table 3. Synonyms of species of family Saturniidae.

S. No.	Scientific valid name	Synonyms
1.	<i>Actias selene</i> Hübner, 1806	<i>dianae</i> Hutton, 1846 <i>mandschurica</i> Staudinger, 1892
2.	<i>Antheraea assamensis</i> Helfer, 1837	<i>assama</i> Westwood, 1848 <i>mezankooria</i> Moore, 1862 <i>subvelata</i> Bouvier, 1930 <i>mezops</i> Bryk, 1944
3.	<i>Antheraea compta</i> Rothschild, 1899	
4.	<i>Antheraea frithi</i> Moore, 1858	<i>fraterna</i> Moore, 1888 <i>confusa</i> Niepelt, 1932
5.	<i>Antheraea mylitta</i> Drury, 1773	<i>tusseh</i> Hutton, 1856 <i>kolisurra</i> Sykes., 1834 <i>kausalia</i> Rondot, 1887 <i>fasciata</i> Moore, 1892
6.	<i>Antheraea pernyi</i> Guérin-Meneville, 1855	<i>bignaulti</i> Clement, 1880 <i>fantoni</i> Rondot, 1887 <i>cinnamomea</i> Niepelt, 1929 <i>constans</i> Staudinger, 1911 <i>lugubris</i> Niepelt, 1928 <i>melaina</i> John, 1928
7.	<i>Antheraea roylei</i> Moore, 1858	
8.	<i>Antheraea helferi</i> Moore, 1858	<i>knyvetti</i> Hampson, 1892
9.	<i>Antehraea andamana</i> Moore, 1877	<i>platessa</i> Rothschild, 1903
10.	<i>Archaeoattacus edwardsii</i> White, 1859	
11.	<i>Archaeoattacus staudingeri</i> Rothschild, 1895	
12.	<i>Argema maenas</i> Doubleday, 1847	<i>leto</i> Doubleday, 1848 <i>rosenbergii</i> Kaup, 1866
13.	<i>Argema sinensis</i> Walker, 1855	<i>virescens</i> Mell, 1950 <i>heterogyna</i> Mell, 1914
14.	<i>Attacus atlas</i> Linnaeus, 1758	<i>ethra</i> Olivier, 1797 <i>vitrea</i> Perry, 1811 <i>talas</i> Hübner, 1820 <i>sumatranus</i> Fruhstorfer, 1904 <i>roseus</i> Fruhstorfer, 1904 <i>gladiator</i> Fruhstorfer, 1904 <i>trumphator</i> Fruhstorfer, 1904 <i>simalurana</i> Watson, 1915 <i>baliensis</i> Juriaanse & Lindemans, 1921 <i>mcmulleni</i> Watson, 1914 <i>burmaensis</i> Juriaanse, 1920 <i>burmana</i> Seitz, 1928 <i>javanensis</i> Bouvier, 1932 <i>strandi</i> Schüssler, 1933 <i>similis</i> Bouvier, 1936 <i>mysorensis</i> Bouvier, 1936 <i>varia</i> Bouvier, 1936 <i>tonkiensis</i> Bouvier, 1936 <i>chinensis</i> Bouvier, 1936 <i>pallida</i> Bouvier, 1936 <i>opaca</i> Bouvier, 1936 <i>incerta</i> Bouvier, 1936 <i>silhetica</i> Helfer, 1837
15.	<i>Cricula andrei</i> Jordan, 1909	<i>zuleika</i> Westwood, 1848 <i>vinosa</i> Watson, 1912

		<i>afenestra</i> Watson, 1912
16.	<i>Cricula trifenestrata</i> Helfer, 1837	<i>haumpottonee</i> Hugon., 1837 <i>ampotoni</i> Rondot., 1887 <i>burmana</i> Swinhoe, 1890 <i>nadari</i> Bouvier, 1929
17.	<i>Loepa katinka</i> Westwood, 1848	<i>sivalica</i> Moore, 1881 <i>sivalensis</i> Silbermann, 1897 <i>sikkimensis</i> Silberman, 1897
18.	<i>Loepa megacore</i> Jordan, 1911	
19.	<i>Loepa sikkima</i> Moore, 1865	
20.	<i>Loepa miranda</i> Moore, 1865	
21.	<i>Loepa</i> subsp. nov.	
22.	<i>Loepa</i> subsp. nov.	
23.	<i>Rhodinia newara</i> moo, 1872	
24.	<i>Salasa tonkiniana</i> Le Moult, 1933	
25.	<i>Samia canningii</i> Hutton, 1860	<i>viridis</i> Mezger., 1928
26.	<i>Samia kohlli</i>	
27.	<i>Samia ricini</i> Boisduval, 1854	
28.	<i>Satrunia pyretorum</i> Westwood, 1847	<i>tegusomushi</i> Chujiro Sasaki, 1908 <i>melli</i> Bryk, 1939 <i>microps</i> Bryk, 1939
29.	<i>Saturnia simlaensis</i> Westwood, 1847	
30.	<i>Saturnia thibeta</i> Westwood	
31.	<i>Saturnia</i> sp.	

Table 4. Synonyms of species of family Bombycidae.

S. No.	Scientific valid name	Synonyms
1.	<i>Andraca</i> sp.	
2.	<i>Bombyx mori</i> Linnaeus, 1758	<i>arracanensis</i> Moore & Hutt., 1864 <i>brunnea</i> Grünberg, 1911 <i>croesiformis</i> Moore & Hutt., 1864 <i>fortunatus</i> Moore & Hutt., 1864 <i>fuscata</i> Motschulsky <i>mandarina</i> Moore, 1872 <i>meridionalis</i> Wood-Mason, 1886 <i>sinensis</i> Moore & Hutt., 1864 <i>textor</i> Moore & Hutt., 1864
3.	<i>Bombyx incomposita</i> van Eecke, 1929	
4.	<i>Norasuma javanica</i> Moore, 1872	
5.	<i>Gunda ochracea</i> Walker, 1862	
6.	<i>Gunda</i> sp.	
7.	<i>Ocinara bifurcula</i> Dierl, 1978	
8.	<i>Triuncina religiosae</i> Helfer, 1837	<i>affinis</i> Hutton <i>bengalensis</i> Hutton <i>huttoni</i> Ww., 1847 <i>sherwilli</i> Hutton
9.	<i>Triuncina</i> sp.	
10.	<i>Trilocha varians</i> walk, 1855	