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CONSERVATION OF MUGA SILKWORM, *ANTHRAEA ASSAMENSIS* HELFER IN THE NATURAL HABITATS AT DIFFERENT GEOGRAPHICAL LOCATION

Subadas Singh^{1*}, Dharmendra Kumar Jigyasu², G. Subrahmanyam³, Prashanth Sangannavar⁴, Rajesh Kumar⁵, Bidyut Nath Choudhury⁶, Reeta Luikham² and K.M. Vijayakumari²

¹Regional Sericultural Research Station, Central Silk Board, Imphal, Manipur-795002, India

²Central Mega Eri Research and Training Institute, Lahdoigarh, Jorhat, Assam-785700, India

³SeriBiotech Research Laboratory, Central Silk Board, Kodathi, Karnataka-560035, India

⁴RCS, Central Silk Board, BTM Layout Madiwala, Bengaluru, Karnataka-560068, India

⁵P4 Basic Seed Farm, Central Silk Board, Manasbal, Jammu & Kashmir-193504, India

⁶PMC (MESSO), Central Silk Board, Guwahati, Assam-781022, India

*Corresponding author Email: mailsubadas@gmail.com

ABSTRACT

North East India is rich in seri-biodiversity being a natural abode for a number of sericigenous insects and their host plant genotypes. Their occurrence is closely link with the climatic conditions of the area, topography, altitude and availability of host plants. Among various wild silk moths available in North East India, Muga, Eri, OakTasar are endemic prerogative and categorized under the *Vanya* silk moths of India. Muga, *Antheraea assamensis* Helfer (Lepidoptera: Saturniidae), the golden silk of India, is a very important bioresource, a pride possession of India, produced nowhere else in the world. By nature, Muga silkworm is reared outdoor on its primary host plants Som (*Persea bombycina*) and Soalu (*Litsea monopetala*) and these host plants are naturally available in different geographical region of North East India. However, from the various survey conducted, it was revealed that population of *A. assamensis* Helfer is dwindling gradually due to different anthropogenic factors. The most important direct causes of depletion of the important genetic resources of Muga silk moths may be attributed to the rapid deforestation, urbanization and unprecedented climatic condition. To conserve this rare species, biodiversity conservation is increasingly recognized as a fundamental component of sustainable development of natural resources by protecting and using biological resources in the ways that do not diminish the world's variety of genes and species or destroy important habitat or ecosystem. The wild Muga silkworm, constitutes a significant component of wild silk moth genetic diversity that cannot be ignored in the conservation and utilization of its potential to increase the Muga silk production in future and to increase farmers income generation.

Keywords : *Vanya* silk, Muga silkworm, bioresource, sericigenous insects, Som (*Persea bombycina*), Soalu (*Litsea monopetala*), *Ex-situ* and *In-situ* conservation.

Introduction

The North East region of India owing to its diverse geographical position, offers a tremendous complex variety of habitat and ecosystem. North East India lies in between 22°-29°N latitude and 90°-97°E longitude with a geographical area of 2,55,000 sq.km. The region comprises of eight distinct socio-cultural zones (eight sister states) and have tropical humid climate, with both evergreen and deciduous forests. It is a mega-biodiversity centre and distinguished as one of the ten distinct bio-geographic zones of the country. North East India is rich in seri-biodiversity being a natural abode for a number of sericigenous insects and their host plant genotypes (Singh & Chakravorty, 2006; Jolly *et al.*, 1979; Srivastava and Thangavelu, 2005). This region produce all four commercially exploited silks *Viz.*, Muga, Eri, Oak Tasar, which are endemic prerogative and categorized under the *Vanya* (wild) silk (Ahmed and Ranjan, 2011).

Muga, *Antheraea assamensis* Helfer (Lepidoptera: Saturniidae), the golden silk of India, is a pride possession, produced nowhere else in the world. Both Muga and Eri

culture is endemic to North Eastern region which plays a pivotal role in ensuring sustainable livelihood of rural inhabitants and supports women and tribal empowerment (Giridgar *et al.*, 2007; Tikader *et al.*, 2013). Muga silkworm is reared in outside environment and Muga silkworm is polyphagous feeding wide range of host plants (Tikader *et al.*, 2013). Most of the food plants of Muga silkworm are perennial tree in nature and available in wide range of geographical region of North East India. Among the numbers of food plants of Muga silkworm, Som (*Persea bombycina*) and Soalu (*Litsea monopetala*) are primary food plants, Dighloti (*Litsea salicifolia*) and Mejankori (*Litsea cubeba*) are secondary food plants. Other food plants *Viz.*, *Cinnamomum glaucescens*, *Cinnamomum camphora*, *Actinodaphne obovata*, *Michelia oblonga*, *Ziziphus mauritiana*, *Xanthozylum rhesta*, *Celastrus hindsii* etc. are tertiary food plants (Thangavelu *et al.*, 1988).

Muga silkworm is a very important bioresource and it is found only in Assam and its neighbouring states. The Muga silk occupies a prominent position in the cultural heritage of the Assamese people, which has high aesthetic value and also

high economic importance (Hazarika *et al.*, 1996; Paliwal and Das, 1989; Raja Ram, 1998; Siddiqui *et al.*, 1998, 2000; Singh *et al.*, 2000; Thangavelu *et al.*, 2005; Tikader and Kamble, 2010). Muga silk production generates additional rural employment in the region. To conserve this rare species, biodiversity conservation is increasingly recognized as a fundamental component of sustainable development of natural resources by protecting and using biological resources in the ways that do not diminish the world's variety of genes and species or destroy important habitat or ecosystem (Dunn, 2004 and Sodhi *et al.* 2009). The wild Muga silkworm constitutes a significant component of wild silk moth genetic diversity that cannot be ignored in the conservation and utilization of its potential to increase the Muga silk production in general and to increase the income of farmers in particular (Narang & Gupta 1980; Mech *et al.*, 2019).

From the survey conducted, it was revealed that population of *A. assamensis* Helfer is dwindling gradually. The most important direct causes of depletion of the important genetic resources of Muga silk moths may be attributed to the rapid deforestation and urbanization. Unlike the mulberry silkworm genetic resources, which are conserved at different places of many countries, Muga silkworm genetic resources are conserved in *Ex-situ* condition in North East India (Thangavelu, 1991; Tikader *et al.*, 2013). The continuity conservation of generation of wild races in *Ex-situ* condition faces difficulty due to different

biotic factors and sterility of Muga moths during hot summer season and thus germplasm materials are vulnerable to extinction thereby causing a threat to the Muga industry. Therefore, development of both *Ex-situ* and *In-situ* conservation of Muga silkworm is important.

Materials and Methods

Survey was conducted several times by different teams comprising scientists from Central Silk Board, State Sericulture Department and State Forest Department at the proposed sites of different states of North East India viz., Assam, BTC Assam, Meghalaya and Arunachal Pradesh. Survey was conducted for availability of wild Muga silkworm, its food plants and other wild sericigenous insects at the peripheral and buffer zone of the proposed conservation sites. During the survey, it was found cocoons of wild muga and other sericigenous insects (Figure-1). Different types of Muga host plants were identified their pictures were taken tagging with location. Densities of different Muga host plants were also studied. It was recorded demographic details of the site including satellite image, latitude-longitude and drone survey was also conducted with the help of NESAC at the conservation sites. Survey was continued several times, after fulfilling all the pre-requisite parameters to established *in-situ* conservation site, agreement was made through Memorandum of Understanding (MoU) between Central Silk Board, State Sericulture Department and State Forest Departments. During survey.



Fig. 1 : Wild Muga cocoon found in the peripheral area of *in-situ* conservation sites

Establishment of *In-situ* conservation site at Upper Doigrung, Golaghat (Assam)

Conservation site was selected at Upper Doigrung Wild Life area, Karbianglong / Golaghat. The elevation point for selected site is 132-162 m asl. The area is near about more than 6 kilometer with dense forest. The latitude and longitude of the area is 26°23'32.29" N 93°47'01.29" E (Figure-2).

During survey, It was observed that the Upper Doigrung Forest area is full of Muga and Eri host plants such as Soalu (*Litsea monopetala*), Mejankuri (*Litsea citrata*), Dighloti (*Litsea salicifolia*), mulberry (*Morus* sp.), Castor (*Ricinus communis* Linn.), Kesseru (*Heteropanax fragrans* Seem), Payam (*Evodia fraxinifolia*), Tapioca (*Manihot esculanta*), Gamari (*Gmelina arborea*) (Figure-3).



Fig. 2 : Google map of Upper Doigrung Wild Life Area, Golaghat for *in-situ* conservation of Muga and other wild silk moths



Fig. 3 : Performance of survey by team of scientists, DoS officials at proposed in-situ conservation sites.

Local villagers nearby to the conservation site informed to the survey team that wild muga silkworm came at times and attracted to the house lights. Sometimes they found female Muga silkworm laid eggs on the curtains, clothes hanging outside their home, which shows availability of wild Muga silkworm in the proposed conservation site. As information gathered from the local people, they informed

that they found many different kind of cocoons in this forest. Therefore, Upper Doigrung Reserve Forest land is suitable in all point of view viz., full of natural host plants of wild silkworm including Mega (Figure-4), availability of different sericigenous insects. Hundred acres in total of land is selected for conservation at Upper Doigrug Reserve Forest area.



Fig. 4 : Major host plants of Muga and Eri at peripheral zone of Upper Doigrung in-situ conservation site showing (A) Kesseru, (B) & (C) Soalu and (D) Mejankori plantations.

The interior forest patch (core-zone) in the Muga insect native habitat was selected and allowed the insect to reproduce *suo moto* and fortify its population in natural habitat without human interference. In the conservation site, there was restriction that nobody could collect Muga insects in any life form (egg, larva, cocoon and adult moth) from the demarcated core-zone area, except for research purposes. This core zone will serve as a gene pool for Muga genetic resources, which is allowed to multiply amidst utter silence

and serenity of nature. Henceforth, Memorandum of Understanding was signed between Assam Forest Department, State Sericulture Department Assam and CMERTI Lahdoigarh for Upper Doigrung Wild Life area, Golaghat up to 2047 (for 30 years) as *in-situ* conservation site. Hoardings were displayed at conservation site for easy demarcation and spreading awareness to the public (Figure-5).



Fig. 5 : Hoardings at the conservation site for proper demarcation and public awareness and Installation of automated weather station near Upper Doigrung Conservation site

Weather station was installed on in the peripheral village (Bankathar Village) of the conservation site for recording meteorological parameters (Figure-5).

was found in peripheral zone, it confirmed the availability of Muga population in core zone of the conservation site. The villagers were sensitized and awareness programme were conducted to carry out maintenance activities to develop wild silkmoth population in the conservation site without human interference (Figure-6).

The regular update of Muga larval population in the peripheral zone and weather data collected from the *in-situ* conservation site was performed. The Muga larval population



Fig. 6 : Awareness programmes in Bankathar village near Upper Doigrung *in-situ* conservation site.

Plantation of muga host plants at peripheral area of *in-situ* conservation site

Plantations of Muga host plants Som (*Persea bombycina*) was conducted at the peripheral areas of *in-situ* conservation to enrich food plants of Muga silkworm

(Figure-7). This plantation at peripheral zone of the conservation sites will facilitate to harbour wild Muga coming from core zone and also will help in developing their population in the peripheral zone and migrate again in to the core zone.



Fig. 7 : Plantation of Muga host plants at the periphery of *in-situ* conservation site

Ex-situ conservation at Bogidhola state farm, Golaghat (Assam)

One *ex-situ* conservation site was also developed and maintaining at Bogidhola Sericulture state farm, Golaghat, Assam (Figure-8). The cocoons collected from *in-situ* conservation site were reared in *ex-situ* conservation site at Bogidhola state farm for easy monitoring and analysis. Fifty

hectare land is available in the farm, in which a total of 20 acre land had been planted with more than 8000 numbers of Muga silkworm host plants i.e. Som, Soalu and Dighlothi. Weather station facilities were also installed at Bogidhola farm of State Sericulture Department, Golaghat along with 5KVA solar grid station (Figure- 8).



Fig. 8 : Plantations of Muga host plants at Bogidhola farm, Golaghat in demarcated area for *ex-situ* conservation and installation of weather station.

Establishment of in-situ conservation site at Kuklung, BTC (Assam)

In-situ conservation site was established at Kuklung, BTC before implementation of NERTPS scheme (Figure-9).

A total of 75 ha of land were selected for conservation. It was found that 20-25 year old Som and Solau plantation are available in the site.



Fig. 9 : Kuklung Reserve Forest range for Muga *In-situ* conservation site, available Som food plants and weather station installed at Kuklung forest area, BTC, Assam

Plantation of different Muga host plants was conducted in Kuklung forest area, BTC. Awareness programme was conducted in the nearby area for spreading awareness among local people about the conservation of muga and other wild silk moths. Weather station was installed in the conservation

site for recording meteorological parameters. Memorandum of Understanding was signed between Assam Forest Department and CMERTI, Lahdoigarh for Kuklung forest area, up to 2048 (30 years) (Figure-10).



Fig. 10 : The main Muga Conservation site at Kuklung Forest Range, BTC, Assam

Establishment of *in-situ* conservation site at Lura Village, East Jaintia hills (Meghalaya)

Several survey was conducted at the proposed site of *in-situ* conservation site in Lura Village, East Jaintia Hills, Meghalaya. From the survey, it was found that Lura Village would be suitable place for conservation site in terms of host plant availability, monitoring, accessibility. During survey, wild eri cocoons were available in the forest. At the same time, the area is rich with vegetation of primary and secondary host plants of Muga and other wild silk moths *viz.*,

Soalu (*Litsea monopetala*), Mejankari (*Litsea citrata*), Dighloti (*Litsea salicifolia*), wild mulberry (*Morus* sp.), wild Castor (*Ricinus communis* Linn.), Kesseru (*Heteropanax fragrans* Seem), Payam (*Evodia fraxinifolia*), Tapioca (*Manihot esculanta*), Cassava (*Manihot utilissima*) Gamari (*Gmelina arborea*), Hingori (*Castanopsis indica*), Tree of Heaven (*Ailanthus altissima* Miller) (Figure-11). Later, MoU was executed with Lura Village council, East Jaintia hills and with DOS Meghalaya for *in-situ* conservation of Muga silkworms for 30 years.

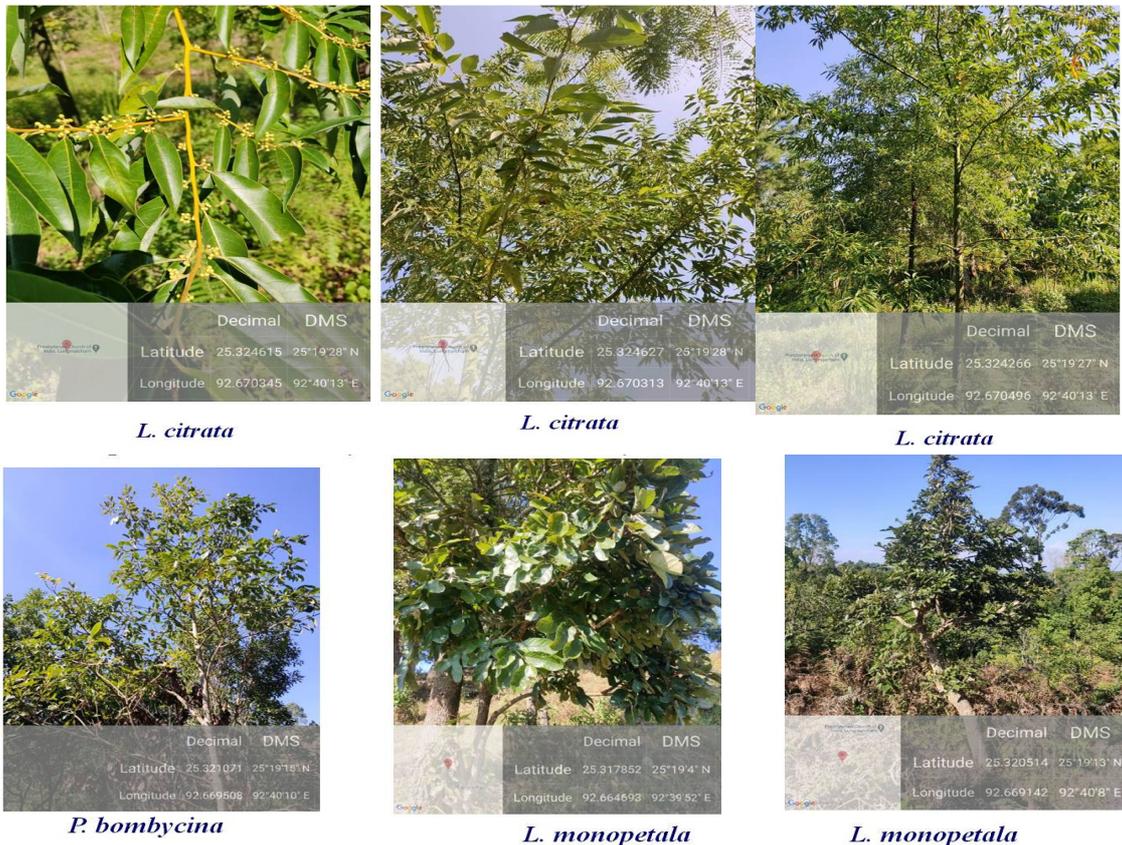


Fig. 11 : Distribution of Muga food plants at conservation site at Lura Village, Esat Jaintia Hills, Meghalaya.

Establishment of *in-situ* conservation site at Mebo Forest, Arunachal Pradesh

From the survey at the proposed site, it was decided that Mebo Reserve Forest, Pasighat is very suitable place for *in-situ* conservation in terms of host plants availability,

monitoring, accessibility and also belongs to reserve forest area (Figure-12). Therefore, MoU was signed between Central Silk Board and State Forest Department, Itanagar and Department of Textiles and Handicrafts, Govt. of Arunachal Pradesh, Itanagar.



Fig. 12: Mebo Reserve Forest, Pasighat Forest Division, Pasighat was selected for the *in-situ* conservation site.

Installation of Microclimate Chamber

Microclimate chamber facilities had been installed CMERTI, Lahdoigarh, Jorhat (Assam) for conducting

breeding programme and stock maintenance utilizing Muga germplasm from conservation sites by simulating weather condition of the *in-situ* conservation sites (Figure-13).



Fig. 13 : Microclimate chamber installed at CMER&TI, Lahdoigarh to conduct the muga silkworm rearing in control condition.

Results and Discussion

After fulfilling all the pre-requisite parameters to established *In-situ* conservation site, four *in-situ* muga conservation sites had been established at Upper Doigrung, Golaghat, Assam i.e. Kuklung Forest area of Chirang District, BTC, Lura Village East Jaintia Hills, Meghalaya,

and Mebo reserve forest, Pashighat, Arunachal Pradesh after agreement was made through Memorandum of Understandings (MoU) between Central Silk Board, State Sericulture Department and State Forest Departments showing in table-1. The following four *In-situ* sites had been established in three states-

Table 1 : *In-situ* conservation sites developed at different geographical places of North East India.

State	Place	Type and area of conservation site	Status of implementation
Assam	Upper Doigrung, Golaghat	In situ (100 acre)	Established the site, MoU completed on 06/11/2017
	Bogidhola, Golaghat	Ex situ (50 ha)	Established the site, MoU completed on 06/11/2017
BTC	Kuklung reserve forest, BTC	In situ (75 ha)	Established, MoU completed on 12/06/2019
Meghalaya	Lura Village, East Jaintia Hills	In situ (200 ha)	Established the site, MoU completed on 19/11/2020
Arunachal Pradesh	Mebo reserve forest, East Siang	In situ (300 ha)	Established the site, MoU signed between CSB and State Forest Department, Itanagar on 07/04/2021.

Activities at *in-situ* conservation sites to enrich Muga population

Muga conservation activities at *in-situ* conservation sites are being monitored regularly. Muga DFLs are being released at the conservation sites at regular interval to enrich

muga silkmoth population at the natural conservation site without human interference (Figure-13). Continuation of monitoring, survey for wild silk moths, maintenance of the conservation sites is very essential.



Fig. 13 : Release of Muga dfls at Upper Doigrung *in-situ* conservation site to enrich its population in natural condition.

Monitor of wild silk moth at conservation sites during night time

Survey was conducted at the *in-situ* conservation site of Upper Doigrung, Golaghat, Assam with the help of officials of State Forest Department and State Sericulture Department, Government of Assam using LED light. During the survey, observation was conducted at different time intervals of night starting from dusk (17-21 hrs), Midnight (24hrs), Early

Morning (3-5 am). From the survey, it was observed that different wild silkmoths and other moths were attracted to the installed LED light with white screen (Figure-14). The common wild silkmoths observed during night time survey were wild tasar moth, wild eri (*Samia cunningi*), *Cricula* (*Cricula trifenestrata*), wild muga (*A. assamensis*), *Attacus atlas* and shingids.



Fig. 14: Scientist and officials of CMER&TI along with officials of State Forest Department, DoS staff and adopted villagers performed night time survey at *in-situ* conservation site.

As routine survey was continued at the established conservation sites, it was found that wild Muga silkworms were feeding on its host plants. It was also observed that wild muga cocoons were found in the twigs, dried grasses and bushes of the conservation sites (Figure-15). Muga silkmoths

were emerged from the cocoons formed in natural condition, and coupling of male and female muga silkmoths were taken place at the conservation sites. Female muga silkmoths were laying eggs on the barks of host plants, as such the life cycle continued in the natural habitat (Figure-16).



Fig. 15: Muga silkworms feeding its host plants and cocooning in the twigs and dried leaves at in-situ conservation site.



Fig. 16: Observation of wild Muga Moth emergence, adult moth coupling and egg laying at in-situ conservation sites.

Conclusion

Muga silkworm is a very important bioresource and it is found only in Assam and its neighbouring states. To conserve this rare species, biodiversity conservation is increasingly recognized as a fundamental component of sustainable development of natural resources by protecting and using biological resources in the ways that do not diminish the world's variety of genes and species or destroy important habitat or ecosystem. Therefore, efforts and outcome of the project is to bring sensitization and awareness towards public domain towards the conservation of rare endemic Muga silkmoth in its natural habitat and its utilization in breeding programme in future. This conservation programme of Muga silkworm may further switch on studies on population dynamics and genetic variability of muga silkmoth and other wild silkmoths associated in the population at different conservations sites and maintain the genetic resources for utilization in the breeding programme in future.

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