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Conservation strategies of *Actias selene* Hubner: A wild silk moth in Nagaland, India

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Abstract

Actias selene **Hubner (Indian moon moth), an indigenous wild silk moth is geographically distributed in tropical moist deciduous forest of South East Asia, mainly Mussourie and North-Eastern region of India, Afghanistan to Borneo, Hongkong, China, Japan and Ceylon. Due to anthropogenic reasons and unabated destruction of natural habitat, the distribution of this sericulturally important species is restricted to highly inaccessible area. Hence, formulation of certain tangible conservation strategies is need of the hour for sustaining the population structure of *Actias selene*. The paper highlights on the strategies of *ex situ* and *in situ* conservation adopted in natural condition in Nagaland climatic condition. Under *ex-situ* conservation replicable rearing were conducted in selected isolated patch on their two natural host plants during March-May (Season-I), July-August (Season-II) and October-December (Season-III). Among the seasons, season-I (March-May) emerged as best for rearing of *Actias selene* with almost equal emphasis to both the host plants followed by season-III (October-December) and season-II (July-August). Under *in-situ* conservation additional breeding material were introduced in Natural habitat followed by three natural regeneration methods namely, release of seed cocoons, release of dfls in leaf cups and release of chawki worms. Maximum production of cocoon was obtained by release of chawki worms followed by release of eggs and seed cocoons.**

Keywords: ***Actias selene*****,** ***ex-situ*** **conservation,** ***in-situ*** **conservation**

Introduction

Actias selene Hubner (Indian moon moth), an indigenous vanya silk moth is geographically distributed in tropical moist deciduous forest (Lefroy, 1909), Earlier, moon moths were recorded from Mussourie and Sikkim in India (Cotes, 1891 – 1893; Arora and Gupta, 1979); Afghanistan to Borneo (Jordan, 1911); Hongkong (Potter, 1941); China, Japan and Ceylon (Essig, 1941) and North East India (Seitz, 1933; Chowdhury, 1981 ; Bhattacharya *el al*., 2004; Singh and Suryanarayana, 2005). Preliminary investigation in Nagaland has ascertained that the worm is polyphagous in nature and feeding on six unusual varieties of food plants, namely *Rhus javonica*, *Alnus nepalensis*, *Evodia flaxinifolia*, *Persea bombycina*, *Betula alnoides* and *Prunus cerasoides*, out of which the first two host plants are most preferable. Massive habitat transformation accelerate the wide spread extinction of bulk quantity of flora and fauna during last 500 years. The extinction of one plant species leads to extinction of several dependent animal species, which threatens the existence of human being (Hazarika and Bhuyan, 2005). North Eastern region including the Himalayan region, a part of "Indo-Burma Hot-Spot" (Meyers *et al*.,2000), reflects a high rate of depletion of natural habitat that results alarming threat to endemic species including sericigenous insects. In fact, loss of a host plant is directly related to loss of silkworm germplasm as well. However, for the past few decades of worldwide conservation, the focus has been mainly on few charismatic species which include typically large animals that attract a lot of public attention while smaller species like insects did not receive any attention though they are an important component of the ecosystem (Sahu and Bindroo, 2007). While compiling a series of studies conducted since 1977, Bhattacharya *et al*. (2004) revealed that wanton deforestation had led to depletion of wild silk moths species, importunate their conservation and preservation of genetic resources. Therefore, the conservation and utilization of existing sericigenous insects and their

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food plants needs utmost priority, which calls for long term *ex-situ* and *in-situ* conservation strategies. The germplasm thus conserve can be used for sustained development of newer hybrids/varieties of commercial value. Quite a few references are available on formulating conservation strategies and utilization of wild silk moths from outside India **(**Kioko *et al.* 2000; Raina and Kioko, 2000; Razafimanantosoa, *et al.*, 2006). In India, the strategies for conservation are mostly confined to commercially exploited species like *Antheraea mylitta* (Sinha and Sinha, 1994; Rao *et al.*, 2000; Alam *et al.*, 2000; Reddy *et al.*, 2000; Purosotham Rao, 2000; Sinha and Srivastava, 1999; Srivastava *et al.*, 1999; Thangavelu *et al*., 2002; Srivastava, *et al*., 2005; Shankar Rao *et al.*, 2005), *Antheraea assamensis* and *Samia ricini* (Thangavelu, 2002; Bhattacharya *et al.*,1999; Bhattacharya and Teotia, 2000; Barah and Chakravorty, 2005; Singh, *et al*., 2005; Singh and Chakravorty, 2005). Recent survey reveals that Nagaland harbours 15 species of wild silk moths (including *A. assamensis* and *S. ricini*) (Kakati and Chutia, 2009) some of which are very scarce and extremely restricted in distribution along the hilly areas in the interior forests. However, no record is available on conservation strategies of wild silk moths in Nagaland. Hence, an attempt has been made to evaluate both *ex situ* and *in situ* conservation strategies for sustainable utilization of wild silk moths with particular reference to *Actias selene* in Nagaland.

Materials and Methods

For evaluation of conservation strategies (both *ex situ* and *in situ*), cocoons of *Actias selene* are selected on the basis of production parameter like fecundity, ERR, cocoon: dfl ratio and commercial characters of cocoon like shape, size, single cocoon weight, shell weight and pupal weight. For *ex situ* conservation, rearing was carried out in previously selected govt. sericulture farm, Ungma during 2013-2015 following the method of Srivastava *et al.*, (2005) and all the biological, commercial and technological information along with meteorological data have been recorded seasonally during the period of study. For *in situ* conservation strategy, two forest patches with sufficient number of nature grown host plants were selected at Karidang and Merapkong forest of Ungma Village. The experimental forest patches were devoid of forest burning, Jhum cultivation and any other natural population of wild silk moths during the study period. The forest patches have been divided into three equal segments with a gap in between the segments. Three natural regeneration methods namely release of seed cocoons, release of dfls and release of chawki worms (Rao *et al.*, 2000) were used in study area during rearing seasons. In each treatment, three replicates was used and monitored in periodic interval. The experiment was continued for second commercial crop and periodic observation was made without any interference. On completion of rearing, mature worms /cocoons were collected from each segment and their commercial characters were analyzed seasonally. The detail methods are given below:

1. **Release of seed cocoons:** 50 seed cocoons were kept hanging (in three replicate) in food plants of the respective species just prior to the regular emergence, in the first segment of forest patch.
2. **Release of dfls (eggs) in leaf cups :** 10 dfls were placed (in three replicate) in leaf cup of the respective food plants and tied vertically to the plant so that rain water could not enter the leaf cup in second segment of forest patch.
3. **Release of chawki worms:** 300 numbers of chawki worms (immediately after hatching) have been released in their respective food plants in the third segment of forest patch.

Results and Discussion

Ex-situ Conservation

Performance of *Actias selene:* A fertile female moth of *Actias selene* was collected from *Rhus javanica* plants in the Sangtemla ward of Mokokchung district, Nagaland during mid of October 2013 and kept in a wooden moth coupling cage in Muga Seed Grainage Centre, Govt. Sericulture Farm, Ungma, Mokokchung, Nagaland. The female moth laid 187 nos. eggs, which were kept in egg cage at room temperature of 19o-20oC and RH-68-78% until hatching. The newly hatched larvae were released on the selected bush plantation of *Rhus javanica* plants and periodically observed until maturation. Later, five nos of larvae of *A.selene* in their 5^{th} stage have also been noticed

separately in *Alnus nepalensis.* Altogether 49 cocoons were harvested of which few were kept in cocoon cage for grainage operation. 14 dfls were utilized (7 each for the two host plants i.e. *Rhus javonica* and *Alnus nepalensis*) for *ex situ* conservation study during first generation. In subsequent seasons and years, rearing was conducted with varied numbers of dfls and data were recorded for two years. Comparative analysis of cocoon production (Cocoon/dfl) from an initial of 187 numbers of eggs and thereafter in different seasons for two years shows increasing trend with strong seasonal influence (Table- 1, 2 & 3).

Table -1: Performance of *Actias selene* Hubner in *ex situ* conservation

Before	After					
Year 2013 (October) Female -1 Eggs – 187 Hatching % -49 Worms - 93+4 Cocoons - 47+4 Dfls - 13+1=14	Year	Season	Dfls		Cocoons collected (No)	
			Host plants			
			A	B	A	B
	2014	I (Mar- May)	7	7	322 (46)	294 (42)
		II (Jul-Aug)	5	5	155 (31)	135 (27)
		III (Oct-Dec)	4	4	168 (42)	192 (47)
	2015	I (Mar- May)	8	8	520 (65)	480 (60)
		II (Jul-Aug)	5	5	125 (25)	105 (21)
		III (Oct-Dec)	5	5	225 (45)	260 (52)

A= *Rhus javonica* B= *Alnus nepalensis*

Table-2: Performance of *Actias selene* Hubner for *in situ* conservation

Treatment/method	Nos. of released	Nos. of cocoon collection			
		2014		2015	
		Crop		Crop	
		I	II	I	II
1. Release of cocoons	50	5	-	8	2
2. Release of Dfls	10	15	21	20	17
3. Release of chawki worms	300	13	27	17	15

Table 3: Meteorological data in different rearing seasons.

Temperature (C)		Spring (Apr-Jun) -2014	Summer (Jul-Aug) -2014	Spring (Apr-Jun) -2015	Summer (Jul-Aug)-2015
	Max	30.7±1.5	31.7 ± 3.2	32.0 ± 1.0	32.7 ± 0.6
	Min	17.0 ± 3.0	20.7 ± 2.18	16.7 ± 3.5	19.3 ± 0.6
Humidity (%)	Max	91.3 ± 1.2	66.0 ± 5.0	43.3 ± 12.0	89.0 ± 3.6
	Min	59.3 ± 9.7	10.0 ± 4.7	8.5 ± 2.9	57.3 ± 6.8

***In-situ* Conservation**

A perusal of Table-1 and Table-2 reveals that all the three regeneration methods have contributed to enhance the population of *Actias selene* in natural ecopockets. Maximum production of cocoons was obtained by release of chawki worms followed by release of eggs and seed cocoons. The low production from release of cocoon technique might be due to synchronization barrier on emergence of male and female moths. This caused failure in pairing which resulted in production of unfertilized eggs. Release of eggs in the leaf cups showed comparatively good result for production indicating its stability with wider range of conservation. Rao *et al.* (2000) collected maximum number of cocoons by releasing eggs in leaf cups and observed a strong positive correlation between release of layings and production of nature grown Raily cocoons of *Antheraea mylitta*. Although the third method i.e. release of chawki worms enhanced natural population with maximum number of cocoon production but it was not practically viable in large-scale programme. However, because of its

economic viability, this method could be adopted in sampling the population in *ex situ* conservation (Rao *et al.*, 2000). The present study helped in arresting the decline of the wild cocoon production, checked the deterioration cocoon quality and preserved inherent genetic variability, which proved that the *in situ* might be the most effective conservation strategy for wild silk moths (Sinha and Naqvi, 1997). The unabated deforestation, unsustainable fuel wood extraction, shifting cultivation, encroachment into forestland for agriculture and settlements etc in Nagaland have direct impact on food plants of different wild silkmoths host plants. Lack of awareness about wild silkmoths and their host plants among the local farmers ar likely to result in local extinction of few species. Therefore, there is a need to initiate conservation awareness programme for the local communities in the state by introducing the concept of silkmoth farming, the practice of which not only provides substantial economic gain to tribal population but also helps to conserve forests and regional biodiversity. Conservation of wild population is much easier than that of domestic population provided int can be carried out *in-situ* (Frankel, 1982). Efforts should also be made for *ex-situ* conservation, protection and proliferation of wild silkmoths through planned and collaborative efforts of state and central government agencies. Encouragement of traditional skills such as maintenance of sacred groves, rewarding local conservators and organization and management of eco-tourism would greatly help the conservation programme. (Sahu and Bindroo, 2007).

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