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Studies on the biodiversity and ecological aspects of Tasar silkworm, Antheraea mylitta, Andhra local ecorace, in relation to other ecoraces

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ABSTRACT

The polyphagous sericigenous insect, tasar silkworm, *Antheraea mylitta* Drury is mostly found in the tropical areas of our country, feeding primarily on food plants like *Terminalia arjuna* and *T. tomentosa* a variety of secondary food plants. Tasar culture is a traditional livlihood for lakhs of tribal populace in the areas of Jharkhand, Chhatisgarh, Orissa, Maharashtra, Andhra Pradesh, West Bengal and Uttar Pradesh. The present study depicts the variation in the different stages of tasar silkworm *Antheraea mylitta* Drury which is distributed in the form of ecoraces in varied geographical areas. From the studies it is observed that rich biological diversity of *Antheraea mylitta* mainly is due to its wide range of distribution, climatic factors, and food plants *etc.*, which have led to made variations in their ethology, physiology and commercial traits.

Keywords: Tasar silkworm, *Antheraea mylitta*, ecoraces, geographic distribution, ethology.

1. Introduction

Antheraea mylitta, a wild sericigenous insect is a species widely distributed from West Bengal in the East to Karnataka in the South with its natural inhabitation in the forest area of Bihar, Orissa, Madhya Pradesh, Maharashtra and Andhra Pradesh. It is a polyphagous insect feeding on a number of food plants primarily on *Terminalia arjuna* and *T. tomentosa*, *Shorea robusta* and secondarily on *Zizyphus*, *Tectona*, *Bauhinia*, *Lagerstroemia* etc. It is well adapted to different areas ranging from 24 – 16° latitude and 80 – 88° longitude. Indian tasar occurs mostly in the tract of Ganges (North), Godavari (South), Orissa (South-East) and Narmada (East).

The wide range of distribution of the species has encountered diverse geographic and climatic variations of the distinct areas, leading to marked differences in not only phenotypical and physiological traits but also in the commercial and technological aspects.

In the state of Andhra Pradesh, the Tasar silkworm, *Antheraea mylitta* is available in the districts of Adilabad, Karimnagar, Warangal and Khammam districts along the river Godavari, the primary food plant being, *Terminalia arjuna* and *Terminalia tomentosa*, which are called in the colloquial language as yeramaddi and tellamaddi, respectively.

Andhra local Ecorace of Tasar silkworm, *Antheraea mylitta* Drury, which is an exclusive race of the state of Andhra Pradesh is well known for its superior commercial qualities like hard

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and compact cocoons, high reelability (69%), high shell ratio (16.85) and low denier (7%). It is on the verge of extinction due to certain weaknesses like poor egg – laying behavior, voltinism, erratic emergence, non-uniform silk deposition in cocoons and pupal mortality. It also shows heavy mortality of larvae due to predators, parasites and climatic hazards (Shamitha and Rao, 2008). The present investigation is an attempt to study the genetic proximity of Andhra local ecorace with other ecoraces of *Antheraea mylitta,* by comparing their geographic distribution, morphological and ecological parameters and bring about an idea of evolving a new breed without losing its beneficial commercial characters and suggest methods to overcome its weaknesses.

In order to preserve the natural biodiversity present among these populations, attempts are being made to understand the genetic structure of each population. Preliminary studies based on quantitative traits such as cocoon weight, shell weight, larval weight etc. were made to understand the genetic basis of this phenotypic variability (Siddiqui *et al.*, 1997). However, no systematic studies were made to generate substantial information on the genetic diversity of these populations so as to develop appropriate strategy for its conservation at the natural habitat. The present study is focused on the genetic diversity of seven commercial populations of *Antheraea mylitta* Drury in selected parts of India based on physical features, climatic conditions and quantitative cocoon and post-cocoon characteristics.

2. Material and methods

For the present studies the economically important ecoraces of Tasar silkworm, *Antheraea mylitta* D- *viz.*, Daba, Sukinda, Raily, Modal, Bhandara, and Andhra local were collected from their natural habitat and were maintained in the germplasm bank of Kakatiya University, Warangal.

2.1. Collection of tasar samples from selected parts of the country:

Collection of wild cocoons of Daba TV/BV and Andhra local ecoraces from distant ecopockets of Andhra Pradesh were collected by exploring the natural habitats (Figure1). The ecoraces like modal, sukinda, raily and bhandara were collected from Keonjhar (Orissa), Sukindergarh (Orissa), Bastar (Chhatisgarh) and Bhandara, (Maharashtra) respectively (Figure 2). The details of the natural conditions which include temperature, rainfall and soil conditions were recorded.

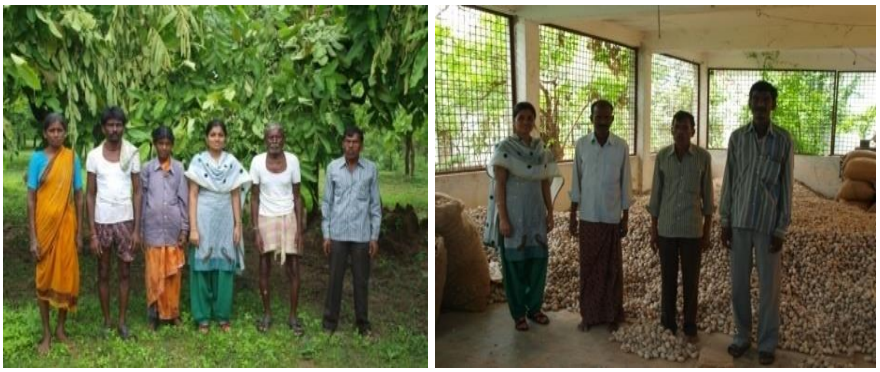

Figure1. Collection of Tasar Silkworm, *Antheraea mylitta,* Daba TV cocoons at Mahadevpur, Andhra Pradesh.

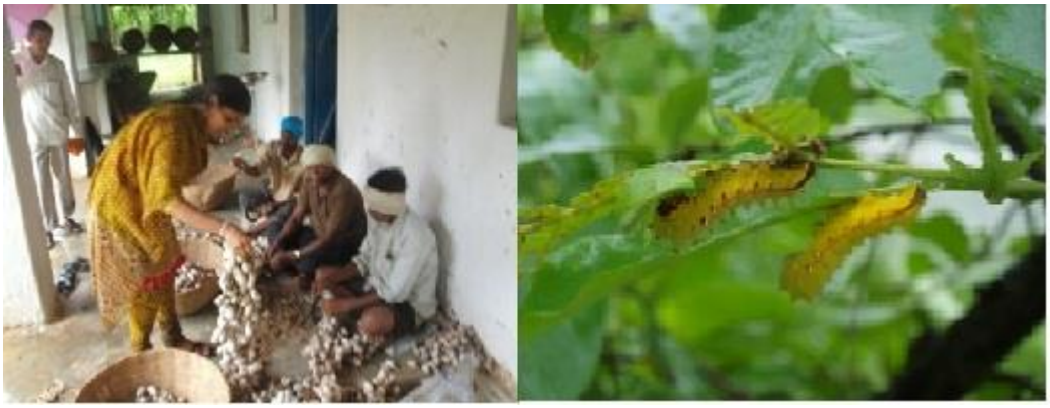

Figure 2: Rearing of Tasar Silkworm, *Antheraea mylitta,* Bhandara ecorace at Bhandara, Nagpur.

2.2. Study of morphological characters

The larval weight was measured using standard electronic balance. The post cocoon parameters *viz.,* cocoon weight, shell weight, shell ratio and pupal weight are measured according to standard procedures and recorded .

2.3 Rearing of tasar silkworm

The rearing of the tasar silkworm *Antheraea mylitta* D (Andhra local, Daba TV/BV) ecoraces were reared on the *Terminalia plantation* raised at Kakatiya University campus (Figure 3) and the larval span, moth colour, voltinism *etc* were observed. During rearing, environmental fluctuations were seen, which sometimes involved unfavourable conditions like rain, storm or hail. As the larvae were also attacked by pests and predators, usage of net for their prevention was ensured. Temperature and relative humidity were measured regularly.

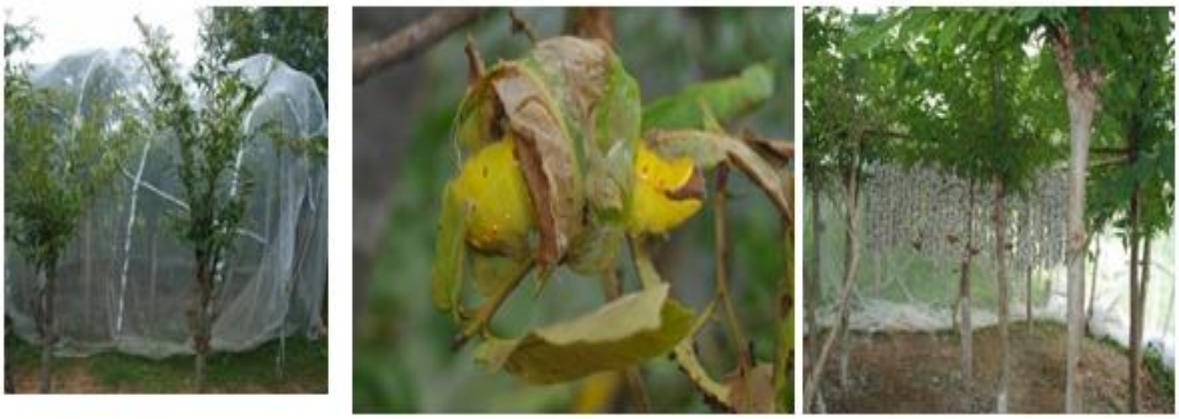

Figure 3: Rearing of Tasar Silkworm, *Antheraea mylitta,* Andhra local and Daba TV ecoraces at Kakatiya University

3. Results

The details of habitat, forest type and environmental factors of economically important tasar ecoraces is presented in table 1a and 1b.

Table 1a: Natural habitat of economically important ecoraces of *Antheraea mylitta* Drury

Ecorace	Area of habitat	Geographical ordinates		Forest type	Soil type
		^{0}N	^{0}E		
Andhra Local	Adilabad (Andhra Pradesh)	19.40	79.18	Tropical dry deciduous	Black clayey
Daba	Singhbhum (Jharkhand)	22.12	86.23	Tropical moist deciduous	Red loamy
Bhandara	Bhandara (Maharashtra)	21.09	79.42	Tropical dry deciduous	Black clayey
Modal	Keonjhar (Orissa)	21.40	86.40	Tropical moist deciduous	Red loamy
Sukinda	Sukindagarh (Orissa)	21.00	86.00	Tropical moist deciduous	Red loamy
Raily	Bastar (Chhattisgarh)	19.05	82.05	Tropical moist deciduous	Sandy red

Table 1 (b): Environmental conditions of economically important ecoraces of *Antheraea mylitta* Drury.

Ecorace	Average maximum Temperature (° C)	Average minimum. Temperature (°C)	Annual precipitation (mm)
Andhra Local	31.52	21.80	925.25
Daba	28.90	18.40	1095.00
Bhandara	34.50	20.80	939.40
Modal	30.40	20.30	1218.20
Sukinda	31.45	20.60	1096.00
Raily	31.50	18.62	1275.62

Cocoon weight of Tasar silkworm, *Antheraea mylitta* D- Andhra local, Daba TV, Bhandara, Modal, Sukinda and Raily ecoraces were 4.60 ± 1.71 (S. D.), 11.63 ± 1.39 (S. D.), 4.95 ± 0.84 (S. D.), 17.50 ± 2.01 (S. D.), 8.03 ± 0.85 (S. D.), 15.26 ± 1.28 (S.D.) grams respectively; Shell weight was found to be 1.39 ± 0.28 (S. D.), 1.52 ± 0.22 (S. D.) 0.9 ± 0.38 (S. D.), 3.99 ± 1.06 (S. D.), 1.22 ± 0.24 (S. D.), 2.97 ± 0.22 (S.D.) grams respectively; while Shell ratio (%) of these ecoraces were 30.36 %, 13.13 %, 18.17 %, 22.80 % , 15.19 % , 19.45 % respectively. The pupal weight of these ecoraces was found to be 4.04 ± 0.40 (S. D.), 8.10 ± 0.43(S. D.), 4.50 ± 0.21(S. D.), 11.09 ± 4.39 (S. D.) , 7.59 ± 0.82(S. D.), 13.02 ± 0.32 (S. D.) grams respectively (Figure 4 and Table 2).

Figure 4: Cocoons of Tasar Silkworm, *Antheraea mylitta* (Andhra local, Bhandara, Daba, Sukinda, Modal and Raily ecoraces)

Table: 2: Cocoon parameters of Tasar ecoraces

Sl.No.	Ecorace	Cocoon weight (Grams)	Shell weight (grams)	Shell ratio(%)	Pupal weight (Grams)
1	Andhra local	4.60 ± 1.71	1.39 ± 0.28	30.36 %	4.04 ± 0.40
2	Daba TV	11.63 ± 1.39	1.52 ± 0.22	13.13 %	8.10 ± 0.43
3	Bhandara	4.95 ± 0.84	0.9 ± 0.38	18.17 %	4.50 ± 0.21
4	Modal	17.50 ± 2.01	3.99 ± 1.06	22.80 %	11.09 ± 4.39
5	Sukinda	8.03 ± 0.85	1.22 ± 0.24	15.19 %	7.59 ± 0.82
6	Raily	15.26 ± 1.28	2.97 ± 0.22	19.45 %	13.02 ± 0.32

The diapause period of the tasar silkworm, *Antheraea mylitta* D is ranging from 4- 5, 5-7 and 10 months for bivoltine, trivoltine and univoltine respectively, in the seven ecoraces studied. The moth colour was also observed to be brown, yellow or grey predominantly (Figure 5).

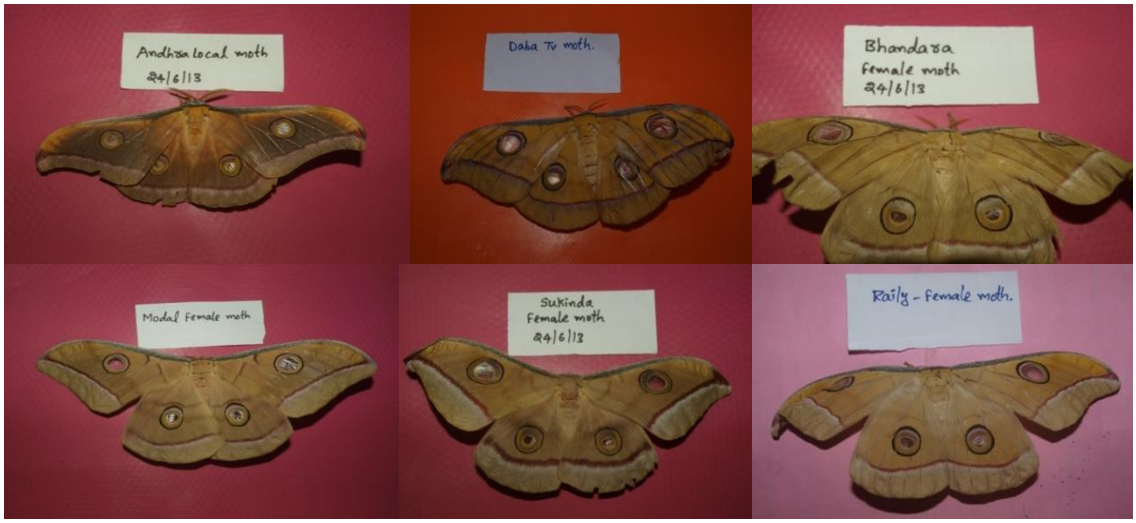

Figure 5: Cocoons of Tasar Silkworm, *Antheraea mylitta* (Andhra local, Bhandara, Daba, Sukinda, Modal and Raily ecoraces)

The average larval weight of tasar silkworm, *Antheraea mylitta* D, Andhra local, Daba TV, Bhandara, Modal, Sukinda, Raily ecoraces were 25,42,30,45,35 and 45 grams respectively.The Average Larval span of tasar silkworm, *Antheraea mylitta* D, Andhra local, Daba TV, Bhandara, Modal, Sukinda, Raily ecoraces were 42,31,35,32,36 and 32 days respectively (Table 3).

Table 3: Larval characteristics of Tasar silkworm, *Antheraea mylitta*

Ecorace	Diapause period (months)	Voltinism	Predominant female moth colour	Average larval weight (grams)	Average Larval span (days)
Andhra Local	4	Trivoltine	Brown	25	42
Daba	6-7	Bi/ Trivoltine	Yellow	42	31
Bhandara	5	Trivoltine	Brown	30	35
Modal	4- 10	Uni /Bi/ Trivoltine	Grey	45	32
Sukinda	4	Trivoltine	Yellow/ Grey	35	36
Raily	4 - 10	Uni /Bi/ Trivoltine	Grey	45	32

Table 4: Origin and characteristics of Andhra local, DabaTV, Daba BV,Modal, Sukinda,Raily and Bhandara ecoraces

Ecorace	Place of origin	Place of use / practice	Primary food plant	Cocoon availability	Level of adaptability	Pre dominant cocoon color
Andhra Local	Adilabad (Andhra Pradesh)	Andhra Pradesh	*T. arjuna, T.tomentosa*	Forest collection	Wild	Cremish /yellow
Daba	Singhbhum (Jharkhand)	Entire tasar producing areas	*T.arjuna, T.tomentosa*	Silkworm rearing	Wider adaptability	Grey
Modal	Simlipal (Orissa)	Simlipal	*Shorea robusta*	Forest collection	Wild	Blackish Grey
Sukinda	Sukindagarh (Orissa)	Entire tasar producing areas	*T. arjuna, T.tomentosa*	Silkworm rearing	Wider adaptability	Yellow
Raily	Bastar (Chhattisgarh)	Bastar	*Shorea robusta*	Forest collection	Wider adaptability	Blackish Grey
Bhandara	Bhandara (Maharashtra)	Bhandara	*T. arjuna, T.tomentosa*	Forest collection	Wild	Blackish grey/ yellow/ cremish

4. Discussion

Tropical tasar silkworm, *Antheraea mylitta* Drury is a commercial variety which exists in various forms of nearly 44 ecological populations or ecoraces in different geographical niches of our country depending on food plants and environmental conditions. In the present study out of the seven ecoraces studied, except the tasar silkworm, Andhra local ecorace, , which predominantly found in dry tropical forest area, all other ecoraces grow in moist deciduous forest areas of red loamy and black clayey regions within maximum temperature range of 30-34°C and a minimum of 18-21°C, the annual precipitation ranging from 925-939 mm in dry deciduous and 1000-1275mm in moist tropical deciduous forest areas (Suryanarayana *et al.*,2005). The voltinism (uni/bi/tri) in *A.mylitta* is regulated by environmental factors like temperature, relative humidity, day length and rainfall. Some have reported that voltinism pattern is found to be stable for a particular zone can change in different environmental conditions (Kar *et al.*,2000). Humidity also plays an important role in growth of the larvae, triggering the moth emergence and preventing pupal desiccation. A statistical analysis of various strains of *B.mori* of different geographical origin has revealed that autumn is the most favourable season for exploiting silk yield contributing characters like pupation rate, cocoon weight, shell weight, shell ratio and filament length (Bhargava *et al*, 2001)

As is evident from the present investigation , the tasar silkworm, *Antheraea mylitta* is found to be distributed in a diverse geographic areas of varied eco-climatic conditions like temperature, humidity, photoperiod, rainfall; edaphic factors like soil, texture; geographic coordinates like latitude and longitude and forest resources of food plants etc, leading to changes in phenotypic, physiological, ethological, adaptational, economic traits and ultimately genetic variations in populations .

In the present study, which is based on the study of quantitative characteristics, the cocoon weight and shell weight were found to be greater in Modal and least in Bhandara ecoraces. It is observed that the pattern of larval weight and cocoon weight were corresponding to each other in all the ecoraces studied. While the shell ratio was found to be highest in Andhra local ecorace, the other ecoraces like Raily, Daba and Sukinda have shown slight variations. The larval span was found to be from 35-40 days in Andhra local, Bhandara and Sukinda, while it was comparatively lesser in Daba, Raily and Modal ecoraces.

Among these ecoraces, modal and raily feed on *Shorea robusta*, while all other ecoraces feed primarily on *Terminalia arjuna* and *T.tomentosa*. The rich biological diversity of *Antherea mylitta* is attributed to its wide range of distribution and foraging of silkworm on a variety of food plants. From the present data it is observed that except Andhra local, the ecoraces primarily feeding on *Terminalia arjuna* have greater cocoon weight and shell weight than those feeding on *Shorea Robusta.*

Antheraea mylitta D., a lepidopteran insect of the Saturniidae family produces tasar silk of commercial importance. This species is endemic and distributed in different geographical regions of India in the form of ecological races (Table 1). They show variation in their phenotypic traits such as fecundity, voltinism, cocoon weight, silk ratio and also in their host plant preference (Sinha *et al* 1994). To understand the genetic closeness and also for the identification of the wild silkworm *A. mylitta* D ecoraces, usage of RFLP markers was reported by Mahendran *et al*., in 2006. The subsequent phylogenetic analysis revealed that their relationships were found to be consistent with a neighbourhood structure of randomly mating population and the geographically closely situated populations tend to be genetically more similar.

Cocoon weight, shell weight and shell ratio play an prominent role in productivity of tasar culture along with fecundity, hatching and effective rate of rearing and the most important being genotype-gene interaction to improve commercial traits. The expressivity of gene, an endogenic factor, to produce a phenotype is based on environment, an exogenic factor. A recent study (Manohar *et al*., 2011) has revealed performance of parental ecoraces and F1 hybrids as superior during commercial crop rearing season due to positive interaction with the environment of crop season to attain better cocoon phenotype.

The tasar silkworm *A.mylitta* D, Modal is *Shorea* based wild, tropical, univoltine and totally disease free ecorace and produces the heaviest cocoon of 17.5 grams , among all the sericigenous lepidopteron of world and contributes 19 **%** raw silk production of India. The interbreeding among different ecotypes in nature over centuries has resulted in high degree of heterozygosity in its natural population resulting in variation in its genotypes in varied ecological conditions. However, due to over exploitation of modal ecorace by human interference, deforestation leading to paucity of sal trees and several other environmental hazards leading to deterioration of Modal biodiversity, paved way to its conservation by identifying the genes for disease resistance and environmental stress and stabilize the population (Ajith, 2011).

A recent study on the molecular identification of tropical Tasar silkworm , *Antheraea mylitta* ecoraces with RAPD and SCAR markers (Monalee Saha and Kundu, 2006), identified and characterized a 281 bp Mbol digested genomic DNA segment which has been used as an RFLP marker to distinguish the closely related ecoraces of tropical tasar silk – producing insect *A. mylitta*.D. Genetic diversity and differentiation among different populations of the wild silkworm *Antheraea mylitta* was examined using ISSR markers (Chatterjee *et al.* 2004; Kar *et al.* 2005). It was also studied that breeding programme can be facilitated through molecular marker technique to produce varities with desirable characters which is the need of hour (Ajith, 2011).

Though Daba and Sukinda are available in many parts of tasar producing states as robust cocoons, Bhandara, Raily, Modal and Andhra local ecoraces are found in limited numbers exclusive areas of natural environs, bestowing their respective unique features, *viz.*, Andhra local, an exclusive ecorace of Warangal region has hard and compact cocoons with high reelability but low yield, Modal of Orissa is the bulkiest of all cocoons, a highest silk yielder producing coarse and heavy filament. However, Bhandara of Nagpur produces a distinctive silk fibre and Raily is bestowed with better shell weight, longer filament length but a low egg fertility and lesser silk yield making commercially less beneficial. These cocoons are not readily accessible in the forest region and found to be gradually decreasing in number. There is a greater need of these indigenous ecoraces to be conserved by evolving a systematic breeding program and thereby preserve their uniqueness. Parental nativity, phenotypic variability and genetic diversity were found to be imperative reasons for better heterobeltiosis in fecundity, hatching, shell weight and silk ratios (Siddiqui, 1997). Relationship of moth colour to fecundity and hatching indicated that moths having yellow colour can enhance grainage efficiency of tasar, thus they may be selected in all seed and breeding programme (Srivastava, 2011). In the present investigation an efforts to study genetic compatibility of Andhra local in relation to the other ecoraces is envisaged. It is observed that

5. Conclusion

The present study infers to the need of conserving the distinct and unique tasar ecoraces, by several measures - as most of the tasar silkworms are polyphagous, the availability of a range

of secondary and tertiary food plants in large numbers in the rearing area by increasing tasar base; an innovative method of total indoor rearing in the case of *Antheraea mylitta*, Andhra local ecorace, as a systematic approach towards its conservation (Thangavelu, 1991, Shamitha and Rao, 2005) and holistic approach to conserve and breed ecoraces, as variations in the ecoraces have genetic basis, by identification of ecoraces based on molecular markers, selection of parental ecoraces, consistent breeding program, production of hybrid seeds to produce desirable commercial characters. However, studies on adaptability of ecoraces in different ecological conditions and synchronisation of emergence pattern need to be focused.

Acknowledgements

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