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STRATEGIES ON CONSERVATION OF GENETIC RESOURCES OF TASAR SILKWORM

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ABSTRACT

Genetic resources of the silkworm, *Antheraea mylitta* Drury are prominent and diversified eco-races distributed along Central India within 12º-31°N and 72º-96°E as a treasure of biodiversity. These are facing threat of erosion showing an alarming decline in population in their natural habitat due to anthropogenic changes and rampant exploitation for the cause of silk industry without obeying conservation measures. As a result it decreases the genetic diversity (GD), subsequently allelic diversity (AD) which is essential for long term sustainability of the species. Hence adoption of conservation strategies is a crying need of the day. For the cause and prosperity of the future generation, it is imperative for crop improvement through various conservation and breeding plan. The base paper portrays an analysis on the factors operating in erosion process, maintenance strategies adopted for conservation of regional wild eco-races, short term and long term conservation in general and some breeding measure for *A. mylitta* Drury.

INTRODUCTION

The Genetic Resources

The silkworm, *Antheraea mylitta* Drury is highly heterogenous and forms an integral part of the forest ecosystem. It has various forms of ecological population in varied topographical, climatological, vegetational and edaphically diverse areas and exhibit diversity in phenotypic, physio – genetic and behavioural characters. From the Breeders point of view, this variation is a treasure --- the conservation, maintenance and protection, which is most important for qualitative and quantitative improvement as a whole. At the time, when the natural resources are depleting in forest, deforestation is a regular phenomenon, no wonder, that the existence of natural population of *A. mylitta* would be threatened. In the recent past, it has been observed that the natural population of A. mylitta is increasingly depleting in general and some of the races like Modal, Andra local, Bhandara, Tira, Laria, Sarihan are endangered in particular. Therefore, the preservation of genetic resources for cause and prosperity in present and future generation is inevitable. The authors reveal the magnitude of the genetic variability which is a determinant factor for the extent of crop improvement through various breeding programmes along with the description of the threatened categories of ecoraces. Long term conservation of wild and semi domesticated ecoraces has become most important since these genetic resources are the vital source for disease - resistance and other desirable genes.

THE CONSERVATION

The conservation maintains three important aspects of life on earth.1. Natural diversity found in living system as *Biological diversity*. 2. The composition, structure and function of these systems as *Ecological integrity*. 3. Resiliency and ability to endure over time (Callicot et al 1999). Biological diversity is organisms at various levels of organization including genes, species, higher taxonomic levels of habitat and ecosystem. Ecological integrity is an assemblage of organisms maintaining its composition, structure and function over time unaltered by human actions. Ecological health is a relative measure of ecological system with regard to its resiliency to stress and ability to maintain its organization and autonomy over time.

The maintenance of high level of genetic variability is the major objective of conservation program. Genetic variation is a pre-requisite for the population to face future environmental changes and ensure long term

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response to natural and artificial selection of economic interest (Barker 2001). To understand the extent of threatened population and monitor the performance of conservation program we must measure the amount of available genetic variability of the species. This represents the expected proportion of heterozygote. The only available information to calculate GD is from neutral molecular markers. High level of heterozygosity implies high level of additive genetic variance and thus the greater potential response to selection (Falconer & Mackay 1996). From evolutionary perspective a straight forward measure of variability is allelic diversity or allelic richness – (the number of different alleles at a locus or the average over loci – present in the population). Some authors believe that this parameter is the most relevant criterion for diversity because high level of AD implies a source of single locus variation for important qualitative traits. It is also essential for a long term evolutionary potential of population because the limit of selective response is determined by the initial number of alleles regardless of the allelic frequencies.

Gene Flow and Genetic Erosion of *A. mylitta* Ecoraces

Genetic diversity within species is influenced by gene flow among population which results from the movement of individuals and in some species long distance transfer of reproductive unit. Movements among population inhibits fixation of alleles. In case of *A. mylitta* which is commercially exploited, they are prone to long distance transfer as described in the following analysis.

Socio-technical analysis

Introduction of Daba and Sukinda ecoraces during 60s affected the population structure of wild ecoraces adversely in the state as well as in the country. Thus an alarming trend of decline was observed in population of Modal and Nalia in Orissa, Laria and Sarihan in Jharkhand, Raily in Chattishgarh, *A*. local in Andhra Pradesh, Bhandara in Maharastra and Tira in West Bengal. The reason for such decline was when high yielding variety (HYV) ecoraces with promising bumper harvest were introduced; the tribal rearers were tempted and preferred it. It called for lesser effort when compared to rigorous drill needed in cultivating wild ecoraces. This weakened their attachment towards the wild ecoraces and host plant. Slowly forest trees fell for one pretext or other and forest ecosystem succumbed to the pressure of changing time. Deforestation disturbed the biodiversity of many species including the vigour of wild tasar. There was a regular qualitative and quantitative decline that made the rearers turn away from tasar culture (Table - 4). Since tasar culture and forestry are inseparable, it is impossible to uplift tasar sector by any means that overlooks forestry. Along with preservation of host environment, application of modern knowledge of Breeding, Genetics and Biotechnology will be helpful in developing tasar sector.

Socio-economic analysis

Tribals generally collect cocoons of wild tasar during their search for minor forest - produce while roaming in forest. Cocoons so collected are exchanged for salt, rice or kerosene. Grocer channelizes to Mahajan and then cocoons are smuggled to neighboring states where more demand and better price is available. Thus tasar cocoon drain out from the forest cover, over the years without interference.

General Methods of conservation of *A. mylitta* Drury:

Conceptually, the issues of genetic resources and conservation are similar, whether dealing with short or long lived genetic material, domesticated or wild type, only strategies and methods differ but not the principles. The work on maintenance of germplasm depends upon the nature of the material, length of life cycle, mode of reproduction, ecological status (wild / domesticated) of the individual and objective of maintenance. The genetic variability of *A. mylitta* is being maintained *in situ* reserve or *ex situ* conditions. The methods of conservation of *A. mylitta* differ from that of *Bombyx mori* which is a domesticated species.

Species like *A. mylitta* for which knowledge on ecology and genetics is scarce, conservation of genetic material *in situ* condition is the most suitable method, provided the area is protected. Under *in situ* conservation programme, systematic release of wild eco-race has enabled the population to perpetuate its generation thereby conserving the genotype in their natural habitat.

***In situ* conservation**

1. Periodic cordoning of forests for natural multiplication: After identifying a prospective area, a time instituted – programme is scheduled to allow collection of nature - grown cocoons in a cyclic manner.

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2. In identified area, additional breeding material in the form of seed cocoons / moths / introduction of breeding material gravid - moths / eggs in sal leaf - cups / *chawki* worms are being released for breeding and multiplication free from interference.
3. Exploration of new pockets : New pockets are explored in core forest - ranges to serve as alternate breeding sites. This has paved the way for continued collection.

Regular surveillance is carried out to check diseases involving the local tribal residing near rearing sites in the conservation task. Each year with the conservation programme, the population of ecoraces increased considerably.

***Ex situ* conservation**

The population of *A. mylitta* ecoraces are a declining alarm in the natural habitat due to rapid deforestation, rampant collection of cocoons and pollution in the forests by coal mines and industrialization. The only way to conserve the original population is through *ex situ* conservation where population which is endangered and *in-situ* conservation is not possible. *Ex situ* conservation of *A. mylitta* ecoraces is being carried out at Central Training Research and Training Institute (CTR &TI, Ranchi and following methods of conservation are in practice.

- Exploration and collection.
- Random sampling of cocoons of *A. mylitta* from their ecological pockets.
- Recording of meteorological data.
- Genetic resources existing in the nature are being collected for further studies on quantitative characters.
- Recording of important ethological parameters during and after diapause.
- Maintenance and acclimatization of ecoraces under *ex situ* condition.
- Generation wise recording and evaluation of eco-races based on biological, commercial and technological characters of ecoraces.

Maintenance

- Biological : Emergence pattern, Emergence span, Coupling behaviour, Fecundity, Hatching, Larval weight, Larval span, Effective rate of rearing, Yielding and cocooning.
- Commercial : Cocoon weight, Shell weight, Silk ratio and Absolute silk yield.
- Technological : Filament length, Denier, Reelability, Recovery of silk, Tenacity and Yield per 1000 cocoons.
- Nature - grown population of tasar silkworm are increasingly endangered by loss of habitat and competition with its large competitors. There is an urgent need of developing comprehensive center for conservation, fully equipped and staffed to take up *ex situ* conservation of threatened germplasm resources of tasar silkworm in planned and systematic manner. There is also need for *in situ* conservation of germplasm in relatively undisturbed ecologically diverse niches.
- As the tropical tasar silkworm, *A.mylitta* is commercially exploited in India. Hence, any erosion in its genetic resources will be a tremendous loss. Hence, the need of the hour is to increase the productivity of tasar silkworm and conserve the precious genetic resource.
- Genetic markers with phenotypic expression are required for identification of genetic material of *A. mylitta*

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ecoraces. Presently, phenotypic characters of the ecoraces of tasar silkworm serve the purpose of identity of race and since these characters vary with season, location and food plants, the full - proof characterization of *A. mylitta* is most wanted. Variations in deoxyribo nucleotide acid (DNA) at different repetitive regions may highlight the genetic diversity and distance of different ecoraces of *A. mylitta.* The homogeneity and purity of stock may thus be achieved which may further be fabricated for hybridization.

- The ecoraces of silkworm, A. *mylitta* is an unique genetic and biological resource of India. So far, genetic diversity among different ecoraces has not been studied by various molecular techniques. Rao (2000) tried to characterize Daba and Andhra Local ecoraces based on molecular parameters and stated that there are certain bands which are common in both the ecoraces which indicates the possible genetic proximity between two ecoraces. Genomic DNA of the samples was isolated and quantification was carried out with 10 base pair oligonucleotides and some ISSR primers were used for DNA analysis. It was observed that the different ecotypes of silkworm were similar but clear demarcation among band patterns also existed (Anonymous 2000 - 2001). By using molecular technique, Kundu et al (2002) identified several ecorace specific Rapiud Amplified Polymorphic DNA (RAPD) bands for molecular characterization of ecoraces. He also undertook molecular and immunological characterization of *A. mylitta.* The characteristics Cytoplasmic Virus *(*AmCPV) fibre of silkworm from non mulberry silkworms also showed wide variability. Silk protein, fibroin from *A. mylitta* was isolated and characterized as a protein rich in glycine, alanine and serine (Datta et al, 2001a). It had been found that the fibroin gene is differently expressed according to developmental stages (Datta et al, 2001b).

Conservation Strategies for Raily

As reported by the work of Rao, K V S et al (1998), Raily is a wild ecorace found in dense tropical moist deciduous forest on shorea robusta of Bastar in Chattisgar. It is not amenable while handling, loosening its original characters on interference and exhibiting low survival, hence an attempt has been made to evolve suitable in situ conservation model. Five methods were studied in forest patch which has no continuity with the adjacent forest and is devoid of natural Raily population. The five methods were --- 1. Release of seed cocoons. 2. Release of male and female moth. 3. Release of gravid moth. 4. Release of eggs in leaf cups and 5. Release of chawki worms. All the five natural regeneration methods were useful strategies for genetic stock conservation and rejuvenation. Release of seed cocoons and moths gave lower production rates due to synchronization barriers and hence could not withstand in terms of cost – benefit ratio. The profitability index for release of gravid moth suggests its viability, release of eggs in sal leaf - cups gave highest profitability index which indicates its stability of profit. Release of chawki worms has no doubt enhanced natural population, but it is not practicable in large scale release - programme. However this method may be adopted in sampling the population in ex situ being economically viable. This study helped in arresting the decline of wild cocoon production, checked the deterioration of cocoon quality and preserved inherent genetic variabilities. Hence it once again proved that in situ may be the most effective conservation strategy for wild ecoraces of Raily (Table - 4).

Conservation Strategies for Modal

Nayak, B K et al (1998) reported that Modal is a wild ecorace of tropical tasar silkworm having superior character and highest silk yield. This ecorace is facing threat of extinction. The farmers have almost abandoned it for economic reason and commercial exploitation in its natural population. This resulted in an ecological disbalance and calls for immediate conservation. The best method is to conserve the ecosystem by setting aside their habitats from further exploitation. Secondly studies on the population dynamics are highly imperative to formulate the action plan for population conservation. In situ conservation of selected areas of the ecosystem are required along with preservation of ecoraces to avoid genetic erosion while under ex situ conservation, static conservation of gene and genotype of original population with better breeding and rearing techniques has to be maintained. Conservation through existing network of protected area include biosphere reserve, national parks, sanctuaries and gene conservation centers in collaboration with wild life conservation agencies. Further entire Simlipal forest should be protected (Table – 1 and 2).

Further Orissa is abode of various tasar ecoraces. They are Modal, Sukinda, Bogai, Nalia which are wild. Therefore conservation strategies include the below :

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TECHNICAL STRATEGIES

a) Protection and maintenance of essential host forest ecosystem.
b) To preserve the existing wild tasar biodiversity and their population in nature.
c) Ensure sustainable utilization of these species and the ecosystem.

The typical Conservation plan of Simlipal Forest Reserve may be projected as follows :

1. The core zone where the silkmoth will reproduce *suo moto* in nature will never be plucked and can work as gene pool reservoir for wild tasar. Thus the species is allowed to flourish amidst utter in silence and serenity.
2. The middle zone act as buffer zone where genetic potentiality of the species will be returned to nature by egg clipping.
3. In the outer border zone consist of village forest, reserve forest and tasar rearing fields where wild seed cocoons collected by the rearers may be processed for production of egg. Massive host tree plantation may also be taken up in this zone. Thus the conservation programme will be successful along with enrichment of the genetic vigor and sustainable economic use of the wild tasar cocoons.

Socio-economic strategies

Publicity and propaganda through social contacts could be slow process but is an effective solution to such problem. A slow impact may be infused in them through dramas, educational teaching, awareness campaign, exhibition, etc.

Strategies for funding and execution : For launching conservation projects a coordination between Central Silk Board and State Sericulture may be organized with funding agencies.

Conservation Strategies for Andhra local

As per the work of RamaRao et al (1998), Andhra local the ecoraces of *A. mylitta* Drury was exclusively reared by the traditional tribal farmers in the area of Andhra Pradesh. A large number of tribals and others particularly in Adilabad, Karimnagar, and Warangle District of the state were engaged in collecting and rearing of this ecorace for their livelihood. After introduction of Sukinda and Daba TV races during 1977 in the state, the local races were neglected and left in the wilderness to fend for itself. In addition to the introduction of races indiscriminate collection of natural cocoons, shrinkage of forest having tasar food – plant, increase in large industries and mines have brought about a drastic decline in the population of this race. This continuous threat for the very existence of the genetic resource in nature and natural manmade hazards lead to the extinction. The depletion of the local ecoraces in recent times may be attributed to less care by the farmers and interference by the population of the other ecoraces. To stop its further deterioration and to avoid mixing with other ecoraces, the local eco-races may be reared in isolated forest patches exclusively demarcated for the purpose. The most important aspect of utilization of tasar cocoons for commercial exploitation rests with silk yield. An investigation on economically important characters of different ecoraces revealed high reelability and lower denier for Andhra local. The study reveal that Andhra local race is superior in its survival, fecundity and hatching and ERR to Daba TV. However regular cocoon crop of the local ecorace is not taken up due to errratic emergence, low coupling ability and above all its non adaptiveness to captive conditions. These yield contributors need improvement either through adoption of advanced technologies of rearing and grainage and development along with strategies suitable for its large scale multiplication or by evolving hybrids of the local ecorace depending on its binding ability with other ecorace of *A. mylitta* Drury.

Conservation Strategies for Bhandara

As reported by the work of Reddy, K J et al (1998), Bhandara local is well distributed in tropical dry deciduous mixed forest belt of Bhandara, Gadchiroli, Chandrapur and adjoining district of Maharastra state facing the danger of extinction. In the last 30 years the farmers have almost abandoned it for economic reasons. Besides commercial

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exploitation of the natural population, the multiplication of the race and basic requirement of tribals has almost stopped. Bhandara is known for their small compact cocoons and have got superior commercial qualities such as better shell percentage, high reelability and low denier over the commercial races. Their silk is durable and the pupa is also a source of medicine, free from pebrine disease. Conservation of this wild ecoraces from their gradual decline in natural population has scope for exploration of hybrid vigour for qualitative and quantitative improvement of tasar cocoons, development strategies for containing the weak voltinism and utilization of these. To design a model for conservation the demographic and ethological studies *in situ* condition, population diversity ethological studies *in situ* condition, population diversity in potential pockets of the ecorace are needed. Further in order to avoid mixing and deterioration of genetic characters it can be successfully developed in isolated forest patches, demarcated exclusively and made totally free from encroachment by other ecoraces of *A. mylitta.* He opined that to overcome the genetically weak characters, on selective basis, methodical breeding activities probing into the binding capacity and combining abilities of the ecoraces with other ecoraces of *A. mylitta* can be undertaken, taking into the consideration the bio-ecology environmental factors.

Conservation of *A. mylitta* Drury in North East :

As reported by Naqvi, A H et al (1998), North East India harbours most of the saturniid wild silkmoth belonging to the genus Antheraea. Wide range of variations existed in cocoon characteristic like volume, color, length of peduncle, cocoon weight, shell weight within and between population of *A. mylitta* collected from various places of North East, India. The important aspect of cocoon utilization is commercial character of cocoon. Collected biomaterial of tasar from North East, India could not survive under Ranchi, Jharkhand condition therefore it is suggested to maintain the breeding stock in *situ* as per the recommendation of Sinha and Sinha (1994). Efforts should also be made on systematic and scientific lines for *ex situ* conservation, protection and proliferation of *A. mylitta* through planned and collaborative efforts of state and central government organization agencies, non-governmental organization, voluntary organization and individual, including district and block level.

Rejuvenation and Conservation of Sukinda

As per the ongoing work of Satpathy, B et al ((2004) Sukinda is a trivoltine tasar cultivated in Orissa during 1970s. The race was suitable for warmer climates and fared well in semi-domesticated conditions. It had advantage over other wild tasar races in low pupal mortality, higher cocoon ratio and less deterioration of economic character in progenies. With introduction of DabaTV, cultivation of Sukinda gradually declined and at present the race is rarely reared on commercial basis.Therefore a programme to rejuvenate the ecorace through collection, isolation, behavioural studies, multi- locational trial for reintroduction of the race for commercial exploitation as an additional and supportive tasar race in warmer climate of Orissa and other places.The operation of programme includes 1. Survey, collection of Sukinda cocoons, morphometric studies and isolation of different lines. 2. Studies on cocoon preservation and grainage behavior of isolated lines at in situ and ex situ condition. 3. Studies on rearing behavior of different lines at in situ and ex situ condition. 4. Multi - locational trial of the isolated lines at Mayurbhanj, Keonjhar, Dhenkanal and Sundergarh at farm and farmer level.

SHORT TERM AND LONG TERM MEASURES

The genetic variability can be conserved *in situ* reserves or can be sampled for establishment of conservation *ex situ*. The fact that the species A. *mylitta* contains diverse structure is not debated and the potential utility of this diversity is beyond serious doubt (Sengupta et al 1999, Singh and Srivastava 1997). However the methods of conservation may differ from that of *B. mori* which is a domesticated species. As the knowledge on Ecology and Genetics in *A. mylitta* Drury is scarce, conservation of genetic material in *situ* condition is the most suitable method provided the area is protected. *In situ* conservation of genetic resources abundant in forest is concerned with population samples, size of area s well as species composition of tasar food - plants. If conservation of genetic reserves is a major objective, the population which is able to retain its self –renewing capacity, must

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be considered rather than the total area of the reserve. The amount of inter and intra – racial variation, distribution of gene frequencies and exact objective of the conservation may be discussed at length before deciding for one large scale reserve. However, from managerial point of view one large area is easy to protect and manage. It is important to include extreme environment and marginal population in which selection effects may have created ecotypes of potential value and gene frequencies may differ from main population providing better chances to capture rare genes.

As short term measure

it is need of the hour to increase the productivity of tasar silkworm and conserve the precious genetic resources by adopting following strategies:

- The deteriorating trend of breeding population can be arrested by introduction of additional breeding material in identified protected area of natural habitat of the eco-race. The moths may be allowed to breed and multiply free from interference.
- Time instituted programme can be earmarked to allow the collection of cocoons in a cyclic manner.
- New eco-pockets can be explored in remote forest areas to serve as alternate breeding sites. This will pave the way for continued collection and closing schedule alternatively.
- Regular surveillance is necessary to check disease in forest ecosystem.
- Motivation, training and sensitization of members of local community on conservation of floral and faunal diversity of tropical tasar silkworm.

Thus, by *in situ* conservation, a particular ecorace of *A. mylitta* can be effectively ensured and the forest ecosystem will have a conservation period to allow luxuriant growth. Frankel and Soule (1981) opined out that the conservation of wild species is much easier provided if carried out *in situ* conditions .i.e. within their ecosystem. Harles and Dewel (1971) hold the view that pool of genetic diversity is required for survival of species otherwise extinction is inevitable. Dobjhansky (1951) emphasized that natural population of outbreeding population are genetically diverse, and the cause and maintenance of this diversity depend upon the occupation of heterogenous population of species and gene flow. Singh and Srivastava (1997) supports above workers and opined that *A. mylitta* population too occupy wide range of distribution with varied topographical, seasonal and vegetational changes creating isolation. Considering the loss of valuable natural population of *A. mylitta* and its potential utility following conservation strategies are required to be adopted.

As long term measures

- Population structure, behavior ecology and population dynamics of *A. mylitta* ecoraces are required to be studied in detail in their natural habitat.
- Comprehensive gene pool with well coordinated programme for collection and evaluation and conservation of the genetic resource are the needed for which *in situ* and *ex situ* conservation methodology is to be adopted.
- State wise establishment of Biotic Resource Inventory and updating Biodiversity Data are required for monitoring biodiversity erosion.
- Identification of rare vulnerable, endangered and extinct ecoraces is necessary for adopting suitable conservation strategies.
- Biotic salvage operation for forest ecosystem and threatened population are to be carried.
- The forest loving tribals can be made to understand how tasar food plants and nature - grown tasar cocoons can vouch a better livelihood for them.
- Establishment of environmental education centers in tasar growing states.
- Since our breeding stocks are being derived from nature and we are also pumping direct or indirect genotypes through our seed system without having any restrictions, the identity of races may be mutilated.

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BREEDING MEASURES

In recent past various breeding programme for crop improvement have been adopted. They are preparation of inbred lines, evolved lines, selected line and cross breeds through the tools of di – allele cross, multi - variate analysis and heterosis studies, inheritance of larval body color, inheritance of lateral shinning spot, inheritance of moth color, pleiotropic inheritance of larval body color, fixation of segregate - based larval body color, fixation of inbred lines without markers. Hybridization programme and many other breeding programmes have been undertaken between the ecoraces. Promising ones are Sarihan X Laria, Modal X Sarihan and Modal X Daba. All these indicate possibility of adoption of suitable breeding programme to enrich the genetic resource and sustainability for crop improvement

Table1—Mean data and index score of eight cocoon characters

S. No.	Genotypes	Fecund-ity	Hatchi-ng(%)	Larva Duration (day)	ERR (%)	Yield /dfl (No.)	SCW (g)	SSW (g)	SR (%)	Index Score value
1	Raily	305.60	63.42	30.20	15.42	30.00	10.30	1.118	10.85	15.07
2	Modal	251.60	64.64	30.40	12.90	20.60	8.58	1.040	12.14	14.38
3	Laria	200.00	65.84	30.00	28.77	37.40	7.62	0.858	11.26	14.84
4	Daba (BV)	231.40	75.24	31.20	40.22	69.60	11.11	1.546	13.92	17.65
5	Daba (TV)	196.20	72.60	30.80	48.57	68.40	10.18	1.192	11.71	17.07
6	Sarihan	183.80	67.64	30.60	38.29	47.00	7.48	0.856	11.48	15.42
7	Sukinda	230.00	70.20	30.40	25.63	40.00	9.28	1.026	11.07	15.43
8	Bhandara	209.20	58.18	29.80	17.46	20.80	8.37	0.972	11.65	14.08
9	Japla	200.00	67.70	31.20	13.31	17.40	9.35	1.108	11.83	14.36

Table2—Phenotypic and Genotypic correlation among the characters

Character combination	Phenotype	Genotype	Environment
Fecundity X Hatching	0.407	0.441	0.311
Fecundity X Larval duration	-0.199	-0.251	-0.035
Fecundity X ERR	0.475	0.480	-0.275
Fecundity X Yield/dfl	-0.224	-0.339	-0.055
Fecundity X Cocoon weight	0.470	0.494	-0.239
Fecundity X Shell weight	0.576	0.289	0.039
Fecundity X Shell ratio	0.301	0.310	0.022
Hatching X Larval duration	0.789	0.445	0.266
Hatching X ERR	0.713	0.835	-0.096
Hatching X Yield/dfl	0.809	0.903	0.115
Hatching X Cocoon weight	0.541	0.599	0.077
Hatching X Shell weight	0.632	0.711	-0.174
Hatching X Shell ratio	0.526	0.650	-0.190
Larva duration X ERR	0.751	0.317	0.063
Larva duration X Yield/dfl	0.639	0.702	0.163
Larva duration X Cocoon weight	0.546	0.878	0.255
Larva duration X Shell weight	0.662	0.058	0.330
Larva duration X Shell ratio	0.611	0.037	0.329
ERR X Yield/dfl	0.748	0.755	0.223

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ERR X Cocoon weight	0.497	0.510	0.312
ERR X Shell weight	0.796	0.407	0.220
ERR X Shell ratio	0.314	0.335	-0.314
Yield/dfl X Cocoon weight	0.458	0.469	0.102
Yield/dfl X Shell weight	0.544	0.552	-0.214
Yield/dfl X Shell ratio	0.454	0.483	-0.262
Cocoon weight X Shell weight	0.807	0.924	0.246
Cocoon weight X Shell ratio	0.668	0.729	0.114
Shell weight X Shell ratio	0.785	0.814	0.933

Table3---Performance of different natural regeneration method for Raily conservation

Treatment/ Method	1990-91			1991-92			1992-93		
	CW(g)	SW(g)	SR%	CW(g)	SW(g)	SR%	CW(g)	SW(g)	SR%
Releasing of seed cocoons	14.787	3.087	22.676	14.450	2.998	22.647	14.617	3.042	22.714
Releasing of male and female moths	14.604	2.995	22.592	14.403	2.987	22.638	14.560	2.990	22.703
Releasing of gravid method	14.600	2.904	21.735	13.995	2.895	22.415	14.087	2.897	22.612
Releasing of egg in leaf cups	14.596	2.810	20.902	13.986	2.800	22.310	13.990	2.798	22.600
Releasing of chawkei worms	13.224	2.470	20.300	13.200	2.450	20.108	13.210	2.458	20.131

Source: proceedings of 3rd international wild silk moth

Table 4 --- Occurence of A. mylitta ecoraces in North East .

Biotype	**Sex**	**Cocoon Weight(g)**		**Shell weight (g)**		**SR%**
		Range	**CV%**	**Range**	**CV%**	
Nawgaon	Male	4.93-11.27	17.49	1.05-2.03	18.62	21.63
	Female	8.06-14.58	8.17	1.15-2.73	21.87	16.00
Jiribam	Male	7.82-12.32	23.60	1.10-1.82	5.52	17.43
	Female	7.81-14.23	28.02	1.62-2.93	25.98	16.27
NG-94	Male	5.02-10.82	19.85	0.80-2.15	25.09	19.17
	Female	8.56-12.79	13.98	1.11-2.07	08.18	15.34
NE 1, 95	Male	5.45-7.49	2.40	0.71-098	6.02	13.30
	Female	8.78-11.13	9.14	0.83-1.35	9.61	10.34
NE 2, 95	Male	7.50-12.30	10.50	0.98-1.62	3.79	17.12
	Female	8.98-13.45	10.99	1.52-2.05	35.13	19.93

Source: Proceedings of 3rd international wild silk moth

Season/	**No. of**	**Natu-**	**%**	**Meca-**	**%**	**Division of natural coupling**

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Year	Coupli ngs	ral coup- ling	coup- ling (Natura l)	nical coup- Ling	coup- ling (Mecha - nical)	Coupli ng obtaine d in bambo o basket	% of couplin g	Coupli ng obtaine d in plastic basket	% of couplin g	Coup ling obtai ned in mosq uito net	% of cou pli ng
First 1995	289	57	19.72	232	80.28	Not used	NA	35	61.40	10	17. 54
Second 1995	30	12	40.00	18	60.00	Not used	NA	6	50.00	-	-
Third 1995	56	6	10.72	50	89.28	Not used	NA	-	-	-	-
	161 (B xB)	31	19.25	130	80.74	23	74.19	3	9.67	5	16. 13
First 1996	218 (B x S)	39	17.89	179	82.11	32	82.05	-	-	7	17. 94
	64 (S x B)	10	15.62	54	84.38	5	50.00	3	30.00	2	20. 00
Second 1996	28	12	42.85	16	57.15	10	83.33	2	16.67	-	-
Third 1996	7	2	28.57	5	71.43	2	100.00	-	-	-	-
First 1997	331	73	22.50	258	77.95	58	79.45	5	6.84	10	13. 69
Second 1997	50	24	48.00	26	52.00	20	83.33	4	16.66	-	-
Third 1997	82	36	43.90	46	56.10	31	86.11	5	13.88	-	-
Mean± SD		**28.05± 12.62**		**71.95± 12.62**		**79.80± 12.21**		**25.64± 18.70**		**17.05 ± 2.09**	

Table 5 Declining trend of population of wild tasar silkmoth ecoraces of A. paphia Linn. (10^5cocoon)

Year	Laria	Srihan	Andhra local	Bhandara	Tira	Modal	Raily
1985-86	12.27	6.52	11.05	8.45	9.69	10.40	190.85
1986-87	10.72	5.90	9.72	6.10	8.83	8.60	160
1987-88	10.17	5.43	9.13	5.92	7.90	1.90	135
1988-89	9.73	4.15	8.15	5.53	7.14	0.70	90.10
1989-90	8.63	3.24	6.93	3.40	6.65	0.18	734
1990-91	7.13	2.70	3.65	2.68	5.71	0.13	21.50
1991-92	3.03	1.95	2.81	1.33	2.65	0.15	30
1992-93	3.11	1.40	2.33	1.22	1.88	0.14	70
1993-94	2.48	0.97	1.86	1.14	2.20	0.12	198.75
1994-95	1.72	1.12	1.44	0.77	1.55	0.11	260.03
1995-96	1.53	0.85	1.52	0.85	1.38	0.11	230.25

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CONCLUSION AND SUGGESTION

While summarizing the whole strategies on conservation of genetic resources, it is concluded that there is tremendous genetic variability in *A. mylitta*. So in order to cater the demand of fashion accessories, furnishing and drapery, preservation of natural wealth and improvement of economically backward sections of the society the following action plans are suggested :

- ✓ Establishment of luxuriant Germplasm with diverse gene pool is required for crop improvement of *A. mylitta.*
- ✓ Improvement in the productivity through physiological, biochemical, genetical and biotechnological approach should be made.
- ✓ Research on synchronization of moth emergence and higher fecundity should be kept on priority by utilizing biotechnological tools.
- ✓ Studies on tasar silkworm genomics should be taken up in order to know the genetic repertoire and genes responsible for economic traits and tolerant for silkworm diseases.
- ✓ To arrest declining trend of ecoraces conservation programme should be taken up on priority basis. In this connection education on conservation of natural wealth along with utilization of tasar may be provided to tribal tasar zone areas through need based training programme.

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