VARIABILITY IN THE ECORACES OF TROPICAL TASAR SILKWORM *ANTHERAEA MYLITTA* DRURY.

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Tropical tasar silkworm, *Antheraea mylitta* Drury is exploited in country for commercial silk production and improved varieties of these silkworms can be evolved by employing various breeding techniques. As the insect has established itself in various forms of ecological populations (Commonly called as ecoraces) in different geographical niches of the country depending on food plants and micro-environmental conditions available to them, the species exists in the form of nearly 44 ecoraces (Singh and Srivastava,1997, Srivastava,2002 and Srivastava et at. 2007) distributed over different states. However, due to free interbreeding in nature for centuries, the fauna is highly heterogeneous.

Tasar culture is a forest based industry being practiced as tradition, since time immemorial by the tribal of Central India, extending from West Bengal in the East to Karnataka in South. The species *A. mylitta* D. is polyphagous in nature. The present study comprises the ecoraces of tropical tasar silkworm of *A. mylitta* D. These ecoraces are mainly restricted in the tropical moist deciduous forest area where the average rainfall varies between 1200-2000 mm and deciduous zone of the dry tropical forest area where the average rainfall has been observed to be about 1000 mm. The Primary food plants of the insects are *Terminalia tomentosa, Terminalia arjuna* and *Shorea robusta and* secondary food plants are *Terminalia chebula, T. bellerica, T. peniculata, Zizyphus jujuba* etc. The Phenotypic and genotypic variability is very much prominent. The present review paper comprises the extent and degree of natural variation in tropical tasar silkworm *A. mylitta* D.

ECORACES:

Exploratory surveys were conducted by Central Tasar Research and Training Institute, Ranchi (Jharkhand) from the year 1965 till date in 17 states viz. Himachal Pradesh, Nagaland, Assam, Meghalaya, West Bengal, Orissa, Jharkhand, Madhya Pradesh, Chhattishgarh, Andhra Pradesh, Maharashtra, Uttar Pradesh, Manipur, Jammu & Kashmir, Rajasthan, Karnataka, Kerala and one Union territory Dadar Nagar and Haveli reveals that there are 44 ecoraces/ biotypes/ morpho variants of *A. mylitta* (Singh and Srivastava, 1997 and Srivastava et al., 2002). The geographical distribution of all ecoraces is shown in figure -1. Observations indicated that range of distribution of *A. mylitta* is almost between 12 – 31^0 N latitude 72 – 96^0 E longitude. This wide range of variation in its genotype, further inter-breeding among different ecoraces in nature over centuries has led to high degree of heterozygosity in natural population of *A. mylitta*. The geographic range of population distribution is limited mainly in five types of soil viz. red loamy, sandy red, black clayey, laterite and forest hill. The details of distribution, forest type and ecological condition of all ecoraces are furnished in table -1.

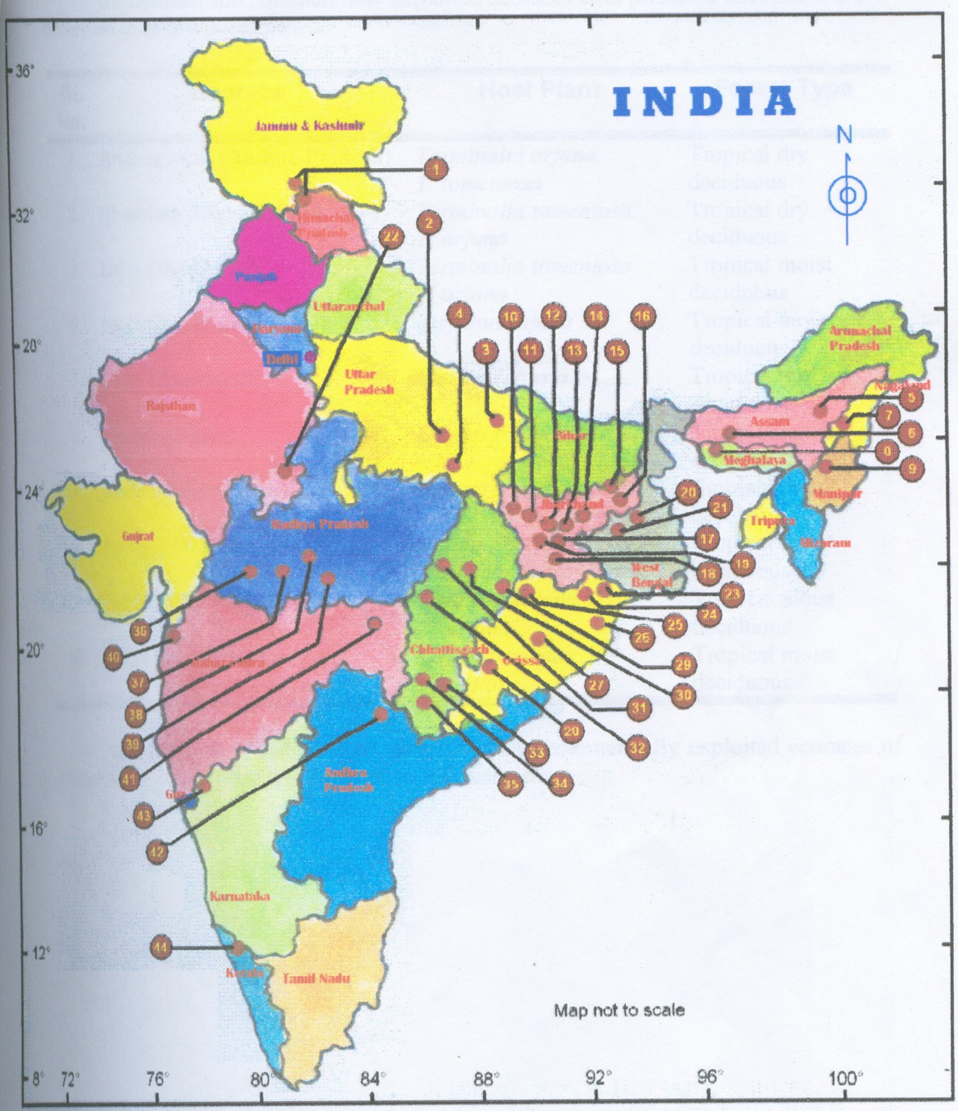

Fig. 1. Distribution of ecoraces of *Antheraea mylitta* Drury.

Figure 1:Distribution of ecoraces of *Antheraea mylitta* D.

Table 1: Diversity of *Antheraea mylitta* Drury in relation to distribution, soil type, food plant and forest type

Sl. No.	**Ecorace**	**Collection site**	**Predominant food plant**	**Soil** type	**Forest type**
1	Daba	Singhbhum (Jharkhand)	*Terminalia arjuna, T. tomentosa*	Red Loamy	Tropical moist deciduous
2	Sarihan	Santhal Pargana (Jharkhand)	*Terminalia arjuna, T. tomentosa*	Red Loamy	Tropical moist deciduous
3	Munga	Santhal Pargana (Jharkhand)	*Shorea robusta*	Red Loamy	Tropical moist deciduous
4	Modia	Dhanbad (Jharkhand)	*Shorea robusta*	Red Loamy	Tropical moist deciduous
5	Laria	Peterbar, Hazaribagh (Jharkhand)	*Shorea robusta*	Red Loamy	Tropical moist deciduous
6	Lodhma	Ranchi (Jharkhand)	*Shorea robusta*	Red Loamy	Tropical moist deciduous
7	Palma	Ranchi (Jharkhand)	*Shorea robusta*	Red Loamy	Tropical moist deciduous
8	Japla	Palamau (Jharkhand)	**Zizyphus Jujuba**	Red Loamy	Tropical moist deciduous
9	Kowa	Palamau (Jharkhand)	*Shorea robusta*	Red Loamy	Tropical moist deciduous
10	Barharwa	Simdega (Jharkhand)	*Shorea robusta*	Red Loamy	Tropical moist deciduous
11	Modal	Keonjhar (Orissa)	*Shorea robusta*	Red Loamy	Tropical moist deciduous
12	Nalia	Sundergarh (Orissa)	*Shorea robusta*	Red Loamy	Tropical moist deciduous
13	Sukinda	Sukindagarh (Orissa)	*Terminalia arjuna, T. tomentosa*	Red Loamy	Tropical moist deciduous
14	Boadh	Phulbani (Orissa)	*Terminalia arjuna, T. tomentosa*	Red Loamy	Tropical moist deciduous
15	Simlipal	Simlipal (Orissa)	*Shorea robusta*	Red Loamy	Tropical moist deciduous
16	Omarkote	Kalahandi (Orissa)	*Shorea robusta*	Red Loamy	Tropical moist deciduous
17	Sukly	Khairpal (Orissa) Beramkela (Madhya Pradesh)	*Shorearobusta Anogeissus latifolia*	Red Loamy	Tropical dry deciduous
18	Raily	Bastar (Madhya Pradesh)	*Shorea robusta*	Sandy red	Tropical dry deciduous
19	Kurudh	Kurudh (Madhya Pradesh)	*Terminalia tomentosa*	Red Loamy	Tropical moist deciduous
20	Multai	Multai (Madhya Pradesh)	*Terminalia arjuna, T. tomentosa*	Red Loamy	Tropical moist deciduous
21	Mandalla	Mandalla (M)	*Shorea robusta*	Red Loamy	Tropical moist deciduous
22	Jhabua	Jhabua (Madhya Pradesh)	*Shorea robusta*	Red Loamy	Tropical moist deciduous
23	Bhopal-patnam	Bhopalpatnam (Madhya Pradesh)	*Shorea robusta*	Sandy red	Tropical dry deciduous
24	Piprai	Piprai (Madhya Pradesh)	*Shorea robusta*	Red loamy	Tropical dry deciduous
25	Seoni	Seoni (Madhya	*Lagerstroemia*	Red loamy	Tropical dry

		Pradesh)	*parviflora*		deciduous
26	Janghbhir	Bastar (Madhya Pradesh)	*Shorea robusta*	Sandy red	Tropical dry deciduous
27	Korbi	Korba (Madhya Pradesh)	*Shorea robusta Terminalia sps.*	Red loamy	Tropical dry deciduous
28	Tira	Purulia (West Bengal)	*Lagerstroemia parviflora, L. speciosa*	Red loamy	Tropical dry deciduous
29	Bankura	Bankura (West Bengal)	*Lagerstroemia parviflora*	Red loamy	Tropical dry deciduous
30	Dadar Nagar Haveli	Dadar & Nagar Haveli (Union Territory)	*Terminalia crenulata*	Black clay	Tropical dry deciduous
31	Shiwalika	Batote (J&K) Palampur (H. P.)	*Zizyphus jujuba*	Forest hill & Alluvial	Mountain sub-tropical
32	Bhandara	Bhandara (Maharashtra)	*Terminalia arjuna, T. tomentosa*	Black clay	Tropical dry deciduous
33	Andhra local	Adilabad, Marimnagar (Andhra Pradesh)	*Terminalia arjuna, T. tomentosa*	Black clay	Tropical dry deciduous
34	Monga	Deoria (Uttar Pradesh)	*Terminalia arjuna, T. Tomentosa, Zizyphus jujuba*	Red loamy	Tropical dry deciduous
35	Mirzapur	Mirzapur (Uttar Pradesh)	*Zizyphus jujuba*	Red loamy	Tropical dry deciduous
36	Sultanpur	Sultanpur (Uttar Pradesh)	*Terminalia arjuna, T. tomentosa*	Red loamy	Tropical dry deciduous
37	Tesera	Sahabad (Rajasthan)	*Zizyphus jujuba*	Red loamy	Thorn Forest
38	Nowgong	Nowgong (Assam)	*Zizyphus jujuba*	Red loamy	Tropical wet ever green
39	NE1, 95	Boko (Assam)	*Zizyphus jujuba, Careya aroborea*	Red loamy	Tropical wet ever green
40	NE2, 95	Mendipathar, Resubelpara (Meghalaya)	*Zizyphus jujuba, Careya aroborea*	Laterite	Tropical wet ever green
41	Jiribam	Jiribam (Manipur)	*Zizyphus jujuba*	Red loamy	Tropical wet ever green
42	NG, 94	Dimapur (Nagaland)	*Zizyphus jujuba*	Red loamy	Tropical wet ever green
43	Belgaum	Belgaum (Karnataka)	*Hardwickia binata*	Laterite	Tropical wet ever green
44	KE_{02}	Moorkan- Paramba (Kerala)	*Ancardium occidentale*	Laterite	Tropical moist ever green

The premilinary studies on the variations on economically important characters reveals that cocoon weight is highly variable from race to race and within a single race. However, Modal cocoons are superior in shell weight, cocoon weight. The details of commercial characters of some important ecoraces are given in table-2 .In technological quality no ecorace is simultaneously good for reelability, denier, silk recovery. Andhra local shows the best performance so far as reelability but it is a poor yielder. Modal is the highest silk yielder but it produce coarse and heavier filament.

Table 2: Commercial characters of some important ecoraces of *A. mylitta* D.

Sl.	Ecorace	Fecundity	Cocoon	Cocoon	Shell	Silk	Filamen	Denier

No.		(Av.)	Volume (cc)	Weight (g)	Weight (g)	Ratio (%)	t Length (m)	
1	Daba	250.00	32.31	12.10	2.80	12.64	750	12
2	Sarihan	201.35	14.32	9.75	1.88	19.28	785	10
3	Munga	185.00	13.00	6.86	0.84	12.97	550	10
4	Modia	190.00	12.39	15.29	3.17	20.32	1234	12
5	Laria	215.00	17.34	9.75	1.88	19.28	785	10
6	Barharwa	166.50	27.40	13.76	3.01	21.27	1234	12
7	Modal	249.00	31.35	14.17	3.64	25.68	1383	12
8	Nalia	182.00	25.58	11.68	2.57	22.00	1201	12
9	Sukinda	266.00	27.00	13.00	1.80	13.58	845	10
10	Raily	280.00	30.36	12.77	2.66	20.83	1232	13
11	Bhandara	195.00	12.09	6.93	1.24	17.89	613	9
12	Andhra local	119.30	21.00	9.45	1.57	16.61	700	10
13	Moonga	185.00	13.00	6.86	0.84	12.97	550	10
14	Mirzapur	175.00	20.00	8.14	1.64	20.14	800	11

Boichemical characterization :

Variaabilities at biochemical level was studied through Gel electrophoresis method for some of the important ecoraces of *A. mylitta* D. A total of 26 bands have been reported, out of which band no. 3,6,17, 20 and 24 were common to all. Band No. 23 has present in Palma and 25 was present in Raily only. Daba and Sukinda had similarly band nos. 8,12, 17, 18 and 24. Bands Nos. 2, 14 , 19, 22 and 26 were present in Sukinda but absent in Daba (Annual report – 87-88).

Biochemical variability in Macromolecular compenents:

The economically important ecoraces viz. Daba, Sukinda, Sarihan, Laria, Raily, Modal, Bhandra, and Andhra local collected from their naturat habitat and were maintained in the germplasm bank of Central Tasar Research and Training Institute, Nagri, Ranchi. Boichemical variation with regard to macromolecular components such as proteins, trehalose, lipids, total carbohydrate, citrate, RNA and DNA and enzymes- acetlcholine, acetycholinesterase, amylase and aminotranfersae of these ecoraces were studied time to time at this institute.

Variability in total proteins

Proteins contents in female ranged from 97.20 ± 8.5 (Sukinda) to 145.00 ± 5.14 (Raily) mg/ ml and in male this was from 62.00 ± 5.63 to 103 ± 2.65. According to the Critical Difference (CD) the ecoraces came under three groups. Female pupae invariably contain higher protein content than male counterparts. The protein content in males of Laria, Daba, Sarihan and Raily were identical while in Sukinda was different from Modal and Bhandra. In females, Daba was different from Sukinda, Bhandra, Modal, Laria, Raily and Sarihan (Kar *et al*., 1994).

Variability in lipids

Sinha *et al.* (1994) studied lipid content in pupal haemolyrnph of Daba, Modal, Raily, Laria, Sukinda, Bhandara and Sarihan. In both the sexes four groups were formed based on CD value. In males there was no significant difference between Daba and Modal; Modal and Raily; Laira, Sukinda and Bhandara and Sukinda, Bhandara and Sarihan. Similarly amongst females no significant difference was observed between Daba and Modal; Laria, Raily and Sukinda; Laria, Sukinda and Bhandara and Sukinda,.Bhandara and Sarihan.

Studies made on lipid concentration of cocoon shells of the same ecoraces of *A .mylitta*, Sinha *et al* (1993) observed that intra-racial variation in lipid content was very low in all races studied. The lipids contents in males of Laria and Modal and that of Sarihan and Bhandara was on par. Similarly in the case of females, the values of Raily and Daba and those of Modal and Laria were on par. Thus seven races form five distinct groups in both the sexes in the variability of lipid contents.

Variability in trehalose

The average trehalose concentration (mg/ml) in the pupal haemolymph ranged from 4.426 ± 0.249 (Sarihan) to 6.359 ± 0.677 (Modal) in male and 8.015 ± 0.539 to 11.636 ± 0.323 in females. The variabilities recorded were quite high and significant ($p< 0.01$) with CD of 1.4 (male) and 1.3 (female). For the storage of carbohydrate trehalose in the pupal haemolymph. Srivastava *el al* (1993) found that Sukinda, Laria nnd Modal were in the same order differing from Raily and also from Daba.

Variability in carbohydrate

While variations in carbohydrate contents in the larval ha,molymph of nine ecoraces,Sinha e*t al* (1997) observed that during each instar of the larva carbohydrate contents are significantly higher in ecorace Daba in comparison to other eight ecoraces. Bhandara, Raily, Simlipal and Modal behave equally and are under second group in decreasing order or contents of carbohydrate. Laria, Lodhma and Sukinda are placed in third group and Sarihan had lowest carbohydrate contents among the ecoraces under study.

Variability in citrate concentration

Srivastava *et al.* (1995) assayed pupal haemolymph citrate concentration among seven ecoraces and observed very high and significant variation in both the sexes. Daba and Modal were having the highest citrate concentration followed by second group comprising of Raily, Laria and Sukinda. The third group i.e. Silrihan and Bhandara had minimum citrate content.

Variability in gonadal proteins, DNA and RNA

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Variation in gonadal proteins, DNA and RNA were studied by Kar. e*t al*

(1999). The total proteins, DNA and RNA contents had increasing trend in all five ecoraces as assayed in 2nd, 7th and 12th day of V instar larva in both testis and ovary. The protein content in ovary was significantly more than testis (P< O.OI) The testicular protein content was highest in Modal (2.444, 4.540 and 9.656 mg/l00 ml tissue) and lowest in Sarihan (l.786, 3.760 and 8.382 mg /100 ml tissue) in 2nd , 7th and 12th days. The trend was identical for ovarian protein too (Modal 4.650, 8.648 and 17.056 and Sarihan 3.376, 7.102 and 15.448 mg/100 ml tissue), Inter-racial variation for protein content was also significant. Testicular DNA and RNA content also expressed similar trend over days -2, 7 and 12 of V instal' larvae. Highest DNA and RNA content were in Modal and lowest in Sarihan.

Biochemical Variability in Enzymes

Significant variation in alanine aminotransferase or glutamic pyruvate transaminase ((GPT) and aspartate aminotransferase or glutamic oxaloacetic transferase (GOT) activities in the gut wall preparation of V stage larvae of seven ecoraces of *A. mylitta* were studied by Sinha *el al.* (1996). GPT activity was found to be more than that of GOT and female of all the races showed higher activities than males for both the enzymes. The descending order of ecoraces for those two enzymes were found to be Sukinda > Raily > Modal > Sarihan > Bhandara > Laria and Sarihan.

Variability in acetylcholine and acetyl cholinesterase

Srivastava et al. (1994) recorded very high and significant variations for the diapausing pupal head acetylcholine content and acelylcholinesterase activity among nine ecoraces of A. mylitta in both the sexes. Males invariably showed higher values for both the biochemical parameters than their female counterpart. According to CD value the races were grouped in five groups. Acetylcholine content was higher in Daba and Modal followed by Sukinda. The ecoraces Laria, Sarihan and Andhra local and Bhandara were grouped in third group. Raily occupied a separate position having the lowest acetylcholine content and acetylcholinesterase activity.

Variability in amylase activity

Amylase activity was studied in non-diapausing V instar larva in the gut wall and muscle of the five ecoraces both in males and females by Kar *et al*. (1999) and Modal occupied the first group differing from Daba which again different from Sarihan and Bhandara. The latter two ecoraces consisted the last group with lowest amylase activity *(Kar et al., 1996).*

Cytological studies:

Cytological studies revealed that the chromosome nos. remained constant in all the ecoraces i.e. n = 31 (Sinha et al., 1992 a). However, variability at cytological level has been reported by Gaur (1986), Sinha *et al*. (1992) among different ecoraces with respect to chiasma frequency. Gaur (1986) has also reported variation on the basis of occurence of β- chromosome.

Genetic variability :

It is well established that the difference between geographic races have genetic basis.This particular difference in each population is related with their adaption to different ecological conditions. Ecological factors influence genetic variability. This is very well reflected from the studies on biological quantitative and behavioural characters of different ecoraces of *A. mylitta* D.(Table -2)

The ecoraces are found to differ from each others for various biological characters such as fecundity, larval weight and several commercial characters viz. Cocoon weight, Shell weight, though there is uniformity among the ecoraces for breeding period .The shorea based faces exhibit always higher shell weight and compactness as compared to Terminalia based varities. Most of the ecoraces are polyphagous. Therefore, these insects have different survival ability on different food plants in different seasons.

Voltinism pattern in *A. mylitta* was obsreved to be in three categories such as uni, bi and trivoltine. Voltinism is largely guided by the year cycle of day length and temperature . Humidity helps in triggering moth emergence and avoiding pupal mortality due to desiccation.

Colour Polymorphism:

In nature four colours of larvae viz. Green, Blue, Yellow and Almond are found. Out of these green is wild and Blue, Yellow and Almond are mutants . Two cocoon's colours viz. Yellow and Grey are usually observed in nature.

Conclusion:

It becomes evident from the above details that there is a tremendous phenotypic as well as genetic variability among the ecoraces of tropical tasar silkworm *A. mylitta* D. On the study of biochemical parameter of *A. mylitta* indicates that the ecoraces Raily and Daba differ from each other. The ecoraces Bhandra, Sarihan and Andhra local differ from Daba in biochemical constituents.

The polyphagous nature of ecoraces of *A. mylitta* and choice of apporiate food plants by them, appear to have a major genetic component sensitive to such selective pressure as host phenology and community composition both of which may have considerable regional variation.

The nature and magnitude of gene effects, helps in determining the most efficient breeding programme. The traditional system of developing hybrid varities exploits primarily the non- additive component consequently it will be desirable to use a breeding procedure that would exploit additive component in addition to utilize the non- additive gene effects. Thus, a type of population breeding approach which would maintain a high level of heterozygosity would be the most desirable. It seems that recurrent selection is the most appropriate scheme. Since it maintatin a high level of heterozygosity due to intercrossing of selects consequently provides an opportunity for new recombinants and breaking of undesirable linkage blocks besides accumulating the favourable additive genes.

Presently, Daba and Sukinda are only commerciallly exploitted ecoraces for tasar culture. The other ecoraces having high economical characters of cocoons can be exploitted on commercial level by improving through conventional as well as modern methods of breeding. The breeding programme can be facilitated through molecular marker technique to produce varities with desirable characters which is the need of the hour.

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