CHARACTERIZATION AND REJUVENATION OF LOCAL ECORACE SUKINDA IN ODHISA STATE

Alok Sahay, Subrat Satpathy* and S.K. Sharan,

Regional Tasar Research Station, Ministry of Textiles, Govt of India, Palbani,
Baripada-757 001, Odhisa.

*Working at Research Extension Center, Bangripasi

Tropical tasar flora and fauna are abundantly distributed in the peninsular forest of Central India boarded by major rivers viz Ganga in the North, Godavari in the South, Mahanadi in the East and Wainganga in the west. Owing to the wide range of dispersal of silkworm, *Antheraea mylitta* D. in India, the species have encountered varied geographical conditions and have formed ecological populations (ecoraces) in varied geography, topography, ecology, food plant flora and frequency of life cycle of the silk moths in latitudinal and altitudinal gradients. These ecoraces exhibit diversity in phenotypic behavior, physio-genetic and commercial characters. These variations are genetic treasure, the conservation, maintenance and protection of which are most important for their qualitative and quantitative improvement as a whole.

Fig-1 Map of Orissa showing tasar culture area.

The forty four ecoraces of *Antheraea mylitta* (Srivastava et al., 2002, 2003, 2004; Suryanarayana and Srivastava, 2005; Thangavelu et al., 2002) have been identified through survey, collection and exploration in different states of tropical India.

These ecoraces breed better and maintain their physical and genetic characters in their natural habitat, the forest. An ecorace, collected from Kunda, Ankurapal, Sukaran and Kans area of Sukindagarh (85.62°N and 20.88°E) of Jajpur district of Orissa, known as Sukinda ecorace was introduced to other areas by the state Department of Sericulture and was commercially cultivated during 1970s. The race being trivoltine was suitable for warmer climates, cocoons were predominately yellow with Silk Ratio ranging between 10.5 to 13.1% in different seasons and fared well in semi-domesticated conditions. It had also advantages over the wild tasar races in low pupal mortality during preservation, higher coupling and cocoon:dfi ratio and less deterioration of economic characters in progenies.

Fig-2 Sukinda Cocoons are ready to be harvested.

An experiment of outdoor rearing was conducted with the available Sukinda (TV) stock of BSM&TC, Sundargarh (SG), CTSSS, Lakha (CTS) and CTR&TI, Ranchi. The objective of this activity is to utilize economic wild life, conserving the associated environment for sustainable rural and tribal development (Raffi and Ramanujam, 2001; Gill and Lal, 2002; Mahapatra, 2009).

The crop performance of SG showed highest cocoon yield i.e., 83 cocoons / dfl in 1st crop followed by 80 cocoons / dfl in 3rd crop and 42 cocoons / dfl during 2nd crop. Yellow coloured cocoons dominated (94-96%) the population in all the three crops. The cocoon weight, Shell weight and Silk Ratio were (9.72g, 1.07g & 11 %) in 1st crop, (9.77g, 1.05g & 10.75%) in 2nd crop and (11.11g, 1.79g & 16.11%) in commercial third crop season. The ERR were 41.64 %, 50.00 % and 74.51% in 1st, 2nd and 3rd crop respectively. This approach for semi-domesticated and commercially exploited Sukinda ecoraces can further enhance their potential because of better inherent performance levels under *in situ* (Suryanarayana and Srivastava, 2005) over the current basic and commercial stocks maintained *ex situ*.

Isolation of different lines/groups of Sukinda

Sukinda TV cocoons of SG lot harvested from third crop were grouped into four groups/lines on the basis of cocoon colour and weight for assessing the preservation behavior of the harvested cocoons viz. **SG-1** (yellow cocoons with cocoon weight > 12 g), **SG - 2** (yellow cocoons with cocoon weight 10-12 g), **SG - 3** (yellow cocoons with cocoon weight<10 g) and **SG** (grey colour cocoons).

Preservation Behavior

The preservation behavior was studied for all the four groups in during January-May (Summer). Erratic moth emergence was recorded regularly and the stock was finally screened to assess pupal mortality. The preservation loss details are presented in Table-1(a) & 1(b).

Table-1(a): Preservation behaviour of different lines of Sukinda TV

Particulars	Yellow			SG
	SG-1	SG-2	SG-3	
No. of cocoons preserved for study	788 05(0.63)	684 45(6.57)	1602 73(4.55)	157 07(4.45)
No of male moths emerged (Erratic)	69(8.75)	60(8.77)	22(1.37)	05(3.18)
No. of female moths emerged (Err.)	74(9.39)	105(15.35)	95(5.93)	12(7.64)
Total moths emerged (Erratic)	08(1.01)	22(3.21)	71(4.43)	04(2.50)
Dead cocoons sorted out	10.4	18.56	10.36	10.19
Total preservation loss (%)				

Table-2(b): Summer Preservation behaviour of different lines of Sukinda TV

Particulars	Preservation loss		
	SG-1	SG-2	SG-3
Cocoons preserved for study	3856	3732	3774
No. of male moths emerged(Erratic)	180(4.66)	186(4.98)	372(9.85)
No. of female moths emerged(Erratic)	141(3.66)	215(5.76)	205(5.43)
Total moths emerged (Erratic)	321(8.32)	401(10.74)	577(15.28)
Dead cocoons sorted out	80(2.07)	84(2.25)	165(4.37)
Total Preservation loss No. (%)	401(10.39)	485(13.00)	685(18.15)
Seed cocoons left for 1 st Grainage, 06	3455(89.61)	3247(87.00)	3089(81.85)

*Figures in parenthesis indicate percentage

It was observed that preservation loss ranged between 10.19 % in SG to 18.56 % in SG-2. SG-1 showed preservation loss of 10.4% while in SG-3 the preservation loss was

10.36 % where as the final preservation loss was lowest 10.39 % in SG-1, followed by 13.0% in SG-2 and 18.85 % in SG-3 group.

Grainage Behaviour of the preserved cocoons was also studied by conducting different grainages the results are presented in the table 2.

Table-2: Grainage behaviour of different lines of Sukinda TV in 1st Crop.

Particulars	Yellow			Grey
	SG-1	SG-2	SG-3	SG
Cocoons processed for study	706	557	1436	141
Male moths emerged	101 (14.30)	241(43.26)	1080(75.20)	78(55.31)
Female moths emerged	596(84.56)	314(56.37)	348(23.23)	56(39.70)
Total moths emerged	697(98.72)	555(99.64)	1428(99.44)	134(95.03)
Pairings obtained	87(86.13)*	245(78.02)	145(41.66)	29(51.78)
Poor fecundity	18(20.68)	58(23.67)	41(28.27)	05(17.24)
Pebrine %	15.94	14.97	16.34	8.33
Cocoon /dfl ratio	13 : 1	4 : 1	17 : 1	6 : 1
Av. Fecundity	240	197	178	191
Date of initiation of grainage	24.06.05	23.06.05	23.06.05	27.06.05
Date of completion of grainage	14.07.05	14.07.05	14.07.05	13.07.05
Duration of grainage (days)	21	22	22	17

*Figures in parenthesis indicate percentage.

A perusal of the data presented in the table indicated that during grainage highest self coupling (86.13 %) was recorded in SG-1 followed by 78.02% in SG-2, 41.66% in SG-3 and 51.78 % in SG. The fecundity ranged from 173-301 in SG-1, 132 – 261 in SG- 2, 122 –197 in SG-3 and 168-201 in SG. The SG-2 lot showed better cocoon dfls ratio of 3.5: 1.

Second crop Grainage was carried out with 3000 seed cocoons (yellow coloured) of each group viz. SG-1, SG-2, SG-3 and 300 Grey cocoons (SG). The grainage performance is presented in table-3.

Table-3: Grainage performance study of different lines of Sukinda TV in second crop

Sl. No	Parameters	SG-1	SG-2	SG-3	SG
1	Number of cocoons processed	3000	3000	3000	300
2	Date of Grainage initiation	25.8.05	25.8.05	25.8.05	26.8.05
3	Emergence Details : Male	1771(59.03)	1737(57.9)	1597(53.23)	178(59.33)
4	Female	1222(40.730)	1242(41.4)	1356(45.2)	107(35.36)
5	Total	2993(99.76)	2979(99.3)	2953(98.43)	285(95.00)
6	Couplings obtained	812(66.44)	691(55.63)	761(56.12)	45(42.05)
7	Poor fecundity	54(6.65)	72(10.42)	156(20.4)	09(20.0)
8	Moths examined	50	50	52	26

9	Pebrine	Nil	Nil	3.84	3.84
10	Number of dfls obtained	50	50	50	25
11	Average fecundity	242	215	213	203
12	Cocoon : Laying Ratio	3.69:1	4.34:1	4.95:1	6.15:1
13	Dead cocoons sorted out	07(0.23)	21(0.7)	47(1.5)	15(5.0)
14	Duration of grainage (days)	12	12	12	7

The grainage data indicated highest coupling in SG-1 (66.44%) compared to 55.63 % in SG-2, 56.12 % in SG- 3 and 42. 05 % in SG line. The cocoon-laying ratio was found most effective in SG-1 (3.69: 1) followed by SG – 2 (4.34: 1), SG-3 (4.95: 1), and SG (6.15: 1). Highest average fecundity (242) was recorded in SG-1.While in other lines the fecundity was 215 in SG-2, 212 in SG-3 and 203 in SG group. No pebrine were found in SG-1 and SG-2 lot.

Table-4: Grainage performance of different lines of Sukinda TV in Third Crop

No	Parameters	SG-1	SG-2	SG-3	SG
1	Number of cocoons processed	842	755	1155	176
2	Date of Grainage initiation	23.10.05	23.10.05	23.10.05	24.10.05
3	Emergence Details : Male	499(59.26)	454(60.13)	748(64.76)	104(59.09)
4	Female	336(39.90)	294(38.94)	366(31.68)	71(40.34)
5	Total	835(99.16)	748(99.07)	1114(96.44)	175(99.43)
6	Couplings obtained	268(79.76)	198(67.34)	293(80.05)	32(45.07)
7	Poor fecundity	22(8.20)	24(12.12)	52(17.74)	07(21.87)
8	Moths examined	50	51	53	Nil
9	Pebrine	Nil	01(1.96)	03(5.66)	--
10	Number of dfls obtained	50	50	50	--
11	Average fecundity	211	199	195	183
12	Cocoon: Laying Ratio	3.14:1	3.81:1	3.94:1	5.5:1
13	Dead cocoons sorted out	07(0.83)	04(0.53)	23(1.99)	Nil
14	Date of completion of Gr.	31.10.05	31.10.05	2.11.05	30.10.05
15	Duration of grainage (Days)	09	09	11	07
16	Cocoons remained unemerged	Nil	03	18	01

During the said grainage highest coupling (80.00 %) was recorded both in SG-1 and SG-3 followed by 67.34% in SG-2, 45.07% in SG. The fecundity ranged from 191 – 232 in SG-1,

175 – 218 in SG- 2, 166 –212 in SG-3 and 152-201 in SG. The SG-1 lot showed better cocoon-laying ratio of 3.14: 1.

It was further observed that the dfl recovery in all grainages was at par with the ruling race Daba TV.

After conducting grainage the rearing experiments with the dfls procured were also performed and the rearing behavior of the different lines was observed which are presented in the table 5.

Table-5: Rearing Performance of different lines of Sukinda TV in First crop

Sl. No	Parameters	SG - 1	SG – 2	SG - 3	SG
1	No. of dfls brushed	50	50	50	10
2	Date of brushing	16.07.05	15.07.05	14.07.05	12.07.05
3	Average fecundity	270	192	189	171
4	Hatching percentage	82.25	84.00	80.00	81.00
5	Larval weight (g)	32.85	32.13	30.98	31.00
6	Date of spinning	07.08.05	07.08.05	07.08.05	07.08.05
7	Larval duration (days)	23	24	24	27
8	Cocoons harvested	4584	4105	4080	728
	Yellow(%)	4461(97.32)	3947(96.15)	3834(93.98)	277(38.05)
	Grey (%)	123(2.68)	158(3.85)	246(6.02)	451(61.95)
9	Cocoons/dfl	92.0	82.0	82.0	73.0
10	ERR (%)	41.00	51.00	54.00	53.00
11	Cocoon wt. (g)	10.12	9.61	9.27	9.27
12	Shell wt. (g)	1.08	1.03	0.90	1.02
13	S R (%)	10.67	10.71	9.70	11.01
REELING PERFORMANCE					
1	Filament length (m)	454	525	573	---
2	Non-breakable Filament Length (m)	194	292	370	---
3	Filament Wt. (g)	0.542	0.615	0.649	---
4	Filament Denier	10.74	10.55	10.18	---
5	Raw Silk %	60.03	65.20	65.85	---
6	Waste %	38.62	34.79	34.14	---
7	Reelability %	67.85	67.36	66.43	---

The rearing performance of above 4 groups/lines indicated that SG-1 performed better with a yield of 92 cocoons/dfl with lesser colour segregation (yellow: grey: 97.3: 2.7), higher cocoon wt.10.12 g, shell wt. 1.08g. While SG-2 yielded 82 cocoons/dfl with(yellow: grey:: 96.2: 3.8), with average cocoon wt. of 9.6 g, shell wt.1.03 g. Similarly SG-3 yielded 82 cocoons/dfl (yellow: grey:: 93.4: 6.6), with average cocoon wt. 9.27g, shell wt. 0.90g and SG yielded 73 cocoons/dfl(grey : yellow 61.9: 38.1), with average cocoon wt.of 9.26 g, shell wt. 1.02 g.

Second crop: Fifty dfls each of SG-1, SG-2, SG-3 and 25 dfls of SG were brushed for further study. The performance details are as in table-6 below.

Table-6: Rearing performance of different lines of Sukinda TV in Second Crop, 2005

Sl.	Particulars	SG -1	SG - 2	SG - 3	SG
1	No. of dfls brushed	50	50	50	25
2	Date of brushing	05/06.9.05	05/06.9.05	05/06.9.05	05/07.9.05
3	Average fecundity	242	221	217	203
4	Hatching percentage	85.0	83.0	85.15	81.0
5	Larval weight (g)	27.65	26.3	25.9	26.0
6	Date of spinning	27.9.05	28.9.05	28.9.05	28.9.05
7	Larval duration (days)	23	24	24	24
8	Cocoons harvested	856	768	1194	235
	Yellow (%)	842(98.36)	755(98.30)	1155(96.73)	59(25.10)
	Grey (%)	14(1.64)	13(1.7)	39(3.27)	176(74.90)
9	Cocoons/dfl	17	15	24	09
10	ERR (%)	8.32	8.37	13.0	6.0
11	Cocoon wt. (g)	9.69	9.58	10.11	10.32
12	Shell wt. (g)	1.03	0.97	0.98	1.04
13	S R (%)	10.63	10.12	9.69	10.07

The rearing performance of above 4 groups/lines indicated that SG-3 gave better result only in respect of yield (24 cocoons/dfl) and cocoon wt.(10.11 g), but showed higher colour segregation (yellow: grey: 96.73:3. 27), lower shell wt. (0.98g.) resulting least SR 9.69%. TheSG-1 group yielded 17 with lesser cocoon segregation (yellow: grey:: 98.36: 1.64), with average cocoon wt. of 9.69 g, shell wt.1.03 g and highest SR 10.63%. Similarly SG-2 yielded 15 cocoons/dfl (yellow: grey:: 98.30: 1.7), with average cocoon wt. 9.58g, shell wt. 0.97g and SG yielded 09 cocoons/dfl(grey : yellow 74.9: 25.10), with average cocoon wt.of 10.32 g, shell wt. 1.04 g.

Third crop: The SG line was discontinued in this crop due to its consistent higher cocoon colour segregation. Fifty dfls each of SG-1, SG-2and SG-3 were reared in this season for performance assessment basing on which a pure line would be selected for re-introduction in the State. The rearing performance is depicted in table-7.

Table-7: Rearing Performance of different lines of Sukinda TV in Third crop

Sl.	Particulars	SG -1	SG - 2	SG - 3
1	No. of dfls brushed	50	50	50
2	Date of brushing	27.10.05	27.10.05	26-27.10.05
3	Average fecundity	206	175	208
4	Hatching percentage	88.33	79.50	72.25
5	Larval weight (g)	32.10	30.65	31.00
6	Date of spinning	16.12.05	16.12.05	16.12.05
7	Larval duration (days)	42	42	42
8	Cocoons harvested	4250	4100	4150
	Yellow (%)	97.79	98.34	98.16
	Grey (%)	2.21	1.66	1.84
9	Cocoons/dfl	85	82	83
10	ERR (%)	46.71	58.94	55.23

11	Cocoon wt. (g)	11.43	10.24	11.15
12	Shell wt. (g)	1.52	1.46	1.54
13	S R (%)	13.29	14.25	13.81
REELING PERFORMANCE				
1	Filament length (m)	711	724	749
2	Non-breakable Filament Length (m)	474	499	326
3	Filament Wt. (g)	0.90	0.88	0.95
4	Filament Denier	11.40	10.99	11.45
5	Raw Silk %	64.51	62.22	64.26
6	Waste %	35.49	37.78	37.74
7	Reelability %	76.38	71.76	70.59
8	Softening %	98.0	96.0	97.0

The perusal of data indicates that the SG-1 showed better yield of 85 cocoons/dfi followed by 83 cocoons/dfi in SG-3 and 82 cocoons/dfi in SG-2 in this crop. All the lines showed more or less same cocoon colour segregation (yellow: grey: 98: 2). However the ERR (59%) and SR (14.25%) are found to be better in SG-2 group followed by ERR (55%), SR (13.81%) in SG-3 group and ERR (48%), SR (13.29%) in SG-1.

From the observations made above, it seems that the complimentary parameters noted are closure to each other for all the three lines/groups in this crop and there is no significant difference in their performances. As such selection of a pure line out of the above three groups at this stage is not feasible. However 3856 cocoons of SG-1, 3732 cocoons of SG-2 and 3774 cocoons of SG-3 group were preserved and pure line selection efforts were done in subsequent years.

In all three lines yellow cocoons dominated (>99%) the population confirmed the race character. Thus all the three groups were pooled together as a rejuvenated race and the cocoons harvested from the 3rd Crop were preserved for production of basic seeds of the race for further utilization.

Multilocal trial of the isolated line(s) at Mayurbhanj, Dhenkanal at farm and farmers' level.

Multilocal trial rearing of 1065 dfis of the Rejuvenated Sukinda TV was conducted in the 3rd crop under four TRCS levels, including in its *in situ* conditions (Sukindagarh, the natural abode of the race) and BSM & TC, Baripada. The performance of the rejuvenated Sukinda TV under Multilocal trial at farmers' level is shown in the table-8 below.

Table-8: Rearing performance of Sukinda TV under Multilocational trial at different zones in 3rd crop

Particulars	Sukindagar h Jajpur Dist.	Chandua, Mayurbhanj Dist.	Niagiri Balasore Dist.	Kuliana, Mayurbhanj Dist.	BSM&TC, Baripada	RTRS ,Baripada
No. of dfls brushed	275	175	295	220	100	150
Date of brushing	13.10.06 20.10.06	14.10.06 16.10.06	9.10.06 11.10.06	9.10.06 12.10.06	18.10.06	12.10.06
Av. Fecundity	200	201	190	201	193	201
Hatching percentage	80.0	83.0	83.0	85.0	90.0	86.33
Larval wt.(g)	40.6	38.75	40.0	37.0	36.0	41.41
Date of spinning	12.11.06	Crop failed	18.11.06	8.11.06	17.11.06	9.11.06
Larval duration(days)	31		41	30	30	29
Cocoons harvested	8880		13865	9580	6500	10300
Yellow (%)	99.00		99.00	99.32	98.00	99.33
Grey(%)	1.00		1.00	0.68	2.00	0.67
Cocoon / dfl	32		47	44	65	69
ERR%	20.18		30.00	25.40	37.42	40.00
Cocoon wt.(g)	11.94		11.98	11.90	11.19	12.60
Shell wt.(g)	1.95		1.87	1.90	1.80	2.07
S R %	16.33		15.61	15.97	16.08	16.43

Perusal of the data indicates highest yield of 65 cocoons /dfl was recorded at BSM&TC, Baripada while rearing at one location namely Chandua failed. Cocoon yield in other three locations ranged from 32 to 47 cocoons /dfl . The silk ratio varied from 15.61% to 16.33 % and the commercial characters were at par at all the places . A rearing with 150 dfls of STV, conducted at RTRS, during the said crop yielded an average of 69 cocoons / dfls with silk ratio of 16.43 %.

Preservation, Grainage and Supply of Rejuvenated Sukinda(TV) basic seeds to state department and BSM&TCs for multiplication and further commercial exploitation

A total of 16081 rejuvenated Sukinda (TV) cocoons harvested in 3rd crop were preserved to supply the rejuvenated Sukinda TV basic seeds to the state TRCSs and BSM &TCs for multiplication and further commercial exploitation in Orissa. Erratic moth emergence was regularly recorded during the period from January to May. The preservation loss details is given in table-9. It was observed that the total preservation loss was 7.63% only

Table-9: PRESERVATION LOSS DETAILS OF REJUVENATED SUKINDA (TV)

Particulars	Values
Cocoons preserved	16081
Male moths emerged	325(2.02)
Female moths emerged	245(1.52)
Total erratic emergence	570(3.54)
Total preservation loss	658(4.09)
Dead cocoons sorted out	1228(7.63)
Seed cocoons left for 1 st Grainage'2007	14853

Figures in parenthesis indicate percentage.

Grainage of the pure line of Sukinda TV in First Crop

The **First crop grainage** was carried out with 14853 cocoons of Sukinda TV. The grainage detail is presented in table-10.

Table-10: Grainage performance of Rejuvenated Sukinda TV in 1st Crop.

Particulars	Values
No. of cocoons processed	14853
Emergence details:Male	9010(61.0)
Female	5760(39.0)
Total	14,770()
Pairings obtained	5001(86.82)
Rejection due to poor fecundity	141(2.82)
Moths examined	4860
Rejected due to pebrine	Nil
No. of Dfls obtained	4860
Average fecundity	211
Cocoons dfl Ratio	3:1
Duration of Grainage(Days)	29
Cocoons remained unemerged	83()
Dfls supplied	4560
Dfls utilized for own rearing	300

First grainage indicated hundred percent moth emergence with 61% male and 39 % female. A total no. of 4860 dfls was prepared @ 3:1 cocoon dfl ratio. There was no trace of pebrine. The fecundity ranged between 187 to 238.However the grainage duration prolonged up to 29 days due to erratic rainfall.

Supply of rejuvenated Sukinda (TV) basic seed to state TRCSs and BSM&TCs for multiplication and further commercial exploitation.

A total of 4560 rejuvenated Sukinda (TV) dfls were supplied as per following details for popularization of the rejuvenated ecorace.

Sl. No.	Name of the recipient	No.of dfls supplied
1	RTRS, Warrangal (A.P.)	330
2	REC, Purulia (W.B.)	280
3	REC, Bangriposi, Orissa	400
4	PPC, Mangalpur,Sukinda Garh, Dist.Jajpur,Orissa	1000
5	Asst.Director (Seri.), Keonjhar,Orissa	1000
6	Asstt. Director(seri.),Mayurbhanj,Orissa.(Chandua, Kuliana and Nilagiri TRCSs)	1550
	Total:	4560

With this experiment a pure line of Sukinda ecorace could be developed which started behaving equally at all the supplied places. This effort with Sukinda ecorace resulted in to the rejuvenation of dying natural treasure of Odisha.

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