

Association of Different Quantitative Traits of Cocoons of Ecoraces Raily of *Antheraea mylitta* Drury with Different Altitudes in its Different Ecopockets

G. S. YADAV¹, G. P. MAHOBIA¹ AND B. C. PRASAD²

¹Regional Tasar Research Station, Jagdalpur 494005, Chhattisgarh, India

²Central Tasar Research & Training Institute, Ranchi 835303, Jharkhand, India

E-mail : yadavdrgs@yahoo.com

Abstract

An attempt was made to assess the morphometric variations in the quantitative traits of cocoons of ecorace Raily of tropical tasar silk insect from its seven eco-pockets presenting different altitudes ranging from 381 to 670 m AMSL. The altitude as independent variable conferred positive association with seven quantitative traits of cocoons as predicted variables. This association remained lowest between altitude and pupal weight and highest between altitude and cocoon volume. The study shows that the weight of cocoon increases along with its volume with increasing altitudes in different eco-pockets of Raily. The cocoon length and breadth with the lowest value of regression coefficients and coefficient of variations indicate that cocoon length and breadth are stable traits as these two have the minimums of deviation from the regression line of all the seven eco-pockets. The intercepts and regression coefficients of the different groups of associates presented different levels of vested prediction. The ecorace Raily shows altitudinal gradients for its voltinism and stability of the voltinism. The vigor of the cocoon traits changes with the altitude of that eco-pocket.

Key words : Eco-race Raily, *Antheraea mylitta*, Cocoon traits, Altitudinal gradients, Regression function.

Raily a natural, sal fed ecorace of tropical tasar silkworm *Antheraea mylitta* Drury (Lepidoptera : Saturniidae), is mainly bivoltine, wild, eurythermic, polyphagous is most important tasar silk producing insect, available naturally in Bastar plateau of Chhattisgarh, India between 17° 45' N to 20° 34' N latitude and 80° 15' E to 82° 01' E with the altitude ranging between 300 to 1200 m AMSL, rainfall 1626.4 mm in 111 rainy days having the maximum temperature of the year 31.01 ± SD 5.80° C and minimum temperature of the year 17.77 ± SD 5.80 C, relative humidity 86.24 ± SD 10.45% as maximum and 49.67 ± SD 20.71 as minimum during the year in dry sub-humid sal forests and moist sub-humid sal forests (1). The ecorace Raily and its association with the aboriginals in Bastar plateau of Chhattisgarh present an important source of earnings to nearly 42,043 tribal (2). The cost of each Raily live cocoon remains Rs 2.60 ± SD 0.14 at Nangoor and Darbha markets of Jagdalpur (2009-10). The Raily natural cocoon changes the socio-economic strata of associates in tasar eco-cosm by conferring more im-

pressive revenue i.e. Rs 10 to 21 crores per annum by collection of natural Raily cocoons from the forests. The ecorace Raily is a population of tropical tasar silk insect, adapted to specific ecological conditions of Bastar plateau, separated with other races geographically. This race is endemic to Bastar plateau as all the ecological requirements of the race are at optimum. This race evinces morpho-metric variations in the quantitative traits of cocoons in its different eco-pockets and adduces different voltinism at different altitudes. It behaves as trivoltine up to 300 m AMSL, bivoltine between the altitudes of 300—600 m AMSL and univoltine above 600 m AMSL. The quantitative traits of cocoons of ecorace Raily of different eco-pockets evince morpho-metric variations due to associated ecological indexes in its different ecological niches. The variation within the population provides a basis on which natural selection can act (3). There are some other specific conditions which influence the genotypes within the population due to migration, mortality or an effect of edge zone where two or

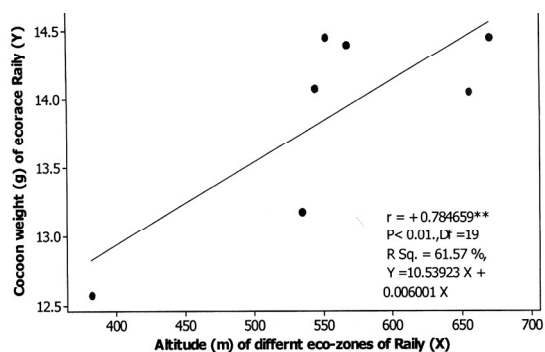


Figure 1. Association between altitude (m) and cocoon weight (g) of Raily.

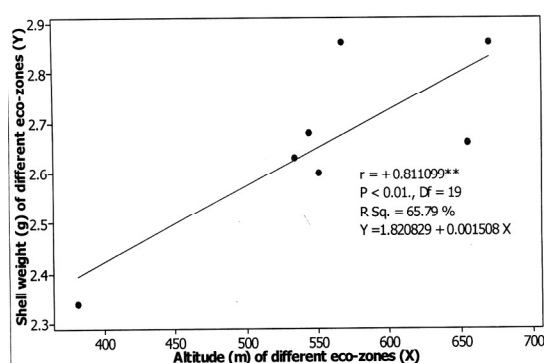


Figure 3. Association between altitude (m) and shell weight (g) of ecorace Raily.

more than two populations meet (3). Increasing altitude may influence the insect communities, population sizes, population densities, seasonal activity periods, life histories and morphology of the insect (4). The developing variation in the body size and population density of *Nicrophorus investigator* (Coleoptera : Silphidae) may be involved in the elevation variation seen in this species (4). The present study adjudicates the morpho-metric variations in the quantitative traits of cocoons of natural population of Raily collected from the different altitudes from its primary centre of diversity from the food plant *Shore robusta* Gaertn.f.

Methods

The experiment was initiated with the nature grown cocoons of ecorace ‘Raily’ collected from the forests of Nangoor (670 m AMSL), Darbha (655 m

AMSL), Tokapal (567 m AMSL), Tongpal (551 m AMSL), Kondagaon (544 m AMSL), Narayanpur (534 m AMSL) and Geedam (381 m AMSL) of Bastar plateau of Chhattisgarh, India. Seven quantitative traits of cocoons viz., cocoon weight in gram (CW), pupa weight in gram (PW), shell weight in gram (SW), shell per cent, cocoon length in cm (CL), cocoon breadth in cm (CB) and cocoon volume in cc (CV) were considered. There were (7 eco-pockets having different altitudes × 3 replications) 21 combinations associated with different altitudes and 100 cocoons selected at random were used per adduced combinations to analyze the different cocoon traits of both the sexes pooled together in the same ratio. The shell % was calculated following the equation :

$$\text{Shell per cent} = \frac{\text{Shell weight of green cocoon (g)}}{\text{Cocoon weight of green cocoon}} \times 100$$

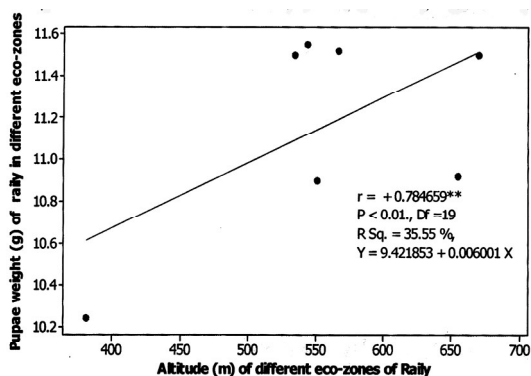


Figure 2. Association between altitude (m) and pupae weight (g) of Raily.

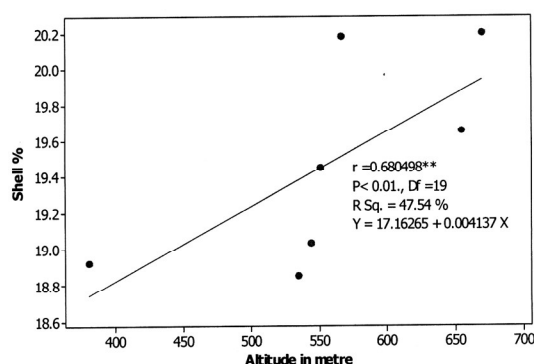


Figure 4. Association between Altitude (m) and shell % of ecorace Raily.

Table 1. Association of different quantitative traits of cocoons of ecorace Raily with different altitudes in its different eco-pockets (mean of three replications).

	Altitude m	CW g	PW g	SW g	Shell %	CL cm	CB cm	CV cc
Nangoor	670	14.45	11.5	2.86	20.2	5.24	3.46	34.86
Darbha	655	14.05	10.92	2.66	19.65	5.1	3.35	32.27
Tokapal	567	14.4	11.52	2.86	20.18	5.24	3.44	33.14
Tongpal	551	14.45	10.9	2.6	19.45	5.15	3.42	32.87
Kondagaon	544	14.08	11.55	2.68	19.03	5.09	3.41	31.61
Narayanpur	534	13.18	11.5	2.63	18.85	5.06	3.39	30.18
Geedam	381	12.58	10.24	2.34	18.92	4.99	3.29	29.41
Mean	557.4285	13.8842	11.1614	2.6614	19.4685	5.1242	3.3942	32.0485
SD	87.9777	0.6728	0.4605	0.1635	0.5278	0.0855	3.0537	1.7098
CV%	15.7827	4.8457	4.1258	6.1433	2.711	1.6686	1.5821	5.335
r (Altitude in meter) vs cocoon raits		0.7846**	0.5962**	0.8110**	0.6895**	0.7061**	0.6545**	0.8152**
P.E. (r)		±0.0980	±0.1643	±0.0872	±0.1337	±0.1278	±0.1457	±0.0855
r / P.E. (r)		8.006**	3.6287NS	9.3004**	5.1570NS	5.5250NS	4.4921NS	9.5345**
t (r)		6.4143**	3.2369**	6.0423**	4.2444**	4.3465**	3.7736**	9.1546**
R2		0.6157	0.3555	0.657881	0.475407	0.498705	0.428361	0.664597
R2 S 100		61.57	35.55	65.79	47.54	49.87	42.83	66.46
Intercept		10.53923	9.421853	1.820829	17.16265	4.740979	3.17168	23.21678
Slope		0.006001	0.003121	0.001508	0.004137	0.000688	0.000399	0.015844
Regression function		Y (Cocoon Weight in gram) = 10.53923 + 0.006001 × (Altitude in Meter)						
		Y (Pupae Weight in gram) = 9.421853 + 0.003121 × (Altitude in meter)						
		Y (Shell Weight in gram) = 1.820829 + 0.001508 × (Altitude in meter)						
		Y (SHELL) % = 17.16265 + 0.004137 × (Altitude in meter)						
		Y (Cocoon Length in cm) Y = 4.740979 + 0.000688 × (Altitude in meter)						
		Y (Cocoon Breadth in cm) = 3.17168 + 0.000399 × (Altitude in meter)						
		Y (Cocoon Volume in CC) = 23.21678 + 0.015844 × (Altitude in meter)						
		NS : Not significant						
		** : Significant at 1% level, Df = 19						

The data were analyzed statistically and are presented (Table 1). Altitudinal variation in the quantitative traits of cocoons for mean, standard deviation, coefficient of variation (%), association (r) between the variables, coefficient of determination (r^2) and regression function were computed following the method of Gomez and Gomez (5). The regression graphs for 7 groups of fairly well associates were calculated following the equation $Y = a + bX$ wherein Y remained as criterion variable and X as predictor variable. The altitudinal control of criterion variable was calculated following the equation $r^2 \times 100$ (6, 7). The significance of coefficient of correlation was tested from Fisher and Yates table for r value to confirm the probability of significance. These values were further tested by the ratio of correlation coefficient (r) and probable error of coefficient of correlation PE (r). The traits which presented the ratio more than 6 were abridged as significant at 1% level; r value was fur-

ther tested by t test for significance of correlation coefficient $t(r)$ and significance of the traits were confirmed with the table values of Fisher and Yates (8).

Results and Discussion

The results conferred positive association between all the seven quantitative traits of cocoon with increase in the altitudes of different eco-pockets of Raily (Table 1). The value of r remained between $r = +0.5962^{**}$ $P < 0.01$ to $r = +0.8152^{**}$ $P < 0.01$, $df = 19$. However, the magnitude of correlation between altitude and pupa weight was lowest among all the 7 traits ($r = +0.5962^{**}$, $P < 0.01$, $df = 19$). This study showed that the weight of cocoon increases along with its volume with increasing altitudes in different eco-pockets of eco-race Raily of *A. mylitta* ($r = +0.7846^{**}$, $P < 0.01$, $df = 19$ for cocoon weight and $r =$

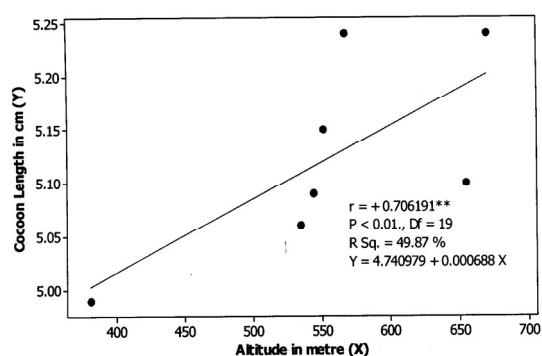


Figure 5. Association between altitude (m) and cocoon length (cm) of Raily.

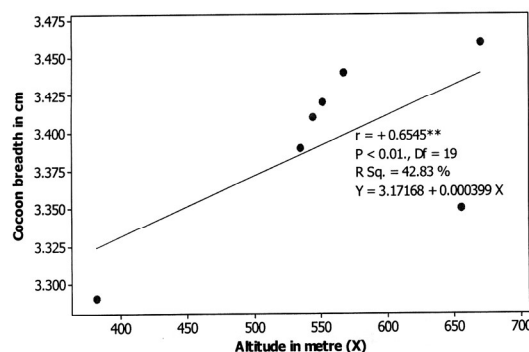


Figure 6. Association between altitude and cocoon breadth of ecorace Raily.

+0.8152**, $P < 0.01$, $df = 19$ for cocoon volume). The shell weight is a part of cocoon weight and has accorded the similar trend. The coefficient of determination ($r^2 \times 100$) explicated that altitude (m) as predictor variable has an associated control of 35.55% on criterion variable pupa weight (g) being the lowest level of prediction and highest control of 66.45% on criterion variable cocoon volume (Figs. 1 to 7). The remaining variations are due to other abiotic and biotic associates of the environment existing in the Raily eco-cosm. The predictor variable (altitude) has more than 50% control on cocoon weight (g), shell weight (g) and cocoon volume (cc) and this functional association in eco-niche of Raily is acceptable (Fig. 1 to 7). The coefficient of determination per cent less than 50 adjudicates contribution of other abiotic and biotic associates are at par to predictor variable.

When $r^2 \times 100$ equals more than 50, it presents the fact that more than 50% points of independent and dependent variables like to remain exactly on or close to the straight line or line of prediction and remaining points of both the associates fluctuates. The regression function of Y on X axis drawn separately for all the seven quantitative traits provides an exact differentiation for the regression constants and slopes (Fig. 1 to 7). The positive slopes in the regression functions show that Y increases (1 to 7 cocoon traits) as X (altitudes in metre) increases and the function runs up hills. All the graphs have presented linear relationship with different magnitudes due to variation in the regression coefficients of bivariate individual groups. The regression coefficient of unity

indicates average stability, greater than one means below average stability and less than one means the genotypes has a greater resistance to the environmental changes and possess average stability (9, 10). In the present study, the cocoon length and breadth have the lowest values for the regression coefficients or slopes. This perfects the fact that cocoon length and breadth are fairly well stable traits and have lowest deviation from the mean of different altitudes of all the seven eco-pockets. The regression points above the trend line (regressed to mean) show superiority of the traits associated with vested altitudes and eco-pockets of ecorace Raily of tropical tasar silk insect. The intercept is a point at which the line of regression intersects the X axis (altitude in metre). This conferred the highest values for cocoon volume and shell percent.

There are evidences from the study of Smith et al. (11) that vegetation of a zone changes with the altitude and there exists a low positive correlation between altitude and canopy cover of that place. Vegetation cover percentage in the high elevation remains significantly higher than the low elevation. This is because of high correlation between precipitation and elevation. The microclimate of the altitude thus has changed the quantitative traits of cocoons of ecorace Raily. Likewise, the vegetation cover percentage also increases with the increasing slopes as the human activities such as cutting and browsing damages the vegetation cover in the low slopes (12). The amount of daily radiation and monthly radiation in slope areas is highest on the south aspect and lowest on

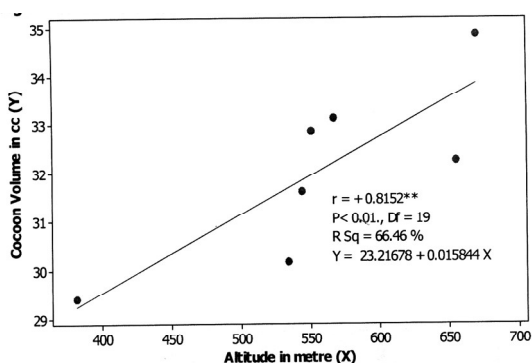


Figure 7. Association between altitudes and cocoon volume of ecorace Raily.

the north aspect (4, 13) as this causes less evapotranspiration and thereby higher water availability. These are the other abiotic and biotic associates which contribute substantially in implied way in the altitudinal variation in the cocoon traits of ecorace Raily of *A. mylitta*.

The population of ecorace Raily of *A. mylitta* adapted to seven different ecopockets presents altitudinal variations in the quantitative traits of cocoons. The population of ecorace Raily adduces altitudinal gradients (10) in voltinism. It behaves trivoltine below 300 m AMSL, bivoltine between 300—600 m AMSL. This population above 600 m AMSL intercedes and induces flexible univoltinism. The value of quantitative traits of cocoon increases with decreasing voltinism. Contrary to this the value of quantitative traits of cocoons increases with increasing altitudes. This finding is in close resemblance with the findings of Yadav et al. (3) who adjudicated latitudinal gradients in the voltinism of ecorace Bhandara of tropical tasar silk insect *Antheraea paphia* L. Thus, the voltinism of tropical tasar silk insect changes with increasing altitudes and latitudes of the vested habitats of the ecoraces. This phenotypic flexibility is however complementary to genetic flexibility because a phenotypic flexible group of genotypes may be able to meet the challenges of the environment for adaptation at different altitudes.

References

1. Yadav G. S., G. P. Mahobia, K. V. Shankara Rao and N. Suryanarayana. 2007. Bastar mein Raily utpadan-Sanrakshatmak Javik Prakriyaon Ka Sankhiyak Visheleshan. *Akhil Bartiya Raj Bhansha Takiniki Seminar. Uttaranchal. Vanya Resham Vikash 4* : 227—230 pp.
2. Ahmad S. 2007. Chhattisgarh Rajya mein gramodyog Resham Prabhag ke Madhyam Se gram Udhog ke Sopan, *Rashtriya Tasar Krishi Mela*. 27—28 Feb, Bilaspur, Chhattisgarh, India. 227—230 pp.
3. Yadav G. S., G. P. Mahobia, S. N. Sinhadeo and N. B. Vijayaprakash. 2009. Latitudinal variation in the population of ecoraces of Bhandara of tropical tasar silk insect *Antheraea paphia* L (Lepidoptera : Saturniidae). *Environ. Ecol.* 27 : 1570—1575.
4. Smith R. J., A. Hines, S. Richmond, M. Merrick, A. Drew and F. Rachele. 2000. Altitudinal variation in body size and population density of *Nicrophorus investigator* (Coleoptera : Silphidae)., *Environm. Entom.* 29 : 290—298.
5. Gomez K. A. and A. A. Gomez. 1984. *Statistical procedures for agricultural research.*, 2nd edition. John Wiley and Sons, New York, USA. 187—240 pp.
6. Elhance D. N., V. Elhance and M. P. Vaishya. 1997. *Sankhiyaki Ke Sidhant*. Kitab Mahal, Allahabad. India. 600—700 pp.
7. Chandel S. R. S. 2009. *A hand book of agricultural statistics*. Achal Prakashan Mandir, Pandu Nagar, Kanpur, India. 266—327 pp.
8. Fisher R. A. and F. Yates. 1963. *Statistical tables for biological, agricultural and medical research*. Oliver of Boxid. London, UK.
9. Singh B. D. 1993. *Plant breeding principles and methods*. 5th edition. Kalyani Publ., New Delhi, India. 1—107 pp.
10. Yadav G. S., G. P. Mahobia, K. V. S. Rao and N. Suryanarayana. 2008. Conservation of Raily ecorace of tasar silk worm *Antheraea mylitta* D. State Level Workshop on Seric. Management. 24—25 Apr 2008. Bhubaneswar, India. 103—107 pp.
11. Smith M. D., S. L. Ustint, J. B. Adams and A. R. Gillespie. 1990. Vegetation in desert environmental influences on regional abundance. *Remote Sensing of the Environ.* 31 : 27—52.
12. Mohammadi A. 2000. Determining range type and condition using RS and GIS. M.Sc. thesis. ITC, Enschede, The Netherlands.
13. Zuviria M. 1992. *Mapping of agro-climates by integrating topographic meteorologic and land ecological data in a geographic information system*. ITC Publ. No. 14, Enschede. 34—100 pp.