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GENETIC VARIABILITY IN COCOON SHAPE, SIZE AND WEIGHT VARIABLES IN MULTIVOLTINE SILKWORM, *BOMBYX MORI.* L.

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ABSTRACT

Studies on variability estimates, heritability, correlation and path analysis in 56 multivoltine silkworm breeds (*Bombyx mori.* L.) consisting of 46 indigenous and 10 exotics were carried out for cocoon shape, size and weight variables. Wide range of variability for all the characters was observed and the variability was normally distributed except for cocoon volume where it was positively skewed. High heritability coupled with high genetic advance as percentage of mean was observed for cocoon volume and area, rest of the traits exhibited high heritability associated with moderate genetic advance. All the correlations were in positive direction. Cocoon volume and area were significantly associated with other characters. Cocoon width was significantly correlated with cocoon weight and shell weight. Path analysis studies revealed the importance of selection pressure on cocoon width, cocoon volume and shell weight in breeding programme aimed at improving the cocoon weight.

Key Words : Silkworm, variability, cocoon shape, cocoon size, correlation, path analysis

Cocoon weight and few other characters associated with raw silk production have been studied in detail in silkworm owing to commercial importance [1-4]. Cocoon shape and size also related to raw silk production, however, have not attracted much attention of silkworm breeders, particularly in Indian even though it is important from evaluation point of view of silkworm [5].

Hybrid (F1) eggs of silkworm are reared at commercial level which necessitates sex separation of moths prior to emergence. Usually male and female pupa are sorted out based on morphological identification after cutting the cocoons which is time consuming and labour oriented. Semi-automatic machines are in use in many countries developed on the basis of cocoon weight and function with precision when male and female cocoon weights are wider. Nadaka [11] suggested that where cocoon weight is not distinct, efficiency of sex discrimination can certainly be improved by combination of one of the shape variables such as length, area and volume, though each one of them independently are not so effective and thus assume importance for their detail studies. The present investigation has been designed to study variability, correlation and path analysis for cocoon shape, size and weight variables in multivoltine silkworm.

MATERIALS AND METHOD

Fortysix indigenous and ten exotic multivoltine silkworm breeds representing wide range of variability for cocoon shape (Table 1), size and weight were reared and studied during March-April 1995 in randomised block design with two replications at Silkworm and Mulberry Germplasm Station, Hosur (T.N.). The rearing was conducted following standard recommended norms. The worms were restricted to 300 number after third moult in each of the replications. Observations on cocoon length (cm), cocoon width (cm), cocoon area (cm^2), cocoon volume (cm^3), cocoon weight (g) and shell weight (g) were recorded on ten randomly selected male and female cocoons by ascertaining their sex on morphological characteristics of pupa after dissecting the cocoons at one end.

Table 1. Variability for cocoon shape in 56 multivoltine silkworm breeds

S. No.	Cocoon Shape	No. of Breeds	Frequency %
1.	Spatulated with narrow base	11	19.64
2.	Spatulated with broad base	5	8.93
3.	Cylindrical	5	8.93
4.	Constricted	1	1.78
5.	Oval	14	25.00
6.	Elongated oval	20	35.71
	Total	56	100.00

The length and width were measured using Vernier-calipers. Only one breed *C. Nichi* from Japan is characterised with constricted cocoons and hence cocoon width measured by averaging the values from both ends. The area was measured by length × width. The volume of cocoon was calculated using the formulae as suggested by Hariraj *et al.* [7].

Volume of cocoons = $\pi W^2 (3L-W)/12$ where,

L = length of cocoon, W = width of cocoon

Cocoon length and width as cocoon shape, cocoon area and volume as size and cocoon weight and shell weight as weight variables have been referred hereafter as shape, volume and weight variables in the text. The average data was statistically analysed for studying variability, genetic estimates, correlations and path coefficient analysis using computer software package procured from INDOSTAT Services, Hyderabad.

RESULTS AND DISCUSSION

It is evident from Table 2 that the silkworm breeds differ significantly (F-value) among themselves for cocoon shape, size and weight variables and exhibit wide range of variability. The co-efficient of variability (CV%) was highest for cocoon volume and lowest for cocoon length followed by cocoon width and cocoon weight. The traits associated with low coefficient of variability suggest high degree of constancy and heritability. The frequency distribution of cocoon length and shell weight were strongly leptokurtic whereas for cocoon area and volume it was marginally leptokurtic. Leptokurtosis, may arise due to stress borne during development and pooling of such samples [8], indicating that fewer values fell within intermediate regions between mean and tails of the distribution relative to a normal distribution within similar mean and variance [9]. The variability, however, was normally distributed for all the characters, except cocoon volume skewed significantly in positive direction above mean, revealing more number of breeds were width lower cocoon volume and thus reducing the mean volume even when the range was very wide.

Table 2. General statistics on variability in cocoon shape, size and weight variables in 56 multivoltine silkworm

Variables	Lowest	Highest	Kurtosis	Skewness	CV%	F-value
Cocoon Length	2.13	3.96	1.76*	–0.47	9.63	39.60**
Cocoon Width	1.18	2.05	–0.28	0.23	12.36	32.81**
Cocoon Volume	2.78	10.10	1.10	0.82*	26.61	29.77**
Cocoon Area	3.00	7.64	0.81	0.40	16.57	31.66**
Cocoon Weight	0.70	1.24	–0.14	–0.12	12.47	8.39**
Shell Weight	0.08	0.22	1.55*	0.02	16.73	4.19**

** : $p < 0.01$; * : $p < 0.05$

The estimates of genetic parameters (Table 3) indicated that phenotypic coefficient of variation (PCV) was invariably higher than the corresponding genotypic values (GCV). However, the difference was too meagre, except for shell weight revealing that genetic effects were important in the expression of cocoon shape, size and weight and thus selection based on these traits is expected to be effective whereas for shell weight care is needed to account for environmental influences. Estimates of coefficient of variability (%) both at phenotypic and genotypic levels were high for cocoon volume followed by shell weight and cocoon area.

Table 3. G●netic parameters of cocoon shape, size and weight variabiles in 56 multivoltine silkworm

Variables	Mean ± SE	Coeff. of variability (%)		h^2_b	Genetic gain as % of mean
		GCV	PCV		
Cocoon Length	3.24 ± 0.15	9.50	9.97	95.07	24.46
Cocoon Width	1.60 ± 0.03	12.17	12.54	94.08	31.16
Cocoon Volume	5.53 ± 0.27	26.15	27.05	93.50	66.77
Cocoon Area	5.19 ± 0.15	16.29	16.82	93.88	41.68
Cocoon Weight	0.95 ± 0.04	11.71	13.19	78.71	27.42
Shell Weight	0.15 ± 0.01	14.60	18.62	61.49	30.22

h^2_b : broad sense hextability

High estimates of heritability (broad sense) was obtained for all the variables associated with cocoon shape and size whereas cocoon weight variables recorded comparatively moderate heritability values. Similar magnitude of heritability and genetic advance was also reported earlier for cocoon weight and shell weight [10, 11]. High heritability coupled with high genetic advance for cocoon volume and area further ensures that substantial improvement for these traits could be achieved through direct selection. High heritability with moderate genetic advance suggests that improvement in these traits would be more effective by selecting specific combinations followed by intermating among segregants.

Correlation studies (Table 4) revealed that both genotypic and phenotypic estimates were in the same positive direction revealing an inherant association between the character pairs. Cocoon length and width were significantly correlated with cocoon area and volume, but the magnitude of association with width was much higher. Extremely close association between cocoon area and volume was observed and both these traits were correlated significantly with rest of the traits indicating that increase in either cocoon volume or area will influence other traits. Cocoon width on the other hand, was significantly correlated with cocoon weight and shell weight indicating that cocoon weight can be improved by selecting higher width and not lengthy cocoons. Our findings of high positive significant association between cocoon weight and shell weight was in agreement with earlier findings [2, 4, 10, 12].

Table 4. Genotypic (above diagonal) and phenotypic correlation coefficient in 56 multivoltine silkworm

Characters	Cocoon length	Cocoon width	Cocoon volume	Cocoon area	Cocoon weight	Shell weight
Cocoon length	-	0.102	0.450**	0.646**	0.144	0.289*
Cocoon width	0.112	-	0.903**	0.823**	0.451**	0.323*
Cocoon volume	0.504**	0.903**	-	0.982**	0.437**	0.404**
Cocoon area	0.648**	0.826**	0.982**	-	0.421**	0.419**
Cocoon weight	0.113	0.373**	0.353**	0.342**	-	0.663**
Shell weight	0.204	0.220	0.276*	0.287*	0.616**	-

** : $p < 0.01$; * : $p < 0.05$

The quality of silkworm breeds is determined in terms of their cocoon weight followed by shell weight as these traits have direct bearing on raw silk production. Shell weight is a component within the cocoon weight. Thus, direct and indirect effects were estimated of rest of the five traits on cocoon weight (Table 5). The results showed that all the traits except, cocoon area had direct positive effects on cocoon weight, cocoon width being the highest. Comparatively the direct contribution of cocoon length was slightly higher than cocoon volume and shell weight. All the indirect effects of cocoon length, cocoon width, cocoon volume and shell weight on cocoon weight through cocoon area were negative. Though cocoon length did not show significant correlation with cocoon weight it had direct positive effect and indirect effects via cocoon volume, cocoon width and shell weight. Similarly, high indirect effects of cocoon width via cocoon volume followed by cocoon length and shell weight was noticed. Moderately significant correlation coefficients of cocoon volume and shell weight with cocoon weight are mainly due to their high positive

Table 5. Direct and indirect effects of five components on cocoon weight in 56 multivoltine silkworm

Characters	Cocoon length	Cocoon width	Cocoon volume	Cocoon area	Shell weight
Cocoon length	**2.107**	0.289	0.693	–3.084	0.142
Cocoon width	0.223	**2.748**	1.246	–3.924	0.158
Cocoon volume	1.048	2.443	**1.426**	–4.677	0.197
Cocoon area	1.352	2.229	1.355	**–4.719**	0.204
Shell weight	0.499	0.720	0.458	–1.638	**0.624**

bold figures are direct effects

indirect effects through cocoon width and cocoon length besides the direct effect. High, direct effect of shell weight on cocoon weight was realised earlier in multivoltine silkworm [4]. Contrary to its positive association, high negative direct effect of cocoon area suggesting that while selecting a strain importance should be given to rest of the parameters under study.

There are not many published literature in silkworm on path analysis considering the cocoon shape, size and weight variables. The results drawn in the present investigation lead to the conclusion that while selecting in breeding programmes aimed at improving the cocoon weight, the component characters like cocoon width, cocoon volume and shell weight should be given due to importance for their respective positive association as well as direct contribution towards cocoon weight.

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