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[Short Communication]

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Some Observations on Phenotypic Variations in Mulberry Silkworm, *Bombyx mori* L.

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Kolar gold (PM × CSR2) is the most popular cross breed of India, especially in Karnataka. During January - February 2004 we observed several phenotypic variations leading to poor survival. Though occurrence of morphologically abnormal individuals is common, the extent of occurrence in the present report was on the higher side (upto 6 percent). It is unwarranted and not desirable in commercial silkworm rearing. The variations exhibited might be due to change in the environmental conditions like incubation temperature during embryonic stage or spontaneous mutation resulting out of environmental stress.

Key words: Phenotypic variations, *Bombyx mori* L., Larva, Pupa, Moth

Introduction

Since ancient times man has been rearing the domestic silkworm, during this long period there would have been frequent mutations, most of which might have remained unnoticed. Spontaneous mutations occur infrequently (one in million) although the observed frequencies vary from gene to gene, generation to generation, year to year and more and more new mutation arise either similar to the preceding ones or completely new. The silkworm *Bombyx mori* L. has (2n = 56) mutated from *Bombyx mandarina* L. (2n = 54) (Aruga 1994). According to Doira (1978), E-group alleles act in embryonic development and cause asymmetric fusion of segments, repetition and/or disappearance of markings, appendages and abnormalities of reproductive organs. Most of them are lethal as embryos in the homozygous state. Heterozygotes between two different alleles tend to show additive, exaggerated or diminished manifestations. Most mutations are deleterious but there are undoubtedly some that do not reduce viability. However, it is difficult to conclude whether the phenotypic variations are the cause of mutant genes or phenocopies (Gardner, 1909). In this report, we are recording different types of morphologically abnormalities phenotypic variations in PM × CSR2 that occurred naturally during different stages.

Materials and Methods

Disease free layings were procured from Government grainage, Rayapur, Karnataka, India. Silkworms were reared as per standard rearing techniques. Observations were recorded on larval, cocoon and silk traits by following standard procedures. Food consumption studies were carried out to compare the feeding between distorted and normal larvae during 5th instar for 4 days. Every day known quantity of leaves were provided to the two sets. Daily after bed cleaning the left over food material was separated from the fecal matter and the weight of both fecal matter and left over food material was recorded. Loss in weight was calculated by keeping same quantity of leaves at room temperature for 24 hrs. Actual leaf consumed and ingested was calculated as follows

a. Leaf consumed (g) = Initial weight of leaf fed − Weight of unconsumed leaves + Moisture loss in initial weight
b. Weight of food utilized (g) = Weight of food consumed − Weight of feces
c. Co-efficient of food utilization = (Weight of food utilized ÷ Weight of food consumed) × 100.

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Results

Phenotypic abnormalities recorded during different stages of *Bombyx mori* L. are as follows.

Larva

The monstrosities mainly concentrated in the abdominal region. Abdominal region showed improper segmentation, puffing, fusion and twisting. The prolegs showed transposition degeneration of 1^{st} pair, reduction (1 to 3 pairs) and addition (one pair) particularly on 5^{th} abdominal segment. The abdominal spiracles were located either below or above the normal position, reduction in number of spiracles was observed either at one side or both sides up to 3 pairs. The spiracles were of either smaller or bigger than the normal. Dermal protuberances almost resembling caudal horn were noticed either on 6^{th} (pleural) or 9^{th} (mid dorsal line) or on both 6^{th} and 9^{th} (pleural/mid dorsal line) abdominal segments. Majority of such larvae had 3 normal moults, but had difficulty during 4^{th} moult leading to death (Fig. 1). Further, Some of the larvae failed to pupate.

Cocoon

The larvae showing morphological variations constructed cocoons of abnormal size and shape. It was interesting to note that such larvae produced more double cocoons inspite of providing normal mounting space (Fig. 2).

Pupa

The abnormal larvae resulted in larval pupal intermediates *viz.,* incomplete prepupa and pupa. After pupation pupa showed improper segmentation, abnormal size and shape, transposition and variation in number of spiracles (Fig. 2).

Moth

Moths resulting from pupae showing distortions, showed

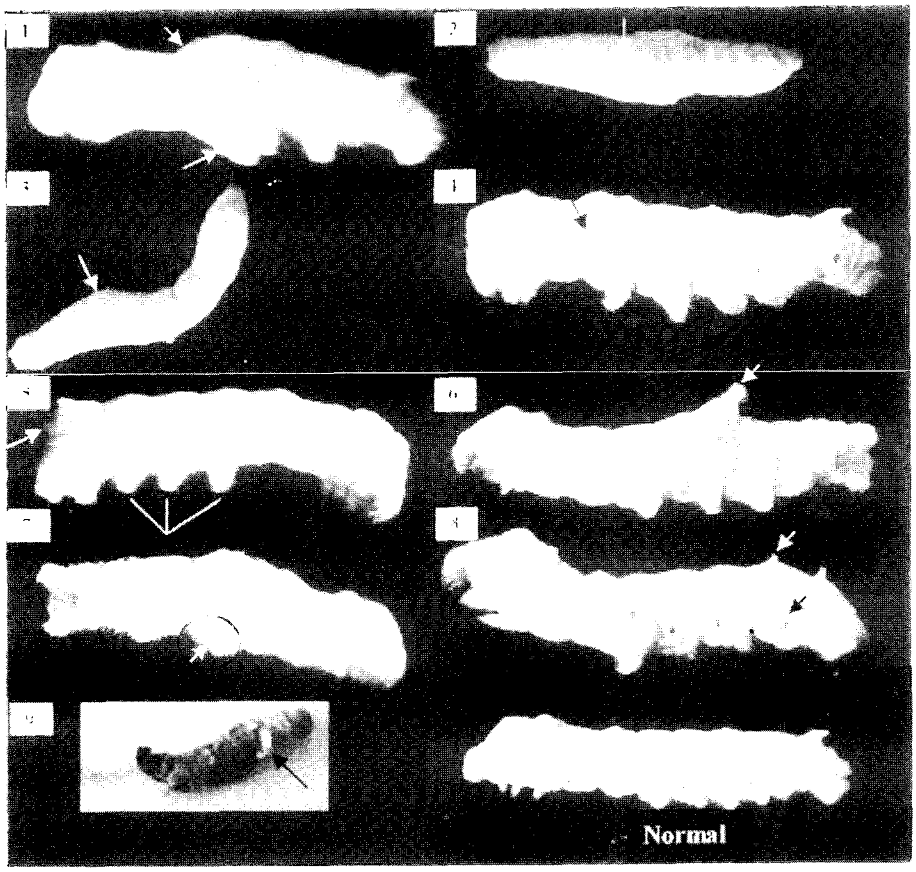

Fig. 1. Phenotypic variations - Larva.
1, Malformed larva. 2, Improper segmentation. 3, Twisting of abdominal segments. 4, Puffing out, fusion of abdominal segments and transposition and reduction of spiracles. 5, Reduction in number of prolegs. 6, Transposition of proleg. 7, Two prolegs fused all along but separated at crochet region. 8, Dermal protuberance (resembling caudal horn) on dorsal as well as lateral sides of the abdomen in addition to abnormal shape, transposition, and reduction in no. of spiracles. 9, Difficulty during 4^{th} moult leading to death.

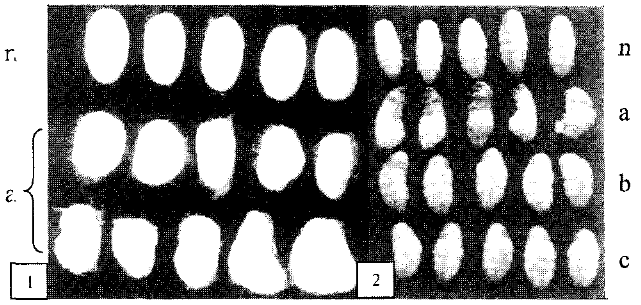

Fig. 2. Phenotypic variations - Cocoon and Pupa.

1. n-Normal
   a-Abnormal

2. n-Normal
   a. Larval pupal intermediates
   b. Abnormal size and shape
   c. Improper segmentation

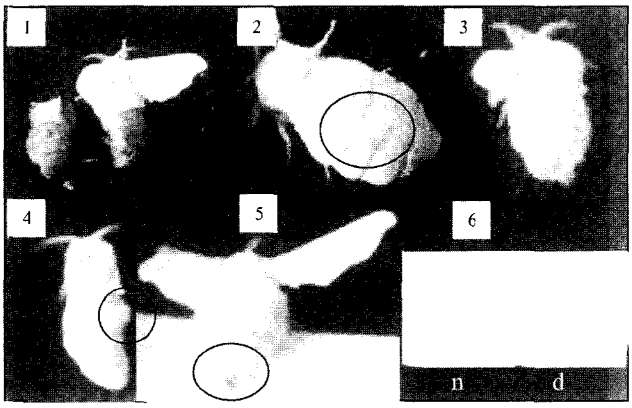

Fig. 3. Phenotypic variations - Adult and Egg.
1, Improper moth eclosion. 2, Improper segmentation. 3, Deformed wings. 4, Deformed moth and Puffing out of abdominal segments. 5, Protrusion of female genetalia. 6, Oviposition pattern in normal (n) and distorted (d) moth.

improper segmentation, deformed wings. Such moths failed to oviposit in characteristic circular fashion and had low fecundity (Fig. 3).

There was no significant difference in food consumption between normal and distorted larvae. The larvae showing morphological variations could complete the life cycle with reduced survival (37.33%) (Fig. 4a). Silk glands of such larvae showed reduced size. Economic traits like cocoon weight (Fig. 4b) and filament weight were affected.

Discussion

In the present study observations were made on various types of morphological abnormalities during different stages. Such larvae had poor survival. Close examination revealed the presence of abnormal number of spiracles.

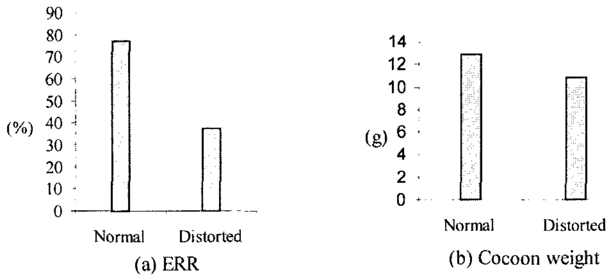

Fig. 4. Effect on (a) ERR and (b) Cocoon weight.

Surviving larvae produced cocoons with lower silk content. This is being reported for the first time in PM × CSR2.

Literature related to present study is meager. However, genes of E-group act in very early stages of embryonic development involving differentiation of body segments frequently causing asymmetric fusion. They are concerned not only with repetition and/or disappearance of markings and appendages, but also with abnormalities of reproductive organs. Further, of the various silkworm stocks maintained at Japan the mutants of translucent skin (larval character) showed difficulty at 4th moult and metamorphosis, dermal protuberances on the sides of crescents and star spots and extra spiracles on 9th abdominal segments in the mutants of body shapes partially justifying the present investigation (Doira, 1978).

Further, Kawaguchi *et al.* (1989) reported that immersion of eggs in N-methyl-N-nitrosourea (MNU) at 0.5 to 24 hrs after the layings resulted in various abnormalities on hatched larvae such as deletion and/or surplus of the legs and so on. It was also recognized that incidence of monstrosities was high in the middle parts of abdominal region from the sixth to the ninth body segment throughout irrespective of the egg age at the onset of MNU treatment as observed in the present study without any mutagenic treatment

The present report fully agrees with Gardner (1909) according to whom, operationally it is impossible to conclude whether the phenotypic variations are the cause of mutant genes or phenocopies or that a particular mutation occurs spontaneously or induced by a mutagenic agent.

However, studies are in progress at our laboratory to findout the cause of such phenotypes through signal transduction pathways to develop breeding programmes using Pure Mysore (female) and CSR2 (male), to reduce the occurrence of morphologically abnormal individuals in silkworm rearing.

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