Available online at
http://currentagriculturetrends.vitalbiotech.org/

ISSN (E): 2583 – 1933

Curr. Agri.Tren.:e- Newsletter, (2025) *4*(10), 62-65

Current Agriculture Trends: e-Newsletter

Article ID: 757

The Science of Silkworm Moulting: Understanding Growth, Development and Successful Rearing."

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Article History
Received: 10.10.2025
Revised: 15.10.2025
Accepted: 20.10.2025

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INTRODUCTION

Silkworm moulting is an important physiological process in the growth and development of the mulberry silkworm, Bombyx mori L. It refers to the periodic shedding of the old cuticle or outer skin to allow the larva to increase in size and continue its development. Since the silkworm's cuticle is relatively rigid and cannot expand sufficiently with body growth, moulting is essential for its normal development from one larval stage to the next.

The larval stage of the silkworm consists of five instars separated by four moults. During each moulting period, the larva generally stops feeding, becomes less active, attaches itself firmly to a suitable surface, and remains in a resting condition known as the moulting or sleeping stage. Before the old cuticle is shed, a new cuticle develops beneath it. The old skin is then cast off, and the larva emerges with a new, soft cuticle that gradually hardens.

Moulting is regulated mainly by hormones, particularly ecdysone, which initiates the moulting process, and juvenile hormone, which influences the nature of the developmental transition. Successful moulting depends on appropriate temperature, relative humidity, ventilation, nutrition, and general rearing hygiene. Adverse environmental conditions, inadequate nutrition, disease, and improper handling may cause incomplete moulting, larval mortality, and reduced cocoon production.

In sericulture, careful management during moulting is essential for maintaining healthy silkworm larvae and achieving better cocoon yield and quality. Therefore, understanding the physiology and environmental requirements of moulting helps farmers adopt scientific rearing practices and improve the productivity of silkworm crops.

Moulting (ecdysis) in the silkworm (*Bombyx mori*) is the periodic shedding of the rigid outer cuticular exoskeleton to permit somatic growth and advancement from one larval instar to the next. Standard commercial silkworm breeds are **tetramoulters**—they moult 4 times during their larval stage, dividing larval life into 5 instars.

1. The Physiological & Hormonal Mechanism

Moulting is governed primarily by the interaction between two major insect hormones:

- **Ecdysone (Moulting Hormone):** Synthesized and secreted by the prothoracic glands (stimulated by Prothoracicotropic Hormone, PTTH, from the brain). Ecdysone initiates apolysis (detachment of the old cuticle from the epidermis) and stimulates the synthesis of a new cuticle.
- **Juvenile Hormone (JH):** Secreted by the *corpora allata*. A high titer of JH alongside ecdysone ensures that the insect moults into another larval instar. When JH levels drop in the final (5th) instar, the subsequent ecdysone surge triggers pupation rather than another larval moult.

Stages of the Moult

1. **Apolysis:** The underlying hypodermal cells detach from the inner surface of the old endocuticle.
2. **Moulting Fluid Secretion:** The hypodermal cells secrete moulting fluid containing enzymes (chitinases and proteinases) that digest up to 90% of the old endocuticle.
3. **New Cuticle Deposition:** A new epicuticle and procuticle are synthesized beneath the digesting layer.
4. **Ecdysis (Shedding):** The remaining exocuticle splits longitudinally along the dorsal ecdysial cleavage line (from the head capsule through the thorax). The larva crawls forward, leaving behind the old skin and the head capsule (*exuviae*).

2. Characteristics Across Instars

Moult Stage	Occurs Between	Approximate Duration	Bed Microclimate Requirements
1st Moult	1st to 2nd Instar	20–24 hours	26–27°C, 70–75% RH
2nd Moult	2nd to 3rd Instar	20–24 hours	26°C, 70% RH
3rd Moult	3rd to 4th Instar	24–28 hours	25–26°C, 65–70% RH
4th Moult	4th to 5th Instar	28–36 hours	24–25°C, 60–65% RH

3. Visual & Behavioral Indicators

- **Entering Moult (Settling):**
  - Worms reduce and then cease feeding.
  - Larvae anchor themselves firmly to the rearing bed using silk spinneret threads.
  - The body appears shiny, translucent, and swollen; the head appears disproportionately small compared to the body.
  - Larvae raise their anterior thorax and head upright at a 45° angle, remaining motionless (often described as being "asleep").

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- **During Moult:**
  - Complete cessation of movement, feeding, and defecation.
  - A new, larger, darker head capsule forms internally just behind the old triangular head capsule.

- **Exiting Moult (Emergence):**
  - The old head capsule drops off, and the larva pushes out of the old crumpled skin.
  - Freshly emerged worms have a soft, wrinkled skin and a pale, enlarged head that rapidly darkens and hardens upon exposure to air.
  - Worms actively begin searching for food.



4. Rearing & Bed Management During Moulting

Improper handling during moulting directly causes irregular growth, missing instars, and disease susceptibility. Standard management follows three key steps:

Entering the Moult

- **Thin Feeding:** As soon as 80–90% of the larvae show signs of settling, provide a final, thin feeding of finely chopped, non-succulent mulberry leaves to avoid leftover wet foliage in the bed.
- **Dry Bedding:** Stop feeding entirely when 95% of the worms settle. Spread the bed slightly to prevent overcrowding, and apply a light dusting of dry slaked lime powder to absorb bed moisture and suppress fungal spores.

During the Moult

- **Zero Disturbance:** Do not disturb, clean, or move the rearing beds. Disrupting the anchored claspers can cause incomplete shedding of the cuticle (*dysecdysis*), leading to death.
- **Ventilation & Low Humidity:** Maintain moderate ventilation to keep the air dry. High relative humidity (above 80%) prevents normal drying and splitting of the old cuticle.

Resuming Feeding (Out of Moult)

- **Patience for Uniformity:** Do not rush feeding when the first few worms emerge. Wait until **90–95% of the population has completely cast off their old skin**.
- **Bed Disinfection:** Before the first post-moult feed, dust an approved bed disinfectant (e.g., *Vijetha*, *Ankush*, or *Resham Jyothi*) through a fine muslin cloth directly over the larvae to prevent muscardine and viral infections.
- **First Feed:** 30 minutes after dusting the bed disinfectant, resume feeding with fresh, high-quality, tender mulberry leaves suited to the new instar.

CONCLUSION

Moulting is an essential physiological process in the growth and development of the mulberry silkworm, Bombyx mori L. During its larval stage, the silkworm undergoes four moults to progress through five larval instars and reach maturity for cocoon formation. Successful moulting depends on proper hormonal regulation, adequate nutrition, suitable temperature and humidity, and hygienic rearing conditions. Careful management during the moulting period, including avoiding unnecessary feeding and handling, maintaining proper ventilation, and protecting larvae from pests and diseases, helps reduce mortality and ensure uniform larval development. Therefore, scientific moulting management is crucial for improving silkworm health, cocoon yield, and silk quality, ultimately contributing to the productivity and profitability of sericulture.