



Climatic Aberrations and Asynchronous Emergence Dynamics in Tropical Tasar Silk Moths (*Antheraea mylitta* D.): Implications on Ovulatory Physiology, Fecundity and Egg Retention

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Tropical tasar sericulture, primarily based on *Antheraea mylitta*, plays a vital role in sustaining tribal livelihoods and forest-based rural economies in India. However, recent climatic irregularities and environmental disturbances have led to the increasing occurrence of unseasonal moth emergence, posing serious threats to reproductive efficiency and seed production. The present article elucidates the impact of abnormal emergence patterns on ovulation, fecundity and egg retention in tropical tasar silk moths. Unseasonal emergence disrupts endocrine regulation, mating synchronization, ovarian maturation, and oviposition behaviour, resulting in reduced egg laying, poor fertilization, and increased retention of unlaidd eggs within the female abdomen. Climatic stressors such as temperature fluctuations, erratic rainfall, altered photoperiod, and ecological degradation further aggravate reproductive abnormalities and decrease the availability of quality disease-free layings (DFLs). The article also highlights the economic implications of reduced seed production and cocoon productivity on tasar farmers and grainage industries. Furthermore, advanced scientific interventions including climate-resilient breeding, precision grainage management, IoT-based environmental monitoring, and molecular reproductive studies are discussed as sustainable strategies for mitigating the adverse effects of unseasonal emergence in tropical tasar sericulture.

Key Words: Tropical Tasar Silkworm (*Antheraea mylitta*), Unseasonal Emergence, Ovulation, Fecundity, Egg Retention

Introduction

Tropical tasar sericulture constitutes one of the most ecologically significant and economically indispensable forest-based cottage industries in India, particularly sustaining the livelihoods of tribal and rural communities inhabiting the forested landscapes of Jharkhand, Chhattisgarh, Odisha, Maharashtra, and the North-Eastern states. The tropical tasar silkworm, *Antheraea mylitta*, renowned for producing lustrous copper-brown silk of exceptional tensile strength and aesthetic elegance, occupies a pivotal position in the non-mulberry silk sector. However, the sustainability of tasar silk production is presently

confronting unprecedented challenges owing to climatic aberrations, ecological instability, and physiological disruptions affecting silkworm reproductive biology (Pravin *et al.*, 2023). Among these emerging concerns, the phenomenon of unseasonal moth emergence has assumed alarming significance in contemporary tasar culture. Traditionally, moth emergence in tasar silkworms is synchronized with favorable environmental cues such as temperature, humidity, photoperiod, and host plant phenology. Nevertheless, recent fluctuations in climatic conditions characterized by erratic rainfall, elevated atmospheric temperatures, prolonged droughts, and altered seasonal rhythms have disrupted the natural emergence calendar of tasar moths. Consequently, premature, delayed, or asynchronous moth emergence is increasingly observed across major tasar-growing regions, thereby adversely affecting reproductive performance, ovulation efficiency, fecundity, and egg-laying behaviour.

Biology of Moth Emergence in Tasar Silkworms

The emergence of adult moths from cocoons represents a highly sophisticated physiological event governed by endocrine regulation, circadian rhythms, and environmental stimuli. In healthy conditions, synchronized moth emergence facilitates successful mating, fertilization, and oviposition. Female moths undergo ovulation shortly after mating, followed by deposition of viable eggs on suitable substrates.

However, unseasonal emergence disturbs this intricate physiological synchronization. Exposure to abnormal climatic stimuli induces hormonal imbalance involving ecdysteroids and juvenile hormones, thereby interfering with ovarian maturation, ovulation, and reproductive metabolism. Such disturbances ultimately impair the reproductive potential of female moths and compromise seed production efficiency (Sunder., 1981).

Causes of Unseasonal Emergence (Reeta Luikham *et al.*, 2024)

- 1. Climatic Fluctuations:** Sudden changes in temperature and humidity profoundly influence pupal metabolism and accelerate or delay moth emergence. Elevated temperatures often stimulate premature emergence before complete reproductive maturation.
- 2. Irregular Rainfall Patterns:** Erratic precipitation and prolonged dry spells alter the microclimatic conditions surrounding tasar cocoons, disrupting diapause termination and emergence synchronization.
- 3. Photoperiodic Disturbances;** Alteration in day length due to seasonal irregularities interferes with neuroendocrinal signaling mechanisms responsible for regulating emergence timing.
- 4. Environmental Stress:** Deforestation, habitat degradation, industrial pollution, and ecological imbalance impose physiological stress upon developing pupae, leading to asynchronous emergence patterns.
- 5. Improper Grainage Management:** Inadequate storage conditions, poor humidity regulation, and mishandling of seed cocoons during grainage operations can also induce abnormal emergence behaviour.

Impact on Ovulation

Ovulation in tasar moths is an endocrine-dependent physiological process requiring proper synchronization between mating and ovarian maturation. Unseasonal emergence often causes incomplete ovulation due to disturbed hormonal secretion and metabolic exhaustion. In several instances, female moths exhibit partial ovarian development, resulting in reduced release of mature ova (Vishaka *et al.*, 2002). Furthermore, asynchronous emergence between male and female moths diminishes mating opportunities, thereby adversely affecting sperm transfer and fertilization efficiency. Physiological stress also weakens muscular contractions necessary for oviposition, causing abnormal retention of eggs within the abdomen.

Reduction in Fecundity

Fecundity, defined as the total number of eggs laid by a female moth, is significantly influenced by environmental stability and physiological fitness. Under unseasonal conditions, tasar moths frequently exhibit:

- Reduced ovarian maturation
- Lower egg production
- Poor mating success
- Increased sterility
- Decreased egg viability

Nutritional deficiencies during larval development, coupled with environmental stress during pupal stages, further exacerbate reproductive decline. Consequently, the total number of disease-free layings (DFLs) available for commercial rearing decreases substantially.

Egg Retention Problem

Egg retention constitutes one of the most severe consequences associated with unseasonal emergence. In this condition, mature eggs remain unlaidd within the abdominal cavity of female moths due to physiological or hormonal dysfunction. Retained eggs eventually undergo degeneration, thereby reducing reproductive efficiency and hatchability.

Major causes of egg retention include:

- Incomplete mating
- Hormonal imbalance
- Weak abdominal musculature
- Environmental stress
- Improper humidity conditions
- Metabolic exhaustion

High levels of egg retention directly diminish seed multiplication capacity and negatively affect the sustainability of tasar sericulture.

Economic Consequences

The economic implications of unseasonal emergence are profoundly detrimental to the tasar industry. Reduced fecundity and increased egg retention result in:

- Decline in seed production
- Reduced availability of healthy layings
- Lower cocoon productivity
- Financial losses to grainage centers
- Decline in farmer income
- Increased cost of seed maintenance

Since tasar sericulture predominantly supports economically marginalized tribal populations, such reproductive failures severely threaten rural livelihood security.

Scientific and Technological Interventions

- 1. Climate-Resilient Breeding:** Development of stress-tolerant and climate-resilient tasar silkworm ecotypes capable of maintaining reproductive stability under fluctuating environments.
- 2. Precision Grainage Management:** Maintenance of optimum temperature and humidity in grainage houses through automated environmental control systems.
- 3. Hormonal and Molecular Studies:** Advanced research on endocrine regulation, ovarian physiology, and reproductive genetics to identify biomarkers associated with abnormal emergence and egg retention.
- 4. IoT and AI-Based Monitoring:** Utilization of digital sensors, machine learning algorithms, and AI-driven prediction models for monitoring emergence patterns and reproductive behaviour in real time.
- 5. Conservation of Forest Ecosystems:** Protection of natural tasar habitats and host plant biodiversity to maintain ecological stability essential for synchronized moth emergence.

Future Perspectives

Future tasar sericulture must integrate climate-smart technologies, molecular breeding strategies, and precision environmental management to combat the increasing prevalence of unseasonal emergence. Emerging biotechnological tools such as genomics, transcriptomics,

CRISPR-based gene editing, and reproductive physiology research may offer transformative solutions for improving ovulation efficiency and reproductive resilience in tasar silkworms. Simultaneously, strengthening farmer awareness, scientific extension services, and eco-restoration programs will be indispensable for ensuring sustainable tasar silk production under changing climatic scenarios.

Conclusion

Unseasonal emergence of tropical tasar silk moths represents a critical physiological and ecological challenge confronting modern tasar sericulture. Climatic irregularities and environmental disturbances profoundly affect reproductive physiology, resulting in impaired ovulation, reduced fecundity, and increased retention of eggs. These abnormalities ultimately compromise seed production, cocoon yield, and rural livelihood sustainability. Therefore, comprehensive multidisciplinary interventions encompassing climate-resilient breeding, advanced grainage technologies, ecological conservation, and digital monitoring systems are urgently required to safeguard the future of tropical tasar sericulture in India.

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